July 2019

Trust in water

PR19 draft determinations

Securing cost efficiency technical appendix

Ofwat

PR19 draft determinations: Securing cost efficiency technical appendix

About this document

Cost assessment is the setting of an efficient total expenditure (totex) allowance for each company for the price control period.

This document sets out our approach to cost assessment as part of our slow track draft determinations. We explain how we develop our view of efficient totex for each company for the period 2020-21 to 2024-25.

Our approach to cost assessment is based on the methodology set out in our PR19 methodology document. Our assessment is implemented through a suite of excel models, which we publish alongside this document.

Contents

1 Securing cost efficiency for customers

As part of PR19 we set a total expenditure (totex) allowance for companies for the period 2020-21 to 2024-25. Our totex allowance is a material component of customers' bills now and in the future. Customers are dependent on their water company. It is important that customer bills reflect efficient costs.

Our PR19 methodology makes clear our expectation that water companies must make a step-change in efficiency by 2025, allowing them to deliver better services for customers, and protect and improve the environment, while at the same time keeping bills low.

Our expectation is based on emerging evidence of efficiency gains from the recent move to the totex and outcomes framework, the greater use of markets and the regulatory focus on innovation in our PR19 framework.

Cost projections at the initial assessment and at draft determination

In September 2018 water companies submitted their business plans for the period 2020-25 (AMP7). In their business plans companies forecasted a total expenditure of £56.3 billion for the five-year period – an increase of 11.4% relative to the expenditure in 2015-20 (AMP6).

There were encouraging signs in the business plan projections. More than half of the companies reduced their base (routine) cost projections for AMP7 relative to AMP6, some significantly. Our allowances for base costs at draft determinations reflect this:

- In wholesale water, seven companies submitted base cost proposals that are efficient. Our efficient allowance for base costs is higher than five of those proposals.
- In wholesale wastewater, two companies submitted base cost proposals that are lower than our view of efficient costs.
- In residential retail, seven companies submitted base cost proposals that are lower than our view of efficient costs.

However, there is still considerable room for improvement for most companies. Some companies submitted proposals for base costs that are a significant increase on historical expenditure, and significantly above our view of efficient costs. We have written to four companies (Anglian Water, Thames Water, Yorkshire Water and SES

Water) expressing concerns over their proposed costs for maintaining a base level of service.

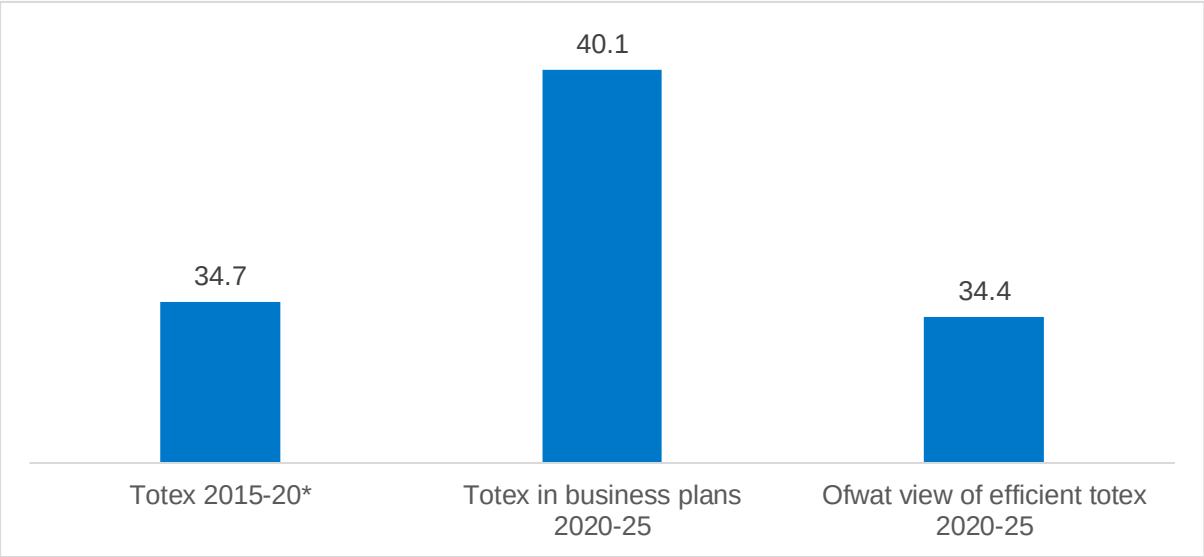
On 31 January 2019 we published the results of our initial assessment of business plans. Consistent with a step change, our results incorporated evidence on efficiency gains from best practice in the wider economy, and the potential gains from the totex and outcomes framework. Our challenge to companies' cost proposals was almost £7.5 billion, ie 13.3% of submitted costs.

In April 2019 the 14 slow track and significant scrutiny companies submitted revised business plans. Overall companies reduced requested costs by £1.43 billion (2.5%). The total expenditure forecasted by slow track and significant scrutiny in their revised plans is £34.4 billion.

We have reviewed the revised proposals of the 14 slow track and significant scrutiny companies. We have responded to feedback on our approach and we outline some of the changes below. For draft determinations, our cost challenge to water companies' proposals remains broadly the same as at the initial assessment of plans stage. A substantial gap between our view of efficient costs and company proposals remains.

Figure 1 shows total cost projections for all water companies relative to the current period. Annex 1 provides detailed tables of business plan costs by company relative to our view of efficient costs.

Figure 1: Historical costs versus projections for 2020-25 for slow track/significant scrutiny companies (£ billion in 2017-18 prices)



* Totex in 2020-25 based on three years actuals and two years of forecast.

Key changes in our cost assessment approach

We have reviewed company responses to our initial assessment of plans. In light of those representations we have made a number of key changes to our approach at the initial assessment of plans. The key areas of change are:

- **Definition of base costs:** we expand the definition of base costs to include costs that are driven primarily by population growth (section 3.2.1).

- **Forecast of cost drivers:** we change our approach to forecasting some of the cost drivers in our econometric models. For example, to forecast the number of connected properties we now use growth rates provided by the Office for National Statistics (ONS) instead of relying on historical trends (section 3.2.2).

- **Bioresources modelling:** we added an additional driver to our bioresources models to control for high transport costs due to population sparsity (section 3.2.3).

- **Updates to historical data:** we updated historical data on booster pumping stations following an information request, with implications for our base econometric models in wholesale water. We also received revised data on pumping capacity in wastewater from one company, with implication for our base econometric models in wholesale wastewater (section 3.2.4).

- **Real price effects:** we make a real price effects adjustment for labour costs. Our adjustment is based on Office of Budget Responsibility forecasts of labour productivity and real wage growth. Given the uncertainty in the forecasts we consider that there should be an ex-post true up at PR24 based on outturn manufacturing wage growth (section 3.3.2).

- **Enhancement operating expenditure (opex):** we assess enhancement activities on a totex basis rather than a capital expenditure (capex) basis as at the initial assessment of plans. That is, we include enhancement opex explicitly in our assessment of enhancement costs, rather than making an implicit allowance in base costs (section 4.2).

- **Resilience enhancement:** we have refined the definition of the type of investment that may qualify as resilience enhancement (section 4.3).

- **Leakage:** we have removed the 15% leakage reduction target as a threshold for allowing enhancement costs. Our threshold is set at the 2024-25 forecast industry upper quartile leakage performance (section 4.4).

- **Environmental obligations (WINEP/NEP):** we updated our benchmarking models based on revised data and representations to the initial assessment of plans. We addressed an estimation bias related to log-linear models where appropriate. We set the cost challenge at a programme level rather than for each activity in isolation (section 4.6).

- **Residential retail:** we updated a number of our cost drivers with recent updates to the data made by the ONS. We have also changed our method for calculating the efficiency challenge from using the 'forward-looking upper quartile' to using both the forward looking upper quartile and the historical upper quartile with equal weights (section 6.1).

We have made additional, less material changes, to our approach. In this document we provide a full account of our cost assessment approach. We expand on how we have developed our approach since the initial assessment of business plans and set out our updated view of efficient totex for the draft determinations of companies classified as slow track or significant scrutiny at the initial assessment of plans.

As part of Ofwat's emerging strategy, on 12 July 2019 we set out proposals to potentially make up to £200m available to fund innovation activities in the 2020-2025 period. One of our proposals is that this additional funding is provided for through the 2019 price review through an addition to the revenue requirement. Alternatively we could fund it through a reward for innovation activities paid out at the 2024 price review. We have not included the additional funding in our revenue limits for draft determinations.

All of the responses to the initial assessment of business plans, including all of the companies' revised business plans provided by the 1 April 2019, are taken into account in our decisions where relevant. Where appropriate, we explicitly set out our response to points and issues raised by respondents.

Our decisions also take into account the representations made on the fast track draft determinations where the points and issues raised are relevant to the slow track and significant scrutiny draft determinations. We will deal with the other elements of the representations to the fast track draft determinations as part of the final determinations.

We have not necessarily been able to take full account of all late evidence, submitted after the 1 April 2019 business plans, and we will consider this information for the final determination.

1.1 Applicability of this document to fast track companies

The approach presented in this document fully applies to fast track companies. Annex 1 provides our view of efficient cost allowances for all companies, including for fast track companies. While for fast track companies these are not revised draft determination allowances, it provides an update on our view of costs from changes in our approach since the initial assessment of plans as we move towards final determinations.

As we set out below, for the slow track draft determinations we assess enhancement on a totex basis. The impact of this change in approach is visible for the fast track companies in our enhancement assessment. For these draft determinations we have not assessed in depth fast track companies' proposed expenditure in areas where we do a deep dive assessment (eg raw water deterioration; taste odour and colour; WINEP/NEP water framework directive requirements; and sludge growth and quality). We will review significant enhancement opex proposals in these areas for final determination. We do not expect material changes to our assessment results.

In our PR19 methodology we set out our early certainty principle for fast track companies. The early certainty principle applies only to specific components of the draft determinations. For cost, the early certainty principle applies only to cost adjustment claims. Companies were allowed to opt in or out of the early certainty principle. Severn Trent Water and South West Water opted in to early certainty for costs. United Utilities opted out. The early certainty principle does not apply to other components of our cost assessment approach.

2 Overview of our cost assessment approach

In this section we explain the different components of our cost assessment approach.

Building blocks of our approach

Our view of the efficient totex allowance for companies is built up from a number of building blocks. These are set out in table 1 below.

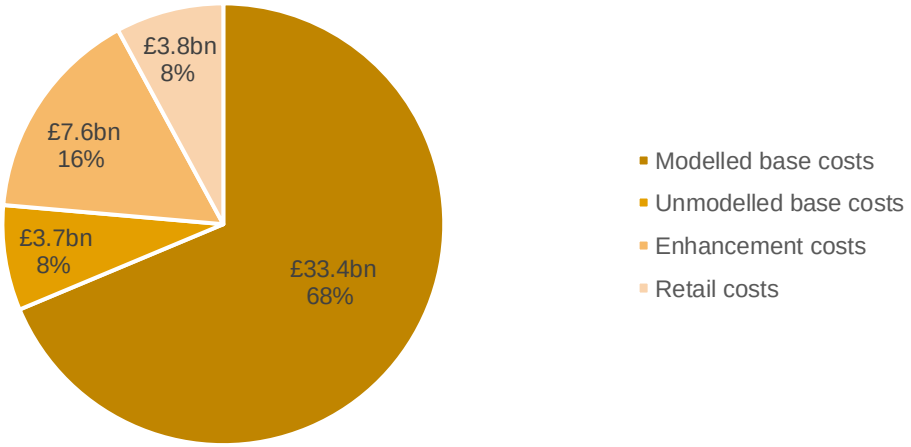
Table 1: Building blocks of our totex assessment

	Building block	Costs included	Assessment approach
Wholesale	Modelled 'base plus' costs	• Operating expenditure (excluding specific cost items included in 'unmodelled base costs') • Maintenance capital expenditure • Specific enhancement lines (see section 3.2.1)	• Econometric models using historical data (Annex 2) • Assessment of cost adjustment claims • Efficiency challenge: historical upper quartile performance in the sector plus a net frontier shift assumption
	Unmodelled base costs (wholesale services only)	• Business rates • Water abstraction charges (water only) • Traffic Management Act costs • Wastewater Industrial Emissions Directive costs (wastewater only)	• Various methods as appropriate. Assessment based on business plan (forecast) data • Assessment of cost adjustment claims
	Enhancement expenditure (wholesale services only)	• Enhancement expenditure reported in business plan tables WS2 and WWS2, except lines that we now include in modelled base costs (see section 3.2.1)	• Various methods as appropriate: – benchmarking models – deep/shallow dive assessment • Assessment of cost adjustment claims
Retail	Residential retail	• Residential retail costs	• Econometric models using historical data (Annex 2) • Assessment of cost adjustment claims • Efficiency challenge: average of historical and forward looking upper quartile performance
	Business retail (where applicable)	• Business retail costs	• Lighter touch. Challenge based on benchmarking with historical/other companies/residential retail

We add together these four building blocks to come to our view of the efficient total cost allowance for each company as set out in figure 2.

Figure 2: Building blocks of our totex assessment

Figure 2: Materiality of allowed cost per building block (prices of 2017-18 CPIH deflated, all companies)



Price controls for which we set an allowed cost at PR19

At PR19 we set efficient totex allowances for up to six different controls for each company:

- water resources control;
- water network plus control;
- wastewater network plus control;
- bioresources control;
- residential retail control; and

- business retail control for Welsh water companies and for English water companies that have not exited the market.

We will also set two separate controls which are company specific:

- Tideway wastewater control for Thames Water only; and
- Havant Thicket water control for Portsmouth Water only.

We do not discuss our assessment approach for the company specific controls in this appendix. We discuss them in the relevant company draft determination summary and appendices.

In section 5 we explain how we pull all the pieces of our assessment together to set allowances to the different controls.

Structure of the rest of the document

In the remaining sections of this document we discuss the assessment method we apply for each of the building blocks of our approach.

- In **chapter 3** we explain our approach for assessing base costs, including both the modelled and unmodelled costs items.
- In **chapter 4** we explain our approach for assessing enhancement costs.
- In **chapter 5** we explain how we pull all the pieces of our assessment together to set allowances to the different controls.
- In **chapter 6** we explain our approach for assessing retail costs.
- In **chapter 7** we explain our approach to assessing cost adjustment claims.
- In **chapter 8** we explain additional details of our cost assessment approach.

3 Our assessment of base costs

Base costs are routine, year-on-year costs, which companies incur in the normal running of the business to provide a base level of service.

We distinguish between modelled based costs and unmodelled based costs. Modelled based costs are the majority of base costs and are assessed using econometric models. Unmodelled base costs consists of a small number of items with characteristics that make them more suitable for a separate assessment. We discuss each below.

3.1 Modelled base costs

To assess whether company business plans include efficient modelled base costs we develop an independent view of efficient costs.

Our independent view of efficient costs is an important part of our incentive-based regulation under information asymmetry. It removes an incentive for companies to inflate their expenditure requirements to influence our view of efficient costs. Because our view of efficient costs is independent of business plans, it means that a company may get more than requested where its expenditure forecast is more efficient that our own view of efficient costs. Such a company will have helped set the efficiency challenge for the rest of the sector.

Our independent view is based on:

- econometric modelling of costs using historical data on cost performance submitted by the water companies;
- our independent forecast of the cost drivers; and
- an efficiency challenge that includes a catch up and a frontier shift component.

We discuss each in turn with a focus on changes to our approach since the initial assessment of plans stage.

3.2 Econometric modelling

The purpose of our econometric modelling is to benchmark companies' costs while taking into consideration the effect of explanatory factors that are largely beyond

company control. Any remaining variation in cost across companies is attributed largely to variation in efficiency. This allows us to identify companies that are relatively efficient and use them as an efficient benchmark for the rest of the sector.

Annex 2 provides a detailed specification of our econometric models. Our initial assessment of plans' document Supplementary technical appendix: Econometric approach provides detail on our model selection process and rationale for our selected models. Below we highlight changes to our assessment approach for modelled base costs:

- Changing the scope of costs included in base costs
- Changes to our forecast of cost drivers
- Changes to our bioresources econometric models
- Updated data provided by companies

3.2.1 Changing the scope of costs included in base costs

Our approach at the initial assessment of plans

At the initial assessment of plans, modelled base costs (which is the dependent variable in our econometric models) included only operating expenditure (opex) and maintenance capital expenditure (capex). Modelled base costs did not include capex related to enhancement activities (except for transferred private sewers and pumping stations in wastewater).

Because companies do not distinguish between base and enhancement opex in the annual reports submitted to us, the opex included in modelled base costs relates to both base and enhancement.

In our PR19 methodology (page 145) we said that it may be appropriate to include certain enhancement activities in the scope of our econometric models, together with base expenditure. In particular, enhancement activities that are driven by growth in demand or population may have an underlying relationship with the same drivers of base expenditure.

Our approach at draft determinations for slow track and significant scrutiny companies

After further consideration since the publication of the initial assessment of plans, we have decided to include a number of areas that were previously considered as

enhancement and, as such, were assessed separately. These are summarised in table 2 for water and table 3 for wastewater.

Table 2: Wholesale water activities added to modelled base costs

Activity	Total totex requested (after reallocations)	Description
New developments	£1,075m	Expenditure for the provision of local distribution assets for the water service to provide for new customers with no net deterioration of existing levels of service.
New connections element of new developments	£622m	Expenditure on local network assets associated with new development in water services.
Addressing low pressure	£21m	Expenditure to reduce the number of properties with low pressure.

Table 3: Wholesale wastewater activities added to modelled base costs

Title	Total totex requested (after reallocations)	Description
New development and growth	£835m	Expenditure for the provision of new development and growth in sewerage services.
Growth at sewage treatment works	£1,150m	Expenditure to meet or offset changes in demand from new and existing customers at sewage treatment works.
Reduce flooding risk for properties	£869m	Expenditure for enhancing the sewerage system to reduce the risk to properties and external areas of flooding from sewers.

Rationale for changing the scope of modelled base costs

For the initial assessment of plans we developed ‘growth’ models in water and wastewater. The models included costs whose underlying driver is population growth. For the water service, our growth model combined new developments and new connection costs. For the wastewater service, it combined new development and growth, growth at sewage treatment works and reducing flooding risk for properties. We assessed companies’ proposals through benchmarking, using an econometric model with the number of new connections in the year as a cost driver.

A number of companies raised issues with our assessment of growth costs:

- Companies said that assessment of growth costs on a capex basis is not appropriate. This issue is not unique to growth costs, but to all enhancement activities. We agree with this view and amended our assessment of enhancement costs to be on a totex basis.
- Our growth models had a relatively wide range of unit costs (ie cost per new connection) across companies. A number of companies suggested that the range was too wide and cannot be regarded as reliable evidence of efficiency. This may be a result of including a single cost driver in the model – some argued that the model may be missing explanatory factors. Some companies suggested that it may be due to differences in reporting.
- In relation to the water growth model, a number of companies argued that we did not consider differences in self-lay penetration.
- In relation to wastewater growth models, a number of companies highlighted the sensitivity of our stand-alone model results to the inclusion of Hafren Dyfrdwy, which is significantly smaller than all other wastewater companies.
- In relation to wastewater growth models, a number of companies suggested that 'risk of sewer flooding' should be assessed separately because of different cost drivers.

We considered two main alternatives to address the concerns above. The first was to test similar models to those at the initial assessment of plans, but on a totex basis. In the wastewater growth model, where we use forecast data we merged Hafren Dyfrdwy with Severn Trent England so that Hafren Dyfrdwy is not an outlier with an excessive impact on our results.

The second alternative was to incorporate growth expenditure into our base econometric models. This is consistent with our view that growth related enhancement expenditure can be included in our base econometric models because they share similar characteristics[1]:

- Growth related expenditure is routine. Companies have incurred it in the past and will incur it in the future.
- Growth related enhancement can be explained with similar cost drivers to operational and capital maintenance (eg company scale).
- We do not expect to see a significant step change in what drives growth enhancement expenditure during PR19.

[1] See CEPA criteria for when it is appropriate to include enhancement costs in base costs econometric models. Source: CEPA, 2018. PR19 Econometric Benchmarking Models. Page 34.

We decided to use the second alternative for draft determinations. We considered that the stand-alone totex growth models did not offer an improvement relative to the models used at the initial assessment of plans. On the other hand, including growth costs in our base econometric models better addresses the concerns raised by companies and our models remain robust. An integrated approach to base and growth costs removes some concern related to inconsistent data allocation between growth and base activities, as well as concerns related to double-counting of the enhancement opex allowance (see section 4.2.4).

With the stand-alone models at the initial assessment of plans, we put some weight on models that use forecast data. Our base econometric models use historical data. One of the implications of the move to integrated base cost models is that we rely on historical cost performance to forecast efficient expenditure. This is appropriate for routine activities which allow us to benchmark companies' proposals to actual efficient cost performance. For a few companies, where we consider that the gap between their forecast of growth costs and ours is large, we carry out a deep dive of their growth costs. This results in us making an additional allowance for South East Water of about £42 million.

The use of historical data means that we do not model Hafren Dyfrdwy separately in our models, addressing the concerns of its excessive influence on modelling results.

Regarding the issue of self-lay penetration, we do not consider that there is a clear relationship between self-lay penetration and new connection costs. High level of penetration may be a consequence of high unit costs by the incumbent or an indication that competition in the specific region is vibrant and keeps the incumbent's unit costs low. We considered including self-lay penetration in the models but decided against it at draft determinations due to inconsistency in data reporting between companies. We have sent out an all company data request alongside the draft determination to better understand the relationship between new connection costs and self-lay penetration. In any case, we consider that any potential distortion to modelling results due to different levels of self-lay penetration should be mitigated when the cost is modelled in our base econometric models. This is because the impact of this factor on modelled base costs is low and we do not use new connections reported in the year as a cost driver.

Regarding the inclusion of 'reduce flooding risk for properties' in our base models, we examined the data and found that companies generally forecast a flat profile of investment over 2020-2025, and that the investment is reasonably driven by population growth and the size of the company. We therefore consider that it is appropriate to include it within the scope of base costs and in our base models.

Table 4 summarises the points of consideration between a stand-alone model and an integrated, base plus, approach.

Table 4: Options for addressing issues with stand-alone capex growth models

Criterion/Issues	Stand-alone totex growth models	Base plus econometric models
Costs suitable for inclusion in base econometric models	N/A	✓
Addresses enhancement opex issue	✓	✓
Addresses issue of excessive modelling impact of Hafren Dyfrdwy	✓	✓
Addresses cost allocation issues	×	✓
Robust model quality	×	✓
Mitigates potential impact of self-lay penetration	×	✓

We assessed whether any other enhancement activities fulfil the criteria for inclusion in our base econometric models. The only additional activity that we decided to add to base costs is expenditure to address low pressure. Companies have always had a requirement to address low pressure and there is no new statutory threshold to obtain. Only four companies submitted any expenditure in this area for a total of £21 million. The same companies reported costs in this area in the historical period on which our models are based. We think this may reflect differences across companies in the classification of costs as enhancement in this area. We therefore consider that it is appropriate to add these costs to our base econometric models.

For all other enhancement activities we consider that they do not sufficiently satisfy the criteria for inclusion with base costs or that we have a robust stand-alone model so there is no good reason to change our approach at this stage.

In the rest of this document we will generally use the term ‘base’ to refer to base expenditure plus the activities in tables 2 and 3. We will use the term ‘base plus’ only when it is needed for clarity.

3.2.2 Our forecast of cost drivers

To set cost allowances for 2020-25 using our cost models we form a view about the value of the explanatory factors (‘cost drivers’) for that period. We put our view of the explanatory factors into the models to obtain a forecast of average costs.

As explained above, developing an independent view of efficient costs is an important part of our incentive-based regulation, and forming an independent view of cost drivers is a key part of this. It is important to protect customers from potentially inflated forecasts that feed into cost estimates and customer bills.

Our approach at the initial assessment of plans

For the initial assessment of plans, our forecast value for the cost drivers was largely based on their historical value. In most cases we use either a linear trend or an average over a number of historical years to forecast the driver. For a small number of cost drivers we use company forecasts of the driver instead of our own.

For example, volume of sludge produced is a cost driver in our bioresources model. The bioresources price control is an average revenue control (ie there is a reconciliation between forecast and outturn volumes of sludge at the end of the period) and our framework includes an incentive for accurate forecasting of sludge. Therefore we consider that it is more appropriate to use company forecasts of the driver to set allowances in this case.

Responses to our approach at initial assessment of plans

Some companies challenged our approach to forecasting costs drivers, in particular in relation to our scale drivers.

Thames Water, Bristol Water and SES Water suggest that our linear trend method to forecast connected properties would be inappropriate for companies that grow at a faster rate in AMP7 than the historical period and rewards those whose driver grow at a slower rate. Thames Water and Anglian Water suggested using external sources, such as Office of National Statistics (ONS) projections, would be more appropriate and could be consistent with the approach we used to forecast weighted average density.

Anglian Water, Bristol Water, South Staffs Water also state that our linear trend method to forecast mains length fails to consider their programme of mains extensions that are scheduled to take place in AMP7. Similar arguments were made regarding our decision to base our booster pumping station forecasts based on the average number in the period 2015-16 to 2017-18 for each company.

Southern Water recognises our view that developing an independent view of forecasts of costs drivers is “important to protect against the risk of unrepresentative forecasts in company business plans”. However, it proposes using its forecasts as

"they have been carefully estimated based on a deep and granular understanding of future demand, supply, and regulatory requirements". A similar suggestion is made by SES Water and South Staffs Water.

We have taken on board company responses regarding our approach to forecasting cost drivers and made changes where we considered it appropriate to do so. For example, we now develop our connected properties forecasts based on household growth rate projections produced by the Office for National Statistics (ONS). We also base our mains length forecasts on the average of our trend based forecasts and company own forecasts to take into account company mains extension programmes. We explain all the changes we have made to our forecast of cost drivers in table 5 below.

Our approach at draft determinations for slow track and significant scrutiny companies

Following responses to our initial assessment of plans and a review of company data we revise the forecast of some of the variables. Our revisions and rationale are summarised in table 5. Our forecasts of the cost drivers are included in feeder model 3 for wholesale water and wholesale wastewater.

Table 5: Summary of changes to our forecast of cost drivers

Variable	Approach at initial assessment of plans	Approach at draft determinations	Rationale
Connected properties (water and wastewater)	Forecasts based on historical growth rates of connected properties for each company.	Forecasts based on household growth rate projections produced by the Office for National Statistics (ONS)[2] (eg to forecast the number of connected properties in 2018-19, we multiply the actual number of	While historical forecasts are independent, we accept that they may not capture changes in growth rates. We have looked at independent and recognised sources as the basis for our forecasts, and consider that ONS best fits these criteria.

[2] Data on household projections in England can be obtained here: England household projections: 2016-based. The Welsh data are provided separately by StatsWales and are available here: Wales Households projections

		connected properties reported by companies in 2017-18 by the corresponding annual growth rate of 2018-19).	ONS growth rates tend to be higher than historical rates and lower than company forecasts (although this is not always the case).
Length of mains (water) and Length of sewers (wastewater)	Forecasts based on historical growth rates of the asset for each company.	Forecasts based on an average of historical growth rates and companies' view of growth rates of the asset.	While historical forecasts are independent, we accept that they may not capture changes in growth rates. In the absence of a readily available independent source (we do not consider that length of mains should grow at the same rate as projected household growth rates), we reviewed companies' forecasts. Company forecasts were close to historical growth rates. We decided to put 50% weight on companies' forecast to reflect their view of change. We retain 50% weight on historical growth rates, which are independent. We consider this approach to be balanced and reduces relying solely on historical growth rates.
Sewage load entering the treatment works	Forecasts based on historical growth rates of sewage load for each company	Forecasts based on companies' business plan projections. For two companies, Anglian Water and Northumbrian Water our forecasts are based 50% on business plan projections and 50% on historical growth rates of	We reviewed companies' projected growth rates. Projected growth rates were generally lower than the ONS' projected household growth rates as well as historical growth rates of sewage load. We consider that adopting companies' view of this variable is in customer interest. Anglian Water and Northumbrian Water forecast sewage loads that are significantly higher than would be expected from historical growth

		sewage load for the company.	rates. We have not found justification for these high forecasts in business plans. We therefore put some weight on historical growth rates for these two companies.
Booster pumping stations	Forecasts based on the average number in the period 2015-16 to 2017-18 for each company	Forecasts based on historical growth rates per company (a linear time trend)	We accept Bristol Water's challenge that it is not appropriate to assume a constant number of booster pumping stations with a growing network.
Weighted average density	Forecasts set as the average of the last three years of actual data	Forecasts based on ONS population projection numbers for water and wastewater	We recognise that for the initial assessment of plans we used different approaches to forecast weighted average density for water and wastewater - ONS population projections for water and the average of the last three years for wastewater. This change has very low materiality.

3.2.3 Changes to our bioresources econometric models

Our approach at the initial assessment of plans

For the initial assessment of plans we developed bioresources econometric models to allow us to set efficient bioresources costs for companies for 2020-2025. Our bioresources models included two cost drivers:

- sludge produced, to control for the volume of output produced; and
- population density or sewage treatment works per property, to control for economies of scale in sludge production.

See Supplementary technical appendix: Econometric approach for more detail.

Responses to our initial assessment of plans approach

Anglian Water argued that the bioresources models used at the initial assessment of plans were too parsimonious, ie that they controlled for too few exogenous factors. It suggested that, although our models rely on a measure of density, these models do not sufficiently capture drivers of costs associated with sludge transport.

Our approach at draft determinations for slow track and significant scrutiny companies

We have reviewed our bioresources models in light of company representations. We tested alternative drivers to control for exogenous factors that may drive sludge transport costs.

We have decided to include the percentage of load treated at band sizes 1-3 as an additional explanatory variable in one of our bioresources models. This variable provides a proxy for differences in transport costs associated with operating in rural and urban areas. In rural areas, sewage is often treated in relatively small treatment works. While sewage can be treated cost-effectively in small works, sludge cannot. The sludge will be transported to a larger treatment centre in order to achieve scale. Therefore, a company that treats a large proportion of its sewage at small works (bands 1-3) is likely to incur high costs associated with transporting sludge from those works to a regional sludge treatment centre. A company that treats a large proportion of its sewage in large works is likely to treat a large proportion of the sludge on site and incur low transport costs. Sludge treatment centres tend to be co-located with sewage treatment works of size band 4 or higher.

We also tested other ways to control for differences in sludge transport costs between companies but decide that the inclusion of ‘percentage of load treated at band sizes 1-3’ was the most robust solution:

- We tested the proportion of sparse areas in water company area. We have developed this variable according to Local Authority District (LAD) population density published by the Office for National Statistics. The variable can be developed based on different thresholds of sparsity (people per square kilometre). We found that for some thresholds this variable is highly correlated with the number of sewage treatment works per property and weighted average density variables, which would create a multicollinearity problem. The choice of sparsity threshold is also quite subjective. Nonetheless, modelling results with the addition of a sparsity variable were consistent with the results we obtained by

adding the percentage of load treated in bands 1-3. We will review suitability of this variable for final determinations.

- We tested the share of sludge treated in a co-located site and found it was highly correlated with the number of sewage treatment works per property. We also consider this variable is more within company control than the alternatives, which may be a detriment for efficiency assessment.

Annex 2 provides the bioresources models' specifications that we have used for the draft determinations for slow track and significant scrutiny companies.

3.2.4 Updated data provided by companies

We have received revisions to historical data on two variables:

- booster pumping stations for wholesale water; and
- booster pumping capacity for wholesale wastewater.

We have updated our econometric models with the revised data.

Wholesale water booster pumping station data

In our initial assessment of plans document 'Supplementary technical appendix: Econometric approach' we explained that topography and the distribution of demand centres across the region can influence a company's distribution costs through greater requirements to pump and transport water to customers.

We use the number of booster pumping stations to control for water companies' topography in our models. The number of booster pumping stations correlate with a company's need to pump water and incur energy costs, as well as with the need to operate, maintain and replace pumping assets on the distribution network.

The query process that followed the initial assessment of plans clarified that companies interpreted our definition of booster pumping stations in different ways, leading to possible inconsistencies in the data. Some companies included only booster pumping stations that are in the distribution network while others also included booster pumping stations that pump into the distribution network.

In May 2019 we issued a clarification to the definition of booster pumping stations and asked companies to resubmit the data. We clarified the definition as the 'total

number of owned and operated potable water pumping stations that pump into and within the treated water distribution service'. This total is the sum of pumping stations delivering water into the treated water distribution network from groundwater, surface water and imported sources, and re-pumping water within the treated water distribution network.

We have reviewed companies' revised data. We decided to use the updated data in our models as we consider that data is reported on a more consistent basis than before. The number of booster pumping stations remains a statistically significant variable in all relevant models.

We tested alternative explanatory variables to capture differences in network complexity and energy requirements (such as average pumping head and pumping capacity) but we did not find a more robust cost driver. We also note that companies report a higher confidence grade to their booster pumping station data than the alternatives.

Wholesale wastewater pumping station capacity data

To capture differences in energy requirements to collect and transport sewage to sewage treatment centres, we use pumping capacity per sewer length in our wastewater collection models. This variable was generally favoured by companies in response to our March 2018 consultation[3] and provides the better statistical results than alternatives.

Northumbrian Water submitted revised data on pumping capacity arguing that it had identified an error in its original data submission. We have carefully reviewed the assurance that Northumbrian Water provided with its revised data. Given the assurance and that Northumbrian Water's data from its original data submission looked atypically low, we accepted its revised data.

3.3 Our efficiency challenge for modelled base costs

Our efficiency challenge for modelled base costs includes a 'catch-up' element and a frontier shift element.

[3] 'Cost assessment for PR19: a consultation on econometric cost modelling'.

3.3.1 Catch-up efficiency challenge

We base the catch-up efficiency challenge on our comparative assessment of the water companies. We use the performance of the most efficient companies as a benchmark. We expect the rest of the companies to catch up.

Upper quartile efficiency challenge

We set our benchmark at the 'upper quartile' efficiency level. That is, a level that 25% of companies have already achieved and 75% of companies are lagging behind. The use of the upper quartile rather than frontier efficiency (most efficient company) recognises that statistical models are imperfect, and consequently the estimation of efficiency imprecise. For example, the model's residual, which we take as an estimate of inefficiency, might include an element of unobserved heterogeneity driven by a company's specific operating circumstances as well as relative efficiency.

An upper quartile benchmark was applied at PR14[4], and regulatory precedent supports the use of an upper quartile or even a more challenging benchmark. Ofgem applied an upper quartile benchmark at RIIO-ED1[5] and RIIO-GD1[6], and the Northern Ireland Utility Regulator has adopted an upper quartile in its most recent electricity (RP6[7]), gas (GD17[8]) and water (PC15[9]) price controls. Whereas Ofcom adopted an even stronger upper decile benchmark in its assessment of the UK postal sector[10].

We recognise that the Competition and Markets Authority (CMA) did not apply an upper quartile catch-up efficiency challenge in Bristol Water's PR14 price determination but instead used an average-efficiency benchmark to which real price effects and productivity improvements were applied. However, the total net efficiency challenge applied (productivity improvements minus real price effects) was arguably more challenging than Ofwat's upper quartile approach[11]. It is also important to note that the CMA's determination and approach was for a single company, whose base expenditure was substantially higher than the estimated expenditure implied by the CMA's econometric base models. The context is significantly different in this case

[4] And accepted by 17 out of 18 companies.
[5] Source: https://www.ofgem.gov.uk/publications-and-updates/riio-ed1-final-determinations-slow-track-electricity-distribution-companies
[6] Source: https://www.ofgem.gov.uk/publications-and-updates/riio-gd1-final-proposals-%E2%80%93-overview
[7] Source: https://www.uregni.gov.uk/publications/nie-networks-td-6th-price-control-final-determination-rp6
[8] Source: https://www.uregni.gov.uk/gd17-final-determination
[9] Source: https://www.uregni.gov.uk/publications/pc15-final-determination
[10] Source: http://stakeholders.ofcom.org.uk/binaries/consultations/royal-mail-review/annexes/benchmarking-report.pdf
[11] Source: https://assets.publishing.service.gov.uk/media/56279924ed915d194b000001/Bristol_Water_plc_final_determination.pdf

where we are setting price controls for the sector. As a result, the estimated expenditure implied by econometric cost models can be higher or lower than what companies are requesting in their business plans. The CMA acknowledged themselves that adopting an average benchmark may not be optimal or even feasible for our periodic reviews of price controls[12]. We note also that a number of companies submitted business plans that outperform the challenging baselines that we set. This provides further supports our view that using a historical upper quartile benchmark is appropriate and in the best interests of consumers.

Consideration of a stronger efficiency challenge for the bioresources controls

While we set cost allowances for each price control, we set the catch-up efficiency challenge based on relative efficiency at the wholesale level. The wholesale water catch-up efficiency challenge is applied to the water resources and water network plus controls; and the wholesale wastewater catch-up efficiency challenge is applied to the bioresources and wastewater network plus controls.

We have concerns that this approach does not provide a sufficiently strong efficiency challenge across the industry for the bioresources controls. This is evidenced by the fact that the sector receives a higher bioresources base cost allowance than it requested despite applying an upper quartile efficiency challenge.

For final determinations we will consider applying a separate catch-up efficiency challenges to each of the wholesale wastewater controls – bioresources and wastewater network plus. We will also consider using the bioresources models alone to set the bioresources controls. We welcome stakeholder views.

3.3.2 Frontier shift efficiency and real price effects

Water companies are regulated monopolies. Our regulatory approach seeks to ensure that customers obtain the benefits as if water companies were operating in a competitive market.

Over time we expect the productivity of companies to improve as they adopt new technologies or new ways of working. These productivity improvements shift the efficiency frontier for the sector. These efficiency improvements are additional to any catch-up efficiency.

[12] See paragraph 4.235 of the CMA's PR14 price determination for Bristol Water.

We consider that there will be frontier shift efficiency improvements in the water sector from two different sources:

- on-going efficiency improvements that affects the economy as a whole; and
- one-off efficiency improvements from water companies making greater use of the totex and outcomes framework at PR19.

To understand the potential scale of these efficiency improvements in the initial assessment of plans we commissioned two consultants' reports:

- 'Frontier shift efficiency and real price effects', by Europe Economics[1]; and
- 'Innovation and efficiency gains from the totex and outcomes framework', by KPMG and Aqua consultants.[2]

Following consideration of responses to the initial assessment of plans, Europe Economics has revised its assessment of real price effects and frontier shift efficiency. We outline the updated findings in annex 3. We also set out our response to points raised by companies and their consultants on the 'Innovation and efficiency gains from the totex and outcomes framework' report by KPMG and Aqua consultants. Finally, we set out our revised assessment of the scope for frontier shift efficiency and real price effects for the 2020-25 period.

We continue to consider that real price effect adjustments should only be made where there is a compelling case for an adjustment. Based on the revised assessment, we conclude that there is sufficient and convincing evidence for us to make an adjustment for real price effects for labour costs. This directly addresses concerns raised by respondents about inconsistency between our frontier shift and real price effect assumptions. We make a real wage growth adjustment based on Office of Budget Responsibility forecasts of labour productivity and real wage growth. We make this adjustment to 35% of total expenditure, reflecting the average proportion of labour costs in water company costs. Given the uncertainty in the forecasts of labour productivity and real wage growth we consider that there should be an ex-post true up at PR24 based on outturn manufacturing wage growth, which follow similar growth patterns to water sector wages. We do not consider that a real price effect adjustment is required for other water sector input costs.

Based on our assessment, and taking into account the findings of the two reports and the evidence put forward by water companies in their business plans and responses to the initial assessment of plans, we continue to consider that we should make an ongoing efficiency adjustment of 1.5% per year to take account of frontier shift and the benefits of the totex and outcomes framework. Following consideration

of responses we consider that this adjustment should apply to both base and, where relevant, enhancement wholesale expenditure. For example we take this into account in our efficiency adjustment for meeting wastewater obligations. Annex 3 sets out further details of the real price effect and frontier shift adjustment.

Table 6: Real price effect and frontier shift assumptions

Year	Real wage rate growth per hour	Real price effect adjustment	Frontier shift
2020-21	1.10%	-0.40%	1.50%
2021-22	1.10%	-0.39%	1.50%
2022-23	1.20%	-0.41%	1.50%
2023-24	1.30%	-0.45%	1.50%
2024-25	1.40%	-0.49%	1.50%

3.4 Unmodelled base costs

We exclude a small number of cost items from our econometric models. The costs that we exclude are:

- abstraction charges (water service only);
- business rates;
- costs associated with the Traffic Management Act (TMA);
- wastewater industrial emissions directive costs (wastewater service only);
- third party costs; and
- pension deficit recovery payments.

We set out below the approaches we take in coming to our view of efficient unmodelled costs.

Abstraction charges

The Environment Agency, Canal and River Trust and Natural Resources Wales impose abstraction charges on water companies to recover their costs of managing and regulating abstractions and discharge consents.

We exclude abstraction charges from our econometric models due to the lower degree of controllability and bespoke company and regional issues.

We assess each company's forecast of abstraction charges for the period 2020-25 and commentary separately. We seek clarifications from companies where there are significant variations between historical and forecast costs, and apply an efficiency

challenge where we do not consider companies' explanations of material increases to be adequate.

Business rates

For wholesale water, we calculate each company's expected 2017-18 business rates using the 2017 rateable values supplied by the Valuation Office Agency and the 2017 multiplier set by central government.

For wholesale wastewater, we calculate each company's expected 2017-18 business rates using the 2017 rateable values supplied by the companies and the 2017 multiplier set by central government.

Some companies experienced a significant increase or decrease in their business rates following the 2017 revaluation. Transition relief is applied to these companies' business rates so that the increase or decrease is phased in over a number of years rather than being applied all in 2017-18.

For companies that have fully transitioned following the revaluation we would expect their 2017-18 business rates to be in line with that implied by its rateable value. We compare our calculation to companies' 2017-18 actual business rates and set companies' allowances as the lower of these two amounts and set the same amount for each of the five years.

For companies that have not fully transitioned following the revaluation, we would expect that by 2020-21 their business rates to be in line with that implied by their rateable values. We compare our calculation to companies' 2020-21 forecast business rates and set these companies' allowances as the lower of these two amounts and set the same amount for each of the five years.

A few companies include increases in business rates due to the revaluations planned in 2021 and 2024. Other companies do not factor in any changes due to the revaluations as there is too much uncertainty. We do not consider that there is compelling evidence to robustly forecast the impact of these revaluations and therefore we do not take them into account in our allowances.

We also do not take into account increases in business rates due to changes in wastewater asset stock in the period 2020-25.

In response to our initial assessment of plans some companies disagreed with our approach to not account for revaluation effects or growth in wastewater assets.

In the Autumn Budget 2017, the government announced that the frequency of revaluations would be increased to improve the fairness of the business rates system and to reduce significant changes to rateable values at revaluations. Therefore, it is less likely that companies will experience the large step changes in business rates that they have at previous revaluations. Equally, the range of impacts across the sector may not be as wide as it has been following revaluations historically.

At this stage, it is likely that transition relief will continue to apply to companies that experience a large change on revaluation of rateable values. This relief means any future large increase will be phased in over time rather than in one year.

We believe companies have some control over the level of business rates they pay, including as a result of efficiencies and by fully engaging with the Valuation Office Agency in the revaluation process.

We do not consider that there is compelling evidence to change our approach for draft determinations. However, we will consider evidence presented in representations to inform our approach for final determinations.

Traffic Management Act costs

The Traffic Management Act (TMA) 2004 places a duty on local authorities to make sure traffic moves freely and quickly on their roads and the roads of nearby authorities. Water companies who want to carry out street works have to apply to the traffic authority for a permit. Companies incur costs relating to the permits themselves as well as the administration of the permit schemes.

At PR14 TMA costs were included in our econometric models. Given that these costs are incurred only by a subset of companies and are not well correlated with the cost drivers in our econometric models, we decided to exclude these costs from our models.

We analyse companies' proposed costs against those that have been incurred historically. Where there are significant increases, we carry out a company specific review based on the evidence presented in business plans and challenge costs accordingly. For companies that propose costs in line with those incurred historically we use the same efficiency challenge as for base costs.

Wastewater Industrial Emissions Directive costs

Three companies include costs associated with the Industrial Emissions Directive. These costs are generally of low materiality. We analyse the forecast costs against historical trends and challenge where appropriate.

3.4.1 Other costs

Pension deficit repair contributions

We follow the approach set out in our information notice 'IN 13/17: Treatment of companies' pension deficit repair costs at the 2014 price review' (October 2013).

In 2009, we set a pension deficit recovery period for each company. For those companies whose recovery period extends to 2020-25, we allow them to recover 50% of the remaining deficit. We do not make any allowances for those companies whose recovery periods end before 2020.

In response to our initial assessment of plans, a few companies disagreed with how we had inflated outstanding pensions deficit repair contributions to 2017-18 prices. For our initial assessment of plans we inflated pension deficit repair contributions from 2012-13 prices to 2017-18 prices using year-average RPI. We have changed our approach and now present the allowances in 2017-18 CPIH deflated prices using our view of both CPIH and RPI. This is now in line with how company's presented costs in their business plans.

Third party costs

Third party costs are incurred by companies in providing services outside of their principal services. Such activities are set out in regulatory accounting guideline (RAG) 4 and include supplying non-potable water and bulk supplies, providing stand pipes and water tanks, and fluoridation, amongst others.

We allow companies' third party costs included in their business plans. We challenge companies that report revenues less than their costs to ensure that customers are not disadvantaged.

4 Our assessment of enhancement costs

In this section we explain how we set efficient cost allowances for well evidenced enhancement proposals.

Enhancement expenditure relates to investment for the purpose of enhancing the capacity or quality of service beyond a base level. It may be driven by a number of factors including new statutory obligations and strategic priorities companies develop in consultation with their customers.

Table 7: Overview of the contents of the enhancement costs chapter

Section	Section name	Summary
4.1	Difference in assessment framework between base and enhancement costs	Summary of the key differences in our assessment of base and enhancement costs.
4.2	High level approach to assessing enhancement proposals	Outline of the enhancement assessment including approach to reallocations, benchmarking, shallow and deep dive assessments. Also describes our company specific efficiency factor and approaches for funding common performance commitments.
4.3	Setting a totex allowance for enhancement costs	Description of how we how we incorporate enhancement opex to our assessment to assess enhancement activities on a totex basis, and how we ensure that customers do not pay twice for enhancement opex.
4.4	Resilience enhancement	Summary of our decisions for the draft determination and resultant cost allowances.
4.5	Supply-demand balance and metering enhancement	Summary of approach at initial assessment of business plans, responses received from companies, our decisions for the draft determination and resultant cost allowances.
4.6	Environmental obligations	Summary of approach for enhancement lines relating to environmental obligations for the Water Industry Environment Programme (Environment Agency) and National Environment Programme (Natural Resources Wales).
4.6	Our assessment approach to other enhancements activities	Summary of our assessment approaches for the draft determination for other enhancement activities including water quantity, water quality and environmental enhancements.

4.1 Difference in assessment framework between base and enhancement costs

The efficient level of enhancement costs is more difficult to estimate than for base costs. Due to their irregular nature, there is less opportunity to compare the cost of required enhancement solutions between companies, and in some areas the exact requirements may be subject to uncertainty. This difference between base and enhancement costs means that the focus of our assessment framework is different between the two.

- For base and growth cost our focus is on an incentive-based framework. We develop our independent cost baselines to incentivise companies to submit efficient business plans and to seek further efficiencies throughout the control period.
- For enhancement costs, given the uncertainty and greater dependence on company forecasts of cost, our focus is less on incentives for submitting efficient costs and more on protecting customers from paying for inefficient, unrequired or undelivered investment in the control period.

This difference is apparent in two important ways.

- Where we use a benchmarking model in enhancement, we usually set our allowance equal to the minimum of our modelled efficient costs and the cost requested by the company. In some cases, we set the allowance to the minimum of our view of costs at a programme level to the company requested cost at the programme level (this is the case for supply-demand balance and for the national environmental programme in wastewater, which we discuss below). We therefore do not allow companies more than the amount they request in their business plans for enhancement costs. This differs for base costs where we set our independent view of efficient costs as a cost allowance and companies may be allowed more than the amount requested in their business plans. This is because for base costs we have greater confidence in estimating robust independent cost allowances, whereas for enhancement costs, we do not have data to use the same approach and are more dependent on company specific cost information.
- Our enhancement assessment framework makes greater use of mechanisms to protect customers against unrequired or undelivered investments. For example, we set out unit cost adjustment mechanisms for as yet unconfirmed environmental requirements which will allow us to adjust our cost allowance at the end of the period once the uncertainty has resolved. Similarly, we set customer protection for enhancement proposals in case the investment is

delayed or not delivered. We achieve this through the outcomes delivery incentives framework.

4.2 High level approach to assessing enhancement proposals

We generally assess enhancement expenditure separately for each enhancement category, as defined by the individual enhancement cost lines in company business plan tables. We assess multiple lines together where there is a potential for costs to be apportioned differently by companies and where there is some synergy between programmes.

Our preferred method of assessment is benchmarking analysis. Where the investment area does not lend itself to statistical modelling we rely more on the evidence provided by companies in their business plans. We follow a risk-based process of having a lighter touch ('shallow dive') assessment for low materiality costs and a more thorough assessment of the evidence ('deep dive') of high materiality costs.

Table 8 sets out our assessment methods for enhancement expenditure.

Table 8: Our assessment methods for enhancement expenditure

Assessment method	Description
Benchmarking analysis	For enhancement activities where most companies incur costs and we identify appropriate cost drivers we develop econometric or unit cost models. Our benchmarking analysis relies on forecast data from company business plan, except for 'first time sewage' in wastewater where we put some weight on historical data.
Shallow dive	If the expenditure is less than 0.5 percent of the company's water or wastewater wholesale totex, we carry out a shallow dive assessment. Where the expenditure is justified, we apply the company specific efficiency factor. At our discretion we choose to carry out a deep dive assessment for investments close to this threshold.
Deep dive	If the expenditure is more than 0.5 percent of the company's water or wastewater wholesale totex, we carry out a deep dive assessment. The deep dive process follows our assessment of cost adjustment claims (see chapter 7). We assess the evidence provided by the company for the need for investment, options appraisal, robustness and efficiency of costs, and customer protection for the proposed expenditure, similar to In very material cases we also look for evidence of affordability and board assurance to demonstrate that the board is aware of the material investment proposals and their impact on customer bills. Where a compelling case is presented, that is well supported by a cost-benefit analysis of intervention options and a transparent breakdown of appropriate and efficient costs, we allow the expenditure in full.

Optioneering challenge in deep dive assessment

Where we accept the need for the investment, but the company has not provided a thorough options appraisal that demonstrates it has chosen the best option for customers, we challenge the proposed costs. If a company provides evidence, for

example, that a lower cost option was available but gives no reasons as to why it was rejected, we use the lower cost option to set an appropriate allowance. Solution options considered can range considerably in cost. Companies have provided evidence that options such as reinforcing a length of main and replacing the same main can have a difference in cost of 35 percent. Where evidence is not provided that the option selected is optimal we protect customers from a potentially sub-optimal company solution by applying a 20 percent challenge to business plan costs.

Company specific efficiency factor

For every company we calculate a company specific efficiency factor. The factor provides an indication of the company's scope for efficiency improvement in its proposed base costs. We use the factor as a guide to challenge the company's proposed enhancement costs in deep and shallow dives, where there is insufficient evidence of efficient costs. We consider it reasonable to assume that the company's scope for efficiency in its proposed enhancement costs will be at a similar level to that of base costs.

The company specific efficiency factor is calculated as the ratio of our view of efficient modelled base costs to the company view of modelled base costs. For this calculation, we remove enhancement opex from the company's view of modelled base costs.

In deep dive assessments we apply the company efficiency factor only where there is insufficient evidence that the proposed costs are efficient. We cap the efficiency factors between a minimum of five percent and a maximum of 10 percent. That is, for companies with an efficiency factor less than five percent we apply the minimum challenge of five percent. We expect every company to provide evidence that its proposed costs are efficient. We recognise that the company specific efficiency factor is an imperfect indicator of the inefficiency of proposed enhancement costs. We therefore cap the challenge at 10 percent. We accept that this may understate the efficiency challenge for an inefficient company but consider that we need to set this against the risk of excessive disallowance of costs. Capping the challenge is consistent with our approach at the initial assessment of plans.

In shallow dive assessment we apply the company efficiency factor automatically. We consider that this is a proportionate approach. In shallow dives we cap the company efficiency factor between a minimum of zero and a maximum of 10 percent. We do not use a five percent floor like in deep dives because in shallow dives we do not look for evidence that the cost is efficient, due to immateriality, so a five percent floor would risk overstating the efficiency challenge.

We do not apply the company specific efficiency factor in our assessment of WINEP/NEP wastewater activities, where we determine an efficiency challenge for each company at a programme level rather than at the individual activity level.

How we use revised business plan cost forecasts

In April 2019, slow track and significant scrutiny companies submitted revised plans with revised cost projections. Some companies responded to the efficiency assessment we had published and reduced their costs in different areas of the plan. Revised projections fed into our benchmarking analysis and impacted our results. This can result in a more stringent cost challenge for companies.

We expect companies to challenge themselves based on our assessment results at different stages of the price review process. To avoid dis-incentivising companies from reducing costs through the price review process, we did not increase the cost challenge for a company in an area where it responded to our initial assessment of plans.

Where a company reduced its costs in response to our efficiency challenge at the initial assessment of plans, we use its revised cost in any benchmarking analysis to derive revised allowances for all companies. However, for the company that reduced its costs, we would not set a lower cost allowance than that at the initial assessment of plans (unless the reduction of cost was a correction of error or associated with a reduction of volume of work).

Reallocating enhancement costs

To ensure we assess companies fairly, we review company reporting of enhancement costs to improve consistency. Where we consider that the cost was not reported in the appropriate place we reallocate the costs.

Many companies included company-defined lines (‘freeform’ lines) to provide clarity. In most cases, we consider the company-defined lines were not required and the costs should have been included in the appropriate standard lines with a detailed table commentary to provide clarity.

We also challenge companies’ classification of costs as enhancement. Where we consider costs to be part of the normal running of the business, we disallow the costs as enhancement. We consider that such costs are included in our base cost allowance and make no further adjustment.

4.2.1 Our approach to enhancement costs where we have common performance commitments

As set out in our PR19 methodology, we challenged companies to adopt stretching performance targets as part of their business plans. We also said that customers should not pay extra for companies to deliver stretching but achievable targets. The delivery of stretching performance is to be funded from base costs.

In exceptional circumstances, where companies consider they are not able to deliver performance commitments from base costs, for example due to unique operating circumstances, they could make the case for their performance commitment level to be adjusted. We consider this is more appropriate than seeking additional costs through a cost adjustment claim. This approach ensures consistency across totex and outcomes – outperformance on costs is rewarded by cost sharing and outperformance on outcomes is rewarded by outperformance payments, where these have customer support.

Some companies requested additional enhancement costs to improve performance in areas such as leakage, supply interruptions and water quality. In these areas, we have set performance commitment levels for each year of 2020-21 to 2024-25. Where companies go beyond these levels, they will receive payments through the outcomes delivery incentive framework.

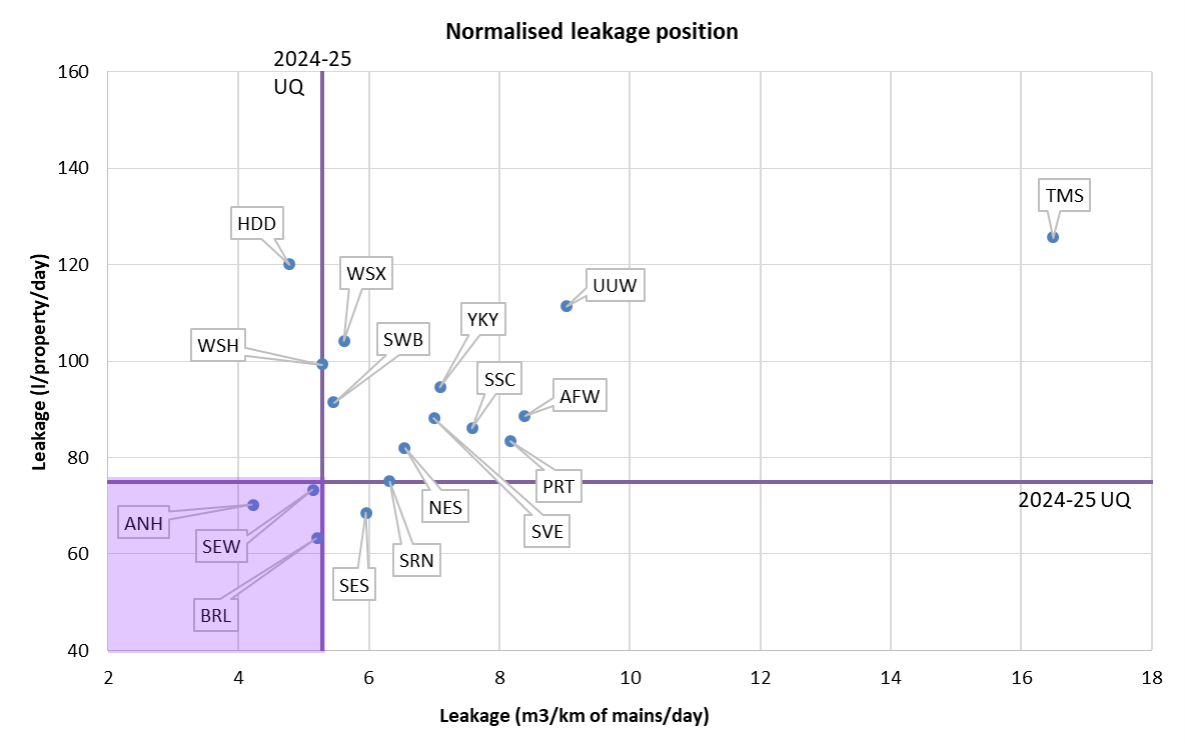
We consider that our package of common performance commitments with stretching performance commitment levels, represents a base level of service. We expect an efficient company to be able to deliver our performance commitments levels through our base allowance. We have therefore rejected requests for enhancement costs to catch up with our stretching performance commitments.

Our policy on leakage is an exception to this general rule. For leakage, we still expect companies to achieve 2024-25 industry upper quartile from our base allowance. In our PR19 methodology we challenged companies to reduce leakage by at least 15% over the period 2020-25. Most companies responded to our challenge submitting stretching targets in business plans. Our common performance commitment in leakage is not set at the forward looking upper quartile level of leakage, but is based on our assessment of whether a company's proposed performance commitment levels are stretching for that company and whether the levels can be delivered under base cost allowances. As a result, there may be companies whose performance commitment takes them beyond the forward looking upper quartile. Such companies will receive outperformance payments only if they exceed their performance commitment. Therefore, we consider it appropriate to

allow enhancement funding for any leakage reduction above the forward looking upper quartile level and up to their performance commitment.

Figure 4 shows company forecast leakage performance for 2024-25 for both normalised measures (leakage per kilometre of mains and leakage per property), alongside the upper quartile level. The purple box represents a performance above upper quartile level for both normalised measures. For the three companies that forecast their leakage performance to be in this region, we make an enhancement allowance up to their performance commitment, as we consider that this is an enhancement to base service. We provide more detail in the supply-demand balance enhancement section how we calculate our allowances for leakage reduction.

Figure 3: Company forecast leakage performance (per kilometre of mains and per property) for 2024-25 post-draft determination intervention



We also make an exception relating to unplanned outage performance for Thames Water. For Thames Water we make an allowance to significantly improve its unplanned outage performance. We expect Thames Water to deliver the industry median performance level by 2025, with investment in improvements to resilience and asset health.

4.3 Setting a totex allowance for enhancement costs

For the initial assessment of business plans we assumed that our base allowance included a full allowance for enhancement opex. This was because the opex associated with historical enhancement programmes is included in the data we use to generate our base models. A number of companies and stakeholders commented on our approach to enhancement opex in their responses to the initial assessment of business plans. We accept that there could be a potential capex bias in an enhancement approach that does not consider opex solutions comparable to capex solutions.

Following the initial assessment of plans, we have refined our assessment approach. Our approach involves two key steps:

- assessing enhancement activities on a totex basis to make totex allowances; and
- removing a component attributed to enhancement opex from our base model allowance.

4.3.1 Assessing enhancement totex

All our enhancement assessments now is done on a totex basis. We add up enhancement opex and enhancement capex for the period 2020-2025 and use the totex for the period in our benchmark analysis or in our deep and shallow dive assessment.

To ensure consistent reporting of enhancement opex, we issued a query to all companies on how they completed their enhancement opex business plan tables. Two companies responded to say that they presented their enhancement opex as cumulative from a start date of April 2015. In order to compare with all other companies which reported data as restarting from a position of zero on 1 April 2020 we adjust the two companies' figures for 2020-25. We do this by deducting from each year of 2020-21 to 2024-25 the value of opex reported in 2019-20 for each enhancement category for the two companies. Our assessments then consider this rebased opex and capex together. We make totex allowances for all enhancement categories for all companies

Responses to the query we sent to companies highlight the need to improve definitions of enhancement opex for future data requests and cost assessment.

4.3.2 Removing enhancement opex implicit allowance from our base allowance

Our base models use historical data of opex and maintenance capex. Our historical opex data is not split between base and enhancement. Such a split is made only for capex (capex is split between maintenance capex, which is part of base, and enhancement capex). This means that our base models include some enhancement opex, which in turn means that there is an implicit allowance for enhancement opex in our base models. Each company's implicit allowance for enhancement opex will relate to the level of its cost drivers.

To ensure that customers do not pay twice for enhancement opex, once through our base allowance and once through our enhancement allowance, we estimate the implicit allowance in our base models and remove it from our base allowance.

We take a top down approach to calculating the enhancement opex implicit allowance for these draft determinations. From our query to companies we consider those who reported all relevant enhancement opex in 2017-18. Six companies reported all appropriate enhancement opex in 2017-18. We have used the data from these six companies to estimate enhancement opex for all companies. We consider it reasonable to use 2017-18 as an 'average' year for enhancement opex because it is half way through the 2015-20 period. We do not have data for actual expenditure on enhancement opex before 2017-18 as it has not been a part of our historical data collection, and any data for after 2017-18 is forecast rather than actual spend.

We calculate an implicit allowance separately for water and wastewater as follows:

1. We add the 2017-18 enhancement opex reported by the six companies for all categories of enhancement, except those that we consider as part of our base models. (This applied to five companies for wastewater rather than six because one company is a water only company);
2. We add the 2017-18 costs for the same six companies for all categories of totex that go into our base plus models (ie 'modelled base costs');
3. We calculate the proportion of enhancement opex in 2017-18 out of modelled base costs for the six companies combined;
4. We calculate the enhancement opex implicit allowance by applying the proportion from step three to our 2020-25 base allowances; and

5. We remove our calculated implicit allowance for all companies from our base totex allowances. We make totex allowances for enhancement.[13]

We show the results of our calculation of enhancement opex implicit allowance in table 9 below.

Table 9: Enhancement opex implicit allowances, £m 2017-18 prices

Company	Water Resources	Water Network plus	Wastewater Network plus	Bioresources
Anglian Water	3.2	9.7	5.8	-
Hafren Dyfrdwy	0.3	0.8	0.1	-
Northumbrian Water	2.9	8.6	2.4	-
United Utilities	4.9	14.8	6.0	-
Southern Water	1.7	5.0	4.4	-
Severn Trent Water	5.5	16.6	7.4	-
South West Water	1.6	4.8	2.1	-
Thames Water	7.8	23.5	11.1	-
Dŵr Cymru	2.5	7.7	3.2	-
Wessex Water	1.2	3.6	2.7	-
Yorkshire Water	3.4	10.2	4.5	-
Affinity Water	2.4	7.4		
Bristol Water	0.8	2.5		
Portsmouth Water	0.4	1.2		
SES Water	0.4	1.2		
South East Water	1.5	4.5		
South Staffs Water	1.0	3.0		
Total	**41.3**	**125.1**	**49.7**	**-**

4.4 Resilience enhancement

Resilience is a key theme of the 2019 price review. The theme reflects on the priorities set by the UK and Welsh Governments in their Strategic Policy Statements, as well as the additional duty for Ofwat to further the resilience objective, introduced by the Water Act 2014.

The Water Industry Act 1991 set out general duties with respect to the water industry which requires water and sewerage undertakers to provide and maintain standards

[13] For draft determinations we have removed the opex implicit allowance from enhancement. For final determination we intend to correct this and remove the implicit allowance from base rather than from enhancement. This will have no impact on total allowed expenditure.

of performance for their water supply and sewerage systems. To support these duties, companies have invested, and will continue to invest, in resilient water and wastewater infrastructure through base cost allowances.

The PR19 methodology defines resilience as the ability to cope with, and recover from, disruption and anticipate trends and variability, in order to maintain services for people and protect the natural environment now and in the future. As a consequence, resilience is a broad concept that spans across different base and enhancement activities. For example, investments in the supply-demand balance enhancement area improve drought resilience, while those driven by the security and emergency measures directive (SEMD) provide resilient supplies in the event of an emergency situation.

Our approach to assessing expenditure submitted under the resilience enhancement line

In this section we discuss our approach to assessing investment proposals submitted under the resilience enhancement lines in water and wastewater. Importantly, our resilience enhancement line is not intended to cover all investment that contributes to furthering the resilience objective, it covers only a small part of it.

Our PR19 data tables allow companies to propose investment to enhance resilience, where the investment does not fit the scope of other reporting lines. Where the primary driver of a resilience investment addresses the need covered by another enhancement line we reallocate the expenditure accordingly to maintain consistency across the different areas' scopes.

Under the resilience enhancement line, we accept proposals that improve service resilience in the face of low probability-high consequence events that are currently beyond management control, including expenditure to meet new, more onerous requirements arising from the National Flood Resilience Review.

Following the initial assessment of plans and company responses we have refined the criteria which must be satisfied to demonstrate the need for investment under the resilience enhancement line. For each proposed investment, we seek evidence of:

- the specific cause of service failures and associated probability of failure the investment is proposing to address;
- the consequence of failure to customer service; and
- how the failure and the consequence are currently beyond management control.

We also seek evidence that the proposed investments are not for activities included in our base cost allowances, for example investments in capital maintenance or delivery of our expectations on performance commitment targets.

Our draft determination allowances reflect investments for sufficiently evidenced proposals that improve resilience for customers and the environment. We consider that some companies propose investments in their business plans that might be eligible for funding as resilience but for which they have provided insufficient evidence to establish the need for this investment. The poor evidence is consistent with our initial assessment of companies' approaches to resilience, which highlighted a range of weaknesses in identifying and mitigating risks to resilience. We expect companies to provide better evidence ahead of final determinations. Excluding investments protected by our 'early certainty principle', we will also apply our refined assessment criteria, as set out above, to investments proposed by companies categorised as 'fast track' following the initial assessment of business plans.

Where we make a material allowance for a resilience enhancement investment, we assess whether bespoke performance commitments sufficiently, or are required to, protect customers against non-delivery of these investments.

We show the allowances for investment in resilience for water and wastewater in table 10 below.

Table 10: Summary of our assessment result for resilience enhancement (£m of 2017-18, CPIH deflated)

	Water resilience enhancement		Wastewater resilience enhancement	
	Requested	Allowed	Requested	Allowed
Anglian Water	55.6	17.1	17.2	1.0
Dŵr Cymru	113.9	3.6	72.2	3.9
Hafren Dyfrdwy	1.7	0.5	0.0	0.0
Northumbrian Water	127.4	55.8	87.8	33.6
Severn Trent Water	137.0	107.2	0.0	0.0
South West Water	54.5	33.4	4.8	3.6
Southern Water	0.0	0.0	0.0	0.0
Thames Water	204.9	73.7	24.3	13.2
United Utilities	107.9	78.5	0.0	0.0
Wessex Water	5.8	0.7	5.0	2.5
Yorkshire Water	0.0	0.0	28.6	0.0
Affinity Water	15.5	13.6		
Bristol Water	12.0	5.7		
Portsmouth Water	2.8	1.2		
South East Water	34.0	3.5		
South Staffs Water	4.1	0.4		
SES Water	8.9	0.0		
Total	**885.8**	**394.8**	**239.9**	**57.8**

4.5 Supply-demand balance and metering enhancement

4.5.1 Supply-demand balance

Summary of our approach at the initial assessment of business plans

Supply-demand balance enhancement considers solutions to ensure companies can provide resilient supplies during periods of drought. For the initial assessment of business plans we identify and allocate proposed investment into six components and assess each separately:

- 2020-25 supply-demand balance enhancement;
- long-term supply-demand balance enhancement;
- leakage enhancement;
- internal interconnections;
- investigations and future planning; and
- strategic regional solution development.

Company responses to our initial assessment of business plans

Our approach to assessment in this area of enhancement has received responses on the following of these components:

- **2020-25 supply-demand balance enhancement** – we received responses in relation to the range of company unit costs and that our industry unit costs do not reflect solutions that have complex treatment requirements. Dŵr Cymru suggest there may be overlap between costs in this component and long term enhancement where this was unclear. Anglian Water suggest that deep dives at a project level should be undertaken.
- **Leakage enhancement** – most companies provided a response to our approach to funding leakage enhancement. Some challenge our conclusion that base allowances cover both a 15% reduction and allow forecast upper quartile (2024-25) performance in both normalised leakage metrics to be achieved. There are also responses raising concerns with the derivation of an industry median leakage unit cost and the application of this rather than the specific company's proposed leakage unit costs.
- **Long-term enhancement** – Portsmouth Water challenges the assessment approach based upon capacity for a specific long-term enhancement scheme and Southern Water raises concerns regarding the available data for use in comparing a scheme to the industry average costs.
- **Internal interconnections** – South East Water responds that we should not re-allocate expenditure related to intra-zonal connections for demand growth to the 'new developments' enhancement line. Anglian Water raises concerns about the scale of cost efficiency reductions on its programme and that it constitutes a challenge of the need. Dŵr Cymru challenges the rejection of a specific scheme based on insufficient evidence of need.
- **Investigations and future planning** – four respondents (Anglian Water, Dŵr Cymru, South East Water, Southern Water) consider water resource planning, drought planning and environmental investigations as enhancement and request funding.

Changes from initial assessment of business plans approach

Since the initial assessment of business plans we have made several changes to the assessment approach for this area of enhancement. Although the approach to funding has not significantly changed, the allowance for strategic regional water resource solution development is covered by its own model (see below) instead of

being one of the six components of the supply-demand model. This reflects that companies have not consistently requested these development costs and to provide transparency on an important intervention. The remaining components where we have made changes are as follows:

- **2020-25 supply-demand balance enhancement** – based on further details provided by companies we allocate the benefits of investment more accurately than at the initial assessment of business plans. The revised allocation and the efficiency challenges in some of the companies' submissions result in a reduced industry median unit cost. We now use £1.20 million per Ml/d of benefit for this component, relative to £1.39 million per Ml/d in the initial assessment of business plans. This industry efficient unit cost is based on consideration of the industry median unit cost for this activity (after removing the costs of companies forecasting a 2024-25 surplus in their latest water resources management plan, WRMP19).
- **Leakage enhancement** – we have removed the 15% stretch target as a threshold for enhancement funding as this relates to in-period stretch covered by outcome delivery incentives and is therefore reflected through the outcomes framework. However, we retain from the initial assessment of business plans the use of the upper quartile threshold in both normalised leakage measures (per property and per kilometre of main). We are also no longer using the industry unit cost because we do not consider this reflective of the costs for the small number of companies receiving funding but instead we revert to using the company specific costs with company specific efficiency factor applied where unit costs are higher than the industry median.
- **Internal interconnections** – we have further developed our deep dive approach to focus our challenge in key test areas in order to provide greater clarity regarding the considerations made in assessing this component. We review the solution to establish if there is a valid need for investment to meet the supply-demand balance. We assess if there is a valid need for these solutions based on the information provided and challenge the costs of valid solutions based on cost efficiency benchmarking evidence, solution sizing and utilisation and optioneering.

Detail of draft determination approach

For our assessment we consider the totex expenditure for supply and demand solutions for both critical period and dry year annual average scenarios in a combined supply-demand balance enhancement assessment. For companies where the expenditure does not represent a material amount we undertake a shallow dive approach applying the company specific efficiency factor. Where expenditure is

material we complete a deep dive using the information provided within the companies' submissions. In the deep dive we disaggregate the totex expenditure into five supply-demand balance enhancement components which we assess separately:

- **2020-25 supply-demand balance enhancement** (supply-side solutions and customer demand management) – This component considers supply-side and customer demand-side (water efficiency) solutions delivering supply-demand balance benefits in the period 2020-25. We determine this allowance through a unit cost approach using the 'minimum of' the company proposed and industry efficient unit cost (£1.20 million per Ml/d) for 2020-25. Unit costs are expressed in units of £ million per Ml/d of benefit. The cost driver is our validated assessment of the companies' proposed benefits for solutions in the period 2020-25. As metering is assessed separately we remove the supply-demand benefits associated with metering from our assessment.
- **Long-term supply-demand balance enhancement** – We identify that some long-term drought resilience investment will not always deliver benefits to the supply-demand balance in the 2020-25 period. This component considers solutions delivering benefits beyond 2025. We assess if there is a valid need for these solutions based on the information provided, and where possible challenge valid solutions against the average solution unit cost from industry-wide water resources management plan option analysis. We assess strategic regional water resource solutions separately.
- **Leakage enhancement** – This component considers the demand benefits identified through leakage reduction activities in the period 2020-25. We do not allow enhancement costs for delivering base service levels. For leakage our expectation for base service levels is that an efficient company should achieve industry forecast upper quartile performance by 2024-25 in both normalised measures (per property and per kilometre of main). Beyond this upper quartile threshold we make an allowance for leakage enhancement funding. We disallow any requested enhancement where these levels are not forecast to be achieved. We also consider this criteria when assessing cost adjustment claims relating to leakage performance.

  We set stretching performance commitments for leakage reduction over the 2020-25 period, taking into account the performance of each company relative to the forecast 2024-25 upper quartile water resources management plan levels and whether the annual percentage reduction is above 15%. If any company outperforms its leakage performance commitment it will earn outcome delivery incentive outperformance payments for this additional reduction in leakage. Any allowed funding is determined through a unit cost approach using the company

proposed costs with a company specific efficiency factor where these costs are above the industry median unit cost (£2.03 million per Ml/d). Leakage benefits associated with metering are assessed implicitly in the metering enhancement model and excluded from this analysis.

Our approach to leakage funding represents a consistent assessment between base and enhancement across all companies based upon comparative performance at an industry level (using 2024-25 upper quartile). Stretching performance commitments then allow for companies to earn outperformance payments based on the company's specific level of leakage reduction over 2020-25.

- **Internal interconnections** – This component considers internal network improvement solutions that provide capacity to transfer supply benefits to overcome local water resource planning deficits. For valid solutions we apply three main tests and interventions to the internal interconnection programmes. These are a project cost efficiency as a result of benchmarking evidence, project sizing (up to 30 percent challenge) based on interconnector utilisation, and optioneering considerations (10 percent challenge or supply-demand balance unit cost applied at £1.20 million per Ml/d) applied where a company has not considered a suitable range of solutions (including consideration of water trading and third party solutions).
- **Investigations and future planning** – We assess if expenditure has been allocated to investigations and future planning such as water resources management plan or regional plan development based upon the information provided in the companies' submissions. We consider these costs are normal operating activities (planning and co-ordination between teams already working on company plans) included within base allowance for the provision of an efficient and secure supply-demand balance in order to meet statutory obligations. One company has accepted that part of its request is base and halved its request and another has removed this component altogether. We note that only five companies requested enhancement funding for this component.

Table 11: Comparison of initial assessment of business plans and draft determination approaches

Component	Initial assessment of business plans approach	Draft determination approach
2020-25 supply-demand balance enhancement	Validated supply-demand benefits (non-leakage) are applied to a unit cost calculated based on the industry median, £1.39 million per Ml/d.	Validated supply-demand benefits (non-leakage) are applied to a unit cost calculated based on an efficient industry rate, £1.20 million per Ml/d.
Long-term enhancement	Deep dive approach with valid solutions assessed against the average solution-type unit cost from industry-wide water resources management plan analysis where possible. Solutions challenged based on evidence of efficient costs and effective optioneering.	No change in approach since the initial assessment of business plans.
Leakage enhancement	Leakage reduction funding allowed for stretch beyond 15%, or where forecasts leakage performance is beyond upper quartile by 2025. Leakage reduction demand benefits applied to a unit cost calculated based on the industry median, £1.60 million per Ml/d.	Leakage reduction funding allowed where a company forecasts leakage performance beyond upper quartile by 2025. Leakage reduction demand benefits applied to the company specified unit cost, with an efficiency challenge applied if appropriate.
Internal interconnections	Deep dive approach with valid solutions reviewed and challenged in the context of £million per Ml/d and £million per km transfer distance where possible. Solutions challenged based on evidence of efficient costs and effective optioneering.	Deep dive with valid solutions reviewed and challenged based on evidence of efficient costs, solution utilisation and optioneering demonstrated.
Investigations and future planning	Normal company activity covered by base allowances, therefore, no enhancement allowed.	No change in approach since the initial assessment of business plans.
Strategic regional water resource solutions	Deep dive approach with focus on comparison with similar solutions.	No change in the approach but not assessed as part of the supply-demand balance enhancement model.

As part of the supply-demand balance assessment we assess the costs and benefits presented for this enhancement line. Although these benefits should be linked to those in the companies' water resources management plans in many cases they are not the same and generally are larger than the quantity of water to meet the deficits

forecast in 2025. We continue to recognise the need for investment identified in the water resources management plans, but we do not cap these benefits to the water resources management plan deficits. Therefore, in some instances we are allowing companies investment to improve their supply-demand balance by more than is necessary to meet its level of service.

Table 12: Draft determination allowances by supply-demand balance component (£ million of 2017-18)[1]

Company	2020-25 SDB enhancement		Long-term SDB enhancement		Leakage enhancement		Internal interconnector		Investigations/ future planning	
	Requested	Allowed	Requested	Allowed	Requested	Allowed	Requested	Allowed	Requested	Allowed
Anglian Water[2]	56.4	40.7	5.7	2.9	76.9	69.2	336.5	241.8	3.1	-
Dŵr Cymru	23.6	21.1	8.5	6.2	52.9	-	5.8	5.5	3.7	-
Hafren Dyfrdwy	-	-	-	-	-	-	-	-	-	-
Northumbrian Water	-	-	-	-	-	-	-	-	-	-
Severn Trent Water	117.9	84.7	3.3	3.3	30.4	-	-	-	-	-
South West Water	3.9	3.9	-	-	11.2	-	-	-	-	-
Southern Water	53.2	53.2	76.6	69.5	33.1	-	56.6	52.6	7.7	-
Thames Water	74.3	74.3	4.9	4.9	157.0	-	-	-	14.3	-
United Utilities	1.2	-	-	-	40.0	-	10.0	9.5	-	-
Wessex Water	2.9	2.9	-	-	25.3	-	-	-	-	-
Yorkshire Water	0.3	-	-	-	136.5	-	-	-	-	-
Affinity Water	53.9	41.1	24.1	21.6	48.2	-	-	-	-	-
Bristol Water	-	-	-	-	4.2	2.4	-	-	-	-
Portsmouth Water	2.7	2.7	-	-	1.5	-	-	-	-	-
South East Water	37.8	37.8	4.6	4.3	29.6	4.6	2.4	2.2	1.7	-
South Staffs Water	5.8	5.9	-	-	10.3	-	-	-	-	-
SES Water	2.6	2.6	-	-	17.4	-	-	-	-	-
Total	**436.4**	**370.7**	**127.7**	**112.7**	**674.7**	**76.3**	**411.3**	**311.6**	**30.3**	**-**

1. Requested costs in this table are after any reallocations that we may have made to or from other enhancement lines.

2. We have removed the costs of schemes that we consider suitable for delivery by direct procurement for customers from the Anglian Water internal interconnections and 2020-25 SDB enhancement (both requested and allowed).

4.5.2 Metering

Initial assessment of business plans approach summary

Metering enhancement considers investment to install meters at properties which currently do not have them. For the initial assessment of business plans we used an econometric modelled approach using historical capex data smoothed over the seven year period from 2012 to 2018. We also completed a deep dive for Thames Water and Anglian Water for smart meter installations and special operating circumstances.

Company responses to our initial assessment of business plans

Our approach to assessing this enhancement activity received several responses in the following areas:

- **Metering penetration** – Anglian Water responds and suggests that a potential improvement to the modelling approach would be to consider a metering penetration variable.
- **Customer-side leakage benefits** – Thames Water responds to highlight that the customer-side leakage benefit costs need to be appropriately reflected in the metering enhancement line.
- **Enhancement opex** – the company responses regarding the exclusion of enhancement opex from some lines are applicable to this model approach.

Changes from initial assessment of business plans approach

Based on the responses received and our own review we make the following changes for draft determination:

- **Totex approach** – The move to a totex model incorporates only a small amount of opex requested associated with this activity (£37 million by three companies). There is no significant impact of including opex within the model regression with a slightly more significant impact on outputs caused by moving to forecast rather than historic data to allow opex to be used. With the incorporation of these changes the metering enhancement model remains robust. We investigated the inclusion of a metering penetration variable but did not find it improved the model (see draft determination approach below).
- **Deep dives** – Northumbrian Water's enhancement investment for upgrading existing meters to smart meters receives a deep dive to ensure a consistent approach with the assessment of this activity for Thames Water and Anglian

Water. This funding was assessed through the econometric model in the initial assessment of business plans. For Thames Water and Anglian Water's deep dive assessment we explain how we have accounted for customer-side leakage benefit costs.

Detail of draft determination approach

We combine the investment on meters requested by optants, selective meters introduced by companies, and meters for businesses into one metering assessment in order to address inconsistent reporting of expenditure and cost drivers between these three lines. We assess the combined metering costs using a unit cost regression model based on forecast totex data for the seven-year period from 2018 to 2025, where the cost driver is the combined number of optant and selective meters installed. We triangulate our cost allowance across two model specifications; level specification (both cost and driver are in levels) and log specification (both costs and driver are in logarithmic scale). The level and log model results are weighted equally (50:50). We have tested the sensitivity of this decision with a weighting of 1/3 to 2/3 (level to log) and this would impact average modelled allowance by 0.35%. We also test for inclusion of metering penetration data (as identified by Anglian Water) and this had no significant impact on the model fit or outputs but does add uncertainty in terms of data confidence, and therefore we decide not to incorporate this variable. Where companies' requested investment is below our modelled allowance, we reduce the allowance to the company's requested amount.

The forward-looking regression results exclude one cost outlier, Thames Water. Thames Water submits a cost adjustment claim (water stress) to further explain its metering costs which it considers are influenced by London specific factors, therefore, we exclude Thames Water from the regression analysis.

The model does not distinguish between the type of meter technology installed (eg smart meters that can measure water usage remotely in real time versus basic meters which require manual collection and processing) because the different technologies are not consistently or clearly identified. Enhancement reallocations to Anglian Water metering are excluded because these relate to replacing of basic meters with smart meters as opposed to completely new meter installations. For the same reasons, enhancement expenditure associated with replacing basic meters with smart meters as opposed to new meter installations is also excluded for Northumbrian Water.

Where companies identify significant metering costs outside of the enhancement line definitions, we undertake a deep dive using the information provided within the companies' submissions. The deep dive assessment identifies if any additional expenditure beyond the modelled allowance is valid. We undertake additional deep dive assessments for Anglian Water, Northumbrian Water and Thames Water to consider replacement of basic meters with smart meters and supporting activities/infrastructure. We include Thames Water's claim for special operating circumstances for this activity here.

- **Anglian Water** – requests additional enhancement funding to deliver replacement of basic meters with smart meter installations and provide supporting infrastructure.
- **Northumbrian Water** – requests additional enhancement funding to deliver replacement of basic meters with smart meter installations.
- **Thames Water** – requests additional enhancement funding to deliver replacement of basic meters with smart meter installations and provide supporting infrastructure. The company also claims for an uplift in unit cost for all meter installations for special regional operating circumstances.

For the deep dives we assess the evidence submitted for each component of the programme, including benchmarking of comparative costs.

Table 13: Draft determination allowances for metering (£ million, 2017-18 CPIH deflated)

Company	Metering enhancement	
	Requested (our view after reallocations)	Allowed
Anglian Water	181.8	108.1
Dŵr Cymru	17.3	17.3
Hafren Dyfrdwy	0.8	0.8
Northumbrian Water	43.1	43.1
Severn Trent Water	66.6	66.6
South West Water	6.7	6.7
Southern Water	10.7	9.5
Thames Water	326.8	178.1
United Utilities	49	41.7
Wessex Water	11.2	10.1
Yorkshire Water	22.1	22.1
Affinity Water	60.5	58.9
Bristol Water	9.4	9.4
Portsmouth Water	5.2	5.2
South East Water	0.6	0.6
South Staffs Water	12.7	11.7
SES Water	21.1	19.5
Total	**845.6**	**609.5**

4.5.3 Supply-demand balance and metering – a joint assessment

Water companies include expenditure relating to water efficiency activities both in the supply-demand balance enhancement and metering enhancement lines. In both areas we set our allowed costs at the lower of the expenditure the company requests or the output of our modelling.

There may be common activities that could be recorded under either activity. We therefore make a joint assessment to consider whether an adjustment to our allowances for the individual activities is appropriate. If a company appears efficient in one area but inefficient in the other, given the potential overlap in allocation of costs in these areas, we make an adjustment to the combined allowance equivalent to the gap between the company request and our modelled output for the efficient component. This adjustment is capped at the total the company requests across both components. For example, a company requests £4 million lower than the modelled amount for the 2020-25 supply-demand balance enhancement component but we apply an efficiency challenge of £1.1 million in its metering component. Therefore, we make an adjustment, increasing the overall combined allowance by £1.1 million.

We make an additional total allowance of £22 million, distributed between seven companies, as a result of this in combination assessment.

4.5.4 Strategic regional water resource solutions

We are intervening to provide funding of up to £450 million for companies to work together to investigate and develop strategic water resource solutions to help solve the drought resilience challenges in the south-east. This includes potential major new water resources, including reservoirs, in the south and south-east of England and national transfers of water from the north-west to the south-east of England. This enables companies to jointly evaluate multiple solutions in more depth and to ensure that appropriate regional solutions can be taken forward in future investment plans. We expect that this funding over 2020-25 will allow integrated solutions to progress through the planning stage to identify the optimum long-term programme for the region. For draft determination we increase the scale of this programme, identifying more solutions to be developed by more companies (note that this impacts all three fast track companies). See ‘Strategic regional water resource solutions appendix’ for more details.

4.7 Environmental obligations

Water companies have statutory obligations to deliver environmental improvements and help meet the environmental targets set out in legislation. For companies operating in England, the Environment Agency sets out these obligations in the Water Industry National Environment Programme (WINEP), and for companies operating in Wales, Natural Resources Wales sets out the obligations in the National Environment Programme (NEP).

These obligations protect a range of environments including bathing waters, shellfish waters and other conservation areas and in addition cover issues relevant to water companies such as intermittent discharges of wastewater to rivers and coastal waters. The interventions that the water companies are expected to provide to fulfil these obligations include treating wastewater discharges to a higher quality standard, to better manage flows of wastewater and to minimise the impacts of abstractions of water for drinking water production.

The investment requested by the industry to deliver the programme at PR19 is significantly larger than the investment required at PR14. We do not challenge the need of company proposals under WINEP and NEP given the need is statutory. However, we challenge companies on the efficient delivery of the programme and make an allowance of 88% of the total expenditure requested by companies.

Dealing with uncertainty in the programme

At the time of our draft determination a significant proportion of WINEP and NEP requirements are yet to be confirmed. In ‘Delivering Water 2020: Our final methodology for the 2019 price review’ we introduced a mechanism to manage this uncertainty. We set our allowance based on the full extent of the programme a company anticipates being required by 2025. Companies were required to link their unconfirmed requirements to an outcome and a unit cost. We use the unit costs to make an adjustment at the end of the control period for outcomes that are confirmed as not being required. The unit costs are specific to each company and set out in the ‘Cost efficiency draft determination appendix’.

4.7.1 Our assessment approach to environmental obligations

Our assessment of companies’ proposed expenditure is based on total expenditure (capex and opex) submitted by the companies. As set out in previous sections our preferred approach is to use benchmarking models, where appropriate. To

benchmark costs, we usually use econometric models with single or multiple explanatory variables. We only apply models where a significant amount of variation in costs can be accounted for by the factors used. Transforming the input data through taking logarithms allows us to explore the potential importance of economies of scale within a given programme. We also use simple unit costs when appropriate. We are aware of the limitations of cost models and control for this in two ways. Firstly we frequently triangulate between multiple models to maximise the number of the factors used in assessing modelled costs. Secondly, for the draft determination stage we take a programme level approach to assessing efficient costs as set out below.

We requested companies to submit in their business plans their costs to deliver WINEP/NEP over a number of standard enhancement areas listed below. These areas of enhancement were defined to allow companies to separately report relatively homogenous types of schemes that, along with other business plan tables detailing costs drivers, could be used to develop benchmarking models. The costs drivers were selected where feasible to be independent of any specific solution, allowing for innovation in this area. For example, for sewage treatment works interventions the works capacity was typically the most appropriate cost driver.

Where the data is not suitable for reliable benchmarking, for example when only a few companies have material investment in a given area, we carry out a deep dive assessment. We also do not use benchmarking models for low materiality programmes as generally scheme numbers and values are small and thus the expected range of programme level costs can be wider than for large programmes.

Since the initial assessment of plans, we have developed our models to take into consideration the responses provided by companies and revisions to their data. When appropriate we elicit further information via the query process. There have been significant changes to company costs and cost drivers since the initial assessment of plans. The table below summarises how each area of enhancement was assessed at draft determination and the requested investment. We assess 92% of the requested investment under wastewater areas of WINEP and NEP using benchmarking models.

Table 14: Summary of assessment method of each enhancement area

Method of assessment	Enhancement area with requested totex
Benchmarking based on Regression model or unit cost – wastewater	– Schemes of Flow to Full Treatment (£535m) – Storage at sewage treatment works (£438m) – Storage in the network (£294m) – Chemical removal schemes (£84m) – Phosphorus removal (£2,404m) – Scheme for reducing sanitary parameters (£298m) – Event duration monitors (£54m) – Flow monitors at sewage treatment works (£110m) **Sub-Total £4,117m**
Deep dive / Shallow dive – wastewater	– Schemes for conservation drivers (£42m) – Schemes for eels regulations (£0.2m) – Chemical investigations (£27m) – Groundwater protections schemes (£33m) – Wastewater investigations (£131m) – Nitrogen removal (£16m) – UV disinfection schemes (£80m) – Other NEP related areas (£19m) **Sub-Total £349m**
Deep dive / Shallow dive – water	– Ecological improvements at abstractions (£94m) – Schemes for eels regulations (£42m) – Schemes for invasive non-native species (£61m) – Drinking Water Protected Areas (£104m) – Water Framework Directive measures (£328m) – Water investigations(£66m) **Sub-Total £695m**

4.7.2 Determining a totex allowance for wastewater obligations

For benchmarked costs at the initial assessment of plans, we set efficient allowances by taking the minimum of the company requested investment and our view of efficient costs in each enhancement area. For draft determinations we have changed our approach. Rather than develop our view of efficient cost within each enhancement area, we develop our view of efficient costs at a programme level, and set an allowance that is the minimum of our programme level view of efficient costs and the company requested costs.

To determine our programme level view of efficient costs, we proceed in two steps:

1. We sum the output of all the individual models, as well as the output of our deep dive and shallow dive assessments. We do not apply any additional cost

challenge on the model results, or a company specific efficiency factor in our deep and shallow dive assessment at this point. This is our view of costs before an efficiency adjustment.

2. We apply an efficiency adjustment to the sum of the outputs in step 1 to obtain our efficient view of costs. On reviewing the evidence we consider that a challenge of nine percent is appropriate. This challenge incorporates a catch up element (which we set at a level significantly less stringent than the 'upper quartile') as well as an expectation that companies will make a step-change in efficiency in the coming regulatory period due to the totex and outcomes approach and ongoing productivity improvements.

Following this process if a company is considered inefficient in one model and efficient in another, the outcomes will balance to a degree. We consider that this taking better account of the accuracy of individual models and potential differences in approaches to cost allocations companies may make.

The table below summarises the output of our assessment. For five of the eleven companies our final allowance is at least 95% of that requested. At an industry level our allowance is 88% of the total requested, with the minimum allowance for any single company is 79% of their requested investment.

Table 15: Total cost allowance in wastewater for WINEP/NEP investment (£m of 2017-18 CPIH deflated)

	Requested costs (after reallocations)	Modelled costs	Efficient costs	Final allowance (min-of requested and efficient costs)	Percentage of requested expenditure allowed
Anglian Water	791.9	737.1	673.6	673.6	85%
Hafren Dyfrdwy	2.7	9.0	8.2	2.7	100%
Northumbrian Water	173.9	158.4	144.7	144.7	83%
United Utilities	647.1	684.1	625.2	625.2	97%
Southern Water	612.2	583.2	533	532.9	87%
Severn Trent England	400.6	513.9	469.6	400.6	100%
South West Water	145.2	189.1	172.8	145.2	100%
Thames Water	379.4	335.7	306.7	306.7	81%
Dŵr Cmyru	207.1	214.4	195.9	195.9	95%
Wessex Water	451.5	388	354.6	354.6	79%
Yorkshire Water	754.6	692.2	632.6	632.6	84%
Total	4,566.2	4,505.3	4,117.2	4,015.1	88%

Below we summarise our assessment approach for each WINEP/NEP enhancement area. Following our review of company responses to the initial assessment of plans, the following were the key areas of development in making draft determinations:

- phosphorus removal;
- reductions in sanitary parameters;
- chemical removal model;
- storage in the network;
- event durations monitors;
- monitors at sewage treatment works; and
- storage in the network

4.7.3 Wastewater benchmarking regression cost models

The discharges from sewage treatment works have a significant impact on the quality of the receiving waters. These works need to comply with discharge consents that typically control the level of substances that either directly impact wildlife or have

a negative influence on biodiversity. Planned interventions in this area are covered within enhancement areas for the control of nitrogen, phosphorus, sanitary parameters such as ammonia, organic matter, bacteria and viruses and the control of chemicals such as zinc.

We developed benchmarking models for programmes to reduce sanitary parameters and for phosphorus and chemicals removal. The enhancement areas related to the control of nitrogen and microorganisms through UV irradiation are assessed through a deep or shallow dive as they are only relevant to a limited number of companies.

Other elements of the WINEP/NEP are concerned with managing flows of wastewater and ensuring less is discharged untreated to the environment. This includes interventions at sewage treatment to monitor flow, provide more storage during wet weather when capacity of the works is exceeded by the flow of sewage and ensure more of the flow is fully treated (often termed flow to full treatment). There are also programmes to manage combined sewer overflows (CSO) that discharge to receiving waters at too high a frequency. A combined sewer overflow is a part of the sewerage system intentionally designed to discharge wastewater when a certain intensity of rainfall in the catchment is exceeded.

Reduction of sanitary parameters

The level of organics (expressed as biochemical oxygen demand) and ammonia in wastewater are controlled principally as they deplete oxygen levels in receiving waters which is detrimental to wildlife. In order to comply with reductions in consent levels companies are typically required to optimise current operations and commission new assets as appropriate. The level of intervention required is expected to be a function of the size of the sewage treatment works and the stringency of the consent.

We assess the investment for this area based on two econometric models, placing equal weight on each. Company responses stated that our model used for the initial assessment of plans was not intuitive and did not take into account the increased cost associated with more stringent consents. Our revised approach addresses these concerns. The first model predicts the required totex using the number of sewage treatment works with new or tightened sanitary parameter consents and the population equivalent (a measure of capacity) of these works as the cost drivers. The second model uses the same number of sewage treatment works and the change in the level of load at these works with an ammonia consent less than or equal to 3mg/L. All variables are in logs to allow for economies of scale and we correct for log transformation bias to ensure that the sum of industry input costs are equal to

industry output costs. Both models appear to provide reasonably robust predictions and both have correlation coefficients (R^2) of 0.77.

Phosphorus removal

Phosphorus, along with nitrogen, is a constituent of wastewater and an essential nutrient for plant life. High levels of nutrients in receiving waters (eutrophication) leads to excessive plant growth and a corresponding depletion of oxygen and a loss of biodiversity. Limiting phosphorus discharges can be necessary for a water course to achieve good ecological status. Phosphorus is reduced in wastewater through enhanced biological or chemical treatment methods. The level of intervention required is expected to be a function of the size of the sewage treatment works and the stringency of the consent.

We assess the investment for this line based on two econometric models, placing equal weight on each. Our model applied for the initial assessment of plans predicts the required totex using the number of sewage treatment works subject to a new or tightened consent and the population equivalent (a measure of works capacity) of these treatment works as the cost drivers. We consider population equivalent to be the primary driver of costs with the number of works providing a measure of the distribution of the size of works in the programme and thus economies of scale at this level. The second model uses the population equivalent and the number of enhanced works with a phosphorus consent less than or equal to 0.5 mg/L as the cost drivers. This model, based on information provided in business plan table WWN4, allows for the impact of the stringency of consent. We use the tightest consent band as companies provided evidence that costs increase significantly (ie non-linearly) in relation to consent levels. Both models were linear regression models and these were chosen because they had better statistical performance in comparison with log models.

Chemicals removal schemes

To safeguard the environment it is important to control the discharges of hazardous pollutants. In this area schemes are require to either prevent exceeding standards through improvement schemes or to prevent a deterioration in river water quality.

We have developed our approach to modelling this area from that applied at the initial assessment of plans. We assess the investment for this area using a model that predicts the required totex using the population equivalent (a measure of works capacity) of the sewage treatment works with an improvement driver and the average level of the consent for zinc as the cost drivers. Further to responses to the

initial assessment of plans we consider the improvement schemes are a more significant driver of costs than no deterioration schemes, due to the frequent need to commission treatment technologies. Our model, based on this factor and the stringency of consents for zinc, provides a substantially improved level of predictive power compared to our initial assessment of plans model. All variables are in logs to allow for economies of scale and we correct for log transformation bias to ensure that the sum of industry input costs are equal to industry output costs. A number of different variables were evaluated including the population equivalent of treatment works with a 'no deterioration' driver. The explanatory variables used have a clear engineering rationale and are consistent with the responses companies provided to our query. The selected model appears statistically robust, although we are mindful of the limited sample size. Our programme level approach to efficiency challenge for WINEP and NEP helps mitigate the limitations of any individual model.

Schemes to increase flow to full treatment

The flow of wastewater to sewage treatment plants increases in response to rainfall in the catchment, especially so in combined sewer catchments. As the treatment capacity of works is limited there is a point at which part of the flow is diverted to storm tanks. If the rainfall is intense and/or persistent these storage storm tanks will eventually fill and discharge untreated wastewater to the receiving watercourse. Increasing the hydraulic capacity of a works or 'flow to full treatment', e.g. by adding an additional treatment stream, reduces the likelihood of an untreated discharge. The costs of the intervention for an individual works is considered a function of this flow shortfall.

We assess costs for this area by taking the average from a log and linear regression model that predicts totex using the number of schemes included in business plans and the shortfall in flow to treatment in litres per second as the cost drivers. Triangulating these models allows us to incorporate both outputs in our assessment. The linear model appears statistically better with a correlation coefficients (R^2) of 0.9, however, the log model may better account for economies of scale that we may expect with increasing the size of programme. We consider that the models with both factors performed better than with either single factor alone. Our log model did not predict realistic costs for Hafren Dyfrdwy, and this data point was omitted from the model. For our determination of Hafren Dyfrdwy's costs we use the linear model alone. To avoid the log transformation bias we make an adjustment to the output from our log model so that the sum of predicted costs (after applying the exponential transformation) is equal to the sum of model inputs (eg actual costs).

Storage schemes at STWs to increase storm tank capacity

As set out in the section above increasing the capacity of storm tanks should reduce the frequency of discharges of wastewater to receiving waters. We expected the cost of interventions to be a function of the increase in volume.

We assess the investment for this area based on two econometric models, placing equal weight on each. The first model predicts the required totex using the volume of storage to be commissioned and the second model includes in addition the number of schemes as the cost drivers. All variables are in logs and we correct for log transformation bias to ensure that the sum of industry input costs are equal to industry output costs. Both models provide robust predictions based on the correlation coefficients, the sign of the coefficients etc. and were preferred to alternative linear models on comparison of these factors

Storage schemes in the network to reduce spill frequency at combined sewer overflow

A combined sewer overflow (CSO) is a part of the sewerage system intentionally designed to discharge wastewater to rivers during high rainfall to avoid the infrastructure that would be required for transporting and managing these flow at treatment works. However, frequent discharges from CSOs will impact water quality and thus also the amenity value of receiving waters. Storage at the point of discharge will limit the volume spilling to the river. However, it is equally feasible to reduce this volume through stopping rainfall draining to the sewer at source. We allow for these interventions and other catchment management approaches within our methodology.

We assess the investment for this area by using a linear regression model which estimates expected totex based on the volume of storage each company is planning to construct. This model has a better predictive power than alternatives, the coefficients appear logical and it fits the data well. We reviewed a range of linear and log models and further tested for the number of schemes as a cost driver. The number of schemes was not shown to be sufficiently statistically significant and is not used. The model includes the costs and cost drivers for the Southern Water conservation driver schemes as they are of a similar nature. Clear representations from Dŵr Cymru stated that our approach at the initial assessment of plans did not allow for funding of alternative approaches to reduce the spill frequency from CSOs based on alternative approaches to surface water management. We welcome innovative catchment management approaches and our modelled allowances for Dŵr Cymru are based on the total effective storage volume within the company

business plan. The effective storage volume of a scheme is the volume that would otherwise have been provided should a conventional CSO storage scheme have been constructed. Evidence provided by Dŵr Cymru indicates that alternative approaches can be cost beneficial and we are minded to further consider whether an additional efficiency challenge should be applied to companies that have not fully evidenced they have considered such approaches.

4.7.4 Wastewater benchmarking unit costs

WINEP/NEP includes requirements to monitor flows of wastewater on sewage treatment works to manage diversions and discharges to storm tanks and intermittent discharges from combined sewer overflows. We did not identify robust regression cost models in these areas at a programme level due to the range of costs and cost drivers. On further scrutiny, the programme of work for individual companies varied significantly and it was appropriate to sub-divide requested investment further and create unit cost models at this more granular level where the scope of works was more homogenous.

Monitoring at intermittent discharges

Company responses to the initial assessment of plans raised concerns that the spread in company unit costs in this area were due to difference in scope of individual schemes. Based on the companies' query responses we developed our approach by generating unit costs at a more granular level. We separately analyse costs for meter installations and permit applications based on the responses to our query from companies. We understand these are distinct activities with a substantially different unit cost. We estimate a unit cost for each of these areas and use this to determine the overall allowance. We use the median unit cost as this is less influenced by outliers than the mean.

Flow monitoring at sewage treatment works

As for event duration monitoring, based on the company's query responses we developed our approach by generating unit costs at a more granular level. We separately analyse costs for new and upgraded meter installations and flow investigations based on the responses to our query from companies. We determine the allowances using the median unit costs as these are less influenced by outliers than the mean costs. Where a company's submission contains schemes necessitating a significant amount of civil engineering work, we separately assess these costs via a deep dive as they unduly impact our unit costs estimates. We

combine the outcomes of any deep dives with the other elements to determine the overall allowance for a company.

4.7.5 Wastewater deep and shallow dive assessments

We assess the enhancement areas below using our deep dive and shallow dive approach rather than benchmarking models. This is typically because only few companies had material investments in the area, or because investment levels, and generally scheme numbers, are small, thus programme level costs can be variable.

Conservation drivers

This enhancement area covers schemes whose primary driver is conservation (eg compliance with Habitat & Birds directives, Countryside and Rights of Way Act 2000) and are not reported elsewhere. Only Hafren Dyfrdwy, Southern Water and Wessex Water request material investment in this area. We assess Hafren Dyfrdwy and Wessex Water via deep dives using the information the companies provide in their business plan submissions. We were satisfied with the evidence provided and allowed the costs, subject to the programme level cost challenge. As Southern Water's preferred solutions were storage schemes, we benchmarked their costs using our sewage treatment works and network storage benchmarking models as appropriate.

Eels Regulations (Wastewater)

This enhancement area covers schemes predominantly in the water service and are to ensure compliance with the Eels regulations to prevent the entrainment of eels and fish. After reallocations only United Utilities requests investment in this area and based on the low materiality of the investment, costs are passed through and subject to the programme level cost

Groundwater schemes

This enhancement area covers schemes whose primary driver is to protect groundwater against pollution and deterioration in quality, in compliance with the EU Groundwater Directive. After reallocations Southern Water is the only company seeking investment in this area for the Thanet Groundwater Scheme. Southern Water has submitted a cost adjustment claim for this scheme and the investment is assessed through the cost adjustment claim process.

Wastewater general investigations and chemical monitoring and investigations

Wastewater investigations can cover a variety of types of study for diverse drivers such as the investigation of frequent spilling CSOs and bathing water quality, for example. We assess the investment for this area based on materiality, using deep dives, as appropriate. We carry out a deep dive using the information the companies provide in their business plan submissions. We apply our optioneering cost challenge to all companies subjected to a deep dive. None of the companies provides sufficient evidence on the design of these programmes and how the under-pinning assumptions had been challenged.

For the enhancement area covering chemical monitoring and investigations, based on the low materiality of the investment, costs are passed through and subject to the programme level cost challenge.

Nitrogen removal

Nitrogen, along with phosphorus is a nutrient linked to eutrophication. In order to comply with reductions in consent levels companies are typically required to treat wastewater through enhanced treatment methods. Only Wessex Water and Southern Water request investment in this area. Based on the low materiality of the investment, costs are passed through and subject to the programme level cost challenge.

UV disinfection

The primary driver for this work is to meet new or tightened consents for microbiological parameters to meet EU Shellfish or Bathing Water directives from wastewater discharges. Only Anglian Water, United Utilities, Southern Water and Wessex Water request material investment in this area, and we assess these lines using deep dives based on the information the companies provide in their business plan submissions. With the exception of Southern Water, we were satisfied with the evidence provided.

NEP discharge relocation

This area relates to AMP5/6 schemes to relocate discharges to controlled waters. After reallocations only Severn Trent Water requires investment in this area and was subject to a deep dive assessment.

National phosphorus removal technology investigations

Only Anglian Water request investment in this area and it relates to WINEP obligations for studies to achieve Common Standards Monitoring Guidance targets. Based on the materiality of the investment costs are passed through and subject to our programme level cost challenge.

Monitoring of pass forward flows at CSOs

The area relates to AMP5/6 schemes to monitor flow at CSOs. We do not expect AMP7 costs in this area as there is no AMP7 driver. Only Severn Trent Water put costs against this area and these were not allowed.

NEP - Flow 1 schemes

This area relates to AMP5 schemes where the primary driver is to prevent the deterioration of receiving waters as a result of increased volumes of discharges. No company requested investment under this line for AMP7 as there is no AMP7 driver.

4.7.6 Water deep and shallow dive assessments

WINEP and NEP for water services consists of the following areas of enhancement,

- **Ecological improvements at abstractions** – schemes to limit the environmental impact at points of abstractions for drinking water production.
- **Eels regulations** – schemes to ensure compliance with the Eels regulations to prevent the entrainment of eels and fish.
- **Invasive non-native species** – schemes, activities and studies to limit the transfer of invasive non-native species, such as floating pennywort and zebra mussels
- **Water Framework directive schemes** – schemes to improve, protect or ensure no deterioration of surface and groundwater under the water framework directive.
- **Drinking water protected areas** – schemes to either reduce current or avoid additional treatment of water for potable supply.
- **Water Investigations** – as with the wastewater service this area covers studies and investigations that will frequently inform plans for future periodic reviews.

We assess all of these lines using deep and shallow dives based on the materiality of the totex requested. We do not challenge the need of the expenditure in this area provided the information submitted by companies reconciles with that in the WINEP and NEP provided by the Environment Agency and Natural Resources Wales respectively. We did not develop programme level benchmarking models as we found that the individual areas of enhancement contained a range of solutions, often with location specific cost drivers. Therefore, the programmes could not be set into relatively homogenous categories necessary for model development.

For the deep dive assessments, we consider the availability and quality of evidence the company provides. We apply our company specific efficiency factor to any costs that we shallow dive. At the initial assessment of plans we provided feedback on areas where we felt supporting evidence was not sufficient. Between the initial assessment of plans and the submission for draft determinations companies were given the opportunity to provide further detailed information to support our assessment of options appraisal and evidence to demonstrate that costs were efficient.

4.8 Other enhancements activities

In this section we explain our approach to assessing remaining enhancements activities not covered in the sections above, and how it has evolved since the initial assessment of plans.

4.8.1 Standard enhancement lines – wholesale water

Table 16: our assessment result in other wholesale water enhancement areas (£m)

Company name	Improving Taste, Odour, Colour		Meeting lead standards		Addressing raw water deterioration		Improvements to river flows	
	Business plans	Our view	Business plans	Our view	Business plans	Our view	Business plans	Our view
Anglian Water	-	-	31.2	11.0	25.5	20.5	-	-
Hafren Dyfrdwy	1.8	1.4	2.9	2.9	0.2	0.2	-	-
Northumbrian Water	-	-	10.3	10.3	34.8	26.4	0.1	0.1
United Utilities	11.9	11.9	14.0	14.0	2.2	2.2	-	-
Southern Water	-	-	19.8	19.8	78.3	61.2	-	-
Severn Trent England	11.3	11.3	16.8	6.3	60.8	37.1	15.2	15.2
South West Water	7.8	6.3	4.0	4.0	83.1	57.2	-	-
Thames Water	-	-	78.2	63.5	10.2	9.2	-	-
Dŵr Cymru	27.2	27.2	15.0	14.0	10.4	9.9	2.2	2.2
Wessex Water	-	-	11.3	11.3	12.1	9.8	-	-
Yorkshire Water	17.0	12.8	12.5	11.1	61.4	50.6	-	-
Affinity Water	-	-	8.4	8.4	3.0	3.0	0.5	0.5
Bristol Water	-	-	0.3	0.3	1.6	1.4	-	-
Portsmouth Water	-	-	0.3	0.2	5.8	5.5	-	-
SES Water	-	-	1.7	1.7	-	-	-	-
South East Water	-	-	-	-	17.5	15.7	1.7	1.7
South Staffs Water	74.3	62.9	3.5	3.0	15.9	10.7	-	-
Industry	**151.4**	**133.8**	**230.2**	**181.8**	**422.9**	**320.8**	**19.7**	**19.7**

Note: The business plan figures include costs we have reallocated to the enhancement line from other areas of the business plan.

Improving taste/odour/colour

Our assessment of taste/odour/colour is mainly based on a deep dive assessment. In our assessment we look for Drinking Water Inspectorate support of individual schemes. We additionally seek evidence of the scale of flow to be treated and the nature of the treatment. We also consider if the company demonstrates adequate customer support and customer protection. We disallow any costs that we consider to be included in our base allowance, including operational costs of new treatment because our modelling of base costs includes a treatment complexity variable.

Meeting lead standards

Companies have statutory obligations to manage customer exposure to levels of lead below a statutory limit.

At the initial assessment of plans we triangulated one model based on historical data and one model based on forecast data, both using the number of lead pipes replaced and the total number of communication pipes at as cost drivers.

Responding to feedback from companies' representations, we no longer use historical data to estimate efficient allowances due to the higher unit cost of some lead reduction programmes for the forecast period, which have large trial programmes and include the replacement of pipes in customers' homes and at schools and nurseries. We now use an econometric model based on forecast data and triangulate with a unit cost approach.

At draft determination we use only the number of lead replacement pipes replaced for water quality as the model driver. For the econometric model, we use a log-linear model as it captures economies of scale better than a linear model and provides more credible results for the very small and very large companies in our sample. The average unit cost in the sector (meeting lead standards costs per lead pipe replaced) provides an intuitive and credible cost per pipe replaced. We consider that unit cost provides a valid alternative outcome to the econometric model and therefore we triangulate both results. For the two Welsh water companies we make an additional allowance over and above the modelling results due to the expectation set by the Welsh Government to meet a lower lead target.

Investment to address raw water deterioration

In our assessment we look for Drinking Water Inspectorate support of individual schemes. For treatment and raw water blending schemes we additionally seek evidence of the scale of flow, the processes required and the extent of any pipeline works. We disallow operational costs of new treatment on this enhancement line as our modelling of base costs includes a treatment complexity variable. We also consider catchment management schemes that seek to prevent raw water deterioration. When we assess these schemes, we look for evidence that companies have considered the impact of the proposed metaldehyde ban on project costs.

Improvements to river flows

We assess the costs for improvements to river flows using our shallow dive process because all proposals are not material. We apply our company specific efficiency challenge to these costs.

Security & Emergency Measures Directive (SEMD) and non-SEMD costs

For wholesale water we maintain our overall approach as used at our initial assessment. We combine SEMD and non-SEMD costs into one security assessment as these areas are both driven by the requirement to ensure that the water network is resilient in the event of an emergency situation. We assess the combined security

costs by determining the proportion of each company's base totex spent on security for the period 2011-12 until 2024-25. Where companies forecast above their allowance, we reduce this to the average proportion of all companies' security costs. For companies whose PR19 costs are material as a proportion of base costs, or whose costs changed substantially since September, we carry out a deep dive using the information provided within the companies' submission.

4.8.2 Standard Enhancement Lines – Wholesale wastewater

Table 17: Key wholesale wastewater other enhancement totex areas

Company name	First time sewerage		Sludge enhancement (quality and growth)		Odour	
	Business plans	Our view	Business plans	Our view	Business plans	Our view
Anglian Water	23.9	19.2	31.2	0.5	14.0	12.6
Hafren Dyfrdwy	0.003	-	-	-	-	-
Northumbrian Water	1.0	1.0	-	-	-	-
United Utilities	5.1	3.5	0.7	0.6	-	-
Southern Water	5.0	5.0	6.4	5.1	-	-
Severn Trent England	17.4	12.8	26.9	0.0	-	-
South West Water	1.0	1.0	5.2	0.0	-	-
Thames Water	8.7	3.3	38.7	0.0	11.5	11.0
Dŵr Cymru	5.9	4.4	6.0	5.8	3.2	3.1
Wessex Water	5.3	3.9	-	-	-	-
Yorkshire Water	1.0	1.0	60.3	35.6	-	-
Industry	**74.3**	**55.1**	**175.4**	**47.6**	**28.7**	**26.7**

Note: The business plan figures include costs we have reallocated to the enhancement line from other areas of the business plan.

First time sewerage

We assess the investment for this line using a panel data model where the cost driver is the number of connectable properties served by s101A schemes. The model includes both a linear and a squared term of the driver. This seems to capture economies of scale and fit the data well. We triangulate our cost allowance across two models, one using historical data for the period 2011-12 to 2017-18 and other using forecast data for the period of 2020-21 to 2024-25. Our allowance is based on the average result of the two models, unless the company requested a lower expenditure than that predicted by the model, in which case we allow the company its requested costs.

Sludge enhancement (quality and growth)

We assess the proposals for costs of providing sludge treatment facilities to accommodate the increase in sludge production that results from population growth or new environmental regulations. We allow expenditure where companies provide sufficient evidence of population growth and evaluate the impact of this and the environmental regulations on sludge production. We also assess how well the companies have engaged with the bioresources market to provide a cost effective solution. For example, whether they have considered third party provision of additional treatment capacity, particularly when the additional capacity is not required immediately. Where companies do not provide such evidence we apply a cost challenge to their proposed expenditure and made a lower allowance. Wastewater companies are well-positioned to stimulate the market and help it work for them and their customers.

Odour

All company proposals are below the materiality threshold and therefore we assess the investment for this line by following the shallow dive process.

Security & Emergency Measures Directive (SEMD) and non-SEMD costs

For wholesale wastewater we maintain our approach as used at our initial assessment. We combine the SEMD and non-SEMD costs into one security assessment. We welcome the proposals for companies to invest in this area and do not apply the company specific efficiency factor to companies where wastewater security costs are not deemed material.

Where costs are material, we carry out a deep dive assessment. We assess these costs by determining the proportion of base totex spent on security for the period 2011-12 to 2024-25. We reduce the company allowance to ensure the total costs for this period do not exceed the average of both the median and the average proportion of base costs spent on security for all wastewater companies.

4.8.3 Assessment of expenditure submitted in freeform enhancement lines

Our reporting tables allow companies to submit enhancement expenditure in freeform lines, where they consider that a specific expenditure does not fit the description of any of the standard lines.

Our consideration and assessment of expenditure submitted in freeform lines is included in our freeform feeder models.

We assess freeform expenditure proposals either through a shallow dive or a deep dive process, depending on materiality. Where we consider it appropriate, we reallocate expenditure submitted by a company in a freeform enhancement line to a standard enhancement line.

5 Pulling the pieces together: setting efficient allowances for wholesale controls

In previous sections we explain our assessment approach to the three building blocks of wholesale costs – modelled base costs, unmodelled base costs and enhancement expenditure. Our assessment is often done at service levels that do not necessarily correspond to the PR19 controls of water resources; water network plus; wastewater network plus; and bioresources.

In this section we explain how we apportion the result of our assessments to arrive at an efficient cost allowance for each of the PR19 controls.

Modelled base costs

For modelled base costs, we use our suite of econometric models to estimate efficient costs at the wholesale service level. In annex 2 we describe how we triangulate the results from the different models to come to a view of efficiency wholesale costs.

To apportion our view of efficient modelled base costs at the wholesale level to the more granular controls, we follow a different approach for water and wastewater.

In water, we apportion our view of efficient wholesale costs based on the proportion of costs in the different controls in company business plans.

In wastewater, we apportion our view of efficient wholesale costs based on the information provided from our econometric models. We calculate a proportion of wholesale costs attributed to bioresources as follows:

1. We average the results of the bioresources plus models and subtract the average result of the wastewater collection models. This provides the first estimation of modelled bioresources costs.
2. We average the results of the bioresources models to obtain a second estimation of modelled bioresources costs.
3. We average the first and second estimation of bioresources costs to obtain a triangulated view of modelled bioresources costs.
4. We calculate the share of our triangulated view of bioresources costs out of wholesale modelled costs.

5. We multiply our efficient view of wholesale costs by the share of bioresources calculated above to obtain an efficient bioresources allowance. The remainder is the efficient wastewater network plus allowance.

As discussed in section 3.2.3, we are considering alternatives to this approach for final determinations. For example, using the same approach as in wholesale water (ie using company business plan proportions) or using the bioresources models alone to set the allowance for the bioresources controls.

Enhancement and unmodelled base costs

In the areas of enhancement and unmodelled costs, most activities fall naturally to the confines of a single price control.

In cases where activities cut across two controls, we make the assessment at the wholesale level. We apportion the result of our assessment to price controls based on the proportion of costs in the company business plan in each price control for the activity in question.

An exception is third party services costs, where we do the assessment at price control level so no apportioning is required.

There may be cases where it is appropriate to make the apportionment differently to the above, directly related to the specific disallowances we have made. We will consider changing our apportionment approach in specific cases for final determination. We expect this to be immaterial.

We note that while the metering enhancement activity falls almost entirely in the water network plus control, we allocated our metering allowances based on supply-demand enhancement split across controls. We will correct this for final determinations.

6 Our assessment of retail costs

In this section we explain our approach to assessing retail costs for the draft determinations.

There are two separate retail controls. The residential retail control applies to retail services to households. The business retail control applies to retail services for businesses, charities and public sector organisations.

6.1 Residential retail

Since we introduced separate retail controls at PR14, we have seen evidence that companies are increasingly more focussed on outcomes and efficiency in delivering retail services. This trend is continuing in the PR19 business plans. Projected costs for 2020-25 in residential retail are generally decreasing relative to the current level of expenditure.

We use econometric models to benchmark companies' costs and set efficient cost allowances. This is a move away from the average cost to serve approach of PR14. We use different models to benchmark different costs:

- models to benchmark bad debt and debt management costs;
- models to benchmark other retail costs (ie total residential retail costs except for bad debt and debt management costs, such as customer service and meter reading costs); and
- models to benchmark total retail costs.

As in wholesale, our models exclude pension deficit repair costs and third party services costs. We set out our approach for these excluded items in section 3.4. Annex 2 of this report provides a description of the models' specifications.

We also consider cost adjustment claims raised by companies, which can result in an additional allowance on top of the allowance based on our models.

As set out in our final methodology we do not index the residential retail controls to a general inflation measure. We set cost allowances at 2017-18 prices which are the nominal allowances for 2020-21 to 2024-25.

6.1.1 Changes to our approach since the initial assessment of plans

Changes to our cost drivers

Council tax collection rate – we used council tax collection rates as a proxy for propensity to default, which in turn is a driver of bad debt costs. A new data release by the Office for National Statistics (ONS) introduced changes to the data, updating actuals for 2016-17 and replacing forecast data with actuals for 2017-18. The revised data reduced the statistical validity of the variable in our models and in alternative models that we considered. The variable also lacked stability and had a weaker economic rationale compared to alternative drivers in our models (eg income deprivation and proportion of customers with default). Therefore, we decided not to use this variable for draft determinations. We exclude the two models (one for bad debt and bad management costs and one for total retail costs) that include council tax collection rates as a cost driver.

Total migration – we use total migration in our residential retail models as a proxy for transience, which in turn drives bad debt and debt management costs. At the initial assessment of plans the coefficient of this variable was negative, which is counterintuitive. Affinity Water and Thames Water highlighted this issue in their response to our initial assessment of plans. The negative sign appears to be a consequence of a change in the ONS' methodology[14] to estimate the variable for 2016-17 relative to that used for the calculation of the variable in earlier years. This rendered the time series inconsistent. To use the variable under a consistent methodology, we can use either the data of 2016-17, or data from earlier years. For draft determinations, we decided to use the data of 2016-17 from the latest ONS release (for each year in our sample). This results in an intuitive positive coefficient. We also tested our models with the transience variable using data from earlier years. While the positive coefficient remains, we choose to use the 2016-17 data rather than the data of earlier years as this is based on an improved methodology and is more suitable to use for forecasting. In August 2019, there will be a new release of data that we will consider using to update our models for the final determinations.

Affinity Water and Thames Water expressed concerns that the impact of the transience variable on our modelling result is diluted because it is included in only one model within our modelling suite. A second change we have made since the initial assessment of plans is adding total migration as a driver to one of our total

14 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/methodologies/methodologyguideformid2015ukpopulationestimatesenglandandwalesjune2016

retail cost models. This increases the overall weight of this variable on our modelling results.

Proportion of metered customers – At the initial assessment of plans, we constructed forecast data for the companies' proportion of metered customers using information from their Water Resources Management Plans (WRMPs). Bristol Water and SES Water suggested the alternative of sourcing these forecast figures directly from companies' business plans. We have reviewed both approaches and decided to pursue this alternative approach. This is because business plan forecasts for the proportion of metered customers has advantages over the WRMP:

- Business plan data is reported consistently while not all companies are at the same stage in the WRMP process (eg some have produced draft plans while others have revised these).
- Business plan data was submitted in April 2019 while WRMPs were submitted in April 2018. The WRMP guidance instructs data reported in business plans to reconcile with that in final WRMPs, therefore information in business plans contains a more updated view of these figures.

While we consider business plan forecasts more appropriate for the reasons outlined above, we recognise that they are not independent forecasts. We have reviewed the values and consider them plausible and consistent with the forecasts in the WRMPs and therefore consider that customers are suitably protected.

Changes to the dependent variable

The dependent variable in our retail econometric models include the relevant retail costs less pension deficit repair and legacy depreciation costs, plus net recharge costs from wholesale. Our total cost and 'other' cost models include depreciation costs.

Depreciation figures – at the initial assessment of plans, we used depreciation costs reported in companies' Annual Performance Reports. Unfortunately, pre-2015-16 data was reported on a different accounting basis (current cost depreciation approach) to that from 2015-16 onwards (historic cost depreciation approach). For draft determinations, we use depreciation figures sourced from the companies' business plans which use only the historic cost depreciation approach. This ensures the data is prepared on a consistent accounting basis.

Changes to our forecast of cost drivers

Average bill size – our econometric models include average bill size as an explanatory factor of bad debt costs. At the initial assessment of plans, we used average bill size in nominal terms to calculate our forecast modelled costs. To ensure consistency of price base with the costs in the dependent variable, in draft determinations we use average bill size in real terms to forecast efficient costs. At draft determinations, we use company forecasts of revenue and numbers of connected households to calculate average bill size. For final determinations, we will consider using an average bill size that reflects our view of costs for final determinations using our financial model.

Endogeneity of average bill size

Average bill size may suffer from endogeneity. Technically speaking, the variable may be correlated with inefficiency (hence with the error term, which is assumed to capture inefficiency). A potential consequence of that is that the estimated effect of the variable (ie the estimated coefficient) captures not only the effect of bill size on bad debt costs, but also, to some extent, the effect of inefficiency. If bill size is in management control, this can create a perverse incentive and reward companies with a higher average bill size a greater cost allowance.

While acknowledging the risk around endogeneity, we consider that the inclusion of average bill size in our models remains appropriate. Our determination of price limits and the wider regulatory framework place limits on management's ability to set bill sizes, and various safeguards exist to protect customers against arbitrary bill rises. Additionally, residential retail costs make up a small proportion of bill size, meaning that concerns over endogeneity might be disproportionate.

At Bristol Water's PR14 price determination, the CMA[15] stated that some cases may warrant the inclusion of a potentially endogenous variable if the alternative was not taking into account potentially important differences between companies. Average bill size is an important driver of bad debt and, consequently, total retail costs. We consider that its inclusion in our models outweighs the use of a possible imperfect proxy.

[15] See paragraph 4.50(e) of the CMA's PR14 price determination for Bristol Water

Changes to our efficiency challenge

At the initial assessment of plans, our efficiency challenge in residential retail was based on business plan costs (forward-looking efficiency) as opposed to historical cost performance. We calculated forward-looking efficiency scores as the ratio of companies' forecast costs submitted to us in their business plan to our independent view of efficient costs, for the period 2020-25. We set the efficiency level at the (forward-looking) upper quartile to adjust our econometric results from average to efficient. The 'upper quartile' efficient level is the level that 25% of the companies' forecast to outperform while 75% of the companies' forecast to underperform.

A number of companies have expressed concern over this approach, arguing that it is based on business plan projections that have not yet been delivered and that it is inconsistent with our approach to wholesale modelling.

We consider that using business plans to inform the efficiency challenge is appropriate, particularly for retail services. The retail control has started only in 2015 and retail services can transform more quickly than wholesale services (eg due to lack of long-lived infrastructure assets). The fact that the majority of companies submitted stretching forecasts that are significantly more efficient than historical expenditure is evidence of the pace at which this service is transforming. It is important that customers share the benefits. We consider that the forward looking upper quartile provides a credible challenge as it does not rely on a single efficient business plan but on five business plans that project efficient costs. What is more, there were companies that have achieved this level of performance in recent years.

Nonetheless, given changes to our models we have reconsidered the strength of the efficiency challenge subject to the forward looking upper quartile. With the modelling changes, our overall challenge has become more stringent. Given that we consider many companies submitted stretching cost proposals in residential retail, we decided to reduce the challenge implied by the forward looking upper quartile. For draft determinations, we set the efficiency challenge based on the average between the forward looking upper quartile and the historical upper quartile performance. We consider that this strikes a balance between the uses of actual cost performance while also accounting for projected efficiencies in the dynamic retail sector.

We do not apply a further frontier shift challenge or input price pressure adjustment in residential retail. Efficient business plans may have accounted for these in their cost forecasts, which feed into our forward looking efficiency challenge, and thereby are reflected in our efficient allowances.

6.2 Business retail

In PR19, we set an average revenue control for a five year period for water companies that expect to have business retail customers on 1 April 2020. This currently means Dŵr Cymru and Hafren Dyfrdwy, because full business retail competition is not extended in Wales, and Yorkshire Water, which has not exited the business retail market (at the time of the draft determinations).

Consistent with the approach adopted at PR16, the average revenue control takes form of default tariff caps based on allowed average cost per customer and net/gross margins. In this section, we explain how we set the efficient average cost per customer allowance for each customer type in the non-contestable segments of the business retail market in England and Wales. For English companies, this would mean assessing the cost to serve allowance for customers using less than five mega litres of water and wastewater services per year, and for Welsh companies, assessing the cost to serve allowance for customers using less than fifty mega litres of water a year and all wastewater customers.

The details of how the efficient cost per customer allowance is used along with application of the different margin caps (net/gross[16)] to estimate total allowed revenue for each customer type is explained in section 2.3 of 'WACC Appendix for DD' document.

Our draft determination assessment for each of the three companies is discussed below:

Yorkshire Water

We accept Yorkshire Water's proposed default tariff caps for customers using less than 5 mega litres (Ml) of water or wastewater per year. Our assessment is based on the detailed evidence provided in the companies' business plan and previously allowed levels of costs.

[16] The application of the different margin caps depends upon the contestability of the market and customer type.

Yorkshire Water's proposals involved only minor changes from their PR14 and PR16 allowance, which were assessed as efficient. Yorkshire Water's proposed tariffs are efficient relative to the comparable tariffs proposed by the Welsh water companies.

Table 18 presents the allowed average retail cost per customer for each customer type using less than 5Ml of water or wastewater services per year.

Table 18: Allowed average retail cost per customer (£, nominal prices)

Customer type	2020-21	2021-22	2022-23	2023-24	2024-25
Water, unmetered	17.53	17.95	17.9	18.33	18.78
Sewerage, unmetered	17.67	18.09	18.04	18.47	18.92
Water, 0-5ml	26.68	27.3	27.23	27.88	28.57
Sewerage, 0-5ml	28.8	29.48	29.4	30.11	30.85
Trade Effluent, 0-5ml	23	23.54	23.47	24.04	24.63

Note: Nominal prices use Ofwat's forecast of CPIH. This may vary from the company business plan forecast.

Dŵr Cymru

At the initial assessment of plans we identified that Dŵr Cymru business retail proposals were not efficient compared to evidence from its residential retail controls. We asked Dŵr Cymru to consider this and revise its business retail proposals, or to provide further evidence on the efficiency of its business retail services.

In response, Dŵr Cymru has reviewed and revised the allocation of costs between residential and non-residential customers. The company provided supporting evidence to justify the revised allocation of costs. The revisions are in line with regulatory guidelines. With the revised proposals, Dŵr Cymru costs per business customer are lower relative to its PR14 and PR16 levels.

We accept Dŵr Cymru revised proposals for their tariff caps for customers using 50Ml of water per year or less.

Table 19 below presents the allowed average retail cost per customer for customers using less than 50Ml of water or wastewater services[17] per year.

Table 19: Allowed average retail cost per customer (£, nominal prices)

Customer type	2020-21	2021-22	2022-23	2023-24	2024-25
Water supplies < 50ML	28.83	27.97	27.38	26.73	26.23
Wastewater services	37.64	36.74	36.15	35.49	35.02

Note: Nominal prices use Ofwat's forecast of CPIH. This may vary from the company business plan forecast.

Hafren Dyfrdwy

At the initial assessment of plans we identified that Hafren Dyfrdwy proposes high costs per business customer. We asked Hafren Dyfrdwy to reconsider the efficiency of its business retail proposals. Hafren Dyfrdwy did not respond to our challenge nor revised its proposals.

Hafren Dyfrdwy's customer base in the business retail segment is made up almost entirely of businesses with low water use (<5Ml per year). These customers are comparable to residential customers. For draft determinations, we set the allowed cost for a customer that uses less than 5Ml per year of water and wastewater services equal to its cost per residential customer, which we consider to be efficient. We consider Hafren Dyfrdwy's proposed costs for all wastewater customers and water customers consuming 5-50 Ml per year are appropriate, and we allow these costs in full.

[17] Wastewater services are not segregated by customer types.

Table 20 below presents the allowed average retail cost per customer for these customer categories.

Table 20: Allowed average retail cost per customer (£, nominal prices)

Customer type		2020-21	2021-22	2022-23	2023-24	2024-25
Water unmeasured and 0-5 Ml/a	Company view	47.04	47.68	47.37	48.44	48.98
	Ofwat allowance	30.88	30.76	28.47	25.75	26.07
Water 5-50 Ml/a	Company view/ Ofwat allowance	163.66	167.34	168.38	173.48	176.53
Wastewater unmeasured and 0-5 Ml/a	Company view	42.7	42.79	41.59	42.08	42.02
	Ofwat allowance	30.88	30.76	28.47	25.75	26.07
Wastewater 5-50 Ml/a	Company view/ Ofwat allowance	173.4	177.57	181.37	18.63	191.44
Wastewater: 50+ Ml/a	Company view/ Ofwat allowance	56.29	57.4	58.07	59.49	60.3

Note: Nominal prices use Ofwat's forecast of CPIH. This may vary from the company business plan forecast.

We note that the cost per customer for 5-50Ml wastewater customers reported by Hafren Dyfrdwy is higher than its reported costs for >50Ml/a wastewater customers. This is peculiar and the company will be queried for further clarification at final determination stage. Hence, the cost per customer allowance for 5-50ML wastewater customer is provisional and will be finalised at final determination stage.

7 Cost adjustment claims

Our cost assessment framework allows companies to submit cost adjustment claims in their business plans. Cost adjustment claims are mechanisms for a company to present evidence of unique operating circumstances, legal requirements or atypical expenditure which drive higher efficient costs for the company relative to its peers. We refer to our Technical Appendix 2: Securing cost efficiency published in January 2019 for an explanation of how we assess whether the companies' cost adjustment claims are well evidenced and appropriate.

We expect cost adjustment claims to be submitted with supportive evidence against the relevant assessment gates identified in Appendix 11 of our PR19 methodology. The most important gate is the 'need for adjustment'. We expect companies to clearly explain why our benchmarking analysis does not adequately capture their unique circumstances. Where this gate is failed, we reject the cost claim.

Slow track and significant scrutiny companies submitted 33 cost claims in their revised plans, four of which are new claims. They withdrew 13 claims since the initial assessment of plans.

Table 21 provides a summary of submitted cost adjustment claims and the result of our assessment. We reject 21 claims and accept or partially accept the remaining 12.

Table 21: Summary of cost adjustment claims submitted by slow track and significant scrutiny companies at draft determination

Company	Claim name	Amount requested	Our assessment	Amount allowed
Anglian Water	Maintain frontier leakage performance	147.9	Reject	0.0
Anglian Water	Sludge transport	41.6	Reject	0.0
Dŵr Cymru	Improving acceptability of water	27.2	Reject	0.0
Dŵr Cymru	Maintaining reservoir safety	69.5 (net)	Partial accept	75.5 (gross)
Dŵr Cymru	Cwm Taf Water Supply Strategy	73.0	Accept under DPC process	To develop under DPC process. (We allow DPC set up costs of £13.6m but deduct base maintenance savings which

				we forecast at £17m.)
Dŵr Cymru	Welsh language service retail costs	5.8	Reject	0.0
Hafren Dyfrdwy	Reducing lead in water networks	2.9	Accept	2.9
Hafren Dyfrdwy	Enhancing biodiversity and well-being in water resources	1.9	Partial accept	0.9
Hafren Dyfrdwy	Maintaining reservoir safety	4.3	Partial accept	2.8
Southern Water	Thanet Groundwater protection	32.9	Partial accept	30.0
Southern Water	Improving bathing waters beyond statutory requirements	21.3	Partial accept	20.6
Thames Water	Population transience - impact on debt recovery and customer account management costs	63.0	Reject	0.0
Thames Water	Incremental cost of water stress on balancing supply / demand	165.0	Partial accept	33.4
Thames Water	CRM and billing system - legacy depreciation costs	66.8	Reject	0.0
Thames Water	Growth and quality investment for bioresources	38.7	Reject	0.0
Thames Water	Network maintenance - higher costs incurred in central London	120.2	Reject	0.0
Wessex Water	Wastewater flooding programme	84.6	Reject	0.0
Wessex Water	Sewage treatment works capacity programme	61.1	Reject	0.0
Wessex Water	Reducing leakage by a further 15%	25.3	Reject	0.0
Wessex Water	North Bristol sewerage strategy	47.2	Partial accept	44.7
Wessex Water	Pollution reduction strategy	15.6	Reject	0.0
Yorkshire Water	Bioresources handling and treatment due to Water Industry National Environmental Programme	60.3	Partial accept	35.6
Affinity Water	Population transience - regional operating circumstances	7.8	Reject	0.0
Affinity Water	Regional wages - regional operating circumstances	12.5	Reject	0.0
Bristol Water	Purchase of water from the Canal and River Trust	9.4	Reject	0.0
Bristol Water	Age and material of water distribution network	12.3	Reject	0.0
Bristol Water	Water treatment complexity	6.0	Reject	0.0
Portsmouth Water	Bill size (residential retail)	1.0	Reject	0.0

South East Water	Geological factors - diseconomies in network plus treatment plants and abnormal groundwater complexity	20.0	Reject	0.0
South Staffs Water	Treatment works investment	74.3	Partial accept	62.9
SES Water	Water softening statutory requirement	12.1	Partial accept	11.5
SES Water	Mains replacement for leakage reduction	13.1	Reject	0.0
SES Water	Wholesale electricity usage	10.5	Reject	0.0

Where we partially accept the claim, our allowance will be lower than the amount requested. This is due to one or more of the following reasons: we deduct an implicit allowance; we make a challenge due to lack of evidence that the proposed solution is the best option for customers; or we challenge the efficiency of the amount requested. We provide further detail on the rationale for our assessment of each cost adjustment claim in the company specific cost assessment draft determination appendix. We publish our assessment of these claims for each company in a separate excel spreadsheet (called FM_CAC) as part of our suite of cost assessment models.

8 Additional details of our cost assessment

8.1 Cost Sharing

Cost sharing rates are the proportion of cost savings that investors get to keep, or the proportion of any cost overrun that investors will have to bear. Cost sharing ensures that customers get a share of the benefits when companies outperform their cost allowance, and that customers and companies are protected when companies overrun their allowance. We will take cost sharing performance into account in the PR19 reconciliation for the next price control period.

The cost sharing mechanism applies to total revenue controls only, namely for water resources, water network plus and wastewater network plus. For the water resources and water network plus controls, we set the same cost sharing rates. We do not apply cost sharing in the residential retail control. In the residential retail control, any deviation from our allowed expenditure will be incurred fully by the company.

In the PR19 methodology we set out cost sharing rates that we would apply for companies in the 2020-25 period. These rates set out the level of out and under performance of our cost baselines companies would share with their customers. These cost sharing rates depend on the ratio of a company business plan costs to our view of efficient cost. The lower the company business plan costs compared to our view, the more preferential the cost sharing rates. In the PR19 methodology we stated that we would review cost sharing rates after the initial assessment of plans to identify whether they continue to remain appropriate.

Our original cost sharing rates have the steepest slope where company business plans are near our baseline. It is clear from both the company plans submitted in September 2018 and the revised company plans submitted in April 2019 that the majority of companies are in the 110 to 120% bracket where the slope of the cost sharing curve is flattest. It is also clear that while some companies have submitted efficient cost proposals, many companies have further work to do to ensure that they have appropriately challenged themselves.

Representations to the draft determination is the final opportunity for companies to provide realistic cost estimates and fully consider the feedback we provide in our initial assessment and draft determinations. Companies should not expect to repeat the same arguments and expect a different outcome, when we have rejected their claims at the initial assessment and draft determination. We are therefore proposing to amend cost sharing rates in the 110% to 120% bracket, where most companies

are currently positioned, to incentivise companies to focus on the most important issues and ensure that their plans are efficient.

To allow companies to respond to this we will place weight on companies' final cost submission that they provide in response to the draft determinations. In determining cost sharing rates we therefore propose to place 50% weight on the company's September 2018 business plans and 50% weight on the company final business plan it sends with its representation to the draft determination. Our view of efficient costs will be provided at final determinations.

As fast track companies accepted our cost baselines, as long as they continue to do so they will be awarded 50:50 sharing rate. In the PR19 methodology we proposed to set cost sharing rates of 75% for underperformance and 25% for outperformance for the companies categorised as 'significant scrutiny' in the initial assessment of plans. Our consideration of applying lower cost sharing rates for significant scrutiny companies is set out in 'Significant scrutiny companies - Application of lower cost sharing rates and outcome delivery incentive cap'.

Table 22: Original and revised cost sharing rates

	Ratio of company plan to Ofwat view					
	80%	90%	100%	110%	115%	120%
Original						
Cost sharing rate (outperform)	65%	60%	50%	40%	37.5%	35%
Cost sharing rate (underperform)	50%	50%	50%	60%	62.5%	65%
Revised						
Cost sharing rate (outperform)	65%	60%	50%	40%	35%	30%
Cost sharing rate (underperform)	50%	50%	50%	60%	65%	70%

In addition to this we set out in the PR19 methodology that we would provide companies with an upfront payment to reduce the scale of any reconciliation of cost out or underperformance at the 2024 price review. This upfront payment was based on the expected company outturn if it spends the costs in its business plan. This revenue was not additional revenue to companies but simply revenue transferred from that which would be reconciled in PR24 when we would reconcile the customer share of out and under performance.

In the light of latest data submitted by companies we no longer consider that such an upfront payment is appropriate. So far in the 2015-18 period companies have outperformed our efficient cost baselines by an average of 4%. This is even for some

companies such as Bristol Water, whose PR14 business plan costs were far higher than their final determination as determined by the Competition and Markets Authority (CMA). Some of this reduction in costs reflects improved efficiency and some of it reductions in scope from schemes that we did not fund in company business plans. We therefore consider that our efficient cost baseline rather than company business plans are likely to be a better guide to the outturn performance of a company. We therefore no longer consider that an upfront payment is required and have not included one in slow track draft determinations. This does not affect the overall cost sharing incentive – only the timing of this reconciliation.

8.2 Transition programme

In our PR19 methodology we allow companies to propose to bring forward some of their investment programmes from 2020-25 to 2019-20.

The purpose of the transition programme is to make efficient use of resources and minimise whole life costs, where it is efficient to bring forward an investment, and to enable statutory deadlines early in the next regulatory period to be met. It may allow companies to respond efficiently to new information related to the next price control period. Although the expenditure would be incurred in 2019-20, for the purpose of cost performance incentives it is considered as expenditure incurred in the following regulatory period (2020-25).

Six of the 14 slow truck and significant scrutiny companies proposed investment under the transition programme for a total of £163.4m (2017-18 prices). Of this we are allowing £84.5 million.

Where companies propose transition expenditure, we expect them to make the case for why it is efficient to bring the investment forward, and why it was not part of its outcomes and long-term planning from PR14. Our criteria for accepting expenditure under the transition programme are:

- the company provided evidence to justify the early start; and
- the investment has early statutory deadlines in the next regulatory period; or
- the expenditure relates to early design and planning of large, non-routine investments.

We consider that under our regulatory framework of totex and outcomes, companies have flexibility to defer or bring forward investment as appropriate and efficient. In contrast to PR09, cost allowances are not linked to specific schemes and companies

are able to bring forward investment, if it is more efficient to do so, regardless of the regulatory cycle. Where we rejected expenditure proposals under the transition programme, we still expect companies to bring forward the investment if it is efficient to do so.

Table 23 provides information on the schemes requested under the transition programme and a brief description of our rationale for accepting or rejecting the expenditure as transition. We provide more information in the companies' cost efficiency appendix.

Table 23: Summary of schemes submitted in PR19 business plans under the transition programme (£m of 2017-18)

Investment	Requested	Allowed	Rationale
Anglian Water			
Raw water deterioration	1.6	1.6	Early obligation for delivery of nitrate removal plant supported by Drinking Water Inspectorate
Resilience scheme at Ludham and planning for WRMP pipelines	17.3	17.3	£4 million relate to the delivery of an early obligation scheme in Ludham, and the remaining investment will allow early planning and delivery of an environmental impact assessment, which we consider efficient to bring forward.
Security of Network & Information Systems (NIS) compliance	1.6	0	Does not meet criteria of early statutory deadlines or large investment that requires planning.
Improve resilience of network interconnectivity	0.9	0.9	Early start related to a large programme to improve the resilience of the water supply network linking to meet requirements of the water resources management plans.
First time sewerage (design of 4 schemes for customers not on public system)	1.9	0	Does not meet criteria of early statutory deadlines or large investment that requires planning.
WINEP / NEP ~ Schemes to increase flow to full treatment	6.0	6.0	The investment relates to an early obligation set by the Environment Agency to be delivered in the first two years of the next regulatory period.
WINEP / NEP ~ Nutrients (P removal at filter bed STWs)	5.6	5.6	The investment relates to the early planning and design of the phosphorous removal programme. We accept it is efficient to start early.
New development and growth sewerage programme	8.8	0	This is a routine investment that does not meet criterion of early statutory deadlines.
Wastewater treatment centres growth programme	4.0	0	This is a routine investment that does not meet criterion of early statutory deadlines.
Northumbrian Water			
Resilience (water)	1.4	0	We do not allow all of the resilience expenditure the company proposes due to lack of evidence on its understanding of the risks it

			proposes to mitigate. We therefore do not allow the associated transition expenditure.
Resilience (wastewater)	0.2	0	As above
Growth at sewage treatment works	1.2	0	This is a routine investment that does not meet criterion of early statutory deadlines.
Welsh Water			
L2 driver for Loughor	72.4	20.9	Consistent with our PR19 methodology, we only consider expenditure incurred in 2019-20 as valid for inclusion as PR19 transition expenditure. The rest was incurred earlier in the 2015-20 period and therefore we consider it in our PR14 totex reconciliation. The arguments presented by the company are not convincing as we consider the PR14 final determination allowance provided funding for the company to meet all statutory obligations and it is the company's responsibility to manage uncertainty around these costs, namely through the totex sharing mechanism. We allow transitional expenditure consistent with this decision, since the company plans to complete the investment in 2019-20.
Wessex Water			
WINEP schemes (water)	0.6	0	Disallowed due to lack of evidence in support of them being required early.
WINEP schemes (wastewater)	20.0	18.2	Most schemes related to early statutory deadlines and therefore allowed. £2.3 investment relates to a catchment management scheme which was chosen instead of building a nitrogen removal plant. £2.2m investment relates to Catchment Nutrient Balancing which we support a trial for before the start of AMP7.
Yorkshire Water			
Lead Programme	2.5	0	Does not meet criterion of early statutory deadlines.
Drinking Water Quality schemes at Tophill Low, Chellow and Fixby	1.6	1.0	We accept the investigations and design work related to the DWI supported water quality schemes to ensure early delivery in AMP7. The company did not clearly evidence why it would be efficient to incur the enabling base expenditure in advance and we do not allow this element.
Reservoir Safety programme	2.6	0	Does not meet criterion of early statutory deadlines.
WINEP Programme expenditure related to investigations and phosphorus removal schemes	8.0	7.7	The investment has early statutory deadlines. The company does not clearly evidence why it would be efficient to incur the base expenditure in advance and we do not allow this element.
Portsmouth Water			
Development of Havant Thicket reservoir	5.2	5.2	The investment is large, non-routine and well justified. The company provides extensive evidence to explain that the investment was not part of the long-term planning from PR14 due to additional information arising in 2017/18

			on the need of additional water and further specifications of the project, which were agreed with Southern Water. Furthermore, the company justifies that it is efficient to bring this investment forward. Delays to the scheme would impact on the ability for the company to transfer water to Southern Water, hence we accept the need for transition funding.
Total	**163.**	**84.5**	

8.3 Grants and Contributions

Companies receive grants and contributions from developers towards the costs of 'new developments', expenditure to reinforce the network, and 'new connections', expenditure to connect a property, for example the meter and connection pipe. We calculate the grants and contributions receivable by applying a recovery rate to our view of new developments and new connections expenditure. This ensures that developers pay a fair share towards costs to connect new properties. We use this calculation of grants and contributions receivable from developers to ensure that the amounts billed to water and wastewater customers correctly reflect only that share of any new development spend which should be borne by them.

We expected company business plan forecasts to reflect a change in the way charges are set for some aspects of developer services. Previously companies applied an 'income offset' to the requisitions charges that they levied when they installed a new mains for a developer. The 'income offset' is a discount which reflects the additional revenue that the company will benefit from in respect of newly connected properties. Under the new regime (which came into force on 1 April 2018 for companies wholly and/or mainly operating in England) the income offset is now applied to the infrastructure charges. We expect that the existing balance between customers and developers of who pays for these costs is maintained in the transition to the new charges regime.

When making our fast track determinations we observed that some companies forecast income offsets which are in excess of the total infrastructure charges that they expected to levy. This leads to a net negative charge, ie a payment to developers. For the fast track companies we formed an industry wide average rate based on levels of recovery that assumed an income offset capped at the total level of infrastructure charges meaning we did not assume any negative amounts. In their representations the fast track companies provide more evidence of the validity of their forecasts. We are satisfied that such negative amounts may be valid to maintain the existing balance of charges. In these draft determinations we have changed our approach and use the company views of the water new development recovery rates

in our modelling assumptions. Table 24 provides our approach to calculating recovery rates.

Table 24: Calculation of recovery rates for grants and contributions

	Water	Wastewater
New developments	We use the rate implied by the company business plans;	The range of recovery activity forecast by the companies is much narrower than is the case for water. We therefore use a rate of 100% based on our understanding of historical practice in the industry and is broadly supported by company business plans
New connections	We use a rate of 100% based on our understanding of historical practice in the industry. However where companies make a case in their business plan for a lower charge, for example where a discount is applied for developments with water saving fixtures, then we may use the company forecast proportion;	Not applicable (there is no connection charge in wastewater)
Diversions	Where companies move their assets to make way for new infrastructure, we have assumed that the company view of the associated income is cost reflective and we would expect this to represent 100% of the costs.	

In modelling our draft determinations we assume that all diversions income is inside the price control. For the final determinations we consider that we should make a distinction between diversions that are inside or outside the scope of section 185 of the Water Industry Act 1991. Works that are outside the scope of section 185 are, for example, works under the New Roads and Street Works Act 1991 or those associated with High Speed 2. We are yet to have sufficient data to be able to distinguish section 185 diversions from non-section 185 diversions. For the final determination we will assume diversions expenditure is inside the price control unless it relates to non-section 185 diversions. Where companies forecast diversions works outside of section 185 then they should provide details of the income relating to this, on an annual basis, in the data request that accompanies the draft determination. This should be returned with the representations to the draft determination.

Some grants and contributions relate to non-price control activities. We use the non-price control proportion of total grants and contributions as forecast in company business plans to calculate our view of this income.

8.4 Operating leases

We make an adjustment to reflect a change in the accounting treatment of leases. We remove the forecast annual cash cost of existing leases from our allowances for companies where Regulatory Capital Value (RCV) adjustments are made. In doing so, we have followed the approach set out in IN 18/09 Guidance for reporting operating leases in PR19 business plans. We have used the adjustment proposed in the company business plan.

Table 25: Operating leases adjustment by wholesale price control for 2020-25, £m CPIH deflated FYA

	Water resources	Water network plus	Wastewater network plus	Bioresources	Thames Tideway	Total
Anglian Water	-0.44	-4.28	-6.44	-2.60	0.00	-13.75
Dŵr Cymru	0.00	0.00	0.00	0.00	0.00	0.00
Hafren Dyfrdwy	0.00	0.00	0.00	0.00	0.00	0.00
Northumbrian Water	-0.17	-1.09	-2.70	-0.14	0.00	-4.09
Severn Trent England	-0.15	-1.25	-0.10	0.00	0.00	-1.51
South West Water	0.00	-3.33	-3.31	0.00	0.00	-6.64
Southern Water	0.00	0.00	-7.72	0.00	0.00	-7.72
Thames Water	-2.43	-9.67	-11.29	-0.81	-5.78	-29.98
United Utilities	0.00	-0.14	-1.05	-0.03	0.00	-1.23
Wessex Water	0.00	-0.31	-0.23	0.00	0.00	-0.54
Yorkshire Water	-0.35	-6.59	-5.88	-1.71	0.00	-14.54
Affinity Water	0.00	-11.96				-11.96
Bristol Water	0.00	0.00				0.00
Portsmouth Water	0.00	0.00				0.00
South East Water	-0.17	-0.73				-0.90
South Staffs Water	0.00	0.00				0.00
SES Water	0.00	0.00				0.00
Industry	**-3.71**	**-39.35**	**-38.72**	**-5.30**	**-5.78**	**-92.85**

8.5 Allocating costs between capex and opex

Companies have proposed pay as you go rates based on their underlying split of opex and capex. To maintain companies' approaches to cost recovery we need a similar split of totex to work out pay as you go rates based on our totex allowance. We apply a technical intervention to pay as you go rates as set out in 'Aligning risk and return technical appendix'.

At the initial assessment of plans we assessed enhancement expenditure on a capex only basis. For draft determinations we assess enhancement expenditure on a totex basis. We have revised our approach to allocating costs between capex and opex to take account of this.

To allocate our totex allowance to capex and opex we use business plan proportions of projected capex and opex. We use company business plan proposals including third party costs but excluding pension deficit repair costs. We adjust company business plan proposals to remove known interventions that wholly relate to either capex or opex, such as strategic regional water resources solutions, and calculate the proportion of adjusted business plan costs that are allocated to capex and opex.

We apply these proportions to our allowances that exclude the known interventions and then add the interventions to the relevant expenditure, for example strategic regional water resources solutions are wholly allocated to capex.

8.6 Totex profiling

We need to profile our totex allowance over the five-year period for the purpose of financial modelling and the setting of an annual revenue cap. We profile our totex allowance over the five-year period using business plan profile of requested totex over the period.

We recognise that our cost interventions may impact the profile of requested cost in company business plans. For draft determination we will also consider whether a 'manual' adjustment is required in cases where we disallow a material investment in specific years over the regulatory period. We will consider representations on our draft determinations.

Annex 1: Cost tables

Table A1.1 compares total costs (base and enhancement costs) as proposed by companies in their business plans with our view of efficient costs at the initial assessment of plans and at draft determinations. The efficiency challenge is the proportion of business plan totex that we disallow due to inefficiency or lack of evidence. For practical purposes, we present costs at wholesale water, wastewater and residential retail levels although at PR19 we set cost allowances at a more granular level. Business retail costs are not included. Costs are in 2017-18 prices and exclude pension deficit recovery costs and third party costs.

Table A1.1: Summary of total costs

Company name	Wholesale water costs (£m)				Wholesale wastewater costs (£m)				Residential retail costs (£m)				Total costs (£m)			
	Business plans	Our view (IAP)	Our view (DD)	Cost challenge (DD)	Business plans	Our view (IAP)	Our view (DD)	Cost challenge (DD)	Business plans	Our view (IAP)	Our view (DD)	Cost challenge (DD)	Business plans	Our view (IAP)	Our view (DD)	Cost challenge (DD)
Anglian Water	2,845	2,202	2,075	27.1%	3,439	2,889	2,842	17.4%	408	403	400	1.8%	6,692	5,494	5,318	20.5%
Hafren Dyfrdwy	120	122	121	-1.3%	26	27	28	-9.9%	14	14	14	-5.9%	159	163	164	-3.1%
Northumbrian Water	1,717	1,563	1,611	6.1%	1,215	1,009	1,053	13.3%	280	253	252	10.0%	3,211	2,825	2,916	9.2%
United Utilities	2,519	2,451	2,498	0.9%	3,074	2,835	2,863	6.9%	508	513	477	6.1%	6,102	5,799	5,837	4.3%
Southern Water	1,180	1,065	1,024	13.2%	2,310	2,100	2,153	6.8%	235	267	258	-9.6%	3,725	3,433	3,435	7.8%
Severn Trent England	3,172	2,833	2,849	10.2%	2,960	3,070	3,137	-6.0%	462	490	489	-5.8%	6,594	6,393	6,475	1.8%
South West Water	906	902	890	1.8%	983	939	914	7.1%	160	140	141	12.1%	2,049	1,982	1,944	5.1%
Thames Water	5,321	4,211	4,164	21.7%	4,795	4,521	4,346	9.4%	877	689	753	14.1%	10,993	9,421	9,263	15.7%
Dŵr Cymru	1,670	1,309	1,340	19.8%	1,576	1,353	1,396	11.4%	268	203	207	22.8%	3,514	2,866	2,943	16.2%
Wessex Water	647	602	610	5.7%	1,554	1,374	1,374	11.6%	164	145	143	12.8%	2,365	2,121	2,128	10.0%
Yorkshire Water	1,920	1,712	1,684	12.3%	2,930	2,384	2,315	21.0%	273	358	325	-18.9%	5,124	4,453	4,323	15.6%
Affinity Water	1,436	1,294	1,311	8.8%					145	139	140	4.0%	1,582	1,433	1,450	8.3%
Bristol Water	459	403	389	15.1%					50	45	50	-0.7%	509	449	439	13.6%
Portsmouth Water	166	232	189	-14.0%					23	22	22	6.6%	189	254	211	-11.4%
SES Water	258	218	215	16.8%					37	25	27	28.5%	296	242	242	18.3%
South East Water	1,005	819	866	13.8%					81	85	87	-7.0%	1,087	904	954	12.2%
South Staffs Water	598	497	526	12.0%					59	60	62	-4.8%	657	558	588	10.5%
Industry	**25,939**	**22,435**	**22,362**	**13.8%**	**24,862**	**22,501**	**22,421**	**9.8%**	**4,045**	**3,853**	**3,846**	**4.9%**	**54,846**	**48,789**	**48,629**	**11.3%**

Table A1.2 is similar to Table A1.1 but for base costs only. Our definition of base costs has changed between the initial assessment of plans and draft determination, as detailed in chapter 3 of this document. The cost challenge on base costs is a more robust measure of efficiency. The efficiency challenge is the proportion of business plan base costs that we disallow due to inefficiency. Costs are in CPIH prices of 2017-18. Costs exclude pension deficit recovery costs and third party costs. Business plans base costs exclude enhancement opex.

Table A1.2: Summary of base costs

	Wholesale water base costs (£m)			Wholesale wastewater base costs (£m)			Residential retail costs (£m)			Total base costs		
	Business plans	Our view	Cost challenge	Business plans	Our view	Cost challenge	Business plans	Our view	Cost challenge	Business plans	Our view	Cost challenge
Anglian Water	1,795	1,508	16.0%	2,547	2,140	16.0%	408	400	1.8%	4,750	4,049	14.8%
Hafren Dyfrdwy	102	109	-7.2%	23	25	-11.4%	14	14	-5.9%	138	149	-7.8%
Northumbrian Water	1,455	1,463	-0.5%	923	872	5.5%	280	252	10.0%	2,658	2,587	2.7%
United Utilities	2,182	2,331	-6.8%	2,328	2,227	4.3%	508	477	6.1%	5,018	5,035	-0.3%
Southern Water	816	743	8.9%	1,646	1,594	3.1%	235	258	-9.6%	2,696	2,595	3.8%
Severn Trent England	2,537	2,460	3.0%	2,423	2,690	-11.0%	462	489	-5.8%	5,422	5,638	-4.0%
South West Water	700	763	-9.0%	780	759	2.7%	160	141	12.1%	1,640	1,663	-1.4%
Thames Water	4,004	3,548	11.4%	4,153	4,017	3.3%	877	753	14.1%	9,034	8,319	7.9%
Dŵr Cymru	1,095	1,095	0.0%	1,201	1,164	3.1%	268	207	22.8%	2,564	2,466	3.8%
Wessex Water	532	550	-3.5%	1,017	971	4.5%	164	143	12.8%	1,713	1,665	2.8%
Yorkshire Water	1,578	1,554	1.5%	1,965	1,650	16.0%	273	325	-18.9%	3,817	3,529	7.5%
Affinity Water	1,027	1,057	-2.8%				145	140	4.0%	1,173	1,196	-2.0%
Bristol Water	424	368	13.3%				50	50	-0.7%	474	418	11.9%
Portsmouth Water	143	172	-20.3%				23	22	6.6%	166	194	-16.5%
SES Water	196	191	2.6%				37	27	28.5%	234	218	6.7%
South East Water	744	694	6.6%				81	87	-7.0%	825	782	5.3%
South Staffs Water	464	429	7.5%				59	62	-4.8%	523	491	6.1%
Industry	**19,794**	**19,036**	**3.8%**	**19,007**	**18,111**	**4.7%**	**4,045**	**3,846**	**4.9%**	**42,846**	**40,993**	**4.3%**

Table A1.3 presents a breakdown of enhancement totex by key areas. The enhancement proposals are dominated by the environmental improvement programmes (WINEP/NEP). Other considerable investments are: solutions to provide resilient supplies during periods of drought (supply demand balance); investment to install meters at properties which currently do not have them; and resilience. Our allowance for total wholesale enhancement is net of an implicit allowance for enhancement opex.

Table A1.3: Key enhancement totex areas (water and wastewater)

Company name	Environmental programme (£m)		Supply-demand and metering (£m)		Resilience (£m)		Other enhancement activities (£m)		Deduction for enhancement opex implicit allowance	Total wholesale enhancement (£m)	
	Business plans	Our view	Business plans	Our view	Business plans	Our view	Business plans	Our view		Business plans (after reallocations)	Our view
Anglian Water	854	729	718	463	73	18	171	78	-19	1,815	1,269
Hafren Dyfrdwy	8	7	1	1	2	1	10	8	-1	21	15
Northumbrian Water	189	159	43	43	215	89	106	51	-14	553	329
United Utilities	676	654	100	51	108	79	47	45	-26	931	803
Southern Water	630	547	238	186	0	0	152	119	-11	1,020	840
Severn Trent England	501	488	218	162	137	107	257	108	-29	1,114	836
South West Water	158	156	22	11	59	37	180	86	-8	419	281
Thames Water	553	448	577	268	229	87	472	184	-42	1,832	944
Dŵr Cymru	229	214	112	52	186	8	423	217	-13	949	477
Wessex Water	470	372	39	14	11	3	119	81	-7	640	463
Yorkshire Water	802	679	159	22	29	0	317	111	-18	1,307	794
Affinity Water	122	117	187	122	15	14	11	11	-10	336	254
Bristol Water	5	4	14	12	12	6	4	3	-3	34	22
Portsmouth Water	5	4	9	8	3	1	6	6	-2	23	17
SES Water	1	1	41	22	9	0	2	2	-2	53	24
South East Water	71	67	135	50	34	4	22	16	-6	261	172
South Staffs Water	8	6	29	18	4	0	94	77	-4	134	97
Industry	**5,281**	**4,653**	**2,641**	**1,503**	**1,126**	**453**	**2,393**	**1,202**	**-216**	**11,441**	**7,636**

Tables A1.4 and A1.5 below are similar to tables A1.2 and A1.3. However, the treatment of enhancement opex implicit allowance is different. We now exclude enhancement opex implicit allowance from base costs rather than from enhancement. All notes to tables A1.2 and A1.3 set out below are also applicable to A1.4 and A1.5 respectively.

Table A1.4: Summary of base costs (excluding enhancement opex implicit allowance)

	Wholesale water base costs (£m)			Wholesale wastewater base costs (£m)			Residential retail costs (£m)			Total base costs		
	Business plans	Our view	Cost challenge	Business plans	Our view	Cost challenge	Business plans	Our view	Cost challenge	Business plans	Our view	Cost challenge
Anglian Water	1,795	1,495	16.7%	2,547	2,134	16.2%	408	400	1.8%	4,750	4,030	15.2%
Hafren Dyfrdwy	102	108	-6.2%	23	25	-11.1%	14	14	-5.9%	138	148	-7.0%
Northumbrian Water	1,455	1,452	0.2%	923	870	5.8%	280	252	10.0%	2,658	2,573	3.2%
United Utilities	2,182	2,311	-5.9%	2,328	2,221	4.6%	508	477	6.1%	5,018	5,009	0.2%
Southern Water	816	736	9.7%	1,646	1,590	3.4%	235	258	-9.6%	2,696	2,584	4.2%
Severn Trent England	2,537	2,438	3.9%	2,423	2,682	-10.7%	462	489	-5.8%	5,422	5,609	-3.4%
South West Water	700	757	-8.1%	780	757	2.9%	160	141	12.1%	1,640	1,654	-0.9%
Thames Water	4,004	3,517	12.2%	4,153	4,006	3.5%	877	753	14.1%	9,034	8,277	8.4%
Dŵr Cymru	1,095	1,084	0.9%	1,201	1,161	3.3%	268	207	22.8%	2,564	2,453	4.3%
Wessex Water	532	546	-2.6%	1,017	969	4.8%	164	143	12.8%	1,713	1,657	3.2%
Yorkshire Water	1,578	1,541	2.4%	1,965	1,645	16.3%	273	325	-18.9%	3,817	3,511	8.0%
Affinity Water	1,027	1,047	-1.9%				145	140	4.0%	1,173	1,186	-1.2%
Bristol Water	424	364	14.1%				50	50	-0.7%	474	415	12.6%
Portsmouth Water	143	170	-19.2%				23	22	6.6%	166	192	-15.5%
SES Water	196	190	3.4%				37	27	28.5%	234	216	7.4%
South East Water	744	688	7.5%				81	87	-7.0%	825	776	6.0%
South Staffs Water	464	425	8.3%				59	62	-4.8%	523	487	6.8%
Industry	**19,794**	**18,870**	**4.7%**	**19,007**	**18,061**	**5.0%**	**4,045**	**3,846**	**4.9%**	**42,846**	**40,777**	**4.8%**

Table A1.5: Key enhancement totex areas (water and wastewater, including enhancement opex implicit allowance)

Company name	Environmental programme (£m)		Supply-demand and metering (£m)		Resilience (£m)		Other enhancement activities (£m)		Total wholesale enhancement (£m)	
	Business plans	Our view	Business plans	Our view	Business plans	Our view	Business plans	Our view	Business plans (after reallocations)	Our view
Anglian Water	854	729	718	463	73	18	171	78	1,815	1,287
Hafren Dyfrdwy	8	7	1	1	2	1	10	8	21	16
Northumbrian Water	189	159	43	43	215	89	106	51	553	343
United Utilities	676	654	100	51	108	79	47	45	931	828
Southern Water	630	547	238	186	0	0	152	119	1,020	851
Severn Trent England	501	488	218	162	137	107	257	108	1,114	866
South West Water	158	156	22	11	59	37	180	86	419	290
Thames Water	553	448	577	268	229	87	472	184	1,832	987
Dŵr Cymru	229	214	112	52	186	8	423	217	949	491
Wessex Water	470	372	39	14	11	3	119	81	640	470
Yorkshire Water	802	679	159	22	29	0	317	111	1,307	812
Affinity Water	122	117	187	122	15	14	11	11	336	264
Bristol Water	5	4	14	12	12	6	4	3	34	25
Portsmouth Water	5	4	9	8	3	1	6	6	23	19
SES Water	1	1	41	22	9	0	2	2	53	25
South East Water	71	67	135	50	34	4	22	16	261	178
South Staffs Water	8	6	29	18	4	0	94	77	134	101
Industry	**5,281**	**4,653**	**2,641**	**1,503**	**1,126**	**453**	**2,393**	**1,202**	**11,441**	**7,852**

Corrections to submitted costs

The notes below help to explain why the costs reported in table A1.1, table A1.2 and table A1.3 may not necessarily align with company business plan submissions. All corrections will be made for final determinations.

Table A1.1

1. Our view of total costs is equal to the sum of base costs (table A1.2) and enhancement costs (table A1.3). However, companies' submitted total costs do not always equal the sum of base costs and enhancement costs due to the reasons described below.
2. Anglian Water's submitted wholesale water totex should be £9.76 million lower to reflect the revised enhancement costs provided in response to query ANH-DD-CE-004.
3. Thames Water's submitted wholesale water totex should be £20.63 million lower to reflect the revised enhancement costs provided in response to query TMS-DD-CE-003.
4. Affinity Water's submitted wholesale water totex should be £73.11 million lower to remove costs associated with the 'strategic development fund' and 'other cash items', which are both excluded from cost sharing.
5. South West Bournemouth incorrectly allocated £20 million to third party services instead of enhancement expenditure. As a result, the company's submitted totex is underestimated by £20 million. This does not affect our assessment of costs.

Table A1.2

6. United Utilities' business plan opex has not been grossed up to reflect the change in the treatment of diversions expenditure (diversions costs should be reported on a gross rather than a net basis). As a result, United Utilities' business plan total base costs are understated by £103.2 million. This does not affect our assessment of costs.
7. SES Water's view of base costs in this table omits £9.03m for water softening costs. This does not affect our assessment of costs.

Table A1.3

8. Enhancement opex rebasing was conducted for Severn Trent England and United Utilities (as described above), which was taken into account in our assessment of wholesale water and wastewater enhancement expenditure. However, this is not reflected in business plans enhancement opex in feeder model 4 and in table A1.3 above. As a result, Severn Trent England and United Utilities' submitted total wholesale enhancement net of enhancement opex is understated by £57.82 million and £44.62 million, respectively.
9. Wholesale wastewater enhancement opex reported in wastewater feeder model 4, and in Table 23 above, does not exclude enhancement opex attributed to: (i) growth at sewage treatment works; (ii) reduce risk of sewer flooding; and (iii) transfer of private sewers. As a result, submitted total wholesale enhancement net of enhancement opex is understated for a number of companies: Anglian Water - £13.12 million; United Utilities - £5.14

million; Southern Water - £8.53 million; Severn Trent England - £1.63 million; South West Bournemouth - £10.81 million; Thames Water - £106.24 million; Dŵr Cymru - £0.40 million; Wessex Water - £7.63 million; and Yorkshire Water - £0.30 million. This does not affect our assessment of costs.

10. Northumbrian Water's submitted wholesale enhancement costs is overstated by £17.49 million. This is because a reallocation of submitted costs from enhancement to traffic management act is currently being captured in both places. This does not affect our assessment of costs.
11. Severn Trent England's submitted total wholesale enhancement is currently overstated by £1.98 million due to costs being captured within chemicals removal and p-removal enhancement lines. We will take this into account for final determination.
12. Wessex Water's submitted total wholesale enhancement is understated by £4.91 million due to a reallocation from p-removal to sludge quality and growth. We will take this into account for final determination.
13. Yorkshire Water's submitted total wholesale enhancement is understated by £35.89 million due to a reallocation from wastewater freeform to wastewater investigations enhancement. This does not affect our assessment of costs.

Annex 2: Our econometric models – specifications and results

In this annex we provide a description of the econometric models we used for the draft determinations of slow track and significant scrutiny companies. We limit the information to a description of the models and how we triangulated them. Details of our modelling approach and model selection criteria was published in Supplementary technical appendix: Econometric approach alongside our initial assessment of plans.

We do not expect to make significant changes to our suite of models for final determinations. We will continue to review our models and consider company representations. We will also re-assess the models in light of the 2018-19 data submission, which we received on 15 July.

Information presented in the tables below

In the tables below we present the specification of our econometric model and the estimated coefficients for each explanatory factor used in the model. All variables included in our models were defined in our initial assessment of plans. Feeder model 1 and the Stata do files also provide a detailed description of how all the variables included in the models are defined.

The notation *, ** and *** denote significance of the estimated coefficient at 10, 5 and 1 percent respectively. P-values are added in parentheses in cases where the estimated coefficient is not statistically significant at the 10 percent level.

Cost models for wholesale water activities

Table A2.1 presents the five econometric models we use to benchmark costs of wholesale water services. The dependent variable is modelled base costs, which now includes costs associated with new connections, new developments and addressing low pressure. All our models are estimated using historical data only, in prices of 2017-18, and using random effects estimation.

As discussed in chapter 3 of this document, the booster pumping station data has been revised since the initial assessment of plans to ensure consistency in reporting between companies.

Table A2.1: Econometric models for wholesale water activities

Table A2.1 presents the five econometric models we use to benchmark costs of wholesale water services:

- 2 water resources plus models (water resources plus is our term for water resources and water treatment combined)
- 1 treated water distribution model
- 2 wholesale water models

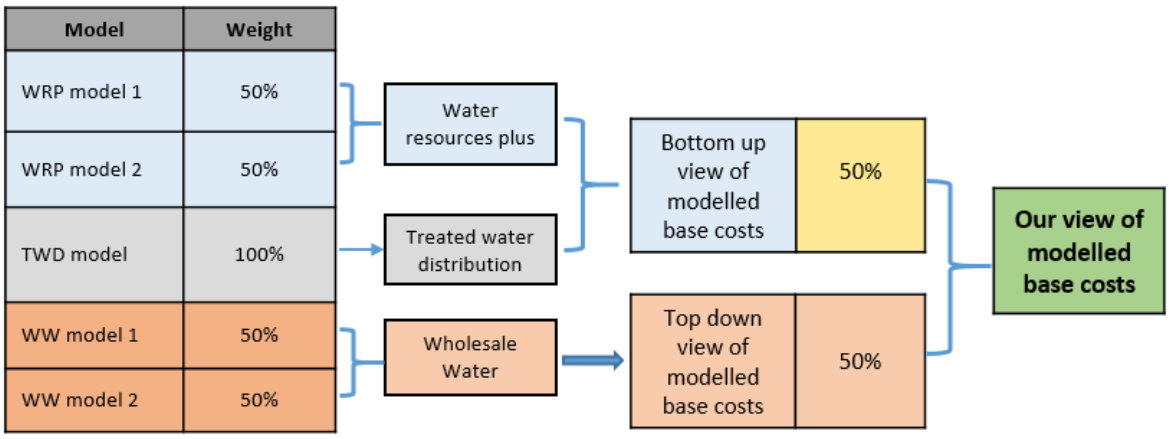
The dependent variable is water modelled base costs, which now includes costs associated with new developments and connections, and costs to address low pressure. All our models are estimated using historical data only, in prices of 2017-18, and using random effects estimation.

Model name	WRP1	WRP2	TWD1	WW1	WW2
Dependent variable (log)	Water resources + Raw water distribution + Water treatment		Treated water distribution	Wholesale water total	
Connected properties (log)	1.013***	1.013***		1.034***	1.021***
Lengths of main (log)			1.044***		
Water treated at works of complexity levels 3 to 6 (%)	0.008***			0.005***	
Weighted average treatment complexity (log)		0.440***			0.524***
Number of booster pumping stations per lengths of main (log)			0.467***	0.236*	0.256***
Weighted average density (log)	-1.389**	-0.729 (0.173)	-2.972***	-2.026***	-1.635***
Squared term of log of weighted average density	0.085**	0.038 (0.332)	0.237***	0.142***	0.114***
Constant term	-5.215***	-7.505***	5.271***	-1.732	-3.230***
Overall R-Squared	0.93	0.92	0.97	0.98	0.98
Number of observations	124	124	124	124	124

Figure A2.1 sets out our triangulation approach of the five models to achieve a view of (average) wholesale water modelled base costs:

- Step 1: we average the models at each level of activity.
- Step 2: we add the results of the water resources plus and treated model distribution models to form our ‘bottom-up’ view of wholesale water modelled base costs; the average of the wholesale water models is our ‘top-down’ view.
- Step 3: we average our bottom-up and top-down views to arrive at our view of wholesale water modelled base costs.

Figure A2.1: Triangulation of wholesale water econometric models



Cost models for wholesale wastewater activities

Table A2.2 presents the eight econometric models we use to benchmark costs of wholesale wastewater services:

- 2 bioresources models
- 2 sewage treatment models
- 2 sewage collection models
- 2 bioresources plus models (bioresources plus is our term for bioresources and sewage treatment combined)

The dependent variable is wastewater modelled base costs, which now includes costs associated with new developments and connections, growth in sewage treatment works and reduce flooding risk in properties. All our models are estimated using historical data only, in prices of 2017-18, and using random effects estimation.

In response to the initial assessment of plans feedback, we have changed bioresources model BR1 by including the percent of load treated at band sizes 1-3 as an additional explanatory variable. This way we capture variations in sludge transportation costs more accurately.

Table A2.2: Econometric models for wholesale wastewater activities

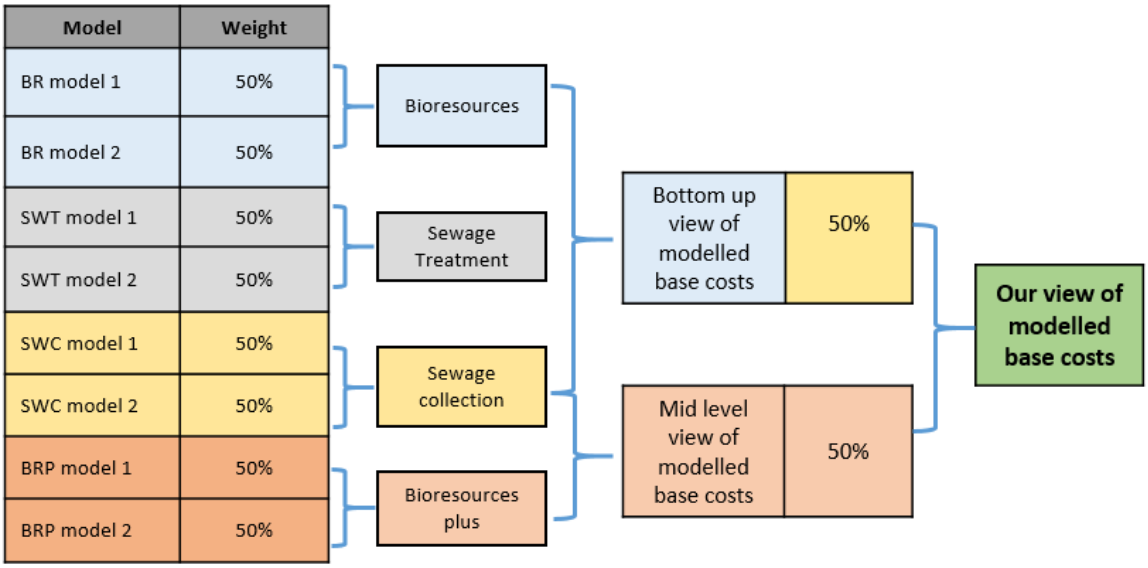
Model name	SWC1	SWC2	SWT1	SWT2	BR1	BR2	BRP1	BRP2
Dependent variable (log)	Sewage collection		Sewage treatment		Bioresources		Bioresources + Sewage treatment	
Sewer length (log)	0.819***	0.897***						
Load (log)			0.856***	0.847***			0.840***	0.809***
Sludge produced (log)					1.217***	1.186***		
Load treated in size bands 1-3 (%)			0.058**		0.053***		0.051***	
Load treated in size band 6 (%)				-0.015*				-0.011**
Pumping capacity per sewer length (log)	0.281*	0.619***						
Load with ammonia consent below 3mg/l (%)			0.004***	0.004***			0.005***	0.005***
Number of properties per sewer length (log)	1.186***							
Weighted average density (log)		0.193 (0.109)			-0.235*			
Sewage treatment works per number of properties (log)						0.325*		
Constant term	-8.588***	-6.534***	-6.273***	-4.765***	-0.542	0.775	-5.777**	-4.296***
Overall R-Squared	0.93	0.87	0.87	0.85	0.82	0.80	0.92	0.92
Number of observations	70	70	70	70	70	70	70	70

Figure A2.2 sets out our triangulation approach of the eight models to achieve a view of (average) wholesale wastewater modelled base costs:

- Step 1: we average the models at each level of activity.
- Step 2: we add the results of the sewage collection, sewage treatment and bioresources models to form our 'bottom-up' view of wholesale wastewater modelled base costs. We add the results of the sewage collection and bioresources plus models to form our 'mid-level' view. We do not use any wholesale wastewater models within our triangulation approach because we did not consider the models we developed at this level of cost aggregation were sufficiently robust[18].
- Step 3: we average our bottom-up and mid-level views to arrive at our view of wholesale wastewater modelled base costs.

[18] We recognise that Anglian Water and Southern Water made the suggestion in response to our initial assessment of plans that we should include wholesale wastewater models within our triangulation approach.

Figure A2.2: Triangulation of wholesale wastewater econometric models



Cost models for residential retail activities

Table A2.3 presents the seven[19] econometric models we use to benchmark costs of residential retail services. Figure A2.3 sets out our triangulation approach of the seven models to achieve a view of (average) residential retail costs. In the first step we average the set of models at each level of aggregation. In the second step, we add the results of the debt and other retail costs models to form our 'bottom up' view. Our 'top down' view is simply the result of averaging the three total retail cost models in the first step. In the third step, we average our bottom up and top down views to arrive at our view of modelled residential retail costs.

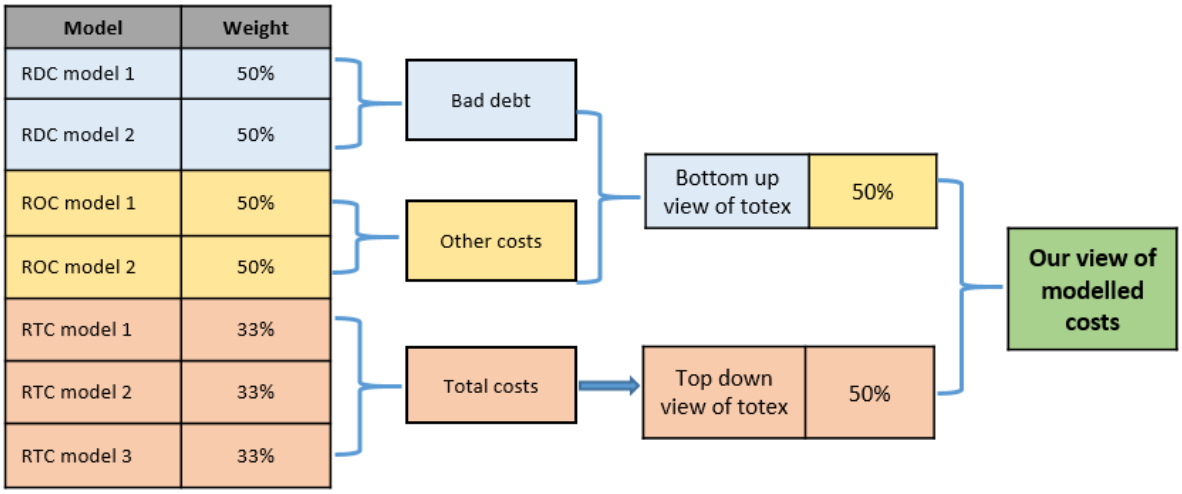
[19] Note that there were nine models at the initial assessment of plans but two have been dropped for the draft determinations. See 'Changes to our approach since the initial assessment of plans' section under Residential retail in main document for more information.

Table A2.3: Econometric models for residential retail

Model name	RDC1	RDC2	ROC1	ROC2	RTC1	RTC2	RTC3
Dependent variable (log)	Bad debt and bad debt management costs per household		Other retail costs per household		Total retail costs per household		
Average bill size (log)	1.138***	1.125***			0.465***	0.521***	0.595***
Households with default (%)	0.060**				0.020 (0.160)	0.029**	
Income deprivation (%)		0.077***					0.070***
Net migration (%)		0.035*					0.046*
Dual customers (%)			0.002**	0.003**			
Metered customers (%)			0.005***	0.005**	0.002 (0.455)	0.003 (0.267)	0.003 (0.333)
Number of connected households (log)				-0.047 (0.308)		-0.062 (0.125)	-0.125*
Constant term	-5.269***	-5.460***	2.468***	3.090***	0.081	0.337	0.062
Overall R-Squared	0.78	0.78	0.14	0.16	0.65	0.68	0.69
Number of observations	88	88	88	88	88	88	88

* Other retail costs include customer service, other operating costs, meter reading, recharges and depreciation.

Figure A2.3: Triangulation of residential retail econometric models



Annex 3: Frontier shift and real price effects

This annex considers the scope for frontier shift efficiency and real price effects for wholesale controls. This annex has been updated following company response to the initial assessment of business plans. We consider each issue in turn.

Frontier shift

Frontier shift refers to a shift in the efficiency frontier for the sector. We consider there is scope for frontier shift efficiency improvements in the water sector from two sources:

- on-going efficiency improvements in the wider economy; and
- one-off efficiency improvements from water companies making greater use of the totex and outcomes framework at PR19.

To understand the potential scale of these efficiency improvements, during our initial assessment we commissioned two consultants reports:

- 'Frontier shift efficiency and real price effects', by Europe Economics
- 'Innovation and efficiency gains from the totex and outcomes framework', by KPMG and Aqua consultants

Following the receipt of responses to the initial assessment from companies and their consultants, 'Frontier shift efficiency and real price effects' has been revised by Europe Economics.

Below we provide a summary of our initial assessment of frontier shift. We then summarise the reports prepared by KPMG and Aqua consultants and Europe Economics and their findings, including noting any changes since the initial assessment. We then set out responses to company comments on the externally prepared reports. Finally, we set out our assessment of the scope for frontier shift and real price effects for wholesale costs in the 2020-21 to 2024-25 period.

Initial assessment

At the initial assessment we considered the potential for ongoing efficiency improvements based on information submitted in company business plans and supporting evidence, as well as evidence prepared by Europe Economics, KPMG and Aqua Consultants.

Our assessment was that the combined ‘all-in’ effect of ongoing frontier shift efficiency and the impact of the totex and outcomes framework is 1.5% per year for total expenditure. The cost models mistakenly split out the 1.5% range into a 1% per year improvement from frontier shift and a 0.5% improvement from the impact of totex and outcomes. This was not how the range was defined and it was based on the overall impact of both the totex and outcomes regime and the impact of frontier shift without identifying the separate impacts.

The 1.5% per year efficiency improvement was based on a range of factors including (but not limited to) the frontier shift efficiency ranges presented by both Europe Economics and KPMG and the outperformance that can be attributed to the totex and outcomes framework. This efficiency challenge of 1.5% also took into account case study evidence of efficiency improvements from the greater flexibility provided by the totex and outcomes framework and catch up opportunities to other sectors following privatisation.

We recognised that our future efficiency challenge of 1.5% per year was at the upper end of the on-going efficiency improvements assumed by water companies in their business plans. In part this reflected most companies taking no account of the impact of the totex and outcomes framework on improved efficiency, placing greater weight on frontier shift from sectors with lower growth (some of which we do not consider are reasonable comparators), not taking account of embodied technological change and placing less weight on longer term productivity growth which has been higher. We acknowledged that our 1.5% productivity assumption would give a strong efficiency challenge to water companies.

Europe Economics assessment of frontier shift at draft determination

This work identifies the scope for frontier shift and whether there is evidence of real price effects that will impact water company costs going forwards. As part of this work Europe Economics considered the evidence put forward by water companies in their business plans and initial assessment responses.

Consistent with the approach used by water company consultants, Europe Economics forecasts the scope for frontier shift efficiency based on total factor productivity analysis of comparative sectors using historical EU KLEMS data of UK productivity. Total factor productivity measures the growth in outputs that is not accounted for by the growth in inputs, in particular labour and capital. Europe Economics conclusions on frontier shift analysis at draft determination stage are substantially the same as those in their report published at the initial assessment. The main change in response to comments is to carry out further analysis on total

economy wide productivity growth after the financial crisis and consider further the reasons for upper end of the range (although their recommended range has not changed).

Europe Economics forecasts a frontier shift of 0.6% to 1.2% per year for total expenditure. The bottom end of this range is based on productivity growth in the most recent post crisis period. The top end of this range is based on the growth of better performing sectors in the pre and post-crisis period.

Table A3.1: Europe Economics recommendations of frontier shift efficiency

	Frontier shift range
Wholesale total expenditure	0.6 – 1.2% per year

Europe Economics recommends using a number towards the upper end of these ranges for the following reasons:

- It is appropriate to place some weight on the value-added measure, which is somewhat higher than the gross output measure as it excludes intermediate inputs.
- The estimates exclude embodied technological change, which are the quality improvements in inputs. Europe Economics cites a study which indicates that taking into account quality improvements could lead to as much as 60% increase in productivity. This could suggest a range of 1% to 2.2% per year. While evidence on this is limited, this could result in somewhat higher productivity growth.

In their response documents to our initial assessment, several companies and their consultants raised points regarding Europe Economics' assessment of frontier shift. These reports included:

- *Review of Ofwat's Proposed Approach to Frontier Shift, Real Price Effects and Output Growth at PR19 - Prepared for Bristol Water*, NERA Economic Consulting, 30 March 2019
- *A review of Ofwat's PR19 approach to estimating frontier shift*, John Earwaker (First Economics), March 2019
- *Responding to Ofwat's Initial Assessment of South East Water's AMP7 business plan - Prepared for South East Water Ltd*, Oxera, March 2019
- *Ofwat's base expenditure models at the IAP: a review - Prepared for Southern Water*, Oxera, March 2019

- *Ensuring consistency in key PR19 parameters: Productivity, equity returns and RPEs - A report for Wessex Water*, Economic Insight, March 2019
- *The scope for frontier shift and real price effects at PR19: Response to Ofwat's evidence - A Report for Yorkshire Water*, Economic Insight, March 2019

Our responses to comments raised in these reports are provided later in this section.

Efficiency gains from the totex and outcomes framework – KPMG assessment

This study[2] was prepared during our initial assessment to consider the potential efficiency improvements from the totex and outcomes framework, although the study also provided estimates for the on-going frontier shift efficiency improvement. The study identifies that introducing the totex and outcomes framework in the 2014 price review removed a regulatory barrier to companies achieving greater efficiency.

The study provides an estimate of frontier shift, based on total factor productivity, of 0.4% to 1.5% per year based on analysis of EU KLEMS data. KPMG estimates the overall scope for ongoing efficiency improvement over the next control period by combining the impact of the totex and outcomes framework, with their estimate of frontier shift.

Table A3.2: KPMG estimates of the ranges of frontier shift efficiency for on-going efficiency target setting

	Total factor productivity	Totex and outcomes	Combined effect
Annual incremental gain (% per year)	0.4 – 1.3%	0.2 – 1.2%	0.6 – 2.5%
Total efficiency gain over the control period (%)	1.2 – 3.8%	0.6 – 3.7%	1.8 – 7.4%

Response to company comments

Below we summarise the points made by companies and their consultants in relation to the reports prepared by Europe Economics and KPMG and Aqua consultants, along with responses to those points. In cases where we consider that points are not valid, we explain why we have not made any changes. We also identify any changes that we have made.

We discuss the points made by respondents under the following headings:

1 Scale of the frontier shift challenge

2 Scale of the totex and outcomes framework uplift

The remainder of this section provides a summary of the points made by companies and their consultants, and the responses provided by Europe Economics and Ofwat.

1 Scale of the frontier shift challenge

Some companies and their consultants provided comments on the scale of the frontier shift challenge proposed for 2020-25. Europe Economics addresses in detail these comments in the supplementary technical appendix to their report. A summary of responses to key points raised is provided below.

1.1 Choice of comparator sectors

Oxera, Nera and Earwaker argue that the upper bound of the range for frontier shift should be based on an average of comparator sectors rather than the most strongly performing sectors. Further, Oxera argues that that some comparator sectors (e.g. chemicals) would be overrepresented in Europe Economics' analysis, while others would be underrepresented (e.g. construction). Europe Economics considers that averages of comparator sectors would not provide an appropriate upper bound on future performance as historical performance indicates many sectors can perform more strongly than the average. In terms of the weight of the comparator sectors, Europe Economics states that sectors are included in frontier shift analysis because

they are similar in terms of the nature of activity carried out, not because the water sector purchases inputs from that sector. For example, the chemicals sector is included as its activities are similar to the water sector - both sectors are capital intensive, there are similarities between industrial processing of chemicals and the treatment and transportation of water and wastewater and both involve the use of materials, plant and equipment to carry out bulk processing activities. Given that the comparator sectors chosen by Europe Economics are similar to those put forward by companies, and comparators proposed by companies have only been rejected for good reason, such as they are subject to regulation (such as the utility sector) or are not similar to water (such as the agricultural sector), we consider that the approach used by Europe Economics continues to be appropriate.

1.2 Choice of time period

NERA, Economic Insight, Oxera and Earwaker raise concerns about the choice of time period used in Europe Economics analysis. Reasons cited included the exclusion of 'full business cycles' or particular years, and that lesser weight was placed on productivity estimates in recent years. Europe Economics' considers that its forecast for frontier shift remains appropriate as it considers both the more recent growth in the post crisis period, and also growth over the longer term. They note that the recommendations for the upper bound are partly based on analysis of complete business cycles using the NACE 1[1] dataset (1971-2007), which includes a number of full business cycles. Europe Economics has excluded the years 2008 and 2009 from their analysis of the post crisis period to prevent a downward bias in the estimates, as the post crisis period would otherwise include a full economic contraction, but only an incomplete part of the period of economic expansion following the financial crisis. Europe Economics notes that the lower bound for frontier shift is based on productivity growth in the post crisis period and so takes account of more recent lower growth, although it notes that comparator sectors have tended to exhibit stronger growth than the economy as a whole. Overall we consider that Europe Economics forecasts of frontier shift are based on an appropriate time period as they consider growth over more recent years and the longer term.

1.3 Gross value added measures of total factor productivity

Economic Insight and NERA argue that Ofwat's decision to attach some weight to the value added measure of total factor productivity growth is incorrect, and that it goes against Europe Economics stated preference for gross output based total factor productivity measures. Europe Economics confirms that while the upper and lower bounds to their frontier shift range are based on gross output based total factor productivity figures, some weight should be placed on the value added measure.

While the gross output measure is generally preferable it is not superior in all cases, and this is a reason for considering a point towards the upper end of the range suggested by the gross output-based measure. We therefore continue to consider that our use of the Europe Economics range is consistent with its advice.

1.4 Embodied technical change

Europe Economics total factor productivity estimates do not take account of embodied technical change, or the change in technical quality, such as improvements in the quality of capital goods. NERA suggests that Europe Economics had no reliable basis for quantifying the extent of the bias related to embodied technological change. Europe Economics states that, while they accept the academic evidence is limited, it does suggest that embodied technical change not captured by total factor productivity growth may amount to as much as a further 60 per cent efficiency gain on top of total factor productivity growth estimates. Europe Economics suggests that embodied technical shift, alongside consideration of gross value added-based total factor productivity data, are reasons for Ofwat to select a frontier shift point estimate from the upper end of their suggested range. While we recognise that the evidence is limited and caveated, we consider embodied technological change has an important impact on productivity growth which should not be ignored and this provides a good reason to use the upper end of the suggested change.

1.5 Academic literature

Economic Insight suggests that some of the academic literature cited by Europe Economics is dated and of little or no relevance to frontier shift. Europe Economics' recognises there are some caveats to the literature they have used, and note that Economic Insight does not suggest alternative sources. Based on this we are content that the literature used is the most relevant available.

2 Efficiency uplift from shift to totex and outcomes framework

In addition to comments provided on the frontier shift challenge for 2020-25, companies and their consultants make specific points in relation to the uplift to efficiency from taking account of the shift to the totex and outcomes framework, and the work undertaken by KPMG and Aqua consultants. We set out our responses to the six key points raised below.

2.1 Comparisons between the energy and water sectors

Earwaker and Economic Insight argue that KPMG relies on a simplistic and subjective comparison with the energy sector to estimate efficiency improvements since PR14 and the same results observed in energy, in particular electricity distribution, cannot be expected to be achieved in water. When comparing with the energy sector, Earwaker cautions Ofwat against using “simple takeaways from complex experiences of a different class of regulated company”. Economic Insight notes that KPMG’s report provides evidence that there are differences between the energy sector and water sector in terms of how cost outperformance has been achieved in the past. We note that no evidence has been provided to suggest the efficiency improvements from totex in water would be materially different from that observed in energy.

Our response

The KPMG analysis of the impact of the totex and outcomes framework is based on an assessment of the impact of the introduction of the totex and outcomes regime across the water, electricity distribution, transmission and gas distribution sectors. KPMG found that outperformance of the totex allowances in the energy distribution and water controls was similar, with lower outperformance in the transmission controls. KPMG also found that outperformance had increased more in the water sector compared to the previous period than it had in the energy sectors.

To identify the potential impact of the totex and outcomes framework for the 2020-25 period, the second period after its introduction in water, KPMG examined the impact in the electricity distribution controls where the regime has been in place for more than one control. Based on this KPMG suggested that there would be diminishing returns from the totex and outcomes regime in the water sector.

Overall we consider that it is appropriate to consider the impact of the introduction of the totex and outcomes regimes in previous control periods across energy and water sectors. While there are important differences between the water and energy regimes, the overall approach to regulation is similar, including the use of the totex and outcomes frameworks. Given this, and that there appears to be similar levels of outperformance from the use of totex and outcomes across the water and energy controls, we consider using evidence from both the energy and water sectors is relevant in determining the potential impact of the totex and outcomes regime in the 2020-25 period.

We note that KPMG has also undertaken a number of cross checks on the potential impacts including the use of 48 water sector case studies, which indicated strong

outperformance from totex and outcomes, and looked at parallels with other major regulatory and structural changes.

2.2 Attributing outperformance to totex and outcomes driven ongoing efficiency improvements

Earwaker cautions against attributing outperformance of electricity distribution network operators (DNOs) to totex and outcomes driven ongoing efficiency improvement for the following reasons:

- Some of the outperformance against the electricity distribution allowances has been due to slower than forecast gross domestic product (GDP) growth and technological change. KPMG should not be confusing under-spending with efficiency improvement.
- There have been criticisms in recent years about the energy controls, which illustrate that out-performance can be as much about the quality of a regulator's starting baselines as of year-on-year efficiency improvement
- Even if it were possible to establish that energy networks have made genuine new productivity improvements, it would be impossible to attribute the savings to specific regulatory innovations or to conclude that companies in the water sector are capable of replicating the DNOs productivity performance over a 10 year period.

NERA also argues that the allowance for totex and outcomes is based on outperformance of price controls, however outperformance of price controls has occurred before the introduction of the totex and outcomes framework and assuming that cost models are accurate is implausible.

Our response

On the point about the quality of the regulators starting baselines, one of the main criticisms levied of the recent energy controls is the over forecast of real price effects (in part due to slower than forecast GDP growth), the over forecast of load related expenditure and the non-delivery of outputs. KPMG has explicitly removed outperformance attributable to these issues in their assessment. In addition KPMG's approach 2 explicitly takes account of the previous outperformance of price controls, in estimating the incremental impact of the totex and outcomes framework.

On the point about outperformance and whether it is possible to attribute to improvements in performance to changes in the regulatory regime. In their report, KPMG identifies evidence, case studies and examples of other regulatory change,

and the impact on productivity and performance. For example they consider the reported performance improvements following a change in regulatory regime (e.g. Scottish Water), introduction of competition (e.g. competition in electricity generation), change of ownership (e.g. formation of Network Rail) and shocks to costs/revenues (e.g. UK oil and gas price shock). KPMG notes that the results from their analysis indicate that major regulatory and structural changes are associated with significant changes in performance, and that the impact of such events is generally positive. Of the examples considered by KPMG, the introduction of the totex and outcomes framework can be most similarly considered to a change in regulatory regime. We note that in addition to the examples cited by KPMG, Senyonga and Bergland (2018) found that the move from RPI-X incentive regulation to yardstick regulation in the Norwegian utilities sector led to a 1.8% per year improvement in efficiency. This is well beyond the upper end of the range estimated by KPMG for the impact of the totex and outcomes regime.

On the point about allocating out performance to the totex and outcomes regime: KPMG identifies 48 project case studies which set out the impact of totex and outcomes on efficiency. The case studies cover 3.8% of total expenditure in the control period. Overall these case studies indicate an average of 35% potential efficiency saving from the use of the totex and outcomes framework. While some of these case studies are replicable, some of them are isolated and might not be representative of all business activities. KPMG notes that the efficiency improvements in the case studies do not appear to have come at the expense of service levels. We consider that this provides strong evidence of a positive improvement on efficiency from the totex and outcomes framework, and supporting evidence for the potential range of efficiency improvements is identified elsewhere in the report by KPMG.

As we acknowledged in our initial assessment, there are other factors that can impact on the level of out or under performance. Some factors may be under management control and others may be external, the impact of which is difficult to disentangle from the impact of the outcomes and totex framework on ongoing efficiency. KPMG's approach, which combines analysis of incremental and overall outperformance, allows us to select an efficiency forecast at the upper or lower end of their proposed range, depending on our assumptions regarding how much of the efficiency improvement is attributable to a move to the totex and outcomes framework compared to wider factors. Our assessment assumes the impact of the totex and outcomes framework is towards the lower to middle of the range suggested by KPMG.

2.3 The size of the impact of the totex and outcomes framework on efficiency

Economic Insight suggests that the efficiency uplift from the totex and outcomes framework in the KPMG report is too high as the range is based on the median to upper quartile range rather than the median (which is around zero). Economic Insight raises the following specific points.

- KPMG's estimate of the median impact of the totex and outcomes framework is between 0.2% and -0.2% per year, depending on the approach. The implication is that the estimated median impact of totex and outcomes is less than the 0.2% and -0.2% range for half of the regulated companies.
- The interquartile range for one of KPMG's analyses is not, in fact, 0% to 1.1%, but rather -0.5% to 1.1%. KPMG 'capped' the lower bound at 0% on the basis that it is unlikely that the introduction of the totex and outcomes framework has caused productivity to fall.
- The results of KPMG's of statistical tests show that the average change in cost outperformance between the non-totex energy distribution controls and the first totex price control is 0.2% and that this figure is statistically insignificantly different from 0%. The implication is that one cannot statistically reject the hypothesis that the introduction of the first totex price control had no impact on cost outperformance.

Our response

KPMG estimates the potential additional efficiency from the totex and outcomes framework based on the midpoint to upper quartile range of outperformance of existing totex and outcomes controls in energy and water which ranged from 0% to 1.2% per year. KPMG limits the bottom end of the range to zero as allowing for a negative growth rate would suggest that companies become less efficient as the result of the introduction of the totex and outcomes framework. KPMG states, and we accept, that there is a wide range of efficiency gains that could be attributed to totex and outcomes that make it unlikely the totex and outcomes framework has a negative impact on performance.

KPMG adjusts the range derived from the experience from the use of totex and outcomes in the water and energy sectors to account for potential diminishing returns from the totex and outcomes framework over time based on the experience from the electricity distribution control where the use of the totex and outcomes framework is in its second control period. If there were constant and not diminishing returns then the potential efficiency improvements would be markedly higher (and up to 3.1% per year).

We consider that there is good evidence to suggest that the totex and outcomes regime has had a positive impact on efficiency, in particular KPMG identifies 48 case studies which indicate a significant positive efficiency improvement from the impact of the totex and outcomes framework. KPMG also considers the impact of other significant structural and regulatory changes where efficiency improvements are wide ranging but generally positive and have been up to 7% per year (in the case of the creation of Scottish Water).

We consider that efficiency assumptions should be based on the performance of the better performing companies. Poorer performing companies are likely to have taken less advantage of the benefits totex and outcomes and so do not provide appropriate benchmarks of the potential improvements. Better performing companies are more likely to reflect the performance of efficient use of the totex and outcomes regime. We therefore consider using a range between the median and upper quartile for identifying impact on ongoing efficiency from the use of the totex and outcomes framework is appropriate. We note that we use an upper quartile benchmark for base expenditure. As stated above, we have chosen a value to the lower to middle end of the range suggested by KPMG for the impact of the totex and outcomes framework.

2.4 Potential for totex and outcomes framework to increase costs

Earwaker suggests that Ofwat needs to consider whether it has the evidence to justify factoring an extra amount of cost reduction into PR19 base expenditure allowances due to regulatory innovations introduced in PR14. He argues that it is not clear why the kinds of regulatory innovation introduced by Ofwat (totex and outcome regulation) should necessarily lead to reduction in recurring expenditures; rather, there is a respectable argument that Ofwat's incentives will typically lead to companies incurring higher ongoing expenditures in the short term as part of a drive towards whole-life cost optimisation.

Our response

The analysis undertaken by KPMG covers both base and enhancement expenditure. The outperformance due to the totex and outcomes framework therefore reflects efficiency improvements in both base and enhancement expenditure. This is supported by the case studies which include a number of examples of efficiency improvements which cover base or recurring expenditure as well as enhancement expenditure. To reflect this we have amended our consideration of frontier shift and totex and outcomes so that the forecast is relevant to both base and enhancement expenditure.

We do not consider that the totex and outcomes would necessarily, or in general, lead to an increase in short term costs. The totex and outcomes framework encourages companies to consider operating expenditure solutions instead of capital expenditure, to deliver the same outcomes. Therefore it is unclear why a company would necessarily increase their total expenditure in the short term if they were undertaking less capital expenditure and more operating expenditure under the totex framework.

2.5 Potential for double counting of the impact of the move to the totex and outcomes framework

Economic Insight argues that KPMG and Ofwat's approach of adding an uplift from totex and outcomes framework to the total factor productivity growth figures results in the double-counting any impact (of the move to the totex and outcomes framework), and therefore results in Ofwat materially overstating the scope for frontier shift at PR19. They argue Ofwat should not add an uplift to its total factor productivity growth estimate because the total factor productivity growth estimates already capture the commercial and operational flexibilities enjoyed by mostly unregulated comparator companies.

Reasons suggested include:

- Total factor productivity growth figures are estimates of the productivity gains that comparator companies, which have at least as much commercial and operational flexibility as regulated companies, can achieve. Although the totex and outcomes framework may have given regulated companies greater commercial and operational flexibility than they previously had, it does not give them greater flexibility versus the comparator companies.
- Total factor productivity growth figures already embody the productivity gains that arise due to commercial and operational flexibility. The approach of including uplift from the move to the totex and outcomes framework, as well as the total factor productivity growth figures, misinterprets the evidence and double-counts the impact of the totex and outcomes framework and results in Ofwat materially overstating the scope for frontier shift at PR19.

Our response

Non-regulated firms already enjoy the flexibility of choosing between capital and operating expenditure. Before the introduction of the totex and outcomes framework, water companies did not enjoy this freedom. The release of this constraint on water

companies will therefore have an additional benefit to their efficiency as they catch up with efficiency in competitive sectors of the economy.

Both KPMG and Europe Economics consider that there should be an additional uplift to the frontier shift to take account of the move to the totex and outcomes framework.

In their report, KPMG states that its approach is appropriate because:

"These total factor productivity results are added to the potential gains from the totex and outcomes framework to understand the overall efficiency potential in AMP7. This approach can be considered appropriate because the methodology for assessing cost outperformance from totex and outcomes compares the level of company outperformance with the allowances made by the regulator at each of the price controls and in each case the regulatory already included an adjustment to their allowed costs for frontier shift efficiency. Therefore any outperformance beyond this allowance should already account for this."

Europe Economics revised report also responds to this point stating: *"The totex framework aims to remove any bias towards capex and will therefore give water companies an incentive to re-optimise between opex and capex in order to reduce overall costs. Similarly, the outcomes framework gives water companies greater freedom in how they achieve outcomes than the previous approach which specified the specific outputs that water companies had to put in place in order to deliver outcomes. This greater flexibility allows water companies to innovate and to adopt lower cost solutions."* Europe Economics also notes that as a result of the change in regulatory framework the *"ongoing frontier shift could be higher, as firms now have greater flexibility on an ongoing basis to innovate and employ more cost-effective solutions"* and that *"there should also be a period of time in which the water sector makes additional 'industry catch-up' efficiency gains as its input mix and approach to delivering outcomes are re-optimised, thus moving the sector closer to the productivity levels that comparator sectors have already been able to achieve. This scope for a temporary period of faster productivity gains from re-optimisation is not open to the comparator sectors because their existing capex-opex balance has not been distorted by a historical capital bias. Since this temporary period of efficiency gains from re-optimisation is additional to ongoing frontier shift, we consider that Ofwat is justified in adding an increment to the frontier shift numbers that we have estimated in our report to take account of these additional efficiency gains."*

Therefore, we do not consider that the approach double counts the impact of the move to totex and outcomes framework as the choice to optimise between opex and capex has only recently become available to water companies. Unregulated companies already had this choice and therefore any gains from given the choice to optimise between opex and capex would not be accounted for in comparator sector total factor productivity estimates.

Our overall assessment of the scope for efficiency improvements from frontier shift and the impact of the totex and outcomes framework

Overall we consider that the combined effect of ongoing frontier shift efficiency and the impact of the totex and outcomes framework remains as an all-in figure of 1.5% per year. In contrast to the initial assessment we consider that this efficiency improvement should apply to base and, where relevant, enhancement expenditure. This is based on a range of factors identified at the initial assessment and draft determination stages including:

- The frontier shift efficiency range of 0.6 to 1.2% per year for total expenditure identified by Europe Economics, before allowing for impacts of totex and outcomes. As frontier shift efficiency challenge will be applied to total expenditure (rather than base), we do not consider Europe Economics range of 0.6% to 1.4% (0.2% higher as it includes a capital substitution effect) for base expenditure in our assessment.
- Europe Economics suggests we use a number towards the top end of the range as some weight should be placed on valued-added measures and to account for embodied technological change. We note that the value-added measure is 1.3% per year compared to 0.6% per year for the gross output measure in the post crisis period, indicating much higher values if weight is placed on the value-added measure. We also note the scope for higher estimates, if input quality effects are taken into account.
- In contrast to the initial assessment, we are including a real price effect adjustment for real wages to reflect improvements in labour productivity. Labour productivity improvements reflect the impact of improved labour quality as well as improved labour productivity as a result of technological progress and better use of capital. As total factor productivity estimates remove the impact of improvements in labour quality, then we could be allowing for the additional costs of improved labour quality without allowing for the additional benefits in terms of increased productivity. We consider this provides us with an additional reason to use a total factor productivity estimate towards the upper end of the range suggested by Europe Economics.
- The KPMG study indicates a range of 0.2 to 1.2% per year from the additional impact of the totex and outcomes framework.
- There are some factors that would indicate using a number towards the lower end of the range identified by KPMG. For example, not all outperformance in this period can be attributed to the totex and outcomes framework.
- There are also some factors that could indicate a figure towards the upper end of their range. For example, KPMG applies diminishing marginal returns to the totex

and outcomes framework, however, evidence on diminishing returns from other sectors is mixed.

- The 48 case studies by KPMG indicate a 35% improvement from the impact of totex and outcomes and cover 3.8% of total expenditure. While some of these case studies are not easily replicable, even just considering these 48 case studies gives an efficiency improvement of 1.3% of totex, equivalent to around a 0.5% efficiency improvement per year.
- We note that Pollitt et al. (2018) found a total factor productivity for the water sector of 1.1% per year between 1998 and 2015. Frontier Economics for Water UK (2017) found a quality adjusted total factor productivity of 2.1% between 1994 and 2017.
- An efficiency figure of 1.5% per year is consistent with using a frontier shift efficiency number towards the upper end of the 0.6% to 1.2% per year range identified by Europe Economics with a small additional increment to take account of the impact of the totex and outcomes framework.
- An efficiency figure of 1.5% per year is towards the middle of the range of 0.6% to 2.5% per year indicated by KPMG for the combined effect of frontier shift efficiency and the impact of the totex and outcomes framework.
- Both KPMG and Europe Economics indicate that the impact of the totex and outcomes framework would be additional to frontier shift efficiency (i.e. not double counting), although Europe Economics suggests an adjustment is made to on-going frontier shift efficiency to account for capital intensity. There is also a wide range of academic literature regarding recent and longer term productivity in the water sector as summarised above that suggests companies could reasonably be expected to achieve 1.5% efficiency from 2020-25.

We acknowledge that our 1.5% productivity assumption will continue to give a strong efficiency challenge to water companies. We have considered whether based on the responses to the initial assessment and available data we should relax the assumption at the current time. We do not consider that anything that the water companies or their consultants have said or other available information should make us change our assumptions. However, we have reviewed our approach where appropriate in response to their comments.

Real price effects

Real price effects are a measure of how much we expect water company costs to change due to input price inflation, relative to the indexation we use in price controls. Key input prices for water are labour, energy and material costs. In PR19 we will index wholesale controls to the Consumer Prices Index including owner occupiers' housing costs (CPIH) as a measure of inflation. Hence any real price effects for

wholesale expenditure will be additional to the change in CPIH and are based on a comparison of the growth of the relevant input price relative to CPIH.

At the initial assessment we commissioned Europe Economics to examine the evidence available on the need to make allowances for real price effects. This report, and our subsequent assessment of real price effects has been revised for the draft determinations, including addressing points raised by companies and their consultants in their responses to our initial assessment. We first present a summary of our initial assessment, then summarise Europe Economics revised report before drawing our conclusions on real price effects.

Initial assessment

At the initial assessment we stated that companies needed to make a compelling case for an allowance for real price effects to be made. This is partly because water companies already benefit from a range of protections not provided to companies that operate in other parts of the economy. These include CPIH indexation of revenues, cost sharing with customers, five yearly price control reviews, interim determinations and substantial effects provisions. In part this addresses information asymmetry where companies will have better information on their future costs than the regulator and are only likely to put forward the case for positive real price effects.

Our initial assessment was based on submissions made by companies and their consultants, Europe Economics' report 'Frontier shift efficiency and real price effects' and relevant publicly available data. Company assumptions on real price effects in wholesale varied in their original business plans, with some companies assuming little or no real price effects, for example Southern Water.

Our findings were that only two costs appeared to be a material proportion of wholesale totex: labour costs; and, materials, plant and equipment. The non material items – energy and chemicals – also did not meet a range of other criteria such as lack of evidence of a wedge between input price growth and CPIH.

Our assessment of the material cost items (labour costs and materials plant and equipment) was that we should not make a real price effect adjustment for either as:

- Both costs make up a similar proportion of wholesale totex and CPIH, and therefore tend to be reflected in movements in CPIH;
- Neither labour nor materials, plant and equipment costs exhibited a material wedge (i.e. increasing at a different rate) from CPIH over recent years; and

- There is scope for management control of both costs (e.g. through longer term contracts with suppliers).

We therefore considered there was no compelling evidence at our initial assessment for a real price effect adjustment for wholesale totex.

Europe Economics work on real price effects at draft determination

Europe Economics considers whether there should be an allowance for real price effects. As part of this analysis they review the evidence put forward by water companies for real price effects in the business plans and responses to our initial assessment.

Comments on the initial assessment and Europe Economics' response

Following the receipt of responses to our initial assessment from companies and their consultants, Europe Economics revised relevant aspects of their approach to analysing real price effects. A summary of the key points raised by companies regarding the assessment approach and criteria, and Europe Economics' response is provided below, with detailed responses included in their revised report. It is important to note that following receipt of comments from companies and their consultants, Europe Economics has removed one criterion in their revised report. The comments and responses highlighted below relate to the criteria used in the initial assessment, as this is what was responded to.

Criterion 1: materiality of cost item

Two main points were raised by companies and their consultants regarding criterion 1.

1. **Materiality test** – Earwaker, Economic Insight and NERA all raised concerns about the materiality test. These included: the 10% threshold was arbitrary and prohibitively high, that under this test small costs with a big wedge from CPIH could be missed (and could potentially have a big impact) and that Europe Economics choice of cost aggregation potentially overlooked some costs.

In response to these comments, Europe Economics has removed the materiality criterion from their assessment. This means that they are no longer rejecting a real price effects mechanism on the basis that a cost area accounts for less than 10 per cent of totex.

2. **Percentage of cost base covered by our real price effects assessment** - Earwaker argues that Europe Economics' analysis was limited to two cost categories that accounted only for 55 per cent of totex and therefore did not consider a real price effect allowance for the remaining 45 per cent of cost items. Earwaker argued that this remaining 'other' category of costs should be subject to further analysis.

In response to this, Europe Economics consider that 45 per cent quoted by Earwaker is overstated, as they also assess real price effects for energy and chemicals which together account for 11 per cent of total expenditure. Europe Economics undertook further analysis of the remaining 'other' category, which accounts for 34 per cent of wholesale totex for the industry. Europe Economics identifies two key items within this category are business rates (which account for 6 per cent of wholesale totex on average) and abstraction charges (which account for 2 per cent on average). Europe Economics finds that there is no evidence that a real price effects allowance should be made for these items as business rates are indexed to the Consumer Prices Index (which moves closely in line with CPIH), and that company business plans show that most companies are not anticipating any real terms increase in the abstraction charges that they pay. We note that both business rates, abstraction charges and traffic management act costs are treated as unmodelled costs and do not have a real price effect and frontier shift adjustment applied to them. We note that companies have not suggested a further breakdown of 'other' costs which would allow a robust and meaningful assessment of real price effects. We therefore continue to consider that these costs should be indexed by CPIH unless there is compelling evidence to the contrary.

Criterion 2: whether costs are adequately captured in CPIH

Two main points were raised by companies and their consultants regarding criterion 2.

1. **Water sector wage pressures -** NERA and Economic Insight state that criterion 2 does not test whether the level and movement of CPIH adequately tracks the inputs in the water sector, and state that wage pressures in the water sector may be different from those in the rest of the economy.

In response to this, Europe Economics has reviewed the data sources used to analyse water sector wage data and have added analysis of ONS wage data that relates specifically to the water and sewerage sectors. This together with the removal of the consideration of input cost shares in other sectors, leads Europe Economics to recommend adjusting for real price effects for labour and including an indexation mechanism for real wage growth. Europe Economics considers

indexing to wage growth of 'All employees' ie indexing to economy wide wage growth, or indexing to 'All manufacturing' wage growth. We consider that based on the updated Europe Economics advice we should provide for a real price effect for labour costs and include an indexation mechanism for wages. Due to the higher correlation between manufacturing and water and sewerage wage growth (correlation coefficient of 0.83) and the fact that manufacturing and water sector labour markets have similarities and often involve similar skills and expertise we consider the 'all manufacturing' category is most suitable for indexation purposes.

2. **Impact of imports on CPIH** - NERA comments that as CPIH also includes imports it is illogical to conclude that CPIH captures labour inflation costs as wage pressures abroad could be different from those experienced in the UK.

   In response to this, Europe Economics undertook further analysis of the import share of CPIH and the impact on the water sector. Europe Economics has adjusted the way they apply criterion 2 in their revised assessment so that they no longer consider input cost shares in other sectors, so the fact that input price pressures may be different overseas from in the UK is no longer a concern for the analysis.

Criterion 3: whether there is a significant likelihood of wedge between relevant input prices and CPIH

Eight main points were raised by water companies and their consultants in relation to criterion 3.

1. **Alleged existence of wedges in Europe Economics charts** - Economic Insight argues that a visual inspection of charts in Europe Economics' report showed a positive wedge between CPIH and the ONS labour cost indices since 2014. They also suggested that similar positive wedges could be observed for the BEIS industrial electricity price index since 2011 and 2012, and for the ONS chemical price index since around 2014.

   Europe Economics considers that Economic Insight misread the chart and failed to notice that the charts have two different vertical axes. The charts are produced with two different axis to illustrate the extent to which the series (which have different absolute levels) move together. Europe Economics notes that the gap between the two series on the chart is not the wedge between the two series. We note that Europe Economics has undertaken a statistical analysis which would pick up the extent to which there is a wedge between CPIH and labour costs.

2. **Use of statistical significance tests** - Economic Insight and NERA commented that examining whether the wedge is statistically different from zero is irrelevant as it is just a measure of probability and ignores whether input price inflation is expected to exceed or fall short of CPIH. NERA also noted that Europe Economics did not present the detailed results of the statistical wedge analysis, in

that it did not state the time period, the granularity / frequency of the data used, nor the significance level chosen.

In their response, Europe Economics highlights the importance of statistical significance tests to determine whether there is robust evidence of a positive or negative wedge, ensuring the case for real price effects is justified given the evidence required for an allowance. Europe Economics also notes that the significance tests have been carried out using a standard 5 per cent level of significance, and that in the revised report they have added footnotes supplying information on the frequency of the data that has been used in carrying out significance testing.

3. **Alleged data mining and choice of time period** - NERA suggested that Europe Economics appears to be 'data mining' (for example, in its wedge analysis for energy costs). It also criticised Europe Economics for restricting its analysis to post-2006 data rather than back-casting CPIH estimates.

   Europe Economics notes that by considering data back to 2006 they were able to look at more than a decade of data, which they consider to be sufficient to determine whether historical data shows a wedge between input prices and CPIH. Europe Economics has adjusted their assessment of energy to acknowledge that whether a real price effects allowance should be made depends on the weight placed on pre-2011 data (where there is a statistically significant wedge only if the pre-2011 data is considered). We are content that the analysis has been carried out over a sufficient period of time and Europe Economics has identified where the analysis depends on the choice of period.

4. **OBR and BEIS forecasts** - Earwaker, NERA and Economic Insight criticised Europe Economics for dismissing Office of Budget Responsibility (OBR) forecasts of wages and the department of Business, Energy and Industrial Strategy (BEIS) forecasts of electricity prices on the basis of a lack of reliability. Oxera and NERA further remarked that since RPEs are forward-looking by their nature, consideration should be given to forecasts that reflect forward-looking expectations.

   In response to this, Europe Economics adjusted their assessment of labour and energy in their revised report under criterion 1A to acknowledge that whether these cost areas qualify for a real price effect adjustment depends on whether reliance is placed (respectively) on OBR forecasts of real wage growth and BEIS forecasts of future industrial electricity prices. Europe Economics recommends that if we use OBR or BEIS forecasts as the basis for ex ante allowances, that we also include an ex post indexation mechanism so that consumers are protected if out-turn values for these input prices come in below the forecast values. This recommendation has informed our assessment of real price effects, particularly for labour where we intend to adopt an ex-post indexation (as discussed later in this annex).

5. **Approach to assessing volatility** - Economic Insight suggests that the five-year rolling average of the standard deviation of the wedge should be used for volatility analysis.

   In response to this, Europe Economics recognises that standard deviation is a widely used measure of volatility but considers that it is less relevant in this context, as it does not consider whether historic movements in the input price have had a material impact on totex. They state that the approach they use for volatility analysis directly assesses whether past movements in the input price relative to CPIH, averaged over a five-year period, have led to an impact on totex greater than 1 per cent of totex. This informs their assessment of whether there is a significant likelihood that unexpected movements in the input price over the five years of the next price control could have a material impact on totex. We consider that the approach used by Europe Economics seems appropriate given the focus is whether an adjustment is required to totex.

6. **Time period for volatility analysis** - NERA stated that Europe Economics' wedge volatility analysis relies on a short time series which may fail to detect long-term historical trends.

   In response, Europe Economics recognises that the use of five-year rolling averages starting in Q1 2011 means that the rolling average was only examined over an 8-year period (less than a decade). In their revised report Europe Economics has extended their calculation of five-year rolling average of the wedges between the various input prices and CPIH back to 2006, using back-casted estimates of CPIH. This approach seems appropriate to deal with the limited period of data where CPIH data is directly available. This extended period only affects the results for energy costs (where extending the series identifies a greater than 1% wedge based on the pre 2011 data, as discussed above).

7. **Labour market tightness** - Oxera noted that labour market tightness could have an influence on wage growth.

   In response Europe Economics states that their revised report recommends an ex post indexation mechanism for wage rates, meaning that if real wage rates rise due to the tight labour market then this will automatically feed through into allowed revenues. An indexation mechanism also means that if real wages do not increase (e.g. due to an economic downturn caused by global trade wars), then water consumers will not be paying for forecast increases in real wages which do not actually happen.

8. **Analysis of gas prices** – NERA and Economic Insight comment on the use of gas prices in the analysis, including that there was limited relevance of considering gas prices in the analysis, and that no weight should be placed on gas prices in the assessment.

In response, Europe Economics has removed this analysis and focus on industrial electricity prices in their revised report. They state that this reflects the fact that power is the most significant energy cost faced by water companies. This does not affect Europe Economics' conclusions in this area.

Criterion 4: whether input costs are outside management control

Three main points were raised by water companies and their consultants in relation to criterion 4.

1. **Whether controlling input prices is possible for an efficient company** - Economic Insight argued that the PR19 framework made deductions for efficiency through Ofwat's catch-up and frontier shift efficiency challenges, and that, once efficiency is accounted for, all input price inflation must by definition be outside company control. It stated that an efficient company must pass on 100 per cent of input price increases since it has no ability or incentive to 'absorb' them.

   In response to these comments, Europe Economics disagrees and states that "an efficient company will choose the optimal mix of inputs given the relative prices of those inputs. When those relative prices change because one of those input prices increases, an efficient company will re-optimise its mix of inputs by substituting away from the input which has increased in price to other inputs." Europe Economics also disagrees with the view that an efficient company must pass through 100 per cent of price increases to customers, noting that the extent to which cost increases in competitive markets are passed on depends on a range of factors including the elasticities of supply and demand. We consider that companies have a range of mechanisms to control or partially mitigate the impact on prices, for example through substitution of inputs, and we may not necessarily expect that 100 per cent of input price increases to flow directly to final costs.

2. **Impact of total costs when there is substitution between inputs** – In contrast to the point raised by Economic Insight above, NERA stated that most input costs are within management control to some extent, as water companies can substitute between factors of production when input price changes but that input price increases would still lead to costs rising once companies have undertaken input substitution. Along similar lines, Earwaker argued that Europe Economics' assessment of controllability conflated the question of whether firms can manage input price pressures with the question of whether they can avoid input price pressures entirely.

   In response to these comments, Europe Economics states that where there is a net cost saving from input substitution, as through engaging in input substitution, firms only have to pay the input price for reduced volumes of the input. They further note that providing a real price effect allowance for the increase in the input price would over-compensate companies in circumstances where they can manage their exposure to that price by input substitution and that as the overall price control framework includes a totex cost-sharing mechanism, the increase in

total costs that may still occur would be shared between the company and customers. Europe Economics notes this argument also applies to Earwaker's comment regarding conflation of managing vs avoiding input price pressures, as in situations where firms can limit exposure to input price increases (even if they cannot avoid them completely), an RPE allowance would over-compensate companies relative to the costs that they actually incur. As set out above, we consider that there are a number of ways for companies to manage the impact of input prices on final costs.

3. **Qualitative nature of assessment** - NERA states that Europe Economics' assessment of management control relied on a subjective qualitative assessment and that they only gave hypothetical examples of how water companies could control input costs.

   In response, Europe Economics acknowledges that their assessment of whether firms can take action to control input costs is qualitative in nature, but they do not think it is appropriate to ignore important considerations because they are not amenable to quantification. Europe Economics also states that its assessment approach allows for consideration of additional actions that may be open to companies should input prices increase, which may not have been identifiable in a quantitative assessment of actions taken by companies to control input costs. We accept that the assessment of management control will be qualitative in nature but consider that it is important that this is part of the analysis and should not be ignored.

Points were also raised by companies and their consultants regarding the consistency of the frontier shift and real price effects analysis. A brief summary of the points and Europe Economics responses are provided below:

1. **CPIH and economy-wide productivity –** Earwaker argues that the analysis was inconsistent as Europe Economics' framework for assessing real price effects accounts for the fact that CPIH inflation reflects input price inflation across the economy, but its framework for assessing frontier shift did not take account of the fact that CPIH inflation also reflects productivity growth across the economy.

   Europe Economics accepts that Earwaker's comment has some theoretical validity, although his report exaggerates the issue as his comment relates to only one of the four criteria (which considered whether CPIH captured the input price) for assessing real price effects employed in its original report. Europe Economics notes that the recommendations in its original report would have been unchanged even without this criterion. In this revised version of the report, Europe Economics has incorporated Earwaker's comment by removing consideration of input cost shares in other sectors from its assessment against criterion 2 of whether CPIH indexation adequately captures the relevant input price. Europe Economics is no longer taking account of price inflation in inputs to other sectors and so is not potentially double counting productivity improvements (as inputs to other sectors would be subject to productivity improvements before becoming

inputs into the water sector). Therefore the concerns raised by Earwaker no longer apply.

2. **Consistency of assumptions on real wage growth and productivity –** Economic Insight and Oxera argue that it is inconsistent to assume that there will be no real wage growth yet still apply a frontier shift which implies significant growth in productivity, as wage rates and labour productivity will be linked.

   Europe Economics now explicitly considers the link between labour productivity and real wages. Based on this, Europe Economics suggests that we should take account of impact of real wage increases outstripping CPIH. Their revised report recommends an ex post indexation mechanism for real wages, rather than recommending no real price effects allowance following changes to Europe Economics' analysis of the potential for real wage growth. The result of this is that if real wages in the water sector increase in line with the assumed growth in productivity, the additional cost will automatically feed through into companies' allowed revenues.

3. **Different levels of evidence for real price effects allowances and frontier shift –** Earwaker and Economic Insight comment that different levels of evidence were required for the real price effects analysis compared with the frontier shift analysis, by requiring a compelling case for any real price effects allowance but not making such a requirement for frontier shift, and that an inappropriate null hypothesis of zero growth input prices was applied.

   Europe Economics states that a higher level of evidence is required for real price effects allowances than frontier shift as there is an information asymmetry between the regulator and the regulated companies. Companies have incentives to provide evidence of higher costs to regulators to seek higher allowed revenues, therefore the regulator needs to undertake robust assessment of the costs submitted for real price effects allowances in particular.

Summary of Europe Economics' revised analysis and findings

Table A3.3 outlines the results from Europe Economics revised approach to assessing cost items and real price effects at draft determinations. The outcome of their revised assessment, which reflects comments from companies and their consultants, is a potential allowance for real price effects in labour and energy, depending on the reliance placed on forecasts made by the OBR (on wages) and BEIS (on energy). The remainder of this section outlines the assessment approach taken by Europe Economics and summarises its findings.

Europe Economics has revised its structured framework to assess the case for real price effects, and is now based on assessing three criteria, one with two sub-criteria (1a and 1b):

1. Is there a significant likelihood that the value of the wedge between the input price and CPIH will differ substantially from zero over the period of the price control?
    a. Is the expected value of the wedge between the input price and CPIH materially different from zero?
    b. Does the wedge between the input price and CPIH exhibit high volatility over time? This could occur because the cost exhibits sufficient variability such that over the course of a five-year control period the wedge may differ substantially from zero. Europe Economics uses a wedge of 1% over a five year period as a threshold.
2. Are there compelling reasons to think that CPIH does not adequately capture the input price? Europe Economics compares the share of a cost item in wholesale totex with the share of the most relatable cost item(s) in the CPIH basket. If the share is similar in both then CPIH indexation should already capture the evolution of the cost item.
3. Is the input price and exposure to that input price outside management control during the duration of the price control?

Europe Economics considers the scope of management strategies to either substitute to alternative inputs, investing in new technologies and/or signing long-term contracts to reduce exposure to future price movements.

Each criterion is scored as a pass or fail (or a partial pass). If a cost fails any of the criteria, a real price effect adjustment should not be considered.

Similarly to their initial assessment, Europe Economics considers real price effects for four cost items: labour, energy, chemicals and materials, plant and equipment. These are similar to those considered by water companies. Overall based on its analysis, Europe Economics concludes that there may be a compelling case to allow for real price effects for labour and energy wholesale costs, depending on the reliance placed on OBR forecasts (on wages) and BEIS forecasts (on energy).

Table A3.3: Europe Economics real price effects assessment at draft determination

Cost item	Labour	Energy	Chemicals	Materials, plant and equipment
1A. Is there a significant likelihood that the value of the wedge between the input price and CPIH will differ substantially from zero over the period of the price control? Is the expected value of the wedge between the input price and CPIH materially different from zero?	**Depends on whether reliance is placed on OBR forecasts.** No historical statistically significant wedge. There is a material wedge in OBR forecasts although forecasts have been tended to over predict wage growth	**Depends on whether reliance is placed on BEIS forecasts** The evidence of a historical wedge depends on the choice of time period. BEIS forecasts show a material wedge going forwards but have shown a significant difference to outturns.	**Fail**. No historical statistical significant wedge and wide variation in company forecasts.	**Fail.**. There is mixed evidence. For some indices, there is evidence of a positive real price effect but in other cases, there is no evidence of a statistically significant wedge. Some water sector input costs have shown a negative wedge and some companies propose a zero or negative wedge for this cost item.
1B. Is there a significant likelihood that the value of the wedge between the input price and CPIH will differ substantially from zero over the period of the price control? Does the wedge between the input price and CPIH exhibit high volatility over time?	**Fail.** Labour costs wedge is below 1% of wholesale totex (-0.7 to +0.9% for ICLH index and -0.4 to +0.6% for AWE index and -0.1 and +0.5% for ASHE index).	**Depend on whether weight is placed on pre 2011 data.** Wedge is above 1% of totex based on pre 2011 data but below 1% since then.	**Fail**. Wedge is -0.1 to +0.1% of wholesale totex.	**Fail**. Most volatile index is construction price index, which has a wedge between -0.3 to +0.6% of wholesale totex.
2. Are there compelling reasons to think that CPIH does not adequately capture the input price?	**Pass.** There is no discrete item for labour costs in the CPIH basket.	**Partial Pass.** Energy (including other fuels) share in CPIH is 5.2 per cent, however the estimated share of energy costs in	**Pass.** There is no explicit category for chemicals in the CPIH basket, and the closest categories that	**Partial Pass.** CPIH categories include housing and DIY equipment, purchase of vehicles, relevant

Cost item	Labour	Energy	Chemicals	Materials, plant and equipment
		water company totex is 9.3 per cent. Therefore CPIH does not fully capture changes in energy input prices.	are included (cleaning equipment and cleaning and maintenance products) would also include equipment and bear little resemblance to chemicals purchased by water companies.	spare parts and the maintenance and repair of those vehicles. These items have a CPIH basket weight of 15.5%. However, the read across from materials, plant and equipment to the CPIH basket may not reflect water company activities.
3. Is the input price and exposure to that input price outside management control during the duration of the price control?	**Partial pass.** While there is no evidence that water companies have market power in labour markets, there are a number of ways they can reduce their exposure to labour costs, for example through long term contracts.	**Partial pass.** There are a number of mechanisms for companies to reduce exposure to changes in energy costs, although a material element remains outside management control.	**Pass.** While some substitution between chemical products might be possible, moving away from chemical products entirely seems largely outside management control.	**Partial pass.** Companies tend to enter into long term frameworks with suppliers, covering the duration of the regulatory control period, which covers materials, equipment and plant costs
Overall	**Depends on whether reliance is placed on OBR forecasts**	**Depends on whether reliance is placed on BEIS forecasts**	**Fail**	**Fail**

The following section outlines our assessment of real price effects in following the findings of Europe Economics' report.

Our assessment of real price effects

We continue to consider that, given the protections available to companies and the information asymmetry between companies and Ofwat, there needs to be a compelling case for making an allowance for real price effects. Based on the revised analysis undertaken by Europe Economics as summarised above, we consider we should make a real price effect adjustment for labour costs but not energy costs as set out below.

Labour costs are a material element of company costs, making up around 35% of wholesale totex. While there has not been a material wedge in wage costs over recent years, there is a material wedge in the OBR forecasts based largely on the assumed growth in labour productivity. However the reliability of OBR forecasts is uncertain. Europe Economics' analysis of the accuracy of previous forecasts identifies that the OBR has systematically overestimated average earnings growth and therefore reliance on these forecasts could lead to an upward bias in any estimated real price effect adjustment. Manufacturing and water sector labour markets have similarities and often involve similar skills and expertise. Manufacturing wages also show a close correlation to water sector wage growth. Therefore, we consider we should include a real price effect adjustment for wages based on OBR real wage forecasts with a true up for manufacturing wages at the end of the period. The true up would adjust for the difference between the real wage growth assumed in the determinations and the outturn manufacturing wage growth. The true up will be based on the labour costs proportion assumed in the determinations.

The case for a real price effect adjustment for energy is less clear cut than for labour costs, and, on balance, we do not consider that we should make an adjustment. The case for a real price effects allowance for energy depends in part on the reliability of BEIS forecasts of energy prices. As with the OBR forecasts for wages, Europe Economics analysis of past electricity price forecasts shows significant differences compared with outturns, raising concerns about the reliability of such forecasts. Uncertainty around Brexit and its macroeconomic effects further adds to the uncertainty about the reliability of BEIS forecasts.

The scale of cost (materiality) is lower in energy (9% compared to 35% for labour). Additionally, some energy costs are reflected in CPIH. Europe Economics presents evidence that CPIH partially captures the impact of changes in energy costs as the total share of energy (including other fuels which tend to move in line with energy prices) in CPIH is 5 per cent. Therefore CPIH indexation will in part reflect increases in electricity prices.

In addition, there is scope for some management control of energy costs through mechanisms such as payment arrangements, increased energy generation, timing of energy use and improved energy efficiency. Although we recognise these mechanisms do not provide management with complete control of energy costs, they can assist companies to reduce costs through reduced consumption and minimising exposure to price fluctuations.

We also note that some water companies do not assume a real price effect adjustment or assume that any adjustment would be very small. We also note that

there are a number of protections within the price control such as cost sharing which provide additional protections to water companies. On balance therefore we consider that we should not make a real price effect adjustment for energy costs

Assumptions for real price effects analysis

As set out above, we include a real price effect adjustment for wage rates. This is based on OBR assumptions of productivity growth and average hourly wages and consumer price inflation. We assume that labour accounts for 35% of costs based on original business plans. We will update this for revised business plans for the final determinations (which would reduce the figure to 34%).

Table A3.4: Assumptions for real price effects

Year	OBR average hourly earnings growth (%)	OBR productivity growth (%)	OBR CPI growth (%)	Real hourly wage growth	Real input price inflation
2020-21	3.0%	1.0%	1.9%	1.1%	0.40%
2021-22	3.1%	1.2%	2.0%	1.1%	0.39%
2022-23	3.2%	1.3%	2.0%	1.2%	0.41%
2023-24	3.3%	1.3%	2.0%	1.3%	0.45%
2024-25		1.4%		1.4%	0.49%

Source: Economic and fiscal outlook, supplementary economic tables, March 2019, apart from 2024 where labour productivity figures are taken from long term economic determinants, March 2019. For 2024 have used labour productivity rather than average hourly earnings growth as this shows greater consistency with figures for earlier years.

References

1 Supplementary technical appendix: Europe Economics Frontier shift and real price effects – updated at Draft Determination
2 Supplementary technical appendix: KPMG totex and outcomes report
3 Productivity growth in electricity and gas networks since 1990 (2018). Victor Ajayi, Karim Anaya and Michael Pollitt. Report for Ofgem.
4 Productivity improvement in the water and sewerage industry in England since privatisation (2017). Frontier Economics report for Water UK

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