

Ofwat consultation: Appendix 4 – Bioresources control and supplementary document

Severn Trent Water response

16th September 2022

WONDERFUL ON TAP



Executive summary

We welcome the opportunity to comment on Ofwat's consultation on the draft PR24 methodology for bioresources and the supplementary document.

We are supportive of Ofwat's aim of helping the bioresources sector create economic and environmental value and of Ofwat's desire to set a price control which encourages the development of the market.

We have some concerns about Ofwat's proposed approach to funding bioresources activities at PR24. Our main points are:

- We consider there is significant uncertainty with regard to the future approach to both Farming Rules for Water (FRfW) and the Industrial Emissions Directive (IED), which could have material effects on bioresources costs in the future. We suggest it would be prudent to have funding allocated and uncertainty mechanisms in the PR24 settlement to cover future risks/policy movements, enabling us to implement the EA's requirements effectively.
- We consider the approach to setting bioresources allowances at PR24 needs to take account of the loss of revenue from the expiry of Renewable Obligation Certificates (ROCs) in 2027.
- We do not support Ofwat setting a separate frontier shift for bioresources given the novelty of the bioresources proposals and regulatory uncertainty in the sector.
- In our view, Ofwat should make the proposed degree of stretch across the whole of PR24 more realistic, including any separate bioresources catch up efficiency challenge Ofwat sets at PR24.
- We understand Ofwat's desire to model bioresources separately and derive separate efficiency challenges. We consider the models currently presented have not yet demonstrated an appropriate level of robustness, nor reliability, for them to be used in a way consistent with the PR19 models. We think that there is a need to explore an improved set of explanatory variables that will be able to better describe the independent cost pressures associated with bioresources. We would be happy to contribute to a process to help identify new explanatory variables.

We are keen to work constructively with Ofwat as it develops its approach to bioresources to see whether the novel proposals can be made workable in practice.

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Response to questions

Please find below Severn Trent’s response to your questions in Appendix 4 of the PR24 methodology consultation on the bioresources control and the additional questions in the bioresources supplement.

Section 2 questions

Q2.1: Do you have any comments on this section?

Severn Trent consider that there are benefits to reducing differences in cost allocation methods between companies and the guidance Ofwat has issued has significantly helped in this regard. However, while this has increased the quality of data available moving forward, we consider the historical data sets, which have been derived using high-level assumptions, will have an adverse impact on the robustness of the econometric modelling.

We would also like to note that although section 2.4.3 refers to the termination of the Heat Incentive, a significant concern for companies will be the expiry of Renewable Obligation Certificates (ROCs) in 2027. For the year 2021-22 Severn Trent produced 178 GWh of renewable electricity from CHP and based on a ROC rate of £45, this incentive is worth £8.0 million annually. We were early adopters of the ROCs scheme and so by 2030, all but a very small proportion of these will have expired. Ofwat has cited the Green Gas Support Scheme as an alternative revenue stream however, the current position is that only new anaerobic digestion sites would qualify. This cannot therefore replace the revenue from ROCs for our existing assets and as a result the historical models will not reflect the lost revenue from ROCs moving forwards. Therefore, we suggest that Ofwat account of companies’ lost revenue through the ending of ROCs when calculating allowances based on the results of the econometric models.

We recognise that energy prices can help to bridge this revenue gap for a commercial operator, but energy prices are volatile and cannot be a considered a long term, stable source of revenue. As a wider waste operation, Severn Trent is a net importer of electricity, and so the price volatility only serves to reduce a cost impact on the waste business. This means that we do not see increased

revenue we can pass on to customers, which we were previously able to do with the ROCs scheme. Essentially the higher energy prices become a cost mitigation that is beneficial but does not appear as a direct income benefit as was the case previously. We believe that Ofwat should take these factors, and wider cost pressures into consideration when setting an appropriate efficiency challenge for bioresources at AMP8.

Q2.2: Do you have any further comments on our approach to a separate efficiency assessment, in particular the options we consider in section 2.4.2?

Severn Trent agree that there can be potential benefits from applying a separate efficiency assessment to the bioresources control. However, as we explained in our response to the PR24 methodology consultation Ofwat should make the proposed degree of stretch across the whole of PR24 more realistic. With respect to the three options presented by Ofwat, we consider none of these adequately address the issue at hand. Option one does not address the issue of costs substitution between wastewater wholesale controls. Option two has merit, however, the suggested materiality threshold of 6% is too high for it to be effective. Finally, option three is contrary to Ofwat's aim of including a wider set of costs within the econometric modelling and could create an avoidable administrative burden.

We consider that option two allows a true representation of costs between the controls and reflects operational realities but would recommend a lower materiality threshold.

Section 3 questions

Q3.1: Do you have any comments on this section?

As a general observation, these proposals require incumbent WaSCs to take on volume, quality, and price risks to treat waste. This is not something we as a company expect is possible to pass forward, whereas most commercial contracts will seek to alleviate at least one of these risk areas. We are also a licensed operator, and as such we have no means of exiting any contract in which these risks materialise. The following sections highlight some of the market concerns we feel would need to be priced in by any market entrant and therefore should also be considered in the modelling for existing companies.

We are supportive of Ofwat's desire to set a price control which encourages the development of the market. However, underpinning Ofwat's proposals is the assumption of sound and robust econometric modelling. Below we provide suggestions as to possible ways the econometric models could be improved.

On the other hand, we are not supportive of Ofwat setting a separate frontier shift for bioresources at this time. Applying dynamic efficiency gains - in addition to catch-up efficiency gains - risks an especially punitive assessment of the cost/revenue requirements of the bioresources control at PR24. We believe that given the novelty of the bioresources proposals and regulatory uncertainty in the sector, Ofwat need to allow time for the market to develop before setting a separate frontier shift for bioresources.

December proposals

Q3.2: Do you have any further comments on the draft methodology proposals which we propose to retain from our December document and our reasons for doing so?

Please note the following discussion points related to this section:

Uncertainty around environmental requirements for bioresources

There are two areas of particular uncertainty around environmental requirements for bioresources, which we think Ofwat's PR24 approach to bioresources should take account of.

1. Farming rules for water

Severn Trent consider that a high degree of uncertainty remains in the area of environmental requirements for bioresources, particularly with respect to the disposal of treated sludge to land. The 2025 scheduled review of the Farming Rules for Water (FRfW) guidance is after when companies will have finalised and submitted their PR24 business plans for the next control period. Therefore, despite Ofwat's guidance that companies avoid using the adaptive planning framework to address the disposal of sludge, we recommend Ofwat allows the use of uncertainty mechanisms to be triggered in the event the Environment Agency (EA) prohibits or restricts sludge to land disposal. This is because should this occur, the cost impact will be material for the bioresources businesses of all companies due to a statutory requirement.

2. Industrial Emissions Directive

We would also like to register our concern regarding the application of the Industrial Emissions Directive (IED) to the bioresources sector and the timescales outlined in the proposed methodology. Despite assurances from the EA that converting to IED permits would be a light touch activity, we have found that the scale of the change to be substantial. There are three principal areas of concern for the water companies, each of which has a different level of uncertainty that the EA is still yet to clarify. Therefore, the proposed timescales are financially and practically unreasonable unless the EA issues prompt guidance on these three issues:

- a) **Containment:** this is a new requirement for sewage permits and necessitates companies investing in either bunding or diversion and attenuation for the contents of the largest tanks on all sites. We are yet to receive feedback from the EA on the spill mapping and solutions we provided to the EA prior to commencing building works. We have acted in accordance with the EA's timescales, however, we have not received permits after 12-18 months of discussion. Once the EA grants approval we will be able to start spending what we estimate to be between £2m-£10m per site to ensure compliance with the new statutory obligation.
- b) **Emissions to air from secondary / pathogen kill tanks:** this again involves a substantial investment (we have nearly 100 tanks), resulting from a new statutory obligation, to cover or capture emissions from secondary tanks and install technology to treat the collected gas.
- c) **Post digestion storage:** it is unclear at this time whether the EA is expecting cake storage to have a roof / forced air extraction / odour control to manage emissions. These pose health and safety challenges as well as requiring a substantial cost to deliver.

Whilst we are supportive of measures to upgrade our bioresources sites to meet these standards, the costs involved are substantial, potentially reaching £100m across our 25 sites. These costs were unfunded in AMP7 due to the EA announcing its approach to the IED after companies had submitted

their PR19 business plans. This meant we were unable to manage a full conversion of sites within our AMP7 allowance. In addition, the timescales to deliver the required work mean that not all the work can be delivered this AMP, particularly given ongoing delays from the EA in terms of what they class as Best Available Technology (BAT) and feedback on our proposals. We therefore believe that the EA should allow a delayed delivery of these activities - we have discussed with and written to the EA to request this. A delayed delivery would allow for a portion of the statutory IED costs to be funded in AMP8, potentially as a special, singular funding stream to manage the switch over of the older assets.

In short, we believe that a high degree of uncertainty remains with regard to the EA's approach for both the FRfW and IED. As a result, we consider it would be prudent to have funding allocated and uncertainty mechanisms in the PR24 settlement to cover future risks/policy movements, enabling us to implement the EA's requirements.

Cost of capital

Severn Trent continue to consider that Ofwat's proposals will lead to an increase in cost of capital over the long term – though this increase may not materialise in the short term. For an example, a lack of protection to post-2020 RCV will increasingly become a factor for investors as the share of post-2020 RCV increases. Also, dependant on how punitive Ofwat's models prove to be, this will determine whether investment in capital projects over multiple periods will be adequately funded and therefore determine the level of return investors will expect for what they deem as riskier investment. This can also have the effect of driving up cost of capital over the long term.

Bioresource growth enhancements

Severn Trent agree in theory with the inclusion of growth enhancements in the econometric modelling, however, we have reservations with respect to the proposed model (option three: fully reformed approach in the supplementary guidance) and its ability to correctly model these costs. This is because there is a significant degree of uncertainty following the pandemic as to how bioresources growth rates will evolve. The pandemic saw a significant change, both temporary and permanent, to the way people lived and worked. We have seen unprecedented fluctuations in our trade and domestic sludge volumes because businesses have changed their production levels and people are spending more of their working hours at home. These changing patterns need to be modelled, however; this is difficult given historical data will not accurately reflect post-Covid trends.

Further to this, we are seeing an increased public focus on water quality and, as a result, the EA are driving the most significant WINEP programme to date. This is not only rapidly increasing sludge volumes, but it is impacting the *types* of sludge we receive. The increased production of chemical sludges makes the treatment of the overall sludge mix much harder and so the growth is not only larger, but more complex to treat through conventional approaches.

When considering bioresources allowances at PR24, we ask that Ofwat considers post-Covid changes in behaviour and the EA's plans and the impact on the growth and *type* of growth of sludge in the future.

Performance Commitments

The common performance commitment to reduce operational GHG emissions is something we are very supportive of and will deliver as part of our Net Zero strategy. However, it is worth noting that the accounting guidance regarding this will evolve rapidly. This could lead to inconsistencies in accounting practices as well as unintentionally rewarding companies that had poorer monitoring in place at the start of AMP8. It would be useful for Ofwat to clarify how these issues could be managed and how we can support your work on this.

Q3.3: Do you have any suggestions on how our approach to PR24 quality enhancements could be implemented in a way that achieves our objectives whilst addressing the concerns raised by stakeholders?

A key concern Ofwat identifies in its current proposals is the reliability of the econometric modelling. Ofwat's bioresources models are currently still being developed and in their current format, there are concerns regarding model robustness. Given this, there is uncertainty that in cases where investment projects span multiple control periods, the models may not have the predictive capability required to accurately calculate the cost/revenue requirement for subsequent price controls.

We would recommend that as the bioresources models are novel, Ofwat should provide increased certainty by committing to fund quality enhancement capital projects undertaken in AMP8 for two control periods. This approach could be reviewed at PR29 for new quality enhancement schemes, once the bioresources models have had time to further develop and embed. This suggestion continues to align with Ofwat's aim of eventually bringing more costs into the econometric modelling, whilst providing more certainty to companies and investors. Alternatively, Ofwat could provide some degree of guarantee that cost adjustment claims relating to such projects are likely to be accepted.

We also support Ofwat's proposal for an additional allowance for quality enhancement claims at PR24. This is particularly relevant in the case of expenditure resulting from statutory WINEP and process emission requirements, which would not be reflected in historical enhancement costs. We would welcome more clarity with respect to the costs Ofwat considers as quality enhancements (as opposed to maintenance costs modelled in base cost models). For example we are currently working on the assumption that projects in the following areas fall under quality enhancements: process emissions, sludge WINEP, impact of waste WINEP, microplastics and Green Recovery related projects.

Updated proposals

Q3.4: Do you agree with, or have any comments on, the degree of regulatory protection we propose for pre-2020 RCV? Do you agree with our proposal to implement option 1 to achieve this?

Severn Trent agree with the degree of regulatory protection proposed for pre-2020 RCV. From the two alternatives presented, we consider that option one is more suited to achieve this.

Question 3.5: Do you agree with, or have any comments on, our updated proposals for modelling financing costs in our benchmarking models?

It is unusual to include financing costs in econometric models in regulated sectors and therefore they needed to be added with care and the results of the models considered in the round. Generally, we consider that econometric models should rely on actual rather than forecast data as this increases model uncertainty. However, Ofwat's proposal to use a PR24 post-tax allowed return on capital in the models might be appropriate given that historical financing costs could be materially different to future requirements. Assuming financing costs are included in econometric models, potential explanatory variables that describe these costs should also be considered.

Question 3.6: Do you agree with, or have any comments on, our proposals in relation to managing volume risk? Do you agree with our preferred option, that is, option 2?

Severn Trent believe that volume risk remains an issue, particularly when considering the uncertainty around environmental regulation and its impact on sludge production that we mentioned in response to Q3.2. Although we acknowledge that this uncertainty isn't particularly higher compared to previous years, the changes Ofwat are proposing to the regulation of bioresources mean that the effects are likely to be of even more material consequence going forward.

We do not have a preferred option from the three options presented by Ofwat. We would instead recommend that given the difficulty in accurately forecasting sludge volumes due to exogenous factors outside companies' control (for an example WINEP drivers), companies should not be penalised for inaccurate forecasts. Instead, we propose a true-up which adjust a companies' revenue within period. For example, companies could re-state their sludge production figures mid-AMP or once a particular identified uncertainty has been resolved. This would ensure companies are not rewarded for inaccurate forecasting, but also that they are not penalised when genuine errors in forecasting result from circumstances beyond their control.

Question 3.7: Do you agree with, or have any comments on, our proposals to make a separate adjustment for tax?

Severn Trent are supportive of Ofwat's proposals to make a separate allowance for tax outside of the econometric models. In line with other PR19 wholesale cost models it is not likely that the bioresources models will be able to accurately forecast tax requirements. This is because they are driven by external decisions by government, outside of company control.

Question 3.8: Do you agree with, or have any comments on, our proposal to continue to refer to the post-2020 asset base as RCV?

We welcome further clarity regarding the nomenclature for the post-2025 asset base.

However, we note that although this provides clarity on how gearing calculation could be calculated, given that the post-2020 RCV is subject to an efficiency challenge, rating agencies might simply adjust companies' RCVs to reflect the lack of protection provided to post-2020 RCV. This would worsen companies' gearing ratios in the view of the rating agencies with potential effects on companies' credit ratings, through no fault of the water companies.

In addition to this, investors may not consider post-2020 RCV as 'true-RCV' and this may have implications for cost of capital over the long run.

Question 3.9: Do you have any comments on our option assessment in the annex?

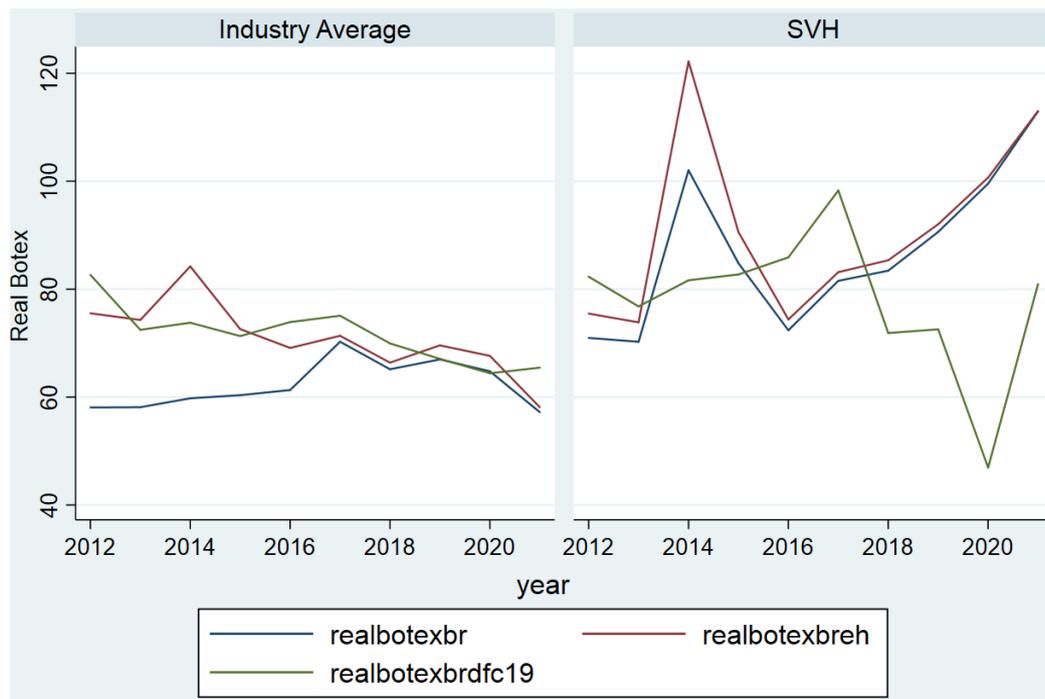
Severn Trent are supportive of Ofwat's aim to try and harness the market to provide value across the bioresources chain. We, however, have reservations that Ofwat's proposals thus far are not sufficiently developed for companies to have confidence in the proposed approach for AMP8.

We would also note that where Ofwat refers to implementation issues in its assessment of its preferred option three, we do consider these to be material. To implement the changes Ofwat proposes, two elements – quality data and robust models are required. Due to a lack of data availability, companies have been asked to derive time series and Ofwat is also considering using forecast data to extend the available time series. There are therefore questions regarding the accuracy and quality of data that is being used as an input into the econometric models and the implications this could have on the predictive capability of the models. Our concern is that Ofwat's option assessment is mainly driven by whether the options are theoretically reasonable in achieving its aims. We urge Ofwat to give more consideration to how its preferred approach will be practically implemented given the challenges around data quality.

Additional questions related to bioresources supplement

QS.1: Do you have any comments on the type of data used for the example model results? Whist recognising the proposed refinements to establishing standardised depreciation in annex 6, do you have further comments on whether RCV and RCV run-off would provide an acceptable and/or more appropriate input to our econometric cost benchmarking models over the 2020 to 2025 period?

The proposed changes to the dependent variable being shown across options 2 and 3 will have a material impact on how they might be appropriately modelled. The graphs below illustrate the time series of the different dependent variables.



The blue line (realbotexbr) shows bioresources base expenditure being used in option 1+. The red line (realbotexbreh) shows bioresources base and enhancement expenditure used in option 2. The green line (realbotexbrdfc19) shows bioresources opex, depreciation and financing costs (which we term the 'gate fee') as used in option 3.

Given the material changes in extent and relative distribution between the above dependent variables, it stands to reason that each of the options should require differing sets of explanatory variables that are sensitive to the actual costs/revenues being identified. This is particularly stark for us when comparing the current construct of the 'gate fee' against the existing base expenditure dependent variable, especially when focusing on the 2017-2021 data panel proposed for option 3.

For robust modelling outputs to be derived, the decision making surrounding which dependent and independent variables to use must be more closely aligned. We understand Ofwat's ambitions to better align the identification of efficient bioresources costs/revenues to the circumstances of the bioresources market rather than the building blocks approach previously used in the wastewater service. However, the focus set out in the supplementary document appears to be on determining if existing explanatory variables used in base cost models are sufficient in materially different 'gate fee' revenue models. We consider that a more appropriate route is finding the best relationship between desired dependent and available explanatory variables supported by expected causal relationships.

Regarding the use of RCV and RCV run-off as a measure for depreciation over the 2020-2025 period, we reiterate our comments from December 2021 that it may have complications for the predictive power of the econometric models. Following the development of the totex approach at PR14, a company's chosen RCV run-off rate no longer necessarily reflects capital expenditure and associated depreciation of assets ('the natural rate'). Therefore, in our view Ofwat should continue to explore using the standardised approach with data now available.

QS.2: Do you have any comments on the econometric models and results? How could our models be improved? For example, should we consider alternative specifications or cost drivers?

The three modelling options in Ofwat's supplementary paper fundamentally relate to the dependent variable that is being modelled – botex, botex+ or 'gate fee' revenue for option 1+, 2 and 3 respectively. There are likely to be benefits and challenges with modelling each of these dependent variables. However, if efficient bioresources costs/revenues are to be accurately revealed, the overarching requirement is to have confidence that the explanatory variables sufficiently capture the external drivers of the relevant dependent variable.

We are concerned that the specification of the models (particularly those that use a unit-cost approach for the dependent variable) is overly simplistic and it is likely that material drivers of expenditure are not being accounted for. We strongly encourage a more thorough exploration of potential explanatory variables that would improve the predictive power of bioresources models across the range of potential dependent variables.

Given the tight timescale for responding to this document, we have not been able to make substantive suggestions for model improvements here. We assume that bioresources modelling will be included as part of the wider spring 2023 cost modelling consultation and will be keen to provide bioresources model improvement suggestions through that process or earlier, if that would be helpful.

Where the predictive power of the models cannot be improved, this would need to be accounted for in the way that model outputs are used (e.g. the application of efficiency challenges) or would bring back into question whether setting out separate efficiency benchmarks for bioresources can be robustly delivered.

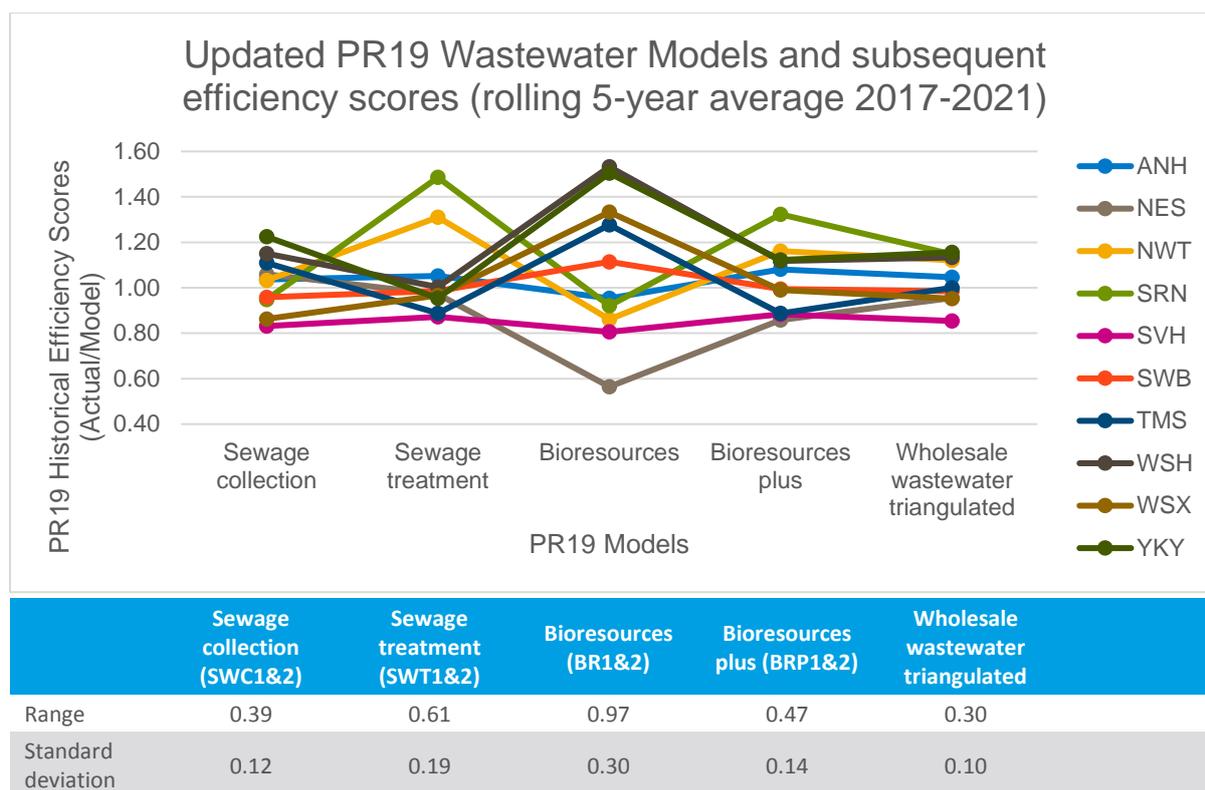
We note that the modelling included in this supplementary document considered SVE and HDD together (consistent with the modelling of SVH at PR19). We consider that this is appropriate for modelling purposes given that HDD will be a major outlier if it is included as a separate observation. However, consideration will be required to make sure that the modelling outputs are subsequently split between SVE and HDD on an appropriate basis.

We describe our initial thoughts on the bioresources models presented in more detail below.

Concerns with the specification of the existing PR19 bioresources models

The models presented in option 1+ and option 2 use the same explanatory variables as the PR19 BR1 and BR2 models. However, as illustrated in the figure and table below, the distribution of model efficiency scores (as shown by the range and standard deviation) is much wider for the bioresources models. This suggests that relative to the other models used, the bioresources models appear to be under specified. This would infer that legitimate cost pressures are being transferred to the model error terms, and that the coefficients of the selected explanatory variables are likely to be biased.

The figure below also highlights the potential for cost allocation inconsistencies between sewage treatment and bioresources for some companies. This is shown by the interchangeability of efficiency scores between the SWT (sewage treatment) and BR (bioresources) models and the tighter distribution of residuals in the BRP (bioresources plus) models.



At PR19, the reduced explanatory power of the bioresources models was mitigated by the fact that Ofwat was using the models to derive an efficient view of wastewater expenditure rather than bioresources expenditure. The relatively small size of the bioresources costs and the triangulation with the SWC (sewage collection), SWT and BRP models (that have tighter efficiency scores) resulted in the range and spread of the triangulated wastewater efficiency scores that were used being much smaller than those in the bioresources models. However, the proposal to identify separate bioresources efficiency scores means that these mitigations are not available. Therefore, there is a much greater need to develop and use bioresources models that have higher explanatory power and minimise the risk of legitimate costs being included in the model error terms to ensure a reliable efficiency estimate can be produced.

Logic for explanatory variables and interpreting the coefficients in the identified models

A fundamental principle of developing robust cost models is that they must be supported by robust engineering logic. However, the current supplementary document does not appear to provide much detail to support the modelling specifications presented. This raises concern that model improvements are being sought based on statistical iteration rather than being driven by engineering expectation. We consider that this should be given greater attention as Ofwat finalises its bioresources approach and models.

The fundamental properties of wastewater mean that transporting raw sewage significant distances is more complex relative to water. This means that the size of sewage works is strongly influenced by the size of the immediate population centres they serve. However, treatment of sludge is less geographically constrained than sewage treatment and also less economic at small scale. This means that sludge is often transported from some smaller sites to regional treatment centres.

The PR19 bioresources models were very parsimonious with only two or three explanatory variables. This creates significant pressure on the variables that were included to account for multiple drivers of

cost. At a high level the PR19 models consisted of one scale driver (sludge produced) and one or two measures or proxies for population density. These were:

- weighted average population density (a direct measure of population density which drives the ability to have large sewage treatment works);
- load treated at sewage works of size band 1-3 (the challenges of transporting sewage significant distances mean that small sewage works are a function of supplying more rural communities, sludge is more likely to be transported to regional treatment centres from small works); and
- Sewage treatment works per connected property (where the presence of large population centres will allow for fewer works relative to more rural populations).

It is uncontroversial to include sludge produced as a scale driver (or an economy of scale driver in unit cost model forms). We note the highly significant coefficients in the Option 1+ specifications, suggests diseconomies of scale are present. All else constant, this may feel surprising given the opportunities from scale within large sludge treatment facilities. However, the interaction with population density is complex as it is likely to drive both the inherent size of sewage works and associated sludge treatment facilities, and also the challenges of treating sludge from small sewage works in regional treatment centres. It is likely that both the scale driver and density related drivers will interact, and it is not clear to what extent the limited number of variables will be able to adequately capture these complex interactions. We consider that this should be tested further.

Whilst scale and population density should rightly be considered as major cost drivers of bioresources costs/revenues, there are other drivers that may not strongly relate to these current variables. These include:

- **The availability and proximity of appropriate disposal routes for treated bioresources.** This is largely driven by the availability and type of agricultural land (driving both transport and level of treatment required). EA sludge use regulations that are reducing the available landbank are likely to mean that historical cost driver relationships relating to treated bioresource disposal may not necessarily be a good proxy for future cost pressures.
- **The composition of the sludge being treated.** As wastewater treatment standards tighten (e.g. ammonia or phosphorus consents) we receive increasing proportions of sludge from secondary treatment. This is harder to treat and has a lower calorific value. Consequently, they require more complex/challenging sludge treatments. The relative complexity of sludge assets installed will have a direct effect on both operating and maintenance costs.
- **The likely growth in sludge expected and the extent to which there is capacity within existing sludge treatment facilities to accommodate it.** Growth in the volume of sludge to be treated is difficult to predict. It is, in turn, driven by increasing populations served and tightening wastewater discharge consents which will increase both the volume and complexity of the sludge to be treated.

It would be sensible to explore whether explanatory variables or proxies can be identified to take account of these potentially omitted variables to reduce the pressure on existing scale and density explanatory variables in the models.

Review the relative statistical performance of the identified bioresources models

In the tables below we have compared the performance of the Option 1+ and 2 models on a like for like basis. To do this we have converted all of the models to unit cost forms and showed both the 5

year and 10 year data panel lengths. By their very nature, scale drivers are likely to drive most of the predictive capability of a cost model. Therefore, where the scale driver is uncontentious (as is the case for sludge volume) converting to a unit cost model form will provide a much clearer visibility of the extent to which the other non-scale drivers are effectively describing costs. We can see the non-scale drivers appear to offer little explanatory power and that the model performance reduces as enhancement costs are included into the model.

We have then replicated the BR1 and BR2 explanatory variables for the 'gate fee' dependent variable (option 3). This change in the dependent variable again leads to the predictive power dropping dramatically (R^2 of 0.09 and 0.03 for BR1 and BR2 respectively) and certain coefficients not conforming to engineering expectations. This suggests that, on a like for like basis, the performance of the BR1 and BR2 models deteriorate as the dependent variable changes from botex, to botex+ to 'gate fee'. This is a strong reason to revisit and find new improved explanatory variables that better describe the different costs/revenues being modelled, especially if the 'gate fee' proposal is preferred.

Bioresources model coefficients and performance (assuming a full panel and unit cost specification)						
Dependent variable option	Option 1		Option 2		Option 3	
Specification	BR1	BR2	BR1	BR2	BR1	BR2
Sludge Produced	0.243***	0.272	0.333**	0.336	-0.144	-0.231
Weighted Average Density	-0.218**		-0.227**		0.032	
Load treated in band sizes 1-3 (%)	0.073***		0.070***		0.017	
Sewage treatment works per property		0.429**		0.406*		-0.023
Constant	-0.686	1.394*	-0.960	0.979	-0.326	0.190
Observations	100	100	100	100	100	100
R^2	0.415	0.284	0.292	0.141	0.093	0.032
Note: ***p<0.01, **p<0.05, *p<0.1						

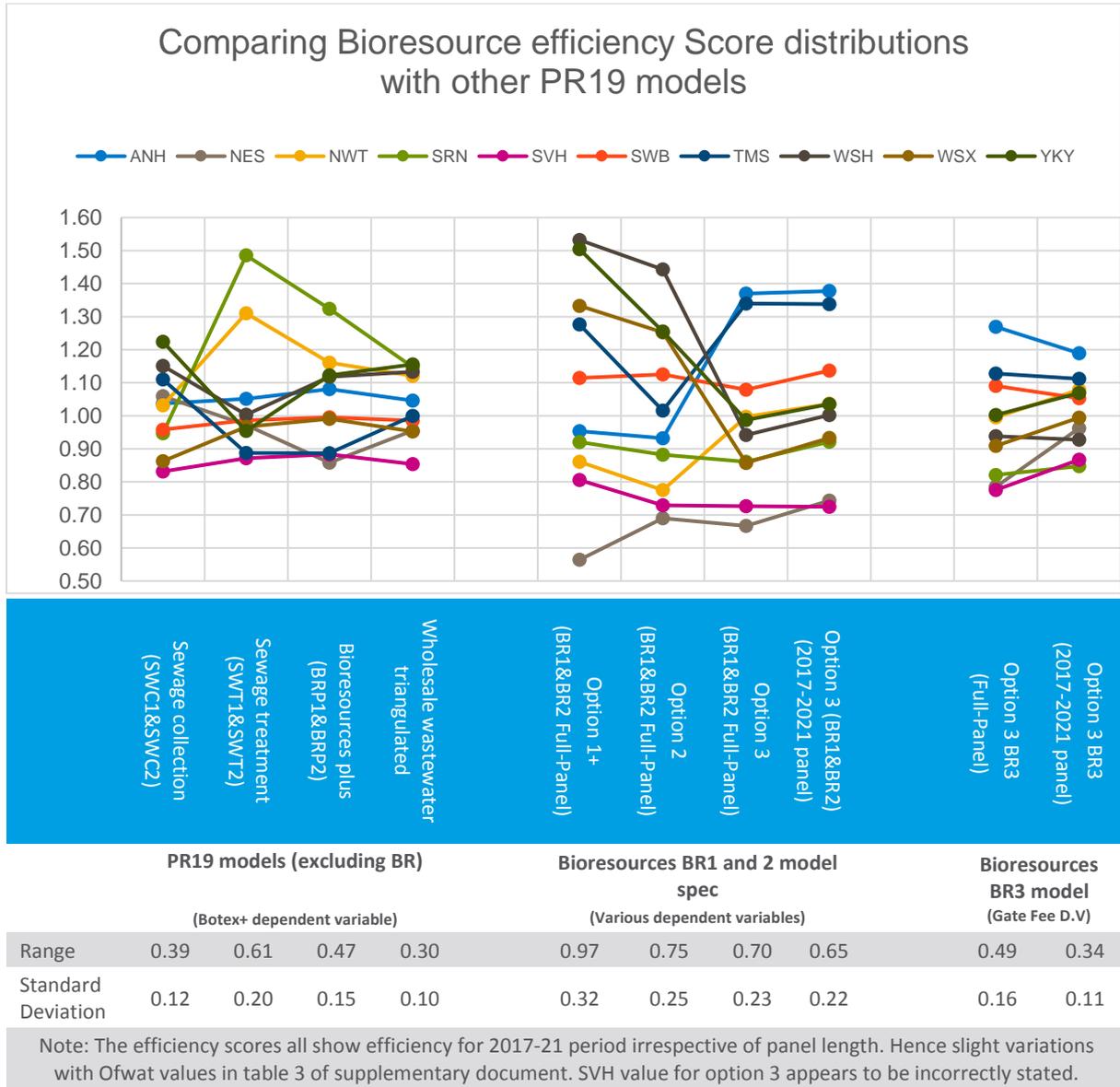
Bioresources model coefficients and performance (assuming a 2017-2021 panel and unit cost specification)						
Dependent variable option	Option 1		Option 2		Option 3	
Specification	BR1	BR2	BR1	BR2	BR1	BR2
Sludge Produced	0.415**	0.408*	0.391*	0.380	-0.037	-0.157
Weighted Average Density	-0.378**		-0.396**		0.041	
Load treated in band sizes 1-3 (%)	0.098***		0.089**		0.043	
Sewage treatment works per property		0.590***		0.565**		-0.003
Constant	-0.432	2.080**	-0.114	2.041**	-1.047	-0.045
Observations	50	50	50	50	50	50
R^2	0.512	0.315	0.491	0.294	0.282	0.062
Note: ***p<0.01, **p<0.05, *p<0.1						

Comparing the model residuals to PR19 wholesale waste models

We have reviewed the distribution of 'efficiency' inferred by the identified bioresources model specifications and remain concerned that their predictive power remains poor relative to the SWC, SWT and BRP models that were used at PR19.

The figure below shows the efficiency rankings for the various bioresources model specifications and how they compare to the PR19 cost models that have a broader scope than bioresources. It shows a much wider distribution of efficiency scores remain for the BR1 and BR2 specifications across all the identified dependent variables. This suggests that misspecification remains an issue which would need to be addressed if a similar level of confidence is to be given to the model outputs relative to PR19. This may be explored further by considering the error terms in the models by isolating the time variant idiosyncratic error term (Epsilon) and time invariant unobserved heterogeneity term (Mu). Whilst the former should be anticipated due to inter-annual modelling noise, a material component of the latter could relate to company-specific factors outside of management control that have not been accounted for by the explanatory variables.

The Option 3 BR3 model specifications do appear to show a material improvement in predictive performance. This is encouraging. However, as described below (and as acknowledged by Ofwat) these specifications have coefficients that are not supported by engineering logic and appear to contain collinearity issues. This significantly weakens the validity of these models meaning that further investigation into the most appropriate configuration of dependent and explanatory variables is needed.



Identified modifications shown in option 3 (BR3) raise further modelling issues

We can see that the option 3 model presented in the supplementary document has had two significant interventions made in an attempt to improve its predictive capabilities:

- The BR1 and BR2 model specifications have been merged to make one (BR3) specification
- The model data panel has been reduced from 10 years to 5 years.

These changes improve the explanatory power and significance of the model (as seen by the improved adjusted R^2 and significance of the explanatory variables). However, the coefficient of the sewage treatment works per property variable becomes counter intuitive and there is evidence of multicollinearity within the model. This is a material concern to the validity of the models as the coefficient can no longer be justified through engineering expectation and the relationship between the coefficients can no longer be relied upon. We also consider that other potential remedies should be exhausted before the length of the data panel is reduced because this is likely to have played a part in some of the model estimates being erratic.

Variance Inflation Factor (VIF) scores were calculated across all models to evaluate the concerns of multicollinearity (see table below). There is no definitive threshold whereby VIF scores confirm collinearity. However, in our response to the 2022 Base cost modelling consultation, we suggested that a value of 5 is an appropriate test. The traditional PR19 BR1 and BR2 models passed the assumed threshold, i.e. no strong evidence of multicollinearity. However, VIF values from the option 3 BR3 specification, combined with the corresponding engineering logic, strongly suggest an issue with the sewage treatment works per connected property variable.

Variance Inflation Factor (VIF) by Bioresources model specification	BR1	BR2	BR3
Sludge Produced	3.18	3.55	3.52
Weighted Average Density	2.36		6.69
Load treated in band sizes 1-3 (%)	2.62		5.69
Sewage treatment works per connected property		3.55	17.61
MEAN VIF	2.72	3.55	8.38

Additionally, pairwise correlations, shown in the table below, show the high levels of correlation between the Sewage treatment works per connected property variable and the three other explanatory variables (all greater than +/- 0.8). Similarly, the table shows that all of the explanatory variables exhibit correlation signs in line with our prior engineering expectations when sequentially correlated with the 'Gate fee' / TTDS unit cost (i.e. the Option 3 dependent variable). These correlations align with the BR3 model coefficients with the exception of sewage treatment works per property. Both analyses therefore suggest that multicollinearity is an issue in the BR3 model specification.

Pairwise Correlations	Option 3 dependent variable ('Gate fee' / TTDS)	Sludge Produced	Weighted Average Density	Load treated in band sizes 1-3 (%)	Sewage treatment works per connected property
Option 3 dependent variable ('Gate fee' / TTDS)	1.000				
Sludge Produced	-0.251	1.000			
Weighted Average Density	-0.248	0.725	1.000		
Load treated in band sizes 1-3 (%)	0.549	-0.774	-0.673	1.000	
Sewage treatment works per connected property	0.268	-0.842	-0.895	0.874	1.000

Given the current information available, we conclude that the increase in predictive capability of Option 3 BR3 specifications relative to the BR1 and BR2 specifications should not yet be relied upon. This is because of the lack of engineering support to the coefficients and the likelihood of them being affected by multicollinearity. Both are likely to be exacerbated by the decision to reduce the size of the data panel. This means that we cannot be confident that the model specification is appropriately accounting for material drivers of bioresources costs/revenues. The issue of multicollinearity should not be ignored because it will likely lead to unreliable and unstable coefficient estimates which eventually feed into Ofwat's view of modelled costs. A company with more sewage treatment works per property exhibiting/receiving less (unit) cost relative to another company with fewer works per property (holding all else equal) is counter intuitive. As these estimates are a key determinant in

efficiency analysis and the subsequent cost allowances, overcoming this issue should, in our view, be a priority.

Summary of the current state of the bioresources models

We understand Ofwat's desire to model bioresources models separately and derive separate efficiency challenges. Whilst the apparent predictive power of the option 2 BR3 model may appear attractive, we consider that it and the other models currently presented have not yet demonstrated an appropriate level of robustness, nor reliability, for them to be used in a way consistent with the PR19 models.

Therefore, we think that there is a need to explore an improved set of explanatory variables that will be able to better describe the independent cost pressures associated with bioresources.

Given the timescales of responding to this supplementary document, we have not been able to make substantive suggestions for model specification improvements here. However, we think this should be included as part of the scope of the spring 2023 cost modelling consultation or an earlier process if it would be helpful, which we would be happy to contribute to.

If the model performance cannot be improved, we suggest that Ofwat might want to reconsider calculating separate bioresources (and network plus) efficiency benchmarks using econometric models.

QS.3: Do you agree with, or have comments on, the proposed, updated approach to calculating asset values and CCA depreciation as set out in annex 6?

We are still working on the data request annex six is referring to. Therefore we will be providing a complete response to this question on the 23rd of September 2022, alongside the data information request: [Bioresources control: New Depreciation and Net Modern Equivalent Asset Value approach](#). We would like to note that the data we will be providing, where appropriate will be subject to first, second and third line assurance.