Severn Trent Water’s response to:

Cost assessment for PR19 – a consultation on econometric cost modelling

4 May 2018

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Executive Summary

Establishing robust econometric models is one of the central features of the 2019 Price Review (PR19). It is vitally important to ensuring customers receive the future services that they desire, at an affordable price.

We recognise that developing robust econometric cost models in the water sector is very challenging. Ofwat’s modelling approach, as presented in its consultation, represents a major improvement on that used for PR14. Ofwat has addressed the majority of the concerns raised by the CMA, following the Bristol appeal and also applied a much more transparent process.

Overall these changes have the potential to deliver improvements in the PR19 econometric models. Such improvements would ensure totex baselines better reflect the underlying cost drivers of the sector. This will ultimately benefit customers through more robust cost allowances and efficiency targets.

We consider that there are opportunities for making further improvements to the suite of models by placing even greater emphasis on engineering and operational factors when selecting primary cost drivers. To deliver this result we think it would be helpful to explicitly identify the ‘primary cost drivers’ that the explanatory variables in each model should be seeking to capture.

We recognise that this is not straightforward as costs will be affected by a range of interrelated factors. We have worked with our operational and engineering teams, and in collaboration with Tim Keyworth and Reckon, to produce a framework for assessing whether the set of explanatory variables in a given model can be expected to adequately capture all of the identified ‘primary cost drivers’.

We have used this framework to identify opportunities for further improvements to the models, and to provide a basis for testing how adequately different models capture primary cost drivers. We have not sought to bring to life the many areas we agree with the consultation, such as Ofwat’s comments on its approach to the testing of coefficients and statistical validity. Instead we have identified a small number of changes that we think would further improve the econometric modelling approach. These are set out below

- **Distance water is transported** is a key water cost driver due to the need to maintain a larger network. In Ofwat’s published models half of wholesale water, network plus and treated water distribution models do not capture the distance water has to be transported (no account is taken of network size). We think the 14 models could be substantially improved through the inclusion of a density variable.

- **Congestion** is a key cost driver reflecting the fact that operating and maintaining a network in both extremely rural and urban settings tends to result in higher costs. Half of Ofwat’s published wholesale water and network plus models do not account for congestion issues (through an appropriate population density variable) and no model explicitly accounts for diseconomies of scale in rural areas. We think the models could be improved through the inclusion of an appropriate density variable, which is a strong and clear proxy for urban/congestion issues; and a measure (or proxy) of sparsity.
• **Economies of scale at water treatment works** is a key cost driver. Half of Ofwat’s wholesale water and network plus models (and 6 out of 10 of its water treatment models) do not seek to capture opportunities for economies of scale in water treatment. The other models only partially cover this. A more effective measure, in terms of explanatory power, would be to use asset-based variables.

• **Treatment complexity** is a key cost driver reflecting the fact that companies need to treat water and waste to different standards, reflecting (i) the source of the water; and (ii) the receiving body (ie, discharging into a small river requires greater treatment versus discharging into an ocean). The current models include a highly limited (in terms of explanatory power) set of variables aimed at capturing treatment complexity. The models could be improved by ensuring that a treatment complexity variable is included, and – for the water models - by including variables such as ‘% of water treated at plants in band 4-6’ (as was used by CEPA) which reflect differences in surface water treatment requirements. The waste models could be improved by using broader measures (such as ‘% of load, ammonia consents <3mg’) which better capture differences between companies.

• **Network complexity** – geography and topography strongly drives costs. We are supportive that the network and network plus water models explore two metrics for this. However we think that such metrics should also be included in wholesale models, where a third of the models do not consider this cost driver.

Alongside the inclusion of these primary cost drivers, we have also identified in the suite of models three drivers that we think create perverse incentives, although this could be readily addressed. We discuss each of the drivers and the incentive implications below.

• **Penalising companies that maintain the health of their network** – a number of the models effectively penalise companies that have laid or refurbished more mains compared to the average. All wholesale water models and 75% network plus and treated water distribution models include a variable that provides greater funding for those companies that have not sought to invest in their network. This perverse incentive could be addressed by removing this variable (and putting the onus on companies to show why their forecast level of refurbished/relined activity should be treated as different from an industry average/target level).

• **Penalising companies for water trading** – we recognise the desire for a simplified approach to water resource modelling. However because bulk supply costs effectively include a financing cost element, they are not being compared on a like for like basis with supplies from own resources (where an allowance for financing costs is provided for separately). This anomaly has the potential to discourage companies from exploring further water trades. This could be addressed quite easily by making a notional downward financing cost adjustment to bulk supply costs ahead of resource cost modelling, with this amount then added back post-modelling.
- **Penalising the use of SUDs** – in a number of the waste models the volume of water treated is used as a primary cost driver. In practice the load is what drives costs, as it reflects the nutrients that have to be removed. By focusing on volume the models effectively reward companies that have a greater volume of water coming through their network – which would discourage investment in SUDs and grey water networks. This could be addressed by using an appropriate load measure or number of properties as the key cost driver.

In addition to the above, we attach Ofwat’s response sheet with a range of model-by-model comments and assessments.

We would be more than happy to discuss these points or share additional information with Ofwat to support the PR19 process.
Cost assessment for PR19 – a consultation on econometric cost modelling

A. Introduction

1. Establishing robust econometric models is one of the central features of the 2019 Price Review (PR19). It is vitally important to ensuring customers receive the future services that they desire, at an affordable price.

2. We recognise that developing robust econometric cost models in the water sector is very challenging. Ofwat’s modelling approach, as presented in its consultation, represents a major improvement on that used for PR14. There are however opportunities to make further improvements. We therefore welcome the opportunity to contribute to the consultation on econometric modelling.

3. This consultation comes at an important point in terms of the model development process. Details of 382 econometric models have been provided: 105 Ofwat-developed models, and a further 277 models developed by companies (including the models that we submitted). A number of the Ofwat models address a majority of the concerns raised by the CMA, following the Bristol appeal. It has also developed a much more transparent process. However there are opportunities for making further improvements to the suite of models by placing even greater emphasis on engineering and operational factors when selecting primary cost drivers.

4. Given this, we begin our response by addressing a number of key ‘approach’ questions:

- **What assessment criteria should Ofwat use to judge the adequacy of models, and to guide subsequent model development and refinement?**
  
The consultation document helpfully sets out some of Ofwat’s current thinking on assessment criteria, and we welcome much of that. In our view, these criteria should result in some key checks being applied that do not appear to have been undertaken yet, and are not explicitly referred to at present.

  In **Section B**, we set out what those checks could look like, why they are important, and how they can be applied in practice in the next phase of Ofwat’s work.

- **How should ‘final’ sets of models be selected for each control?**
  
  Considering this now can help highlight why some types of model specification are likely to merit further consideration (because it can help inform what the purposes of including additional models might be).

  In **Section C**, we present a practical approach that Ofwat could use to select sets of models.

- **How should Ofwat use the selected models to determine its view of efficient cost baselines?**
  
  In **Section D**, we set out why we think that an upper quartile approach is likely to be appropriate.
5. The consultation document says that models ‘should include at least one scale driver…and other primary cost drivers’. We think Ofwat could progress this further by specifying what these ‘primary cost drivers’ should be, or what they are aiming to capture for each modelled cost categories. We consider this to be a key step in the assessment process. In Section E, we set out what we consider to be the primary cost drivers that models should be seeking to capture in each of the modelled cost categories.

6. Sections F and G present our summary assessments of the wholesale water and wastewater models respectively. In particular, we set out a small number of areas where we think there are opportunities to enhance Ofwat’s models, and we provide practical suggestions in terms of how this could be achieved. Sections H and I provide our comments on Ofwat’s retail and enhancement modelling respectively.

7. In addition to the above, we attach Ofwat’s response sheet with a range of model-by-model comments and assessments.

8. Alongside this document, we submitted (on May 3 2018) a set of indicative modelling claims as part of our initial cost adjustment submission. That submission includes two types of claim that we would not expect to impact on the model development and selection process:
   - Un-modelled expenditure (UME) claims, which relate to identified enhancement expenditure which we do not consider would be adequately reflected in the historical dataset used for modelling.
   - Ongoing expenditure claims where we consider that future cost and/or volume levels will be substantially different to that for otherwise analogous expenditure included in the historical dataset used for modelling. We have submitted two such claims (relating to future power and new development costs).

9. However, our initial cost adjustment submission also includes three indicative modelling claims. These relate to the potential for using models that inadequately capture cost drivers in such a way that, material aspects of Severn Trent’s efficiently incurred expenditure would be unlikely to be adequately funded without an adjustment. These modelling claims are fundamentally linked to this consultation because the need for them will dependent on how adequately cost drivers are captured within the set of models that Ofwat selects. Our modelling claims have been presented in high level terms given the lack of certainty over the types of models that will eventually be used, and the extent to which the issues we have highlighted in this consultation response will be addressed adequately through model adjustments.

10. Our work reviewing cost models has been supported by Tim Keyworth, Reckon (Nic Francis and Pedro Fernandes) and Arup (Teddy Spasova, and Priyanka Shanbhag). Their involvement has been particularly valuable given previous inputs into both the PR14 development of econometric models and their subsequent review during the Bristol Water CMA Inquiry. We have included comments from Reckon on Ofwat’s cost modelling consultation in an Appendix to this response.

B. How should Ofwat assess, develop and refine models?

11. The consultation document helpfully sets out Ofwat’s current thinking on assessment criteria, and we welcome much of that thinking. We agree, in particular, with the emphasis Ofwat puts
on the use of engineering, operational and economic understanding. Given its significance – we have made this the main focus of our model reviews. We think there are opportunities for Ofwat’s models to further reflect the engineering and operational understanding.

12. The consultation document says that the models ‘should include at least one scale driver…and other primary cost drivers’. We agree with that, but in order to test whether it has been satisfied, it would be a helpful next step to specify what those ‘primary cost drivers’ are, based on engineering, operational and economic understanding. Ofwat’s consultation document, and model commentaries, make some references to different cost drivers, but it would be helpful to address this in a more systematic manner. For example setting out a clear statement of what the set of primary cost drivers is, for each cost area, that Ofwat’s models are trying to capture.

13. By specifying what the primary cost drivers are that the models are seeking to capture, Ofwat could then more readily assess different models. In line with this, we think the following should be central to Ofwat’s approach to developing, refining and selecting models:

1. For each model, the adequacy of primary cost driver coverage should be assessed.

2. For each primary cost driver, the case for using alternative explanatory variables should be assessed.

14. In our view, (a) – the adequacy of primary cost driver coverage - should be a treated as a key part of the model assessment process. We think Ofwat should go further than assessing whether there is a coherent underlying engineering/operational/economic rationale for each explanatory variable included within a model: that test can be met easily by models that are plainly oversimplistic. It is important also to consider the extent to which a given model may ignore cost driver relationships that would be expected, given the implications that such omissions can have for modelling error.

15. We developed (through collaboration with Tim Keyworth and Reckon) and have published a framework for assessing whether the set of explanatory variables in a given model can be expected to adequately capture all of the identified ‘primary cost drivers’. As we set out below, this provides a means of identifying opportunities to improve the current models by filling in the gaps in coverage.

16. In addition to cost driver coverage, it is important to assess how cost drivers are being captured within a model relative to alternative options ((b) above): that is, which explanatory variables should be used to try to capture primary cost drivers? We appreciate that an alternative range of explanatory variables may have been considered, but the basis upon which the current set of variables have been included – and other, unstated variables not included – is largely unclear (or addressed in a very brief manner in model commentaries).

17. Enhancing the transparency of the approach would be useful as this is a highly material matter. This is because using different measures to try to capture the same primary cost driver can result in very different outcomes, something we highlight below for example in relation to water and wastewater treatment complexity. It is important that the potential for these differences in outcome is considered, and that the case for using alternative explanatory variables is explicitly assessed.

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The underlying issue here is that it can be far from straightforward to identify explanatory variables that can be expected to capture primary cost drivers adequately. This may be because of data limitations (lack of data and/or reliability issues), partiality of coverage (such that a variable may capture some aspects of a primary driver but ignore others that are likely to be material), and/or endogeneity (and concerns over the potential for perverse incentives – an issue that Ofwat explicitly recognises in its criteria). Given this, it is important that the modelling process includes an assessment of the advantages and disadvantages of using different variables are, and - where limitations are material – includes the consideration of alternatives.

We note that Ofwat’s modelling has so far focused on the use of an OLS approach for model estimation. We recognise the benefits that can come from this (in particular at this stage of the model development process) in terms of allowing some simplification of approach. We would, though, encourage Ofwat to consider also using a Random Effects approach at a later stage in its modelling work as part of the process of cross-checking the stability of results.

C. How should ‘final’ sets of models be selected?

The use of multiple models can help make it more likely that the gaps identified between modelled and actual costs on the basis of the modelling are broadly reasonable (and not simply the result of model errors and/or data limitations). In line with this, we welcome the efforts Ofwat has been making to explore the use of wide range of different models, and assessing costs at different levels of disaggregation.

Ultimately much will depend on the adequacy of the models within a selected set, and what the ‘balance’ of that overall set looks like. Given this, model selection looks likely to be best approached in two stages:

i) Determining minimum criteria that a model must satisfy for it to be a candidate for inclusion in a final set.

ii) Selecting an appropriate mix from those models remaining after stage (i).

For stage (i), we think that adequacy of cost driver coverage should be key criterion ((a) from Section B above). If a model does not capture one or more primary cost driver in a reasonable manner, then it does not seem likely to be reasonable to include it within a final set, unless other actions are being taken to address the omission (for example, through the approach taken to modelling claims).

‘Hygiene checks’ should also be applied to explanatory variables (as part of (b) from Section B above) such that models should only be treated as candidates for selection if the explanatory variables they include are identified as sufficiently well-founded (in terms of engineering, operational and economic understanding, and data reliability). Stage (i) would also be expected to include a range of checks of the kind Ofwat identifies in its existing assessment criteria, including plausibility and robustness checks on coefficients.

Having identified a candidate set of models for final selection, it will be important to take stock of the extent and forms of differences in approach that the remaining models provide for. For example, some ‘qualifying’ models may be very similarly specified, and it will be important to consider how the inclusion of such models should be weighed against other models where differences are greater (an extreme example of this can be seen by considering Ofwat models.
ONPWW1 and ONPWW4, which appear to be different, but are in practice different ways of presenting the same underlying model specification).

25. When combining models, it may be appropriate to consider the relative confidence that can be put in different models, given the results of the tests from stage (i), and this may be particularly relevant to the use made of some disaggregated modelling. Such modelling has the potential to provide a helpful alternative approach to cost estimation, but the weight put on it should be informed by the model assessment process, and – as above - subject to minimum criteria being met.

26. Our expectation is that a key benefit of using multiple models is likely to be that it can avoid ‘too much’ weight being put on any particular decision with respect to the specification of explanatory variables. This highlights why step (b) from Section B above is important: any particular explanatory variable is unlikely to provide a perfect way of capturing a primary cost driver, and so assessing and - where appropriate – including alternatives can lessen the risks of results being unduly affected by variable specification decisions.
D. How should Ofwat use the selected models to determine its view of efficient cost baselines?

27. Ofwat applied an upper quartile benchmark for cost efficiency in PR14, and an equivalent approach is likely to be appropriate for PR19, providing that – when considered alongside other parts of the control – the benchmark allows efficient companies a reasonable opportunity to earn their cost of capital. The use of a benchmark that is more stringent than upper quartile risks results being driven to an undesirable degree by modelling errors and/or data specification problems and inconsistencies, rather than by genuine observations of more efficient performance.

28. The relevance and significance of modelling accuracy issues to the choice of benchmark was highlighted by the Competition Commission in its Northern Ireland Electricity Inquiry, and by the Competition and Markets Authority in its Bristol Water Report, when noting that: ‘The effect of modelling error and limitations will tend to mean that an upper quartile benchmark will require levels of efficiency that are, in practice, greater than upper quartile’.

29. Improvements in modelling approach can be expected to materially lessen the extent to which bespoke special cost factor claims are likely to be required to offset underlying limitations in the modelling process. However, modelling errors and limitations will inevitably remain, however, and will be important that the approach to setting cost benchmarks takes appropriate account of this. As set out above, the use of an upper quartile approach (if appropriately applied) provides a means of applying a stringent challenge while guarding appropriately against the well-recognised risks of ‘going too far’

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2 CC (March 2014) Northern Ireland Electricity Limited Price Determination, Paragraphs 8.135-6
3 CMA (October 2015) Bristol Water plc, Paragraphs 4.219-4.224
E. What are the primary cost drivers that the models should be seeking to capture?

Wholesale water

30. In the document ‘Identifying drivers of water costs’, we identified 11 underlying factors as driving network plus botex. These are presented in Table 1 below, but grouped into three categories of what we refer to here (following the terminology used in Ofwat’s consultation document) of primary cost driver, and one ‘other’ category, which captures factors that may be relevant/material and, if so, may be addressed through the model specification or through an adjustment separate from the model.

Table 1: Identifying primary cost drivers for network plus botex

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<tr>
<th>A. Scale drivers</th>
<th>A1. The distance water has to be transported.</th>
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<td>A2. The number of customers to whom it is distributed.</td>
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<td>A3. The quantity of water that has to/may have to be transported</td>
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<td>B. Network-specific drivers</td>
<td>B1. The geography and topography over which water has to be transported</td>
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<td>B2. Opportunities for Economies of Scale in the transportation of water</td>
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<td>B3. The extent to which transportation activities are affected by ‘congestion’</td>
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<tr>
<td>C. Treatment-specific drivers</td>
<td>C1. Opportunities for the economies of scale in water treatment</td>
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<td></td>
<td>C2. The extent and forms of treatment that are required.</td>
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<tr>
<td>Other potential underlying drivers (not treated as ‘primary’)</td>
<td>Regional differences in relevant input costs</td>
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<td>Service quality variations</td>
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<td>The significance of other customer characteristics</td>
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31. Although developed to describe network plus cost drivers, Table 1 can be unbundled to provide the primary cost drivers for Treated Water Distribution (TWD) and Water Treatment (WT), by combining the scale factors (when relevant) with the appropriate network/treatment-specific drivers. All of the scale drivers might have some relevance for TWD costs, but it is not obvious that the ‘distance’ driver would be relevant to WT costs. This points to the following primary cost drivers:

- For treated water distribution:
  - The distance water has to be transported
  - The number of customers to whom it is distributed to
  - The quantity of water that has to/may have to be transported
  - The geography and topography over which water has to be transported
  - Opportunities for Economies of Scale in the transportation of water
  - The extent to which transportation activities are affected by ‘congestion’

- For water treatment:
  - The number of customers to whom it is distributed to.
  - The quantity of water that has to/may have to be transported.
  - Opportunities for the economies of scale in water treatment.
  - The extent and forms of treatment that are required.

Water resources
32. When developing the set of cost drivers presented in Table 1, we deliberately separated out water resource costs, as doing so removed a material source of complexity and idiosyncrasy. In line with that, it is simply not clear to us that the drivers associated with differences in water resource costs across companies align closely with the drivers of water network plus costs.

33. Water resource costs can be expected to be linked to a range of physical and environmental characteristics that different companies face (which affect resource availability). There are also a range of historic factors (including the terms of long-standing bulk supply agreements) that have a direct and ongoing bearing on water resource costs, and that raise additional complex issues for cost benchmarking.

34. We have been as yet unable to identify an equivalent set of primary cost drivers that look to sufficiently reflect the main factors which might be expected to influence water resource costs. Also our attempts at developing water resource models have had limited success (and we note that this seems to have been a common experience across companies and for Ofwat). In line with this we recognise that a more simplified approach to water resource modelling (of the kind that Ofwat has currently taken) may be pragmatic and proportionate, and our comments below reflect this.

35. At the same time, we would note that if the characteristics of water resources are not being captured (because of complexity, idiosyncrasy, etc.), then the inclusion of water resources in a wider set of costs to be modelled may introduce a significant degree of ‘noise’ into the process. This has implications for the reliance that should be put on model results, and while that ‘noise’ may be relatively diluted when aggregate water wholesale models are being considered, this suggests that significantly more caution may be merited when seeking to use water resources plus models.

**Wholesale wastewater**

36. As we set out in the context to the wholesale and network plus wastewater models that we developed and submitted as part of this consultation, we considered that the primary cost drivers for wastewater as set out in Table 2.

37. In contrast to water modelling, we considered that, while physical, environmental and historical factors will clearly have some relevance to bio-resource costs, those factors were likely to be a much more limited source of ‘noise’ in wholesale cost modelling compared to water resources. Therefore, we saw more applicability to modelling at the wholesale level than compared to the water service.

| A. Scale drivers               | A1. The distance sewage has to be transported (network size). |
| A2. The total nutrient load within sewage to be removed before it can be safely returned to the environment (treatment requirement). |
| B. Network-specific drivers   | B1. Challenges of geography and topography within the network |

Table 2: Identifying primary cost drivers for wholesale and network plus botex
38. Although developed to describe wholesale and network plus cost drivers, Table 2 can be unbundled to provide the primary cost drivers for Sewerage Network and Sewage Treatment by combining the scale factors (when relevant) with the appropriate network/treatment-specific drivers. The bioresources models we submitted previously provided some consideration of cost drivers. We have not repeated that here as the focus of our comments on Ofwat’s bioresources models concern variable choice, and in particular the avoidance of using variables under management control where possible, given the context of evolving bioresources arrangements.

**Retail**

39. In line with our previous submissions on retail modelling, we consider that primary cost drivers for retail can be identified as falling into three categories:
   - Scale (where we have used number of households connected in our modelling)
   - Deprivation – This is important as debt costs represent around 40% of retail expenditure and vary significantly across companies. However, it is also important because ‘Other Opex’ (after debt costs are excluded) will also tend to be higher when the risk of bad debts arising is higher.
   - Other structural factors: we have considered the role of population dispersion here, and extent of metering.

**Capturing primary cost drivers**

40. As we set out in ‘Identifying drivers of water costs’, the above does not imply that each model should have a separate explanatory variable for each of the relevant primary cost drivers. Rather, some cost drivers may be captured indirectly, as some explanatory variables can potentially capture more than one cost driver. For example:
   - The quantity of water that has to/may have to be transported, may be largely captured by a variable aimed at capturing the number of customers (such as number of properties). This makes the assumption that per capita consumption is approximately equal between companies.
   - A density variable can provide a means of capturing an additional scale driver, as it can measure the way in which scale drivers are related: e.g. number of customers per length of main. As is highlighted below, this is important as the relationship between network size and number of customers differs markedly across companies, and these difference can have a
material impact on costs. As well as allowing an additional scale variable to be captured, however, a density variable may also provide a way capturing the effect that ‘congestion’ issues can have in urban areas.
F. Our summary assessment of the wholesale water models

41. This section sets out our review of whether and how each primary cost driver is being captured in Ofwat’s current set of wholesale water models. Below we focus on those specific areas where further improvements could be made to Ofwat’s models:

1. **Distance water is transported** - is a key water cost driver due to the need to maintain a larger network. In Ofwat’s published models half of wholesale water, network plus and treated water distribution models do not capture the distance water has to be transported (no account is taken of network size). We think the 14 models could be substantially improved through the inclusion of a density variable.

2. **Congestion** - is a key cost driver reflecting the fact that operating and maintaining a network in both extremely rural and urban settings tends to result in higher costs. Half of Ofwat’s published wholesale water and network plus models do not account for congestion issues (through an appropriate population density variable) and no model explicitly accounts for dis-economies of scale in rural areas. We think the models could be improved by the inclusion of an appropriate density variable, which is a strong and clear proxy for urban/congestion issues and a measure (or proxy) of sparsity.

3. **Economies of scale** - is a key cost driver. Half of Ofwat’s wholesale water and network plus models (and 6 out of 10 of its water treatment models) do not seek to capture opportunities for economies of scale in water treatment. The other models only partially cover this. A more effective measure, in terms of explanatory power, would be to use asset-based variables.

4. **Treatment complexity** - this key cost driver reflects the fact that companies need to treat water and waste to different standards, reflecting (i) the source of the water; and (ii) the receiving body (ie, discharging into a small river requires greater treatment versus discharge into an ocean). The current models include a highly limited (in terms of explanatory power) set of variables aimed at capturing treatment complexity. The models could be improved by ensuring that a treatment complexity variable is included, and - for the water models - by including variables such as ‘% of water treated at plants in band 4-6’ (as was used by CEPA) which reflect differences in surface water treatment requirements. The waste models could be improved by using broader measures (such as ‘% of load, ammonia consents <3mg’) which better capture differences between companies.

5. **Mains laid or refurbished** - a number of the models effectively penalise companies that have laid or refurbished more mains compared to the average. All wholesale water models and 75% network plus and treated water distribution models include a variable that provides greater funding for those companies that have not sought to invest in their network. This perverse incentive could be addressed by removing this variable (and putting the onus on companies to show why their forecast level of refurbished/relined activity should be treated as different from an industry average/target level).
6. **Network complexity** – geography and topography strongly drives costs. We are supportive that the network and network plus water models explore two metrics for this. However we think that such metrics should also be included in wholesale models, where a third of the models do not consider this cost driver.

7. **Bulk supply costs** - we recognise the desire for a simplified approach to water resource modelling. However because bulk supply costs effectively include a financing cost element, they are not being compared on a like for like basis with supplies from own resources (where an allowance for financing costs is provided for separately). This anomaly has the potential to discourage companies from exploring further water trades. This could be addressed quite easily by making a notional downward financing cost adjustment to bulk supply costs ahead of resource cost modelling, with this amount then added back post-modelling.

42. In line with our earlier comments, these opportunities for improvement focus on the substantive question of the extent to, and manner in which primary cost drivers have been captured in different models.

### Scale drivers

**No account taken of distance/network issues**

Half of Ofwat’s wholesale water, network plus and treated water distribution models simply do not capture the distance water has to be transported (no account is taken of network size). These gaps could be addressed through the inclusion of density variable.

43. Fourteen of Ofwat’s models take no account of the distance that water has to be transported/network size:

- Half of Ofwat’s Treated Water Distribution models take no account of the distance water has to be transported: they take no account of length of main.
- Half of Ofwat’s network plus models take no account of distance/length; and,
- Half of Ofwat’s wholesale water models take no account of distance/length.

44. The underlying engineering/operational/economic logic for distance/length being a primary cost driver in each case would seem to be readily apparent (and underpinned Ofwat’s inclusion of length of mains in its PR14 models). While one might expect some difference in views over how this primary cost driver is best captured in these models, we think the models should seek to capture distance/network size. This is particularly so given the relative scale of network costs, which account for around two thirds of network plus botex.

45. The reason for Ofwat’s approach appears to be the desire to use a different scale variable in half of the models: number of properties. This, in itself, looks to be sensible. But it does not follow that distance/length should be disregarded.

46. For each set of models (treated water distribution, network plus and wholesale water), the other half of the models all include ‘length of main as an explanatory variable and so do capture ‘distance’. And in those models, Ofwat includes a density variable. The reason for including the density variable in these models is explicitly described as follows:
‘This is to account for the fact that a company that serves a larger population per km of mains may incur higher distribution costs.’

The logic here is sensible: if length is used as the scale variable, then Ofwat wants to include a density variable – which measures the relationship between number of properties and length – in order to also capture scale in terms of number of properties.

47. We think the same logic should be applied to the other half of the models where number of properties is used as the scale variable, and where the inclusion of a density variable provides a means of also capturing scale in terms of length (‘to account for the fact that a company...’ with a larger network per property ‘...may incur higher distribution costs’). As set out above, we consider this a major omission that makes the coverage of primary cost drivers in 14 of Ofwat’s models plainly inadequate but which would be readily addressed (OTW1, OTW2, OTW3, OTW4, ONPW1, ONPW2, ONPW3, ONPW4, OWW1, OWW2, OWW3, OWW4, OWW5, OWW6). As was noted above, it should be emphasised that issue here is not that number of properties (rather than length of main) is being used as a scale driver, but that a density measure has not also been included in these models to provide a means of capturing scale in terms of length as well.

**Network-specific primary drivers**

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<th>Non uniform consideration of topographic complexity in the network</th>
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<td>Whilst Ofwat’s network and network plus water models explore two metrics for accounting for network complexity, a third of the water wholesale models take no account of it. We consider that the geography and topography over which water has to be transported is a primary cost driver. Therefore the model suite could be enhanced by including a relevant cost driver.</td>
</tr>
</tbody>
</table>

**The geography and topography over which water has to be transported**

48. We support the underlying position Ofwat has taken to account for network complexity in most of its models. However, this also exposes the deficiencies of the four wholesale models that do not include an appropriate driver.

49. We have also considered the relative suitability of using booster stations or service reservoirs as proxies. Service reservoirs will be linked to the topographic challenges faced, rural areas will likely require more network assets in order to maintain appropriate pressure and continuity of supply (a greater number of relatively smaller service reservoirs). Booster stations have a more direct link to topographic challenges (required in either very flat areas or in areas where the resources are located such that assets need to work against, rather than with, gravity).

50. From a theoretical perspective, we consider that the booster station metric, is more appropriate than the proposed service reservoirs metric. This is because the economies of scale of large service reservoirs is likely to be, in large part, already accounted for assuming an appropriate treatment economies of scale cost driver has been included. However, the relative need for network pumping/booster stations will be largely independent of any measure of dispersion - whilst the number and size of service reservoirs may be a function of population density, the amount of pumping needed to fill them is not.
Congestion issues and opportunities for Economies of Scale in the transportation of water

<table>
<thead>
<tr>
<th>Most models do not adequately account for costs relating to network dispersion (diseconomies of scale or congestion issues)</th>
</tr>
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<tbody>
<tr>
<td>Half of Ofwat’s wholesale water and network plus models do not account for congestion issues or the potential for opportunities to achieve network-related economies of scale to be more limited in more rural areas, as they do not include an appropriate population density variable. Density measures could help to address this gap.</td>
</tr>
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</table>

51. The interaction of costs with the level of rurality / urbanity in which a network sits is complicated and potentially difficult to accurately reflect in models. Engineering logic and regional case studies suggest that operating and maintaining a network in both extremely rural and urban settings will both increase costs. In our own consultation models, we considered that the use of quadratic terms would in part help to allow for this effect. We note that squared terms have not been included in Ofwat’s (or most other companies) models. We suggest that they do merit further consideration. It also stands to reason that quadratic terms would be useful to account for diseconomies of scale at the company level that the smallest companies are likely to face.

52. In our framework document, we considered that the issue may be better considered as two primary cost drivers; those relating to congestion (driving costs up in urban areas) and diseconomies of scale (driving costs up in rural areas). On this basis, separate drivers can be included; removing the need to account for a U shaped distribution. We consider that population density is a strong and clear proxy for urban/congestion issues and a measure (or proxy) of sparsity could then account rurality issues. Given the potential importance the explaining these primary cost drivers, we think 14 of Ofwat’s models could be improved by including a population density explanatory variable.

53. Very few models (including none of the Ofwat models) allow for a network diseconomies of scale (rurality) driver. We consider that this is worthy of further consideration. The omission of such a variable will likely disproportionately impact small rural companies. This is because they will not be able to make use of the natural offsetting that other companies with rural cost drivers will be able to take advantage of. Namely by being able to ‘recover’ poorly specified rural cost drivers through the attributes of more urban areas.

Treatment-specific primary drivers

Opportunities for economies of scale in water treatment

<table>
<thead>
<tr>
<th>Economies of scale in Treatment either not at all, or not adequately, captured</th>
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<tbody>
<tr>
<td>Half of Ofwat’s wholesale water and network plus models (and 6 out of 10 of its water treatment models) do not seek to capture opportunities for economies of scale in water treatment. The other models all include one of two density variables, and while these variables may be expected to capture opportunities for treatment economies of scale to some extent, and in some circumstances, they have major limitations (in this respect). We recognise there are more</td>
</tr>
</tbody>
</table>
54. As was set out above, we consider opportunities for economies of scale to be a primary driver of water treatment costs, and given the relative scale of water treatment costs – a primary driver of network plus and wholesale water costs. In particular:

- It is widely recognised that larger treatment works can allow for significantly lower costs per unit of treated water to be achieved, other things equal;
- But, the opportunity to achieve plant-level economies of scale is not simply a function of the overall volume of water that a company treats, or may have to treat, so will not be adequately captured by scale variables such as number of properties, length of mains or Distribution Input.

55. Given this, we consider that all water treatment, network plus and wholesale water models should seek to capture the opportunity for economies of scale in treatment in order to be regarded as providing adequate primary cost driver coverage. We think there is an opportunity to improve Ofwat’s models:

- Half of Ofwat’s network plus and wholesale water models (and 6 of its 10 water treatment models) do not appear to seek to capture opportunities for economies of scale in water treatment; and,
- The other models capture opportunities for economies of scale in a partial and incomplete way, through reliance on one of two density variables.

56. Population density is clearly relevant to opportunities for economies of scale, and urban populations may allow for larger plants to be efficiently developed and operated. But there are two key factors that undermine the adequacy of relying on the density variables Ofwat has used to capture treatment opportunities for economies of scale:

- a. The size, location and condition of available water resources.
- b. The extent to which densely populated groups of customers are in practice dispersed:
- c. The ‘sunk’ nature of historical decisions concerning the location and scale of long-lived treatment assets

57. The first point is most obvious in relation to groundwater sources, the availability of which is constrained by the location and potential yield of suitable aquifers. In practice, though, while economies of scale can be more difficult to achieve in the treatment of groundwater sources, they will also often be less significant, in that groundwater sources will typically (although not always) require a lesser degree of treatment. Therefore, when considered in the round, the key economies of scale issues tend to relate to surface water treatment, and the proximity of available surface water resources to demand centres. By focusing only on population characteristics, density measures do not reflect these factors.

58. The second point is highly relevant for Severn Trent Water. While it is the case that we serve a large number of customers that are located in densely populated urban areas, it is also the case that we serve a large number of geographically dispersed urban areas (Severn Trent serve the largest number of discrete urban conurbations (greater than 300,000 population) in England and Wales). This has a material bearing on opportunities for economies of scale, and is not captured in the density measures that Ofwat has used (and does not look straightforward to capture in such measures).
59. There is a significant difference – in terms of costs - between serving a population of a given density level (e.g. based on Ofwat’s weighted density measure), when that population resides in a small number of larger cities, as compared with when they reside in a larger number of smaller cities. Our area is characterised by that latter feature: we serve a large number of relatively small cities. Given this, the density measures relied on by Ofwat imply that we have materially greater opportunities for economies of scale in treatment than is in practice the case.

60. Historical decisions are relevant here ((c) above) as the locations of most of water treatment plants were determined many years ago (and before privatisation), based on assessments that would have been informed by then prevailing supply and demand conditions and expectations. The long-lived nature of treatment assets means that opportunities for economies of scale are likely to be constrained by those decisions in practice, even if prevailing population density conditions were to imply that opportunities might be greater in principle. For example, the capacity of Bamford WTW (one of our most efficient WTWs) has been essentially constrained since 1945 with the sizing and construction of Ladybower reservoir. Therefore, it not able to take advantage of the potential for increasing economies driven by the growing population centres that could potentially be served.

61. Given these points, in our modelling work we concluded that it was appropriate to include an asset size-based measure in our models: that is, to directly consider the size of existing treatment plants in order to capture economies of scale. While this inevitably involves including a variable that is to some extent under management control, in practice we conclude that the long-lived nature of treatment assets meant that the risk of problems of perverse incentives arising was likely to be very limited (as decisions to modify plant size would themselves be long-term decisions that would be made in a context where the use of an asset based measure in future price controls would be highly uncertain).

62. Given the relevance of water sources to opportunities for economies of scale (as discussed above), we have sought to capture economies of scale through the introduction of two explanatory variables: one that measures the ratio of number of groundwater vs surface water (GW/SW); the other that measures the number of water treatment works (Number of works). An alternative approach might involve focusing on the number of surface water treatment works used to provide the overall volume of DI that is supplied by surface water works. Our analysis, in table 3 below, shows that the inclusion of the GW/SW and Number of works variables significantly improve the model fit of Ofwat’s current water treatment models, when compared with models 1-6 (which take no account at all of economies of scale) and with models 7-10 (where density measures are currently relied upon).

| Table 4: Analysis of model specifications for choices in treatment economies of scale drivers |
|---------------------------------------------|---------------------------------|---------------------------------------------|
| Coverage of treatment economies of scale    | OWT1-6                          | OWT7-10                                    |
| Standard deviation of model efficiency scores| 0.24                           | 0.21                                       |
| Range of model efficiency scores (max-min)  | 0.73                           | 0.80                                       |

**Treatment complexity**
Treatment complexity is addressed in a very limited manner
The current models include a highly limited (in terms of explanatory power) set of variables aimed at capturing treatment complexity. The models could be improved by ensuring that a treatment complexity variable is included, and – for the water models - by including variables such as '% of water treated at plants in band 4-6' (as was used by CEPA) which reflect differences in surface water treatment requirements. The waste models could be improved by using broader measures (such as % of load, ammonia consents <3mg') which better capture differences between companies.

63. We consider treatment complexity to be a primary driver of treatment, network plus and wholesale water costs. Treatment complexity is a function of the type of water resources available to the company and the condition of those sources. There are significant differences between companies given the different water resource options that are available (and the effect of environmental circumstances on the condition of those resources, and thus on the extent and forms of treatment that are likely to be required.

64. We note that Ofwat has included a variable that seeks to capture treatment complexity requirements in all of its water treatment models. However, both of the variables that are considered are very broad and do little to capture material differences in circumstances. In particular, 6 of the 10 treatment models simply include the % of DI from boreholes. While groundwater often requires only limited treatment, that is not always the case, and by only considering this measure highly material differences in the cost of treating surface water of differing quality are simply ignored.

65. In the other 4 treatment models, Ofwat uses a variable for the % of water treated at works in band 3-6. While on the face of it this may seem to offer a way of capturing relevant differences in treatment requirements, in practice the measure is so broad that it can be expected to include most surface water treatment irrespective of quality and treatment requirement differences.

66. Ofwat’s reason for preferring the measure of % water treated at works in bands 3-6, rather than in bands 4-6 is unclear. The band 4-6 measure was used by CEPA in its report, and in our view is likely to provide a much better means of trying to capture relevant cost differences.

67. We are unclear on the approach to treatment complexity in the network plus and wholesale models, and in particular the way in which different Average Pumping Head (APH) measures have been introduced apparently as a means to capture treatment complexity. That is:
   - In Ofwat’s network plus models
     - Half of the models use the Band 3-6 measure (which as above we consider too broad)
     - Half of the models use APH for water treatment as an apparent alternative
   - In Ofwat’s wholesale models:
     - 3 out of 10 use the broad Band 3-6 measure.
     - 9 out of the 10 use APH for water resources (not for treatment as in the network plus models)

68. While we recognise that there is no straightforward way to capture drivers of treatment complexity costs, the options that Ofwat has considered so far look to be limited, and do not address the fact that surface water treatment requirements can differ materially. In our view this is an area where the use of a broader range of variables is likely to be desirable as a means
of reflecting and trying to capture the different relevant dimensions of treatment complexity that can have a material bearing on costs.

**Maintaining the long-term capability of the network**

The inclusion of ‘% of mains laid or refurbished since 1981’ is inappropriate and unnecessary

A number of the models effectively penalise companies that have laid or refurbished more mains compared to the average. All wholesale water models and 75% network plus and treated water distribution models include a variable that provides greater funding for those companies that have not sought to invest in their network. This perverse incentive could be addressed by removing this variable (and putting the onus on companies to show why their forecast level of refurbished/relined activity should be treated as different from an industry average/target level).

69. All of Ofwat’s wholesale water models, and 75% of its network plus and treated water distribution models, include a new variable that measures the percentage of mains that have been laid or refurbished since 1981. In all cases, this new variable has been included in addition to the ‘% of mains refurbished and relined’ variable.

70. Ofwat notes that its reason for including the variable is as a driver of maintenance costs. However, by including it in a cost assessment model the practical implication is that:

   a. It is appropriate to make future cost allowances dependent to some extent on a mains age-based measure;
   b. A botex model over a relatively short number of recent years is an appropriate way of determining what that relationship should be; and,
   c. ‘% of mains refurbished and relined since 1981’ is an appropriate metric to use for both (a) and (b).

However, in our view, none of (a) – (c) appear to hold, and the issues raised go well beyond model specification.

71. The RG05 2016 UKWIR report on long term investment in networks calculates a ‘best estimate’ network renewal rate of 1.2% per year is necessary to prevent deterioration in key asset health metrics (mains bursts and interruptions to supply). In contrast, the UKWIR study identifies a current median rate of 0.6%. Analysis of the modelling data (6 year average shown below) also shows that there is a significant variance in current rates between companies.

<table>
<thead>
<tr>
<th>ANH</th>
<th>NES</th>
<th>NWT</th>
<th>SRN</th>
<th>SVT</th>
<th>SWT</th>
<th>TMS</th>
<th>WSH</th>
<th>WSX</th>
<th>YKY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.22</td>
<td>0.40</td>
<td>0.09</td>
<td>0.26</td>
<td>0.54</td>
<td>0.28</td>
<td>0.24</td>
<td>0.45</td>
<td>0.58</td>
<td>0.23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AFW</th>
<th>BRL</th>
<th>SBW</th>
<th>DVW</th>
<th>PRT</th>
<th>SES</th>
<th>SEW</th>
<th>SSC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.77</td>
<td>0.64</td>
<td>0.43</td>
<td>0.44</td>
<td>0.56</td>
<td>0.60</td>
<td>0.27</td>
<td>0.66</td>
</tr>
</tbody>
</table>

72. It will be clear from the table that there are material differences between companies in terms of their network renewal activity. As the figure below highlights, however, it is far from clear that these differences in actual levels of mains renewal activity over time have been driven by differences in network age (indeed some of the data might suggest the opposite).
73. There are a wide range of factors that can be expected to influence actual renewals activity over any given period. We don’t think there is merit looking at a short period of data (which is what Ofwat’s botex modelling does) to assess the case for a clear age-maintenance costs relationship, and for specifying and quantifying what that relationship is. There are also reasons for concern over the reliability and appropriateness of the specific age measure that has been chosen (‘% of mains refurbished and relined since 1981’). Why 1981 is considered an appropriate cut-off date is unclear, as is the extent to which the underlying data has been subject to sufficient robustness checks (our initial review of the data suggests there are some oddities in terms of the relationship between age-based data and renewal rate data, for example).

74. We considered this issue of asset history and maintaining the long term capability of assets in our report ‘Identifying water cost drivers’. As was highlighted in that report, it is clear that past decisions will affect the relative condition of assets now. However, that need not imply that differences in the opening condition of assets should be taken into account in econometric benchmarking. Indeed, one might expect such differences explicitly not to be allowed for so as to preserve the incentive properties of the price control framework.

75. The risk here is that the inclusion of the kind of age-based variable used in Ofwat’s models can result in companies that have done less renewal activity over time being effectively rewarded now with higher cost allowances (because their proportion of refurbished/relined mains since 1981 is lower), and those that have done more renewal activity effectively penalised now with a lower cost allowance. Not including an age-based measure in the econometric modelling avoids this kind of problematic incentive issue arising, and would put the onus on companies that considered the age/condition of their network to give rise to material additional cost requirements to make the case for additional funding through the modelling claim process.

---

76. The inclusion of the ‘% of mains refurbished and relined since 1981’ variable in almost all of Ofwat’s models is particularly concerning given the scale of the effect that it has on model outcomes in many cases. This makes it particularly important to consider the above points, and in particular to take careful account of the potential for this approach to modelling to have highly undesirable incentive properties.

77. As was set out in ‘Identifying water cost drivers’, this does not imply that no account should be taken of past asset management activity. Econometric benchmarking of the kind that Ofwat is undertaking involves deriving relationships on the basis of past expenditure (with those relationships then used to make projections of what future allowance levels may be appropriate). If past expenditure differences across companies reflect differences in levels of activity aimed at maintaining the long-term capability of assets, and those differences are not captured by other explanatory variables in the model, then there is the potential for model results to be materially inaccurate because relevant variables have been omitted.

78. In our view, the case for including the ‘% of mains refurbished/relined’ variable is best understood in this way. That is, including it allows account to be taken of the different levels of activity that companies have undertaken during the data period used for model estimation aimed at maintaining the long-term capability of the network. Including this can help avoid such differences in activity levels unduly affecting the basis upon which future expenditure requirements are forecast. Not including it may effectively leave a significant amount of ‘noise’, and undermine the accuracy of the results that are generated.

79. The use of a ‘% of mains refurbished/relined’ variable then raises the question of how forecast levels of the variable should be determined for the purpose of setting cost baselines. Our expectation would be for Ofwat to consider this in relation to an opening view of what an appropriate ‘average’ renewal rate should be. It would then be for companies to demonstrate that using an average rate was not appropriate, where they considered that to be the case. In our view, this process of arriving at forecast levels for the ‘% of mains refurbished/relined’ variable provides a much more appropriate context for age-related cost arguments to be considered, than seeking to include an age-based variable within the model.

Water resources

<table>
<thead>
<tr>
<th>Bulk supply costs should be adjusted to avoid non-like-for-like comparisons being made with costs when owned assets are being used</th>
</tr>
</thead>
<tbody>
<tr>
<td>While we recognise that it may be appropriate to adopt a highly simplified approach to water resource cost modelling (in the absence of a better alternative), the inclusion of (unadjusted) bulk supply costs within water resource botex means there isn’t a like-for-like assessment.</td>
</tr>
</tbody>
</table>

80. A bulk supply that is otherwise equivalent to a resource secured through owned assets will be treated as more expensive, because the financing costs associated with the owned asset will be counted and funded separately. That is, for existing bulk supplies, water resources botex can be expected to equal to the total resource costs associated with that supply, whereas for an equivalent owned resources, total costs will exceed botex (because of financing costs). This will tend to make bulk supplies look more expensive than they are on a like-for-like basis.

81. In future price controls it would seem sensible to address this issue in a more fundamental way, so as to avoid the cost assessment arrangements potentially distorting decision. However, for
PR19, this anomaly could be addressed in a more straightforward manner. For example, the level of water resources `botex` to be used for modelling purposes could be reduced by an amount that approximates the portion of total own resource costs that would be funded through a provision for financing costs. This amount, \( x \), could then be added to the `botex/totex` figure that results from the cost assessment process (in the same way that a financing cost allowance is effectively added separately to `totex`), with the cost assessment process based on ‘`botex-x’’. This could provide a relatively straightforward way of addressing the inconsistency that would otherwise affect the cost assessment process.

82. Given that we secure much of our water resource requirements from bulk supplies, we would expect this issue to be of primary relevance to Severn Trent Water (and perhaps only be a material issue for us). Nevertheless, it seems an important point of principle, as the cost assessment process would otherwise effectively involve erroneous comparison that relates to a key area of activity that Ofwat has been keen to facilitate the growth of (i.e. bulk supplies) where such further growth is efficient.

83. We have not included this as a modelling claim, and note that it would not meet the modelling claim threshold Ofwat has set. In practice, though, we consider the issue to be different in kind the other modelling claim issues, as it effectively concerns how different costs should be counted and compared. Clearly it could – in principle - be addressed through model design. However, the use a highly simplistic model design for water resources, while understandable, makes it important to address this issue separately.
Our summary assessment of wholesale wastewater models

84. This section sets out our review of whether and how each primary cost driver is being captured in Ofwat’s current set of wholesale wastewater models. We highlight four main opportunities for improving the development of these models:

1. Some of the scale drivers used in Ofwat’s models suffer from serious deficiencies such that we consider them not appropriate for use:
   i. The load data Ofwat has used implies that there are major differences in the underlying assumed level of load/person across companies. In the absence of load data being recalculated in a consistent manner, we consider it to be not fit for purpose.
   ii. Volume should be regarded as inferior to load or some form of population equivalent measure (given its more limited relationship with costs), and risks perverse incentives (for example, by effectively rewarding companies that perform less well in terms of encouraging water efficiency).
   iii. Three of Ofwat’s sewage collection models take no account of network size, which we consider to be a primary driver of costs. Those models include either volume or number of connected properties as a scale driver (without the use of a density variable that could take network length into account). Modelling costs based on volume raises particular concerns as it will tend to penalise the use of SUDs and other actions which are intended to reduce volumes that flow through the sewerage network.

2. Economies of scale - Ofwat’s Wholesale and treatment models seek to capture opportunities for economies of scale in wastewater treatment in too limited a way through the use of a single plant type threshold (‘band 1-3’). Unit costs tend to reduce with scale across all size bands and a variable that reflects the average size of all treatment works provides a better of capturing these effects, while avoiding the need to select a particular threshold (which effectively assumes there to be a step change in opportunities for economies of scale as plants move above band 3). Also, most of Ofwat’s network plus models do not seek to take account of treatment plant economies of scale at all.

3. Density - Eight out of the 18 Ofwat Wholesale and Network plus models do not include a density variable. Given this, they do not provide a means of capturing the extent to which costs are affected by congestion issues.

4. Treatment complexity - Ofwat takes no account of treatment complexity in most of its models, and in those models that do seek to capture it, a single, inappropriately narrow measure has been used.

Scale variables in wastewater models

Some of the scale drivers used in Ofwat’s models suffer from serious deficiencies such that we consider them not appropriate for use
The load data Ofwat has used implies that there are major differences in the underlying assumed level of load/person across companies. In the absence of load data being recalculate...
- Amount of combined sewers (combined sewers include surface water, separated systems do not).
- Spare capacity at the STW at the time of the precipitation.
- Groundwater flowing into the sewerage network increases the volume arriving at treatment works. This is driven by factors such as length of sewers and serviceability of sewer network (propensity of the sewers to leak). Companies with poorer serviceability will tend to benefit from having higher volumes.
- Increased levels of connected industry will lead to increased volume received. However, the cost to treat one volume unit of industrial effluent is likely to be significantly greater than an equivalent volume of domestic sewage.

The load data does not currently look to be fit for purpose

88. Load can be considered as:

\[
\text{Connected HH population (properties x household size) x Load per person (60g of BOD per person) + Industrial load}
\]

89. In line with this, load does not increase as surface water or infiltration increases.

90. We have interrogated the load received data used in the Ofwat modelling submission subtracting the industrial load, then dividing by resident population to expose the inferred load per person value. Load per person would be expected to be broadly the same across the UK as it relates to diet and corresponding sanitary expectations. However, our analysis of the load data implies that markedly different load per person levels have been assumed in different areas. This undermines the usefulness of the data, and in our view makes it not fit for purpose.

91. This can overcome by recalculating load values, but assuming a fixed load per person of 60 BOD.
That is, load would be recalculated as:

\[
\text{Properties x average household size x default load per person value (60g BOD) + Industrial Load (typically measured on an effluent by effluent basis).}
\]

The size of the network is not adequately captured in Ofwat’s sewage collection models

92. Three of Ofwat’s sewage collection models take no account of network size, which we consider to be a primary driver of costs. Those models include either volume or number of connected properties as a scale driver (without the use of a density variable that could take network length into account). Modelling sewerage network costs based on volume raises particular concerns as it will tend to penalise the use of SUDs and other actions which are intended to reduce volumes that flow through the sewerage network.

Economies of scale in wastewater treatment

Ofwat’s models seek to capture opportunities for economies of scale in wastewater treatment in too limited a way
Ofwat’s models seek to capture opportunities for economies of scale in wastewater treatment in too limited a way through the use of a single plant type threshold (‘band 1-3’). Unit costs tend to reduce with scale across all size bands and a variable that reflects the average size of all treatment works provides a better of capturing these effects, while avoiding the need to select a particular threshold (which effectively assumes there to be a step change in opportunities for economies of scale as plants move above band 3).

93. All of Ofwat’s wastewater treatment models and wholesale models seek to capture economies of scale by including a variable for the proportion of load treated at band 1-3 works. However none of Ofwat’s network plus models (which sit in between in terms of level of aggregation) appear to be seeking to capture economies of scale at all.

94. We consider Ofwat’s use of an asset-based metric in its treatment and wholesale models to be appropriate, as opportunities for economies of scale is a primary cost driver, and looks highly unlikely to be captured adequately through the use of other type of variable, such as density measures. In particular, opportunities to achieve economies of scale in wastewater treatment will be heavily affected by geography/topography (given the extent of reliance on gravity for transportation of wastewater) and by the availability of an appropriately sized receiving water course with capacity to take nutrient load.

95. Our analysis, which was corroborated by Jacobs in the ‘Wastewater cost drivers’ (2017) report, shows that unit costs for treatment reduce on average as scale increases across all bands. Ofwat’s use of the ‘band 1-3’ variable will not adequately capture this and it effectively assumes there to be a step change in opportunities for economies of scale as plants move above band 3 in size.

96. We think that using a variable that takes account of the average size of treatment works (such as the inclusion of the total number of works) provides a much better way of capturing economies of scale than Ofwat’s current approach. It avoids having to select a particular threshold (above band 3, band 3 and below) and having to implicitly assume that only relevant differences in opportunities for economies of scale occur in relation to that threshold.

**Wastewater treatment complexity**

**Ofwat takes no account of treatment complexity in most of its models, and in those modes that do seek to capture it, a single, inappropriately narrow measure has been used**

Ofwat takes no account of wastewater treatment complexity in two of its treatment models, in 8 out of 10 of its network plus models, and in 6 out of 8 of its wholesale wastewater models (and in the other 2 wholesale models account is only taken through inclusion of the % of load from trade effluent customers). We consider treatment complexity to be a primary driver of treatment costs and – given the relative scale of treatment costs – of network plus and wholesale costs. As such, we think that all models for these cost categories should seek to capture treatment complexity.

In those models where Ofwat has sought to directly capture treatment complexity, a single and inappropriately narrow measure has been used (which would only have a positive value for two companies). This can be addressed by specifying a broader measure that better reflects the ways in which treatment requirements typically affect costs.
97. Treatment complexity is a primary driver of wastewater treatment costs and – given the relative scale of those costs – of network plus and wholesale costs. Given this, we consider that all models for these cost categories should be seeking to capture treatment complexity.

98. No account is taken of wastewater treatment complexity in two of Ofwat’s treatment models, in 8 out of 10 of its network plus models, and in 6 out of 8 of its wholesale wastewater models (and in the other 2 wholesale models account is only taken through inclusion of the % of load from trade effluent customers). Given this, we consider that some of Ofwat’s treatment models, most of Ofwat’s network plus models, and all of Ofwat’s wholesale models do not adequately capture this primary cost driver.

99. Treatment complexity is a function of the nutrient load of the wastewater to be treated, but also of the condition and sensitivities of the receiving waters available to the company – which will be affected by a range of environmental factors. We have undertaken a significant amount of analysis on understanding the interaction between expenditure and treatment complexity. Our report on wastewater undertaken by Jacobs was published alongside this consultation.

100. In those models where Ofwat has sought to capture treatment complexity directly, it has used a single measure: the percentage of load subject to an ammonia consent of <1Mg/l. It is clearly the case that works with ammonia consents of <1 Mg/l will require complex and costly treatment processes. However, delivering against a <3Mg/l consent will require a similar technological process, and is likely to increase costs (relative to less stringent consents) by an amount that is only marginally lower than the increase that would result from meeting a <1 Mg/l consent. This was explored and presented in our Wastewater cost driver report that was completed by Jacobs and submitted alongside our models ahead of this consultation, and was supported by previous work commissioned by Ofwat (2006).

101. By using a <1Mg/l limit, Ofwat’s models effectively imply that costs are only materially affected by treatment complexity for 2 companies. This is not representative or realistic and will have a knock on impact on the adequacy of the model coverage and results. If the boundary for ‘tight’ (and therefore costly) consents is increased from 1 to 3Mg/l (in line with the evidence referred to above), there is a corresponding increase in the number and distribution of relevant sites across the industry [add graph]. This is significantly more representative of the distribution of treatment complexity across the country and can be expected to improve model performance (this is supported by consideration of the effect on model variance when the treatment complexity diver in ONPWW9 and 10 is modified to be <3mg/l).

102. Given the difficulty of accurately capturing complexity, it may be prudent to use a range of approaches. In developing our own models, we have considered the following variables:

- The sum of the number of tight BOD and ammonia consents (at band 6 STWs).
- The number of sewage treatment works (band 6) with tertiary processes.
- The proportion of load subject to a tight ammonia consent.
- The proportion of load subject to a tight BOD consent.

**Bio-resources**

103. Ofwat’s bioresources models appear to provide for reasonable coverage in terms of primary cost drivers. We would urge Ofwat, however, to give further consideration to the extent to which variables which are subject to some degree of management control might give rise to perverse incentives, particularly given the evolving nature of the bioresources arrangements.
This appears to be particularly relevant to the use variables whose level is determined by transportation choices.

H. Retail modelling

104. We welcome Ofwat’s further work on retail modelling. We note the options Ofwat has considered in order to try to capture the effect that different levels of deprivation can have on debt costs and on total retail expenditure. We consider it important that these models seek to capture the effect that default (and default risk) can have on costs, and welcome Ofwat’s consideration of different ways of doing this. In our modelling work, however, we have also found that measures which seek to capture the economic significance of water bills to household customers were relevant to consider.

105. We have considered various ways of doing this, and found average bill size as a proportion of 1st decile pay to perform best. That is, this measure this looks to provide a reasonable way of capturing the economic significance of water bills to lower income customers. This type of measure looks to measure further consideration in Ofwat’s ongoing modelling work. In particular, it can reflect that costs can be expected to be driven by a broader set of deprivation factors than credit risk alone. For example, the economic significance of bills to relatively low-income customers may tend to reduce the speed with which payment is received and generate additional customer services activity.

I. Enhancement modelling

Using Botex+ models

106. Botex+ models can provide a convenient way of modelling some enhancement expenditure while avoiding the need for additional more bespoke assessments. In part the case for inclusion concerns the likelihood of relevant cost drivers – in terms of the enhancement expenditure – being already sufficiently captured within the Botex models allow the enhancement expenditure to be added without this generating material problems in terms of the likelihood of errors. To a significant extent, this is likely to raise proportionality questions, as a more approximate approach may be more easily justified when the scale of the enhancement expenditure under consideration is relatively modest, as compared with when it is more substantial.

107. In Table 1, Ofwat ‘shows enhancement activities we are considering for inclusion in botex plus models’. The consultation document says that most of the activities in Table 1 are driven by population and demand growth, and are interlinked with each other and with base costs. However, Table 1 includes some very broad categories of cost that one would expect not to be able to add to botex model without significant problems emerging. For example, Table 1 incudes expenditure to improve resilience. It may be that some aspects of resilience spending could be captured within a botex+ model in a reasonable manner, but at the same time it is clear that some resilience expenditure would be highly unlikely to be captured reasonably in such a model. Trying to do so may materially undermine the reliability of the model and the efficient cost baselines that may be identified on the basis of it. A similar point could be made in relation to a number of other categories in Table 1, including expenditure to enhance the balance of supply and demand.

108. We recognise that Ofwat’s consideration and development of potential Botex+ models is ongoing. In line with the above comments, we encourage Ofwat to carefully consider the extent
to which the addition of different types of enhancement expenditure may undermine the benefits of having moved to putting a greater focus on Botex rather than Totex modelling.

**Ofwat’s enhancement models**

109. We focus our comments here on Ofwat’s Water new developments and new connections models, and refer also to the modelling claim that submitted related to Developer Services Costs. As set out in our modelling claim, we consider there to be differences in the way companies report costs.

110. In particular, think that not all companies report costs that cover (i) new mains laying (requisitions); (ii) connections from properties to a main (new connections); and (iii) network reinforcement (off site upgrades to existing water company assets). This result in non-like-for-like comparisons and undermines the likely reliability of new developments/new connections cost models.