

CMA base cost modelling working paper

Severn Trent response

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1. Severn Trent's consultation response

Thank you for the opportunity to respond to the CMA's updated approach to modelling base costs for the five PR24 appellant companies.

We acknowledge the CMA's attempts to remedy some of the modelling issues in the Provisional Determination (PD) models as identified in our and other parties' responses to the PD consultation. These improvements include:

- Use of Principle Component Analysis (PCA) to arrive at one view of population density thus removing counterintuitive relationships between different density terms.
- The removal of interaction terms involving the wages and energy indexes where an economic or engineering basis cannot be expected.
- Removal of multicollinearity risk in wastewater models from economies of scale drivers and associated population density proxies through the removal of the density variables.
- Correction of the identified lambda error.

From our initial review, the stability of the updated models appears to have improved relative to the PD models.

However, **we remain unconvinced that the CMA's PD or updated models are likely to have identified an appropriate view of efficient base expenditure for water companies – and this is particularly so if such a method were to be used for setting costs for all companies post AMP8 at PR29.** It is for this reason that we are responding to this consultation despite not being involved in the CMA redeterminations or directly impacted by these models or methodological updates.

We raise three substantive concerns on the CMA PD and updated methodology for modelling base costs. These are summarised below and then discussed and evidenced in more detail in subsequent sections.

Issue	Summary concern
1. The models have been developed with an over reliance on data driven techniques – rather than through an informed / detailed understanding of the engineering rationale that drives the costs that we incur.	• We are concerned about over-reliance on data driven techniques, such as LASSO, to select models. But we agree that such methods can be helpful in testing prior expectations. • However, a fundamental limitation of both Ofwat's and the CMA's cost models is that the choice of potential variables was not sufficiently broad to allow the models to work effectively and did not include ones that closely reflect the costs that we incur.
2. Refining models down to one water and one wastewater model is not appropriate and has significantly affected the catchup efficiency challenge.	• No model is perfectly specified, therefore, relying on just one model for water and one model for waste increases the risk of misspecifications (i.e. companies may appear unrealistically efficient or inefficient because the given variables used / not used are particularly forgiving / disadvantageous for a given company's circumstances). • This has the potential to significantly impact on the catch-up challenge applied – as evidenced by the range of UQ catchup efficiencies and company efficiency ranks that would result from each of the individual PR24 wastewater models (see the table in Appendix B).
3. Energy and wages indexes should not be used as explanatory factors in the cost models.	• Using energy and wage indexes as explanatory variables in base cost models is inappropriate because these factors are uncontrollable, volatile and risk biasing efficiency assessments. • Instead, we remain of the view that real price effects are best handled through separate adjustment mechanisms and true-up processes to maintain transparency, fairness and predictability in cost allowances.

Our suggestions for the CMA

We understand that the CMA needs to arrive at a robust view on the efficient level of base expenditure in a tight timescale and without the benefit of being able to collect and refine data of appropriate quality. Therefore, it is not likely that a perfect modelling solution will be found that will fully address the underlying concerns that we raise. Consequently, models will tend to an average configuration where the specific circumstances of particular cost drivers cannot be accounted for. Whilst this might be appropriate if seeking to understand an average level of expenditure, in our view it is not fit for purpose if the requirement is to arrive at the efficient level of expenditure for each company in the data panel.

Given the current limited time remaining in the redetermination process, we suggest the CMA could address the concerns we and other stakeholders have raised by:

- Increasing the number of models being considered by triangulating across a range of plausible but necessarily imperfect models (that may have been informed by data driven techniques such as LASSO). This will help to limit the impact of distorting the catchup efficiency challenge by removing the risk that it is driven by the specific circumstances of given companies rather than a true representation of efficiency.
- Making more use of post model adjustments where companies can demonstrate that their circumstances move away from the average configuration that is assumed within necessarily simplistic / imperfectly specified models. To this end we consider that the CMA has been unrealistic by assuming that a cost assessment solution that has fewer post-modelling adjustments can be justified.

Concern about setting a precedent for understanding efficient costs in future AMP periods

We are concerned that the CMA's approach goes in a different direction to that recommended in the Cunliffe review and so should not, in our view, be used more widely in future price reviews.

The Cunliffe review states that there is a need to make sure cost assessment better reflects the assets and regional circumstances water companies face with a greater input from supervisors rather than an over reliance on statistical techniques. The Cunliffe Review final report stated: *"Ofwat has relied too heavily on a data-driven, econometric approach, and has not taken sufficient account of company-specific conditions and challenges"* (page 193 of [Independent Water Commission Final Report](#)) and *"econometric benchmarked outputs [should be] balanced with company-specific and expert supervisory judgement"* (page 194).

We consider that the CMA's approach moves in the opposite direction to the Cunliffe review's recommendation, which doesn't help provide a consistent message to customers and investors as the sector seeks to rebuild trust and deliver a record level of investment to deliver improvements for customers and the environment.

The CMA's updated base cost models result in total industry base cost allowances for AMP8 that are £3bn or 7% lower than in Ofwat's PR24 final determinations. In our view, this goes in completely the wrong direction given the findings of the Cunliffe review and in the context of companies' AMP7 allowances being insufficient with companies having to overspend by 13.5% for base expenditure in the 2020-25 period (see page 43 of [Ofwat water company performance report 2024-25](#)).

2. Over-reliance on data driven techniques and the need for more detailed consideration of engineering rationale

We are concerned about the over-reliance on data driven techniques, such as LASSO, to select models. These methods can be helpful in testing prior expectations (e.g. whether APH and boosters / length describe similar or separate drivers of cost). But they should not replace the need for deep-rooted engineering and economic rationale.

Relying almost exclusively on data-driven model selection risks decoupling the fundamental need for models to reflect the drivers of costs that companies face. The CMA approach to model development appears to prioritise automated, data-driven selection rather than engagement and consideration of the underlying economic and engineering drivers of cost. As a result, model selection is determined by statistical properties (such as model fit) rather than economic and engineering rationale that have underpinned previous regulatory benchmarking exercises. In our view, this lack of transparency risks weakening the shared understanding between regulators and companies regarding the rationale for cost differentials.

Although the CMA (and Ofwat) describe their potential variables as having engineering rationale, we believe that this needs to be much more robustly considered and linked to the actual costs incurred on the assets and processes that deliver core services to customers. Currently, we think that the consideration of engineering rationale is too high-level and insufficiently tested against the real cost drivers that companies face.

A fundamental limitation of both Ofwat's and the CMA's cost model development approaches is that the choice of potential variables was not sufficiently broad and did not include those that closely reflect the costs we incur. While changes to the econometric method can lead to different models, we think that the resultant updated models remain unable to accurately reflect our cost base. The list of candidate variables from which LASSO is required to select from is overly restricted. The CMA limits this list of candidate variables to include only the variables used by Ofwat in the PR24 FD models and three new (additional) water variables and two new wastewater variables as advanced by the appellant companies.

As shown in Appendix A, the water models selected are actually very similar to the Ofwat PR24 models. This is unsurprising given that the actual choices that LASSO can make when arriving at water models is limited to the following:

- Selection of the PCA derived composite scale variable – i.e. no choice
- Selection of the PCA derived composite density variable (or not)
- Inclusion of the quadratic density term (or not)
- Selection of none, one or two of 'TWD pumping head' and 'booster pumping stations/length'
- Selection of none, one or two of 'construction wages index' and 'DESNZ energy index'

In our opinion, this lack of variables that can appropriately describe our costs has clouded the discussion about the potential benefits of LASSO. Techniques such as LASSO require a sufficiently encompassing range of appropriate variables in order to select the most effective ones for inclusion in a robust model.

The importance of having appropriately specified models is particularly important in the water price review context as the models need to arrive at efficient cost forecasts for all companies in the data panel rather than finding the efficient expenditure of an average company or of the sector as a whole.

By illustration, while LASSO is designed to prioritise variables with strong predictive properties across the whole sample, it may fail to capture cost drivers that are only important in certain companies or circumstances. As a result, the model will likely exclude variables that are statistically weak at the sector level but nonetheless material for a subset of companies, reducing the scope for those companies to demonstrate the need for the legitimate costs that they have incurred. It may also fail to capture cost drivers that may not have been important in the past but are likely to be important in the future (as companies face new challenges driven by climate change and population growth).

Detailing example areas of concern

Assessing engineering rationale based on a detailed understanding of the cost drivers faced

We consider that the assessment of engineering rationale by the CMA has been too superficial. We agree that all of the variables considered have a level of engineering rationale at a high level. However, this does not offer up much comfort that they will be able to effectively describe the costs that have been borne. Costs are fundamentally driven by the assets and processes that we have had to develop and deploy in order to deliver our core services over time. This mismatch is because no consideration is given to the extent to which these high-level variables and proxies are disrupted by other factors that then shape the costs that are incurred.

For example, it is uncontentious to infer that areas of higher population density have the potential to develop larger water treatment assets that will exhibit economies of scale. However, this assumes that:

- equivalent populations being supplied are equally spread or bunched;
- water resources were equally available;
- raw water quality consistent (both spatially and temporally);
- assets will not fail / will not require a level of resilience provision; and
- the circumstances when assets were first planned are as they are today.

In reality, none of these are likely to be true. Therefore, the realised economies of scale will necessarily depart from the opportunity for economies of scale as inferred by a population density proxy.

To provide a more detailed understanding of the inherent engineering rationale of water service provision, we have set out our views in appendix C and D across the cost driver categories. We have then articulated why the Ofwat PR24 and then CMA models are unlikely to adequately capture these cost drivers.

We also summarise the key observations below:

Water

Cost driver Issue	Summary observations
Scale	Costs rise with the volume of water extracted or consumed and the distance that water needs to travel from source to tap. Ofwat's wholesale models use population served (as a proxy for volume) as the sole scale driver and ignore network length explicitly, relying on proxies that mask real cost variations. CMA models use a composite scale variable, whilst logical this needs to be weighted appropriately and will simplify the richness of the individual metrics.
Water resources cost drivers	Models do not currently account for differences in water resources used over and above potential interactions with treatment complexity. E.g. Fundamental differences between surface water and groundwater resources and any pumping undertaken prior to (and including) water treatment.
Water treatment economies of scale	Surface and groundwater treatment both exhibit economies of scale. However, the interaction between the two is complex – groundwater treatment assets are significantly smaller but can have comparative unit costs to larger surface water assets (given equivalent levels of treatment requirement). These cost drivers are currently covered only by a poorly fitting population density proxy due to multiple additional disrupting factors that determine WTW size and unit cost.
Water treatment complexity	The current water treatment complexity bands do not adequately differentiate between installed processes which exhibit significantly differing cost signatures. Therefore, irrespective of the complexity driver used (or not), differences in treatment complexity costs are unlikely to be adequately captured.
Water network density effects	Water network costs can increase at both extremes of population density. • In rural areas due to the dispersion of assets and challenges of effectively operating and maintaining them. • In urban areas due to the congestion of both moving around to operate and maintain the network and the interaction of our network with other underground utility providers (e.g. gas, electricity and communications). Given that metrics are at a company level, this assumes that the population is equally spread. Companies can and do have varying densities across their supply areas. It is the prevalence of these extremes rather than the average that drives costs. None of the density variables on offer, or the PCA composite variable consider this.
Water network complexity	The differential need to pump water in large part due to topographical constraint is a key driver of cost. This is due to the additional assets that need to be maintained and the operational costs to run them. These two aspects are best described through separate variables (Average pumping head and booster pumping stations /length of main). However, Ofwat's models only considered them once at a time. Therefore, it is good to see that the CMA LASSO approach has selected these variables in tandem.

Waste

Model coverage Issue	Summary observations
Scale	Costs rise with hydraulic flow, foul sewage volume and strength (Load), plus distance to treatment. Flow drives hydraulic capacity needs whereas load drives biological treatment requirement. Ofwat's wholesale models use load as the sole scale driver and ignore flow and network length explicitly, relying on proxies that mask real cost variations. The CMA models use a composite scale variable. Whilst logical, this needs to be weighted appropriately and will simplify the richness of the individual metrics.
Surface water flows	High surface water flows increase network and treatment capacity needs. Current metrics rely on broad assumptions about precipitation and permeability. These assumptions oversimplify regional differences, making the proxy inaccurate for companies with unique catchment characteristics.
Wastewater treatment economies of scale	Larger treatment works reduce unit costs, but Ofwat's size bands are coarse and skewed to describing smaller STWs. The CMA includes two variables together, which is logical, but underlying data limitations remain. The coarse banding fails to capture cost variations within large STWs, leading to distorted efficiency signals.

Wastewater treatment complexities	Complexity increases with tighter effluent permits, requiring energy-intensive processes and retrofits. The current proxy used (% load at STWs with ammonia consent <3mg/l) oversimplifies and ignores other permit-driven complexities. Whilst ammonia consents are a good metric to describe treatment requirement; a single proxy cannot reflect diverse treatment requirements or retrofitting challenges across sites.
Wastewater network complexity driven by supplying customers in very dense areas	Wastewater network costs are likely to increase with population density. In urban areas the congestion of both moving around to operate and maintain the network in very urban areas, and the interaction of our network with other underground utility providers (e.g. gas, electricity and communications) is likely to elevate costs. There is no metric for this cost driver included in the CMA models. In contrast to water rural cost drivers are likely to be less prevalent in the sewerage network as networks can be much smaller and simpler given that treatment is often much more localised to the population being drained. However, this will be subject to specific circumstances.
Wastewater network complexities driven by topography	Operating and maintenance costs increase as the amount of pumping increases. This is due to the need to both maintain more assets and operate pumps. This is accounted for in Ofwat's model using a pumping capacity / sewer length. This is a sensible variable given the information that is available. However, wastewater pumping can vary dramatically over short periods of time. Pumping capacity will not account for this, nor levels of redundancy in the system.

The rationale for using multiple explanatory variables for similar cost drivers in the same model

We don't think the CMA models are simpler and more interpretable than the Ofwat PR24 models. The number of Ofwat models is simply a function of the iteration of an agreed model form with substitution of equivalent variables for density and complexity where equivalent metrics exist. The key difference here is that the variables were considered by Ofwat to be equivalent ways of accounting for the same cost driver – rather than an additional variable being needed to describe a different cost driver. Conversely in its PD models, the CMA often included the equivalent variables in the same model. We comment on the rationale for each of these occurrences in the table below.

Variable	Occurrence	Comment
Inclusion of multiple water network complexity drivers in a given model (TWD APH and boosters/length)	- Considered only iteratively in Ofwat FD models - Included together in CMA PD and updated models	- We support the inclusion of TWD and boosters/length together in models. This is because we consider that they are describing different cost drivers. - TWD APH will describe the costs of running pumps e.g. the very material energy costs of pumping water up hill. - Conversely, booster pumping stations / length will more accurately describe the additional capital maintenance requirements that are generated from additional assets rather than the additional head at a given pumping asset.
Inclusion of multiple wastewater economies of scale drivers in a given model (weighted average size band and % load in bands 3 to 6)	- Considered only iteratively in Ofwat FD models - Included together in CMA PD and updated models	- We understand the potential rationale for inclusion of two variables here. - The underlying data is the same for both metrics. But, inclusion of a weighted average variable and a threshold variable can be interpreted as acknowledging the general opportunity for economies of scale across all STW sizes, and an additional cost pressure for operating and maintaining very small STWs.
Inclusion of multiple density drivers in a given model (properties/length, MSOA, LAD from MSOA)	- Considered only iteratively in Ofwat FD models - Included together in CMA PD models	We do not support the inclusion of multiple density variables in the same model.

	• Included holistically through composite density variable in CMA updated model	• Including several density variables in the same model will lead to them attempting to describe the same cost driver (i.e. opportunities for economies of scale / effect of operating in rural and urban areas). This will create a multicollinearity issue. • We note the use of a composite density driver and acknowledge that this will help with multicollinearity issues. However, such instruments will reduce the richness of the primary data. Each separate metric is legitimate with companies responding differently to them according to their circumstance. Acknowledgement of these variations will be lost in a composite variable.
Inclusion of multiple water / waste scale drivers in a given model (length and properties, length and load)	• One scale variable included per model in Ofwat and CMA PD models (acknowledging indirect inclusion of a second scale driver in some models through properties / length driver) • Included holistically through composite scale variable in CMA updated model	• We consider that the scale drivers for sub service models are relatively uncontentious (properties, mains length, load, sewer length). • Where one scale driver is to be used in a wholesale model, it is logical to use the scale driver that best relates to the majority of the costs being modelled. This supports the use of properties and load over length. This is improved further if the other scale driver can be included as a density term (as per models that included properties / length). • The use of a composite scale driver has appeal if the underlying weightings between the two terms are coherent. However, such a method will also lose a level of interpretability.

Selective inclusion of Wages RPEs

We are concerned about the appropriateness of including wages and energy indices as explanatory variables, and discuss this elsewhere in this document. However, the current inclusion of a wages variable in water but not in waste also highlights a separate concern. This a clear demonstration of where the data driven approach has been followed too precisely at the expense of engineering rationale.

The wage variable is selected through the application of LASSO for the water model but not the wastewater model. The logic and rationale for wages real price effects is the same for water as it is for waste (as is the relative proportion of wages costs incurred across the two services). Adherence to engineering and economic rationale should lead to a decision to include or exclude an explanatory variable and then inclusion (or not) in both of the models. However, exclusion in one and not the other suggests that wages cost pressures are a legitimate cost incurred in water but an inefficiency in waste. While one could argue that wages are being captured through high correlation with other variables in waste, this omission fundamentally reduces the confidence that the models adequately capture RPEs and brings into question what the efficiency scores are actually relating to.

3. Refining models down to one, the role of triangulation and the knock-on impact on catchup challenge

Selecting only one model for water and one model for waste – based on very small variances of RMSE values – feels unnecessarily restrictive and leads to a significant impact on the UQ catchup challenge applied. This contrasts with Ofwat’s triangulation approach where equivalent models furnished with alternative, but equally justifiable, variables are run in parallel to moderate the effect of outliers against given model specifications.

All models contain errors, and triangulation between models is a proven way to mitigate the risk of large errors for any given company. This is particularly important in the AMP8 price setting context, where allowances needed be fair and appropriate for all companies, not just to identify the efficiency costs of an “average” company (i.e. without the specific circumstances that each are likely to contain).

As articulated above, we do not agree with the precise specifications of Ofwat’s PR24 FD models. However, they are based on underlying intuitive assumptions about the relationship between explanatory factors and base costs. This makes them more transparent and easier to interpret or critique. The fact that Ofwat uses multiple models, each with different measures of certain cost drivers such as density, does not make the approach less simple or transparent; rather, it strengthens its robustness whilst acknowledging that there is not a perfect universal metric for some of the cost drivers.

By contrast, the CMA’s refining down to just two models, rather than triangulating results across a broader range of diverse models, fails to capture the varied operational characteristics faced by companies. This risks incorrectly attributing legitimate expenditure as inefficiency, meaning that the cost assessment approach is unlikely to deliver a fair allocation of allowances across companies.

Although the CMA’s single-model approach may improve predictive ability relative to historic data, it does so only for an average company. It does not address the heterogeneity of companies or operational characteristics such as demographics, topography, geology and sunk asset history. Whilst this would be appropriate if the requirement was to understand the efficiency of an average company or the sector as a whole, this becomes problematic where the models are seeking to understand the efficient costs of every company (i.e. with the inclusion of all of their specific circumstances). Using multiple models with different variables, on the other hand, allows for a better reflection of individual company circumstances and ensures that allowances are more equitable and representative of real-world conditions.

The impact of refining down to one model on the setting of the catchup efficiency challenge

The number of observations and data that is available to the CMA will mean that it will only be possible to calculate relatively simple econometric models. Consequently, these will necessarily contain an element of error where specific cost drivers are not fully accounted for. Therefore, it is unsurprising that the choice of different explanatory metrics will impact on the efficiency scores of individual companies. This occurs where the chosen variables will more favourably / less favourably reflect the specific circumstances of the company:

- Companies for which the chosen variables better reflect their specific circumstances will show as more efficient (lower efficiency scores)

- Companies for which the chosen variable less well reflect their specific circumstance will show as less efficient (higher efficiency scores)

However, the companies in both of the above circumstances can have the same level of actual cost efficiency. This risk is significantly amplified if one simple model is considered in isolation as there is no opportunity for the favourable or adverse circumstances to be moderated.

As shown in detail in Appendix B, we have reviewed the efficiency score performance for each company for each of the 31 wholesale models that contributed to Ofwat's PR24 base cost modelling assessment and how these were triangulated to arrive at the efficiency score that was eventually used as the catchup efficiency challenge. This shows how much the efficiency ranks – and by extension efficiency scores – of the companies that have set the catchup challenge can vary if individual models are considered.

We make the following summary observations:

	Water	Waste
How the UQ is set and which companies' efficiency scores contribute to it?	- The UQ is defined as the efficiency score of the 5th ranked company. - This is essentially determined by the efficiency scores of the first 5 companies (the 5th company quantifying the challenge, and the top 4 companies placing them in their position).	- The UQ is defined as the efficiency score of the 3.25th ranked company. - This is essentially determined by the efficiency scores of the first 4 companies (the 3rd and 4th companies quantifying the challenge, and the top 2 companies placing them in their positions).
The attributes of the Ofwat UQ catchup challenge	Ofwat's PR24 UQ was set by TMS. - However, across the 31 models TMS rank between 2nd and 12th. In 13 of the 31 models, TMS is outside of the top 5 companies. - SSC and PRT are the top two companies, both companies appearing in the top 5 ranks of 29 of the 31 models. However, in one model SSC appears as the 13th ranked company. - The remaining 3 companies in the top 5 are much more variable. Of the triangulated companies in ranks 3-5 (ANH, AFW and TMS) only 2 of the 31 models include them all in the top 5 ranks. 4 of the 31 models show ANH or AFW ranked in the bottom 3 companies. - Across the 31 models, 6 other companies occupy UQ (top 5) ranking positions.	Ofwat's PR24 UQ was set by YKY and SVH. - However, across the 7 models YKY rank between 1st and 10th (the least efficient). In 4 of the 7 models, YKY is outside of the top 4 companies. - SVH sits within the top 4 companies in only 2 of the 7 models. - WSH and WSX are the top two companies, but they fill the top two spots in only one model. WSX are in the top 4 for all the models, and WSH for 5 of the 7. - Across the 7 models, 3 other companies (TMS, NES and NWT) appear in the top 4 ranks, with TMS appearing the most efficient company in one model.
The attributes of the CMA UQ catchup challenge	The CMA's UQ is set by ANH. This is based on just one model. - ANH appears as the 3rd ranked company in Ofwat's triangulation (with individual model efficiency scores from 2 to 16). - TMS, the UQ company in the Ofwat triangulation drops to the 13th ranked company. - HDD moves into the UQ ranked 3rd having had a triangulation rank of 7 (and individual model ranks ranging from 4th to 13th). - SSC, PRT and AFW remain in the top 5.	The CMA's UQ is set by YKY and ANH. This is based on just one model. - ANH appears as the 7th ranked company in Ofwat's triangulation (with individual model efficiency scores from 3 to 8). - WSH, WSX and YKY remain in the top 4 but change order. - SVH drops to the 6th ranked company.

In conclusion, we consider that the CMA should adopt a triangulation approach using multiple models to ensure allowances reflect diverse company circumstances and avoid distortionary efficiency challenges that can transpire if individual models have considered in isolation (as is the case for the CMA updated models).

4. Accounting for energy and wages RPEs

As per our PD consultation response, we remain of the view that incorporating wages and energy real price effects (RPEs) as explanatory variables in econometric base cost models is inappropriate. Including these factors risks undermining the integrity of benchmarking, introduces bias, and conflicts with established regulatory principles.

Base cost models are designed to capture structural and operational cost drivers such as scale, complexity, and geography. Energy and wage price movements are systemic, volatile macroeconomic forces—rather than company-specific cost drivers. Their inclusion as standard variables in base cost models risks double counting:

- Multiple precedents (including many endorsed by the CMA) use methods that **separate out RPEs** as part of the overall price control process. This means that they are instead dealt with through dedicated adjustment mechanisms (with associated outturn true-ups), not as regressors in the base cost efficiency models themselves.
- Mixing these approaches by **including RPEs as explanatory variables in cost models** would mix structural inefficiency with external price shocks, leading to biased efficiency assessments. It would also create inconsistency and risks undermining transparency in cost assessment.

Companies have minimal control over regional wage levels or global energy prices. Therefore, including uncontrollable factors in base cost models weakens incentives for efficiency and contradicts the principle that cost allowances should incentivise efficiency cost costs that companies can control. Reducing RPEs to an explanatory variable will infer a level of (in)efficiency between the panel observations for which there is very little opportunity to control.

Including Energy and Wages costs pressures as explanatory variables makes them more opaque and introduces unnecessary risk

RPEs are a vital element of price control frameworks, designed to address the uncertainty of forecasting input price movements beyond general inflation when setting ex-ante allowances. Combined with a true-up mechanism to adjust for outturn values of input price indices, RPEs reduce the likelihood of windfall gains or losses for customers and companies, and remove uncontrollable risk from price controls to the benefit of all.

Including real price effect indexes in the base cost models makes the identification and assessment of energy and wages cost pressures more opaque relative to the volume of the cost categories incurred. The models will pick up price pressures interacting with other legitimate variables, making them harder to understand. For example, in the waste model the power units and unit costs realised will be shared between the pumping capacity variable, the Energy RPE index and spread across other variables where power usage is not covered by the pumping capacity variable (e.g. for blowers at Activated Sludge Plants). This will create a confusion of coefficient variances – some for which we have management control and others that we don't.

The inclusion of price pressures in the base cost models also makes them harder to true up for at the end of the price control period because it is harder to calculate what allowances companies have actually been given for energy, wages and plant / machinery / equipment. One of the big improvements at PR24 was the creation of real price effects (RPEs) and true ups for energy and plant / machinery / equipment prices – in addition to the existing PR19 RPE for wages. This is a key risk mitigant for customers, companies and investors. We think there is a strong case for taking price pressures back out of the models and reinstating the true ups.

Why the inclusion of historical Energy RPEs are likely to materially underestimate AMP8 energy costs

Energy prices and wage inflation can be highly volatile as they are subject to external shocks, such as geopolitical events or labour market fluctuations. Incorporating these variables into cost models is likely to introduce noise, reducing model stability and predictability. The dramatic swings in energy cost pressures after the invasion of Ukraine were of international concern necessitating national and international remedies – very much outside of a water company's control. However, these occurred right at the end of the data panel, meaning that they introduce significant noise with limited predictive benefit. This is driven by two reasons:

- Most of the panel length was relatively unaffected by energy cost pressures relative to CPIH.
- The sensitivity of company energy costs to the energy spike was significantly dampened for some companies due to procurement strategies and hedging. This meant that energy spikes impacted companies at different times depending on if / when hedges had been serendipitously made.

Limited occurrence of energy spikes across most of the data panel

As shown in the graph below, for the duration of the cost assessment data panel (starting in 2011-12) up to the invasion of Ukraine of 2022 and its associated energy price spikes, energy prices were largely flat after CPIH inflation had been removed. This means that energy cost pressures over and above CPIH for most of the data panel length were relatively trivial. Consequently, most of the data panel will show very little effect of energy prices (as they were limited for most of the time period) leading to small coefficients. This is in line with Ofwat's decision not to allow an RPE for energy at PR19. It is also corroborated by the closeness of the pre-efficiency modelled outputs for Ofwat's models (that do not include energy pressures) and the CMA models (that do).

Long term electricity price index for the industrial sector including Climate Change Levy, deflated by CPIH



Source: DESNZ

The lag effects of hedging further distort the relationship between energy indexes and energy costs incurred by water companies through the spike

When energy costs substantially increased between 2022 and 2024, many companies were still protected by existing hedged contracts, so many companies were not immediately exposed to these

spikes in prices. The direct correlation between the energy index and water industry costs is weaker during this period and variable by company, for example while energy prices increased by 60% over AMP7, some companies experienced a reduction in power costs between 2020-21 and 2024-25. However, when existing contracts expire, companies are then suddenly exposed to current market rates for new contract periods. These significant step change increases for many companies coincide with the start of AMP8. The Ofwat approach acknowledged and reflected this step change, adopting recommendations that we made as part of our PR24 Draft Determination representations.

5. Appendix A: The variables in the original CMA PD, updated CMA and Ofwat PR24 base water models

In the tables below we summarise the explanatory variables that have been used in the PR24, CMA PD and updated CMA models. This shows the relative similarities between the fundamental construct of the Ofwat PR24 and CMA models.

Summary of the explanatory variables in the CMA water PD and updated models

	Original CMA TWD (1 model)	Original CMA WRP (1 model)	Updated CMA Water wholesale (1 model)
Approx. weight to final view of modelled base costs	50%	50%	100%
Scale	Length of mains	Properties	PCA of properties and length of mains
Density	- LAD from MSOA AND - LAD from MSOA^2 AND - Properties/length - MSOA^2	- LAD from MSOA AND - MSOA^2 AND - Properties/length - Properties/length ^2	- PCA of 3 x density measures AND (PCA of 3 x density measures) ^2
Complexity	- TWD APH AND - Boosters/length	% treated at band 3-6 AND - Weighted average treatment complexity	- TWD APH AND - Boosters/length AND - Weighted average treatment complexity
RPEs	- Construction wages index x length of mains AND - DESNZ energy index x length of mains	DESNZ energy index x length of mains	- Construction wages index AND - DESNZ energy index

Summary of the explanatory variables in the Ofwat water PR24 FD models

	PR24 FD TWD (6 models)	PR24 FD WRP (6 models)	PR24 FD Wholesale (12 models)
Approx. weight to final view of modelled base costs	25%	25%	50%
Scale	Length of mains	Properties	Properties
Density	Either: - LAD from MSOA and ^2 - MSOA and ^2 - Props/length and ^2	Either: - LAD from MSOA and ^2 - MSOA and ^2 - Props/length and ^2	Either: - LAD from MSOA and ^2 - MSOA and ^2 - Props/length and ^2
Complexity	Either: - TWD APH - Boosters/length	Either: - Weighted average treatment complexity % treated at band 3-6	Either: - Weighted average treatment complexity % treated at bad 3-6 AND Either: - TWD APH - Boosters/length
RPEs	None (addressed post model)	None (addressed post model)	None (addressed post model)

Summary of the explanatory variables in the CMA waste PD and updated models

Original CMA TWD (1 model)		Updated CMA Water wholesale (1 model)	
Approx. weight to final view of modelled base costs		100%	100%
Scale	Load	PCA of load received and length of sewers	
Density	- Properties per sewer length AND - LAD from MSOA AND - MSOA		
Economies of Scale	- Weighted average size band AND % size bands 1-3	- Weighted average size band AND % size bands 1-3	
Complexity	- Pumping capacity / length AND % of load treated at STWs with an ammonia consent <3mg/l AND - Urban rainfall / length	- Pumping capacity / length AND % of load treated at STWs with an ammonia consent <3mg/l AND - Urban rainfall / length	
RPEs	DESNZ energy index x pumping capacity	DESNZ energy index	

Summary of the explanatory variables in the Ofwat waste PR24 FD models

PR24 FD SWC (3 models)		PR24 FD SWT (2 models)		PR24 FD WWNP (2 models)
Approx. weight to final view of modelled base costs		25%	25%	50%
Scale	Length of mains	Load received	Load received	
Density	Either: - LAD from MSOA - MSOA - Props/length (given twice the weight of other two)			
Economies of Scale		Either: - Weighted average size band % size bands 1-3	Either: - Weighted average size band % size bands 1-3	
Complexity	- Pumping capacity / length AND - Urban rainfall / length	% of load treated at STWs with an ammonia consent <3mg/l	- Pumping capacity / length AND % of load treated at STWs with an ammonia consent <3mg/l AND - Urban rainfall / length	
RPEs	None (addressed post model)	None (addressed post model)	None (addressed post model)	None (addressed post model)

When comparing the wholesale forms between Ofwat’s PR24 FD models and the CMA’s updated model (above), it is noticeable how similar the models are. With the only changes being as follows:

Variance between Ofwat and CMA updated wholesale water models	Variance between Ofwat and CMA updated wholesale wastewater models
• The use of a composite scale driver of properties and length of mains rather than just properties as the scale driver. • The use of a composite density driver from the three Ofwat variables, and its associated quadratic, rather than the sequential use of each of the density drivers separately. • The inclusion of both TWD APH and boosters/length together rather than in sequence. • The removal of the treatment complexity % treated at band 3-6 WTWs. • The inclusion of wages and energy price indexes as explanatory variables.	• The use of a composite scale driver of load and length of sewers rather than just load as the scale driver. • The inclusion of both Weighted average size band and % size bands 1-3 together rather than in sequence. • The inclusion of an energy price index as an explanatory variable.

Therefore, we can conclude that the fundamental driver of the significant reduction on post catchup efficiency costs is:

- less related to the selection of scale, complexity or economies of scale / density drivers; and
- more a function of **the lack of triangulation of multiple iterations of similar models**, and the **inclusion of RPEs as an explanatory variable** rather than as a post modelling adjustment.

6. Appendix B: Understanding the catchup challenge implications

For both water and waste, if considered before catchup efficiency, Ofwat's and the CMA's estimates of modelled base costs give relatively similar results for forecast base costs. It is only when the catchup challenge is applied that the very large reductions on efficient base expenditure appear. We have explored why this is the case.

The two tables below show the efficiency ranks for each of the Ofwat models and how they were then conflated into one catchup efficiency values through triangulation of the models. We show this by highlighting the ranks of the companies that eventually were considered as the upper quartile companies. This is then compared to the CMA catchup challenge that has been derived from the distribution of the efficiency scores originating from one model.

The following observations are clear to see:

- The companies that form the Ofwat upper quartile after triangulation vary significantly in their efficiency rank from model to model. UQ companies can appear as the least efficient company in both specific water and wastewater models.
- Patterns emerge showing where companies appear to be particularly advantaged or disadvantaged by particular variables or model types. This will likely relate to the extent to which a given variable more closely matches a particular circumstance than this driving costs for a company. This will make particular companies appear more (or less) efficient than they inherently are. This increased range of efficiency will likely lead to larger UQ efficiency assessments if models are considered in isolation.
- In water, HDD is particularly advantaged by the CMA model moving from 7th to 3rd (as it appears by some but not all of the Ofwat models). However, TMS is conversely materially disadvantaged (the benchmark company in the Ofwat triangulation moves to be ranked 12th). The changes in these two companies drive most of the challenge, as evidenced if HDD is removed and the UQ is approximately halved if it is set by SEW which would then become the benchmark.
- In waste, ANH is particularly advantaged by the CMA models moving from 7th to act as part of the UQ benchmark in 4th. Conversely SVH move from 4th to 6th, in part due to the removal of the treatment only models which showed them to be particularly efficient.

The use of composite scale and density drivers and the inclusion of multiple complexity / economies of scale drivers in the CMA models will have helped them to arrive at a similar pre catchup allowance compared to the Ofwat models at an industry level. This is unsurprising as most of the cost drivers across the Ofwat models have been included into the one CMA model in some way. However, the heterogeneity of how these costs are distributed specifically between companies based on their specific circumstances will be lost. Hence the greater variances that drive the more stretching UQ challenge.

Table showing:

- The efficiency ranks of Ofwat’s individual water cost models;
- The efficiency ranks of Ofwat’s triangulated assessment (what determined the PR24 catchup challenge applied i.e. TMS as the 5th company at 0.99);
- The efficiency ranks of the CMA Water model (i.e. ANH at 0.93)

Efficiency score rank	Ofwat PR24 water resources plus treatment models						Ofwat PR24 treated water distribution models						Ofwat PR24 water wholesale models												Ofwat PR24 water triangulation	CMA Water wholesale model
	WRP1	WRP2	WRP3	WRP4	WRP5	WRP6	TWD1	TWD2	TWD3	TWD4	TWD5	TWD6	WW1	WW2	WW3	WW4	WW5	WW6	WW7	WW8	WW9	WW10	WW11	WW12		
1	SSC	SSC	SSC	SSC	SSC	SSC	PRT	PRT	PRT	SWB	SWB	SSC	SSC	SSC	PRT	PRT	PRT	SSC	SSC	SSC	SSC	SSC	SSC	SSC	SSC	SSC
2	ANH	ANH	PRT	ANH	PRT	ANH	SWB	SWB	NWT	SSC	NWT	SWB	PRT	PRT	SSC	SSC	SSC	PRT	ANH	ANH	TMS	TMS	PRT	PRT	PRT	PRT
3	AFW	PRT	ANH	PRT	ANH	PRT	NWT	NWT	SSC	NWT	TMS	PRT	AFW	AFW	AFW	AFW	AFW	AFW	SEW	SEW	PRT	PRT	ANH	ANH	ANH	HDD
4	PRT	AFW	AFW	AFW	AFW	AFW	SVE	TMS	SWB	SVE	PRT	NWT	SVE	ANH	TMS	NWT	HDD	HDD	PRT	PRT	SEW	ANH	HDD	HDD	AFW	AFW
5	SEW	SEW	TMS	TMS	HDD	HDD	SSC	SRN	TMS	TMS	SSC	TMS	NWT	NWT	SVE	BRL	NWT	ANH	TMS	AFW	ANH	SEW	AFW	AFW	TMS	ANH
6	TMS	TMS	SEW	SEW	WSH	BRL	NES	NES	NES	PRT	SVE	SEW	SEW	SEW	NWT	TMS	WSH	NWT	SVE	TMS	AFW	AFW	TMS	SWB	NWT	SEW
7	HDD	HDD	HDD	BRL	TMS	TMS	TMS	YKY	HDD	NES	SEW	NES	ANH	SVE	YKY	SEW	ANH	WSH	NWT	NWT	NWT	NWT	SWB	SEW	HDD	BRL
8	YKY	YKY	SVE	HDD	BRL	WSH	HDD	BRL	AFW	ANH	NES	SVE	YKY	YKY	SEW	SVE	SVE	BRL	AFW	SVE	SVE	SVE	NWT	NWT	SEW	WSH
9	SVE	BRL	BRL	SVE	SEW	SEW	WSH	SVE	SVE	HDD	BRL	HDD	TMS	BRL	BRL	ANH	YKY	SEW	YKY	BRL	SWB	BRL	SEW	TMS	SVE	NWT
10	WSH	SVE	WSH	WSH	SVE	SVE	WSX	WSH	YKY	SES	SRN	ANH	HDD	HDD	HDD	YKY	SEW	SVE	SWB	SWB	BRL	SWB	SVE	BRL	SWB	SWB
11	BRL	WSH	YKY	YKY	YKY	YKY	SRN	WSX	SRN	SEW	ANH	SES	NES	TMS	WSH	HDD	TMS	YKY	NES	NES	NES	NES	WSH	SVE	WSH	SVE
12	NWT	NWT	NWT	NWT	NES	NWT	AFW	HDD	WSH	WSX	SES	AFW	WSH	NES	ANH	WSH	BRL	TMS	BRL	YKY	YKY	YKY	BRL	WSH	BRL	YKY
13	NES	NES	NES	NES	NWT	NES	YKY	SSC	SEW	WSH	HDD	WSH	BRL	WSH	NES	NES	NES	NES	HDD	HDD	HDD	HDD	NES	NES	NES	TMS
14	WSX	WSX	SWB	SWB	SWB	SWB	ANH	SEW	WSX	BRL	YKY	YKY	SWB	SWB	SWB	SWB	SWB	SWB	WSH	WSH	WSH	WSH	YKY	YKY	YKY	NES
15	SWB	SWB	SES	SES	SES	WSX	BRL	AFW	BRL	AFW	WSH	WSX	WSX	WSX	WSX	WSX	WSX	WSX	WSX	WSX	SES	SES	SES	SES	WSX	WSX
16	SES	SES	WSX	WSX	WSX	SES	SEW	ANH	ANH	YKY	WSX	BRL	SES	SRN	SRN	SRN	SES	SES	SES	SES	WSX	WSX	WSX	WSX	SES	SES
17	SRN	SRN	SRN	SRN	SRN	SRN	SES	SES	SES	SRN	AFW	SRN	SRN	SES	SES	SES	SRN	SRN	SRN	SRN	SRN	SRN	SRN	SRN	SRN	SRN

Table showing:

- The efficiency ranks of Ofwat’s individual wastewater cost models;
- The efficiency ranks of Ofwat’s triangulated assessment (what determined the PR24 catchup challenge applied i.e. between YKY and SVH as the 3.25th company at 0.99);
- The efficiency ranks of the CMA Water model (i.e. between YKY and ANH at 0.94)

Efficiency score rank	Ofwat PR24 waste collection models			Ofwat PR24 waste treatment models		Ofwat PR24 waste wholesale models		Ofwat PR24 triangulation	CMA Waste wholesale model
	SWC4	SWC5	SWC6	SWT1	SWT3	WWNP6	WWNP8		
1	WSH	WSX	WSX	TMS	YKY	WSH	WSH	WSX	WSH
2	NES	NWT	NWT	SVH	SVH	WSX	YKY	WSH	WSX
3	WSX	WSH	WSH	WSX	ANH	YKY	WSX	YKY	YKY
4	ANH	ANH	ANH	NES	WSX	TMS	NWT	SVH	ANH
5	NWT	SRN	SRN	YKY	TMS	SVH	SVH	NWT	NWT
6	SRN	SVH	NES	WSH	NWT	NWT	ANH	TMS	SVH
7	SVH	NES	TMS	NWT	NES	ANH	TMS	ANH	TMS
8	YKY	SWB	SVH	ANH	WSH	NES	NES	NES	NES
9	TMS	TMS	YKY	SWB	SWB	SRN	SRN	SRN	SRN
10	SWB	YKY	SWB	SRN	SRN	SWB	SWB	SWB	SWB

7. Appendix C: Water cost driver expectations and misspecifications

Cost driver category	Expectations for our cost base	Issues with Ofwat model coverage (as articulated in various PR24 consultations)	Issues with CMA model coverage
Scale	Costs will increase with the volume of water abstracted / treated / consumed. Costs will also increase as the asset base increases e.g. as distance that water has to travel from source to tap increases.	• Uncontentious scale drivers for Water Resources Plus (properties services proxying for water volume) and Treated Water Distribution models (length of network). • Properties selected as scale driver for wholesale models. Given a straight choice, this is justified given that treatment costs are typically larger than network. The use of a treatment dominated scale driver is partly mitigated where a properties / length density driver is used (below). But other wholesale models might over or under account for the relative size of the network. • Consideration of properties rather than volume consumed assumes that PCC is equal and does not reflect differences in industrial/commercial usage.	• Potential benefits from PCA which selecting the scale driver for a wholesale model, but only if the relative weighting is appropriate.
Water resources / raw water cost drivers	Abstracting water from the environment from reservoirs, rivers or groundwater aquifers will have very different cost signatures.	• No consideration given to different water resources assets (other than any knock-on impact on raw water quality – which assumes that all sources of equivalent raw water quality characteristics). • No consideration of raw water pumping (this can be significantly distortionary as material pumping can be before (i.e. raw water) or after treatment (i.e. in the treated water distribution network). We have examples of both configurations (WTWs proximal to resource and distal to demand; and WTWs distal to resources and proximal to demand)	• As per Ofwat model coverage issues. Models do not account for these differences in any meaningful way.
Water treatment economies of scale	Unit costs reduce as treatment works increase in size due to opportunities for economies of scale in manpower, procurement and maintenance provision. Noting that economies of scale at surface water and groundwater treatment assets should be considered separately	• Accounted for by a proxy using Density and Density^2 only which don't closely reflect WTW size. Population density is one of many contributing factors to the sizing of WTWs – hence it is a poor proxy. • The assumed non-linear U-shaped relationship between cost and density acknowledged in water networks is much less justified or visible in water treatment assets. It is not clear why economies of scale should reverse at very large sizes as proxied by high densities. Our largest WTW that supplies the Birmingham conurbation is one of the most efficient. Consequently, very few companies appear to the right of the inflection point of the U curve in the WRP models. • Considering the opportunity for treatment economies of scale at a company average level is also misleading. The distribution of WTW sizes across a company can vary dramatically (with their associated cost pressures) despite having a similar company average value. • The very different attributes of surface and ground water treatment are not considered. Whilst both exhibit economies of scale (i.e. large surface water treatment sites have lower unit costs all else equal, as do large groundwater treatment sites. However, this is not clear when considered together – the largest groundwater sites can show similar unit costs to the largest surface water sites despite being significantly smaller. This is a major impediment to using a more legitimate measure of WTW size rather than a density proxy.	• Whilst the use of principal component analysis (PCA) to arrive at one density variable may help to simplify model selection and remove antagonistic coefficients; it does not change the fundamental misspecification issues identified by using density as a high-level proxy for water treatment economies of scale.
Water treatment complexities	Unit costs will increase as the complexity of treatment increases. This will mostly be driven by the raw water quality and associated drinking water quality requirements. This is driven by increased power and chemical usage, more complex maintenance requirements (or provision of assets that can mitigate the effects of water quality spikes such as bankside storage).	• Ofwat's models make a choice between two drivers that are built up from Ofwat WTW complexity grades. Whilst this appears logical, we do not consider that the definitions of these complexity grades adequately describe the range of treatment complexity costs that we incur. • Our WTW cost data shows a range of operational and maintenance unit costs across our asset base. However, most of our surface WTWs fall within one complexity band. Our analysis shows that there is more unit cost variance within this band than across the other complexity bands. • Conversely, the banding of supplementary groundwater processes appear to give a misleading view of the cost drivers incurred (e.g. the categorisation of UV treatment suggests higher unit costs than we typically see in our own data). • Consequently, the complexity bands essentially suggest that our WTW unit costs are largely the same for WTW's of a similar size – our analysis shows that this is not the case. • Ofwat's use of the threshold between complexity band 2 and 3, essentially removes all surface water treatment cost differentiation. This is largely because coagulation and flocculation as considered separately despite the processes being fundamentally integrated (we are not aware of any example where a surface WTW has one without the other). This means that the complexity band 2 to 3 threshold is describing just a shrinking subset of groundwater treatment sites that do not have any supplementary treatment processes added.	• The CMA relies on a weighted average WTW complexity band value only. Whilst this potentially has greater ability to describe variations in WTW unit costs driven by treatment complexity, it does not address the fundamental concern that the treatment complexity bands are not a good proxy for the complexity relative costs that we incur. • Consequently, it is not likely that any configuration of this data is likely lead to a robust coverage of this cost distribution.
Water network relative size and dispersion	Companies that have a longer transport distance from source to tap for a given volume of water abstracted / treated / consumed will have increased operational and maintenance costs. This is particularly exemplified in very rural areas.	• Ofwat's models account for both this pressure (i) associated with relative network size (at its extreme illustrated by supplying rural areas) and (ii) the complexity driver associated with supply in dense urban areas (described below) though the use of the Density and Density^2 proxies. Taken together, these reflect an assumed U-shaped distribution where costs reduce with density to an inflection point before rising towards higher population densities. • Not an issue in WRP (costs not included in scope of model) or TWD models (directly accounted for in the scale driver) • Where models use properties / length as a density term, the inclusion of properties or length as the scale term essentially means that the model has two scale drivers without the attendant problems of multi-collinearity. We note that this can sometimes lead to counterintuitive circumstances where models are assuming that costs should reduce as network length increases after growth – due to the relative interaction of the scale and density coefficients. • However, for the remaining population density driven models (MSOA and MSOA from LAD), the effect of length relative to volume is much less clear as these values are an imperfect proxy. • Considering the impact of relative network size and dispersion at a company average level is also very misleading. The attributes of individual supply networks can vary dramatically (along with their associated cost pressures) despite having a similar company average value – it is the occurrence of very rural areas that drives costs the most. Consequently, only two companies are assumed to have rurality cost pressures despite very sparce areas of the country being spread across a wide range of companies – these companies are not helped by the fact that they supply higher density areas elsewhere.	• Whilst the use of principal component analysis (PCA) to arrive at one density variable may help to simplify model selection and remove antagonistic coefficients; it does not change the fundamental misspecification issues identified by using density at a company average level to describe the cost drivers that are likely to occur at both extremes of density within companies (and between companies).
Water network complexity driven by supplying customers in very dense areas	Companies that have greater challenges with above and below ground 'congestion' will incur higher unit costs in operating and maintaining their assets	• Ofwat's models account for both this pressure (i) the complexity driver associated with supply in dense urban areas and (ii) those associated with relative network size (at its extreme illustrated by supplying rural areas as described above) though the use of the Density and Density^2 proxies. Taken together, these reflect an assumed U-shaped distribution where costs reduce with density to an inflection point before rising towards higher population densities. • Considering the impact of congestion at a company average level is likely to be very misleading. The attributes of supply networks can vary dramatically with their associated costs pressures despite having a similar company average value. Companies can legitimately have cost drivers from rural and urban areas, but these will be averaged out to the middle of the U shape distribution if one company level value is used.	• Whilst the use of principal component analysis (PCA) to arrive at one density variable may help to simplify model selection and remove antagonistic coefficients; it does not change the fundamental misspecification issues identified by using density at a company average level to describe the cost drivers that are likely to occur at both extremes of density within companies (and between companies).
Water network complexities driven by topography	Operating and maintenance costs increase as the amount of pumping increases. This is due to the need to both maintain more assets and operate pumps (pumping head is a function of volume, height raised and frictional losses)	• Ofwat models legitimately included network complexity variables that relate to operational costs (average pumping costs) and maintenance costs (booster pumping stations / length of mains). • These variables were only used in models one at a time. But the operational and maintenance aspects are separate cost drivers, and each variable will be an imperfect proxy for the other.	• CMA make appropriate use of LASSO to identify that TWD APH and Booster pumping stations / length are sufficiently distinct variables to be included into cost models together. This reinforces our view that they describe separate water network complexity cost drivers.

8. Appendix D: Waste cost driver expectations and misspecifications

Cost driver category	Expectations for our cost base	Issues with Ofwat model coverage (as articulated in various PR24 consultations)	Issues with CMA model coverage
Scale	Costs will increase with the volume and strength (pollutant load) of sewage received for treatment. Flow and Load relate to slightly different drivers of cost. - Flow drives costs associated with physically managing the volume of sewage received (hydraulic capacity). This is complicated by surface water flows which increase volume but not pollutant load. Consequently, assets need to consider both dry weather flow and multiples expected from surface water. - Load received drives the biological treatment capacity required to meet the environmental discharge consents set. Costs also increase as the asset base increases (i.e. more cost is incurred where there is more STW capacity or network length)	- Uncontentious scale drivers for Sewage Treatment (Load received) and Sewage Collection models (length of network). - Load is selected as scale driver for wholesale models. Given a straight choice, this is justified given that treatment costs are typically larger than network. Length cost drivers might be allowed somewhat by the cost allowed though treatment economies of scale drivers (if we assume that small STWs lead to relatively larger networks. This is implicit rather than explicit though).	Potential benefits from PCA which selecting the scale driver for a wholesale model, but only if the relative weighting is appropriate.
Surface water flows	Companies with a greater amount of surface water (either though increased combined sewers, or high levels of regional precipitation) are likely to require a sewerage network with greater capacity and treatment works with greater hydraulic capacity in order to satisfy flow to full treatment requirements. Note that sewer infiltration will also drive treatment hydraulic capacity requirements.	- Construction of the urban rainfall metric requires a series of high-level assumptions relating the variation of precipitation, and assessments of the permeability, across the supply area. - In practice operational cost pressures relating to surface water can be very localised rather than driven at a company level.	As per Ofwat model coverage issues.
Wastewater treatment economies of scale	Unit costs reduce as treatment works increase in size due to opportunities for economies of scale in manpower, procurement and maintenance provision. Sewage treatment asset sizes are typically determined by the size and location of the populations that they are draining, and the characteristics of the receiving watercourses available.	- Accounted for through two metrics that describe the distribution of STWs sizes. - However, size bands are relatively course and strongly skewed to the smaller size bands (the vast majority of the sectors flows are treated at band 5 and 6 STWs which encompass STWs for small provincial towns through to the largest cities (e.g. to effectually drain Birmingham) - When using Weighted average size band: - Unlike in water models, waste coefficients assume that economies of scale are linear and will continue to grow as average STW size increases (accepting that the vast majority of load is sitting in the same size bands). This appears more logical but is likely to be misleading at the extremes. - Considering the opportunity for treatment economies of scale at a company average level is also misleading. The distribution of STW sizes across a company can vary significantly with associated costs pressures despite having a similar company average value. - When considering % of load treated a bands 1-3, this inherently assumes that costs pressures are only seen at the smallest STWs with not further economies of scale at larger STWs where the vast majority of the sectors load is received.	- The CMA has allowed both variables to be used in tandem. This appear to be a logical development as we expect economies of scale to continue as STWs increase, and also acknowledge that additional cost pressures faced are very small works. - However, the inherent coarseness and associated limitations of the underlying data remain. - Note that we understand the removal of population density proxies (that were also allowed into the model in the CMA PD), this likely introduced multicollinearity issues into the model.
Wastewater treatment complexities	Unit costs will increase as the complexity of treatment increases. Complexity can lead to energy intensive secondary and tertiary treatments and increased interstage pumping (driven by site geography and requirements to retrospectively add processes within existing works hydrology). Treatment complexity will mostly be driven by the treated effluent permits than need to be met. These in turn relate to the load received relative to the carrying capacity of the receiving water. This leads to increased power and chemical usage and more complex maintenance requirements.	- Models use % of load being treated at STWs with ammonia consents of <3mg/l as a proxy to describe costs driven by treatment complexity. We agree that ammonia consents are a good proxy indicator of the need to escalate to more complex secondary biological treatments. However, this is necessarily a simplification. Ammonia is one of many treated effluent consents that we might need to meet at a given works these are driven by both the influent and receiving water characteristics. Consents typically tighten as flows increase to ensure that the nutrient carrying capacity of the receiving water is not exceeded. But the requirements for more complex treatments will depend on: - The potential for permits to be met by lower intensity chemical dosing in tandem with existing treatment assets - The ability of existing secondary treatment assets to be retrofitted to more effective biological treatment (e.g. conversion of activated sludge plants to MABR, IFAS or MBBR plants). - The type of tertiary treatment required and the ease of integrating it into the existing treatment flow paths (e.g. the need for interstage pumping). - The availably of land to appropriately site additional processes.	As per Ofwat model coverage issues.
Wastewater network complexity driven by supplying customers in very dense areas	Companies that have greater challenges with above and below ground ‘congestion’ will incur higher unit costs in operating and maintaining their assets	- This is accounted for in Ofwat’s SWC models through three different density drivers. In the waste models a quadratic term is not added. This may be appropriate as the increase in network length in rural area is less distinct than in water. This is because sewerage networks tend to be much more localised as treatment can be effectively delivered close to the collection point which is not feasible for water resources and treatment. Consequently, costs are likely to increase linearly with density rather than at the two extremes as seen in water. - Considering the impact of relative network size and dispersion at a company average level is also misleading. The attributes of individual sewerage networks can vary dramatically along with their associated cost pressures despite having a similar company average value – it is the operation and maintenance of sewerage systems in very urban areas that will drive costs. - In the CMA and Ofwat’s Waste network plus models, no variable is included for this cost driver.	No coverage for the sewerage cost driver in the CMA model.
Wastewater network complexities driven by topography	Operating and maintenance costs increase as the amount of pumping increases. This is due to the need to both maintain more assets and operate pumps	This is accounted for in Ofwat’s model using a pumping capacity / sewer length variable. This is a sensible variable given the information that is available. However, wastewater pumping can vary dramatically over short periods of time. Pumping capacity will not account for this, nor levels of redundancy in the system.	As per Ofwat model coverage issues.