WSX-C09 – Enhancement costs – wastewater treatment

Response to Ofwat's PR24 draft determination

Wessex Water
YTL GROUP

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Representation reference: WSX-C09

Representation title: Enhancement costs – wastewater treatment

CONTENTS

1. Summary

This document explains our representation to Ofwat's Draft Determination on our PR24 Business Plan for the following wastewater treatment enhancement cost areas:

- Phosphorus removal
- Nitrogen removal
- Sanitary parameters
- Chemicals removal
- Flow (Capacity & Monitoring)

1.1. Phosphorus removal summary

Ofwat's proposed cost allowances for phosphorus removal are significantly too low and do not reflect the true cost of delivering this essential programme. Not allowing the efficient costs for the site-specific factors leaves a material gap between our efficient programme costs and Ofwat's cost allowance.

We have significant concerns with the reliance placed on simple cost modelling used to set cost allowances for this enhancement area and its ability to capture all the material cost drivers that determine the efficient cost of a phosphorus removal scheme. We have also identified some specific issues with the modelling approach used, in particular:

- **Historical Data**: The historical models used by Ofwat are based on data from previous programmes (including some currently being built). These models have a low R-squared value, indicating that they do not explain a significant amount of variation in costs. Our experience shows there are considerable site-specific differences experienced in scheme delivery.
- **Limited Cost Drivers**: The models use very few cost drivers, such as population served and enhanced permit levels. We consider that other factors, such as land requirements, site expansion, existing site permits, and treatment processes significantly impact costs. These additional factors are not captured in the models, leading to an underestimation of the true cost of delivering our programme.
- **Outliers**: Ofwat has identified outliers by considering distance from modelled allowance. With the exception of one, all outlier sites serve more than 20,000 population equivalent. Such sites are where the site-specific factors listed above are seen to be material, causing variance to the model outputs. However, we would contend that site-specific factors are equally relevant across all size ranges.

We have carried out bottom-up and site-specific design for our phosphorus removal programme which has revealed significant costs driven by factors not explained by Ofwat's modelling approach at many of our sites.

We provide additional evidence to support our requested cost allowances, including:

- **Bottom-up Costing**: We have conducted bottom-up costing for a representative sample of our phosphorus removal schemes which has been used to inform costs for the remaining schemes along with AMP7 outturn costs where applicable. This approach considers all factors that drive scheme-level costs, including site-specific information. This detailed bottom-up costing provides a more accurate picture of the true cost of delivering the program.
- **Site-Specific Information**: We provide detailed information about the specific challenges associated with our phosphorus removal schemes, such as land purchase requirements, site expansion, and existing site treatment processes and permits. This information highlights the complexity and range of factors specific to our programme, which are not captured in Ofwat's models.

We request that Ofwat reconsiders its approach and increase the cost allowance to **£928.7 million**, reflecting the actual site-specific costs of delivering this vital environmental improvement programme. This is an increase of £271 million on Ofwat's Draft Determination allowance. This revised cost allowance reflects the true cost of delivering the programme, considering all relevant factors and detailed site-specific information. We would be unable to deliver on our statutory requirements within the cost allowance provided in the draft determination.

1.2. Nitrogen removal summary

Ofwat's proposed cost allowances for nitrogen removal do not take account for the bespoke nature of nitrogen removal solutions, the limited reference data available, and the complexity of the programme which necessitate a different approach to cost assessment. We support Ofwat's deep dive approach, which allows for a more detailed assessment of the specific challenges and costs associated with each nitrogen removal scheme. Our key concerns are:

- **Unique Solutions:** Nitrogen removal solutions are highly site-specific and depend on various factors, including existing permit levels, treatment processes, and interactions with other drivers. This bespoke nature makes it difficult to model costs accurately using traditional econometric benchmarking approaches.
- **Limited Data:** There are relatively few sites in the UK where nitrogen removal is operational, leading to a limited dataset for modelling purposes. This lack of data further hinders the accuracy of econometric models and necessitates a more nuanced approach to cost assessment.

Ofwat's proposed cost allowance for nitrogen removal represents a 40% reduction from our requested costs. This reduction is based on concerns about the evidence provided and the cost efficiency of our solutions. We are providing additional evidence in this document which demonstrates that our solutions are optimal and cost-efficient.

We have provided additional evidence to support our requested cost allowances, including:

- **Bottom-up Costing:** We have conducted bottom-up costing for all of our nitrogen removal schemes, considering all relevant cost drivers and site-specific factors. This approach provides a more accurate picture of the true cost of delivering the program.
- **Site-Specific Assessments:** We have provided the optioneering appraisal for our nitrogen schemes, including a breakdown of benefits.

We request that Ofwat increases its cost allowance to **£209.93 million** for nitrogen removal to reflect the efficient cost of delivering the programme.

1.3. Sanitary parameters

The company-level modelling approach used by Ofwat lacks robustness and underestimates the efficient cost of delivering these schemes where investment in additional biological treatment capacity is required. We recommend adjustments to the model. Our key concerns are:

- **Lack of focus on company-level data**: There is scheme-level data that is available and could provide more robust results. Company-level aggregation may not address the issue of unexplained cost drivers, and significant variation in unit costs exists across schemes, indicating important factors not captured by the model.
- **Inclusion of low-cost sites:** Many sites have "no additional treatment capacity" solutions, leading to low but not zero costs. These sites should be treated separately due to their different characteristics and cost drivers. Their inclusion underestimates efficient costs for schemes requiring investment and overestimates costs where optimisation is sufficient.

We request that Ofwat increases its cost allowance for sanitary parameters **£87.3 million** for our efficient costs of delivering 12 sanitary parameter tightening schemes.

1.4. Chemicals removal

Ofwat's approach to cost assessment for chemicals removal allowed more than we requested in our business plan.

Our response to the draft determination builds on our October 2023 business plan, with more detailed design indicating a different allocation of costs between chemicals removal and other categories including Phosphorus removal is appropriate. Our requested costs for chemicals removal have subsequently increased and we request Ofwat to consider our updated proposals and allow our chemicals removal proposals in full in the final determination.

1.5. Flow capacity and flow monitoring

We request Ofwat considers the mitigating factors we explain for the increase in costs to the AMP7 U_IMP5 scheme at Avonmouth from changes to regulatory requirements made after the PR19 final determination. We request Ofwat allows **£61.04 million** to accommodate these material changes outside management control.

Ofwat's shallow dive efficiency challenge applied to our flow monitoring proposals is inappropriate. Our requested costs are over the 0.5% wastewater wholesale totex threshold for a deep dive (0.52%), Ofwat has assessed our costs as "overall efficient" compared to the unit cost benchmark but has applied the 20% shallow cost efficiency challenge. We ask Ofwat to apply its stated enhancement cost assessment methodology and allow our demonstrably efficient flow monitoring costs of **£29.75 million** in full.

1.6. Bathing waters

Since our business plan submission there have been new bathing water designations that require improvements to be made in AMP8. We propose **£19.97 million** of additional costs in our response to the Draft Determination and provide evidence that the solutions are optimal and costs are efficient. This enables Ofwat to carry out a deep dive and allow our proposed costs in full.

2. Phosphorus removal

Data table line	Business Plan request	Draft Determination allowance	Our requested allowance
CWW3.66 & 69 – Treatment for phosphorus removal (biological/chemical) (&CWW12.66 & 69)	£1,130.37m*	£654.89m*	£916.43m** (+£0.49m) (+£8.59m)
CWW3.72 – Treatment for nutrients (N or P) and / or sanitary determinants, nature based solution (&CWW12.72)	£3.23m	£2.59m	£3.21m

* Ofwat's Draft Determination assessment was based on an updated submission to align with the Sept'23 version of the WINEP. This differed from our Oct'23 Business Plan submission documents. Ofwat's assessment was also based on AMP8 (inc. transition) totex plus AMP9 capex to complete schemes.

** Our PR24 request is only for costs in AMP8, recognising Holdenhurst WRC was overlapping AMP8/9 to meet a WINEP regulatory completion date of 2033 (with £8.59m capex profiled beyond 20209/30), as well as carryover spend to complete PR24 schemes for which the output would be claimed in 2030 but some spend (e.g. for landscaping, operational handover documentation) would continuing into 2030/31 (£0.49m).

Ofwat applied a material cost challenge to our phosphorus removal costs through a benchmarking approach which takes only limited factors into consideration as driving the costs of the programme. Ofwat used models with low confidence of them properly explaining the variation in costs experienced in outturn scheme data which is likely to be due to site-specific factors. We have such site-specific factors that cause significant variance in unit costs of phosphorus removal. These additional factors are significant at many of our AMP8 sites where investment is required. We provide additional evidence to support the deep dive assessment of outlier sites, in particular Poole and Dorchester, but in so doing demonstrate that our processes for options appraisal and developing our cost estimates will result in appropriate scope and efficient costs for our phosphorus removal programme.

This representation builds on information provided in our business plan, and particularly in the following key documents and appropriate sections:

- WSX16 – Waste water networks plus strategy and investment
  - 6.2 Nutrients (Phosphorus & Nitrogen)
- WSX17 – Annexes – Wastewater networks plus strategy and investment
  - A1 Enhancement Cases
  - A3-1 WRC Assessments – Technical Assurance/Benchmarking
  - A3-2 WRC Assessments – Nutrients
  - A8 WRC Screening Reports
- WSX45 – Annexes – assurance reports
  - A1-5 Solutions process
  - A4-1 Wastewater Treatment
  - A4-2 P-Removal, WINEP and Growth Programme
- WSX50 – Costs wholesale waste water tables commentary
- Responses to related Ofwat queries

In this section, we explain our concern's with Ofwat's methodology of assessing our phosphorus removal schemes, explain our changes since the October 2023 submission and provide additional evidence for the identified outlier schemes.

2.1. Ofwat's approach to setting cost allowances

2.1.1. Ofwat's methodology

Ofwat has set cost allowances for phosphorus removal schemes using econometric benchmarking, taking a scheme-level approach to estimating costs. Furthermore, in response to the challenge made by the CMA during the PR19 redetermination, Ofwat has used outturn data to inform costs of P removal schemes in AMP8. Specifically, triangulation between four scheme level models, applying a 25% weighting for each. This data with the cost drivers have been used to estimate allowances for individual phosphorus removal schemes in the draft determination.

Outliers were then identified based on Cook's distance approach and assessed via a deep dive. This process identified two Wessex Water schemes (Poole WRC, Dorchester WRC) for which modelled costs were significantly lower than requested costs.

Finally, a reconciliation adjustment was applied to account for the fact that some schemes were dropped from the draft determination modelling process for data reasons; and for the differences in business plan requested costs between scheme level data (CWW19) and aggregate phosphorus removal enhancement costs (CWW3).

Overall, Ofwat has proposed our cost allowance for phosphorus removal of **£654.89 million** in AMP8, compared to assessed costs of **£1,130.37 million**[1]. We would be unable to deliver on our statutory requirements within the cost allowance provided in the draft determination.

Ofwat has also applied a 20% shallow dive efficiency cut to our nature-based solutions, with a cost allowance of **£2.6 million** compared to our assessed costs of **£3.2 million**.

2.1.2. Fit of Ofwat's chosen model

In principle, we are supportive of the use cost benchmarking where it can be shown to produce reliable estimates of efficient costs, and where the results are interpreted to account for other relevant information. However, we have some concerns with these models that we ask are taken into consideration when making assessments for final determinations:

- The data used to model efficient cost allowances, in particular the reliability and weight given to historical data to determine forward-looking efficient allowances. The very low R-squared values of the models based on historical APR data indicates they do not explain a significant amount of variation in costs.

- The models do not capture all the relevant factors that drive scheme-level costs, such as land purchase requirements, site expansion, existing treatment processes and site permits. There is also a potential for cost allocation differences between companies to impact the apparent efficiency of their programmes.

We discuss these points in more detail below.

[1] Our business plan requested lower expenditure allowances for phosphorus removal in AMP8 than £1,130.37 million, as we proposed to phase some nutrients schemes into AMP9. Ofwat undertook its Draft Determination using separate information we provided to Ofwat in February 2024, which included the expenditure we considered was required to deliver all phosphorus removal schemes.

<u>Data used to model cost allowances.</u>

Historical and forecast data

Ofwat's historical (7F) models are based on APR 2022/23 data. These models explain significantly less variation in historical costs than Ofwat's forecast models – the adjusted R squared for these models is around 0.3 compared to 0.6 for the forecast models. All other things equal, this indicates that the models based on forecast data are more reliably able to predict efficient cost allowances based on the cost drivers used and the underlying relationships present in Ofwat's available data.

Furthermore, as the models based on forecast data are derived using information on the specific schemes for which Ofwat is setting cost allowances, we consider it is appropriate to have primary regard to this evidence rather than information from a different programme of works. This is also the approach that Ofwat has taken for the rest of its enhancement cost benchmarking. Ofwat notes that it uses historical data to set efficient allowances in other settings like base costs, but enhancement programmes are, by definition, generally more novel than capital maintenance work[2].

Notwithstanding this, we recognise that historical data can be used as a cross-check on modelled allowances using forecast data, or to inform an efficiency-wide challenge. Ofwat's historical models would allow significantly lower total sector allowances. Ofwat considered a range of possible explanations for this. We consider the differences in PR19 and PR24 programmes to be the key reason for this. As highlighted in the draft determination:

- PR24 WINEP / NEP programmes are much larger than at PR19. Ofwat said the PR24 phosphorus removal programme is not much larger than the PR19 programme in terms of the population served receiving phosphorus upgrades. This reflect that the average size of the site in PR24 is smaller than that of PR19, but the size of companies' programmes in terms of number of sites is significantly higher.

- There is a greater prevalence of tighter permits. As Ofwat notes, there are more enhanced phosphorus permits at or below TAL in PR24 compared to PR19. As such, we would expect historical cost models to be much less effective at explaining efficient costs for these upgrade schemes.

- Ofwat also considered possible data issues. We are confident in how we allocated our costs for the purposes of phosphorus removal, with a revised allocation for schemes that also had a chemical removal driver in our updated data-tables (to ensure we were attributing the costs appropriately across each driver). While we cannot be so confident on other companies' cost allocations, we note that Ofwat is requiring companies to confirm whether their forecasts exclude bioresources and business rates expenditure in response to its draft determination. This is therefore not a reason to place reliance on historical models at final determination – rather, it reflects the importance of obtaining robust and comparable data (as discussed further below).

For these reasons, we disagree that the difference in modelled allowances suggests the PR19 phosphorus removal programme was delivered more efficiently compared to companies' PR24 business plan forecasts. The typical AMP7 scheme is different in scope and scale to the typical AMP8 scheme[3] and we consider the variation in results based on historical and forecast models is more likely to be driven by these and scheme specific circumstances.

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[2] Additionally, as set out in our PR24 business plan and our separate representation WSX-C02, we do not agree with Ofwat's approach to setting base cost allowances using backward-looking models.
[3] The top 10 highest capex schemes in the APR data serve 3.466 million PE, costing in total £364m capex and only 3 of them are to meet 0.25mg/l permit levels. The top 10 highest capex schemes in the forecast data serve 4.028 million PE, costing in total £1,309 million capex with all of them to meet permits of 0.25mg/l or below.

Coupled with the fact that forecast models are better able to explain variation in costs, and recognising the importance of ensuring that companies are adequately funded to deliver their statutory nutrients programmes, it is important that the weighting given to forecast and historical models is reviewed. We note that the equal weighting given to historical models removes around **£900 million** in industry allowances for phosphorus removal in AMP8, which represents a very sizeable totex challenge. In reviewing its approach to setting modelled allowances in this area, we request that Ofwat considers reducing the weighting of the estimates based on the APR data, since the models are less robust than the models using forecast data.

Furthermore, to the extent that historical models are used:

- We consider these should be updated using the restated information in the latest APR 2023-24. Since business plan submission, a number of our AMP7 phosphorus removal schemes have progressed through detailed design and into completion, increasing cost certainty. In many cases, AMP7 forecast costs have increased from those envisaged at the time of APR 2022/23 and PR24 business plan preparation as the AMP7 schemes have begun on site and some risks have materialised.

- We also consider it preferable to avoid extrapolating beyond the range of the model input data when using the model to estimate costs of AMP8 schemes. This may require restriction of the use of the outturn model data to use the model only within the combination of PE and permit levels of the AMP7 schemes.

Comparability of company data

We support Ofwat's desire to obtain a more granular view on the forward-looking efficient costs of phosphorus removal, but we consider this reinforces the importance of ensuring comparability in the available data. This is particularly so when modelling at scheme level which gives rises to (i) more complex cost allocation issues and (ii) companies' different weightings. By way of example, we note that Anglian Water has included c.£24 million totex for final effluent monitoring of P schemes but as a separate line to be reviewed in a shallow or deep dive. Conversely, we have included monitoring costs against individual schemes. Those with existing stringent limits (i.e. through AMP7 schemes) will already have monitors installed, and we do not include costs for monitors at these sites. We suggest that allocating Anglian Water's monitoring costs across all of their phosphorus schemes would ensure a more appropriate cross-company comparison.

More generally, we would welcome Ofwat reviewing the updated data that companies are providing via updated data tables to ensure consistency of approach across companies.

Reconciliation adjustment

Ofwat drops several schemes from the modelling due to data issues that could lead to model distortions if otherwise included. It then applies a reconciliation factor to provide an implicit allowance for these dropped schemes, based on the overall efficiency challenge for the relevant company from the modelling.

We consider this is a reasonable approach to address this implementation issue, as it assumes these schemes are as efficient as the average efficiency of the rest of a company's phosphorus removal programme.

<u>Functional form and cost drivers</u>

Ofwat's choice of functional form and selected choice of cost drivers is reasonable. We agree that change in PE served and change in permits are the main cost drivers for this type of enhancement activity. We also agree that historical and enhanced permit limits will influence scheme-level costs, and that there is likely to be a non-linear relationship between permit tightening and costs due to increasing marginal costs as companies approach technically achievable limits (TAL).

In one specification, a dummy variable was used to capture this effect, set at 0.25mg/l and therefore result in the need for tertiary treatment. To avoid nutrient deficiency within the biological process through overdosing of metal salts on the front end of the WRC we consider backend dosing is required for permits <0.8mg/l P. We accept that due to site specific effluent quality such as low particulate P or suspended solids levels <0.8mg/l P may be achievable on some WRCs without it. However, we consider a permit limit of <0.7mg/l as a cutoff point requiring secondary back-end dosing and therefore tertiary solids removal is required to achieve metals limits. We suggest this is used as a suitable threshold for the dummy, based on engineering rationale.

We have also considered the relevance of other cost drivers. For sites without existing Phosphorus limits, Suspended Solids (SS) permit limits could be considered a cost driver. The average size of site in PR24 is smaller than in PR19. Suspended Solids (SS) has a cost impact on tertiary solids removal both in sizing for tight permits (<0.7mg/l) and requirement for metals compliance for more lenient permits.

<u>Goodness of fit</u>

Whilst we recognise the high number of data points available to Ofwat to inform their modelling, we have concerns over the robustness of models.

As discussed above, Ofwat's historical models report low R squared values. The forecast models report reasonable R squared values (around 0.6) – significantly higher than the historical models, but still lower than for other enhancement areas such as lead pipe replacement and smart metering.

This indicates that there is significant variation in scheme-level costs that is not being explained by either modelling approach. This creates a major risk that Ofwat's cost modelling will not capture all the factors that determine scheme-level efficient costs and, depending on the mix of schemes within each company's programme, could lead to companies being underfunded for the efficient costs at programme level. This is reflected in the fact that there are some very large differences in requested allowances and modelled allowances at scheme level, both upwards and downwards. This can be seen both across companies and within companies; in other words, for a given company some modelled allowances are much larger than the company's own view of efficient costs, and vice versa. It is highly unlikely that this variation can be explained by inefficiency or mis-forecasting on the part of companies; rather, Ofwat's econometric modelling is not capturing all the key cost drivers that determine efficient costs.

This is unsurprising, given the highly complex and bespoke nature of phosphorus removal programmes. Unlike in other areas where activities may be comparable across companies and repeatable over time, phosphorus removal schemes are discrete and their costs will vary for numerous reasons, for instance:

- Land requirements and site expansion – Where there is insufficient space within our existing land ownership to accommodate new treatment process, we have prioritised site expansions adjacent to existing operational sites, to reduce any extent of interstage pumping, pipelines and cabling, as well as any doubling of welfare, security, access etc. facilities. Whilst we have good relations with many – but not all – of our adjacent landowners, all are acutely aware of the limited locations in the siting of these expansions, and are able to hold us to high market rates for any land purchase. We are also now competing with nutrient, carbon, biodiversity etc. credit markets.

- More expansive biodiversity net gain measures, given the starting land is generally of high quality.

- Other scheme-specific complexities – We have undertaken a screening approach across all of our sites, identifying extent of land purchase, any environmental sensitivities, flooding zones etc.

- Existing site permit – WRCs with lenient SS/BOD permits may require increased upgrades beyond standard chemical dosing and tertiary solids removal to ensure loading onto new assets is within design. Conversely, WRCs with stringent ammonia limits may be at risk of nutrient deficiency or alkalinity dosing requirements.

It is difficult to capture these factors in a benchmarking model, but they have been included in our bottom-up costing where relevant and will be driving variation in the observed forecast data. To illustrate this, Ofwat's PR1 p-removal model would result in reallocating £735 million in costs between companies – before any efficiency challenge is applied – compared to proposed costs in companies' business plans. We question whether the scale of this could be explained by relative efficiency assumptions in plans and under / over-forecasting on the part of companies; it is far more likely to reflect the presence of omitted variables.

The precise mix of schemes, and the extent to which they exhibit specific characteristics, will therefore have a major impact on the efficient cost of that programme of works. While some of these characteristics may 'average out' over a programme, there is no reason to believe that a given company's programme will have as many of the more complex schemes as simple one. It would be appropriate to consider these factors in any interpretation of modelling results. We discuss this in more detail below.

Additional factors not considered.

When combining models derived for different solution types, there is the risk in assuming that the selection of the lowest cost solutions are meaningful efficient benchmarks, when apparent "efficiency" may in fact be due to cost allocation differences. There is often overlap in wastewater treatment upgrades required to meet multiple WINEP drivers and growth drivers and the interpretation of causality of cost drivers across multiple assets at each site varies across WaSCs.

As such, there may be significant differences between how companies have allocated costs between WINEP and growth programmes, and within the WINEP programme itself (i.e., between P and N removal), which impact their apparent cost efficiency. There are also often synergies to be gained at sites affected by multiple drivers in construction and upsizing or addition of assets common to multiple drivers. However sometimes the converse is true, particularly for sites with tight limits for both phosphorus and nitrogen. The solution for each parameter depends on the existing treatment process and its ability to provide the most efficient treatment process using bolt-on processes. When both phosphorus and nitrogen removal are required such bolt-on stages are not selected through the options appraisal process due to the need to reduce all constituent parts of nitrogen (e.g. ammonia as well as nitrate) in order to achieve the required performance of the new total nitrogen permit. When combined with phosphorus removal, our options appraisal process shows that the optimal whole life cost solution is to change the existing secondary treatment process. If a company has a high proportion of sites where one upgrade can be delivered to meet multiple investment drivers, it may appear more efficient than a company which has many sites requiring investment to meet individual drivers. Ofwat is not considering optimal whole life costs to customers and the environment in its cost assessment approach but merely considering AMP8 totex in its benchmarking.

2.1.3. Ofwat's Deep Dive Assessment

Two of our P removal sites were identified by Ofwat as outliers and subject to a deep dive assessment, Poole WRC and Dorchester WRC. For both sites, a 50% cost reduction was applied, stating "some concerns whether the proposed investment is efficient." Ofwat also noted the following issues with our evidence:

- Limited evidence that costs are outside model scope.
- Limited evidence of why the additional scheme costs are justified.
- Cost breakdowns were not substantiated with evidence of cost efficiency or benchmarking (Poole was benchmarked against a historic P removal scheme, however Ofwat considered this outdated and not sufficient to justify the associated costs are efficient and justified).We support Ofwat's deep dive approach for these sites, given the complexity and materiality of the solutions required. In the following sections, we provide additional evidence which proves the proposed investments are efficient. The evidence provided in this document expands on the overarching solution development as described in our business plan documents:

- WSX16 section 6.2.2,
- site assessment reports in WSX17 section A3-2, and
- screening reports in WSX17 section A8.

Where appropriate, we signpost to previously issued reports, including:

- ChandlerKBS benchmarking report (WSX17 annexes A1-5, A4-1 & A4-2)
- Stantec reports (WSX17 annex A3-1)

2.2. Required adjustment to cost allowance

We request Ofwat sets an allowance of **£928.7 million** in enhancement funding for our phosphorus removal programme in AMP8. This is an increase of **£271 million** on Ofwat's proposed allowance. This reflects the following:

- We have reviewed our phosphorus removal programme since our business plan submission, to reflect changes in the WINEP and in light of new information that we have obtained since then as we continue to develop the design of the schemes ready for construction. This has resulted in some changes to scope and costs. We have also included all phosphorus removal schemes in our draft determination response AMP8 cost tables. The changes to scope (and thus costs) are summarised below in Section 2.2.1 and reflected in the associated data tables.

- It is more appropriate that forecast models are used to set cost allowances, for the reasons set out above (using updated scheme data that we have provided in response to the draft determination).

- We agree that a modelled approach should continue to exclude our phosphorus removal schemes at Poole and Dorchester given the unique circumstances of these schemes, the efficient costs for which are not well-reflected in the modelling. The full cost allowances should be allowed for these schemes.

- We also consider, in light of the general difficulties with reliably benchmarking efficient costs for phosphorus removal, that interpretation of modelling results is used conservatively, and weight is placed on companies' engineering evidence presented as part of their business plans, and in response to draft determinations.

2.2.1. Changes since October 2023 submission

Updated WINEP

We have continued to engage with the Environment Agency and other regulators since our business plan submission. Our updated submission reflects the EA's latest snapshot of the WINEP (5th July 2024) along with any agreed changes since (up to 16th August 2024).

<u>October 2023 Business Plan vs September 2023 WINEP</u>

Our PR24 Business Plan submitted in October 2023 did not fully align with the WINEP version (September 2023) or guidance at time of submission, as described in section 6.2.2 of WSX16. Significant areas of difference to our phosphorus removal programme in the October business plan to the September WINEP are summarised below:

- Catchment permitting at catchment scale for Levelling-up and Regeneration Act.
- Catchment permitting at sub-catchment scale for Water Framework Directive objectives in the Bristol Avon.
- A more catchment and nature-based approach to meeting Habitat Directive targets.
- Phased delivery of some large/complex schemes to complete by 2033.

Whilst we accept that our proposals differed from the WINEP, we believe that they delivered the equivalent phosphorus load target reduction required at a more appropriate geographic scale and at lower overall cost and greater environmental benefits overall.

Ofwat's Draft Determination assessment was based on an updated data table submission to align with the September 2023 version of the WINEP, including meeting all dates as stated in the WINEP. The draft determination assessment was based on AMP8 (inc. transition) totex plus any AMP9 capex to complete schemes, although it did not recognise that Holdenhurst WRC remains included in the WINEP with a 2033 completion date.

Levelling-up and Regeneration Act

The Levelling-up and Regeneration Act (LURA) came into law on 26th October 2023. The act introduced new nutrient pollution provisions for sensitive catchments, that are designated due to the habitats site related to the catchment being in an unfavourable condition as a result of phosphorus and/or nitrogen pollution in water. The sensitive areas and list of WRCs requiring upgrade are as published by Defra on 25th January 2024 (and updated 24th May 2024). The relevant sensitive areas[4] within the Wessex Water region are:

- Somerset Levels and Moors Special Protection Area – Phosphorus
- Poole Harbour Special Protection Area / Ramsar site – Phosphorus and Nitrogen
- Hampshire Avon Special Area of Conservation – Phosphorus

LURA places a requirement on water companies to upgrade WRCs, in designated areas, to the ‘technically achievable limit’ (TAL) for nitrogen (N) and/or phosphorus (P). The technically achievable limit (TAL) has been determined by the EA as 0.25mg/l for phosphorus and 10mg/l for nitrogen. WRCs ≥2,000 population equivalent (pe) are required to achieve TAL; <250pe are exempt; WRCs between 250-2,000pe are by default exempt but can be designated as requiring improvement by the Secretary of State.

Under provisions within the LURA, water companies can use a catchment permitting (CP) approach to achieve the required nutrient load reductions, subject to approval by the Secretary of State. Furthermore, the LURA allows the Secretary of State to consider alternatives to site-based permits – such as catchment nutrient balancing (CNB) – subject to secondary legislation being put in place.

We were invited by Defra in November 2023 to respond to an opportunity to promote CP and/or CNB in LURA-affected catchments. Our response in January 2024 offered alternative CP and hybrid CP and CNB proposals for the sensitive areas within our region, to achieve at least the equivalent nutrient load reduction for lower cost and wider environmental benefits. Our proposals built upon our successful CP and CNB delivered in AMP6 and AMP7, but we recognised that constraints for other regulatory drivers limited our ability to offer even greater overall benefit from a full catchment-based approach.

Whilst developed and presented for consideration as options that had potential to provide the most optimal outcomes, our alternative LURA proposals, however, did not meet regulator expectations without what we felt would leave us with excessive financial and performance risk for the amount of environmental benefit compared to the original LURA proposal.

Subsequently, however, we have agreed to deliver phosphorus TAL at WRCs 1,000-2,000pe within the Poole Harbour catchment by 2035 (through the PR29 WINEP), leading to the May 2024 update to the list of designated sites. This has allowed Natural England to remove their phosphorus nutrient neutrality requirement for developers within Poole Harbour.

WINEP updates

[4] At the time of our PR24 Business Plan submission (Oct 2023), it had been assumed that the Chesil and the Fleet SAC/SPA site would be designated for both phosphorus and nitrogen, although this was not included in the Government’s notice of designation of sensitive catchment areas on 25th January 2024. This non-inclusion, however, does not affect our plan as our WRCs within this area are all less than 2,000pe and had thus already been considered as exempt from upgrades under LURA.

Since the September 2023 version of the WINEP there have been a number of changes affecting phosphorus schemes, including but not limited to new sites requiring phosphorus removal, amendments to limits already in WINEP and driver changes. We have worked with the EA through their updated water quality models to determine appropriate permit limits for WRCs at waterbody, sub-catchment and catchment scale, as well as upstream of multiple habitat site offtake locations, cognisant of the various regulatory drivers and any constraints on solution types.

Revised Costs

As part of our AMP8 delivery programme, we have continued to develop our solutions and costs for our phosphorus removal programme since our business plan submission. This has resulted in some changes to scope and costs as is expected for the next stage of feasibility assessments and options development.

Since PR24 October submission, we are moving to the next stage of our investment approval process. This is the step beyond the PR24 business planning process, during which we conducted high level WRC treatment reviews to identify where upgrades are required, developed solution scopes using the PR24 design guidance, and prepared bottom-up cost estimates (where possible, otherwise used a cost curve) based on our internal cost database. These costs went into the October business plan.

In the next stage of the process, the AMP8 feasibility team are undertaking a separate WRC performance assessment and solution development process which is more in-depth than the process followed for PR24, representing an improvement on certainty of scope and costs. At the end of this next stage, an updated scope is established for the main capital delivery elements for each WRC based on the more in-depth analysis of its specific requirements and constraints. This scope is used to determine a new upgrade cost estimate as part of this next stage.

A selection of schemes has now passed fully through the next stage (post PR24) of the process. There have been several design changes between PR24 planning and AMP8 delivery processes which are identified below. The key difference is the level of detail that we have developed since October 2023. Of the 15 phosphorus and 2 nitrogen removal sites where we have progressed the development of the scopes (and with an associated updated estimate), we have then determined the weighted average reduction from scope optimisation and applied this to comparable or equivalent schemes across the remainder of the programme, with a significant reduction of costs to approx. 50 other schemes, as we believe this next stage in the process to yield similar opportunities for scope rationalisation (in the round, but not equally scheme by scheme).

We have further developed our risk evaluation guidance to include an adaptive ‘risk mitigation plan’ (RMP) as a control measure for medium risk sites. For AMP8, we are determining whether upgrades are necessary based on a more risk-tolerant approach. The AMP8 compliance risk evaluation guidance requires a ‘*current risk score’* to be calculated based on historical flow and water quality data, which is then adjusted to a ‘*future risk score’* based on estimated future flows and loads. Future risks are then categorised as low, medium, and high risk which guides the mitigation required. Low risks do not trigger mitigation action, medium risks may be managed under a *‘risk mitigation plan’* (RMP) – which allows investment to be deferred until triggered by future conditions – and high risks require investment action. This is a step change in approach to that used at PR24 for two main reasons:

- We are able to provide greater certainty in our ability to manage these medium risks with a RMP and greater confidence in the levels of risk identified as this assessment incorporates more data in consideration of site-specific performance issues when determining compliance risk (i.e. not just process unit loading but the existing performance of the unit and its ability to achieve permit limits even if overloaded), but noting the updated risk/optimism bias included for the associated updated scopes reflects these improvements in confidence.
- Adjusting for future risk also allows some exceedance of triggers for asset upgrades within the design standards, depending on the current risk score. For example, a biofilter process with a low current risk score of 1 can be overloaded by 14% before its future risk score is considered high (≥20). Whereas the same

process with a medium current risk score of 16 can only be overloaded by 4% before its future risk is considered high.

Figure 1 – Example of risk scoring taken from our risk evaluation guidance, with an adaptive risk mitigation plan

Table 10: A table showing an adjusted risk score based on the percentage increase above the hydraulic design loading rate for a fixed film process at the Risk Horizon.

Existing Risk Score	%age Increase Above Hydraulic Load Design Standard								
	0%	2%	4%	6%	8%	10%	12%	14%	16%
1	1	3	6	8	10	12	16	20	25
2	2	5	8	10	12	16	16	20	25
3	3	4	10	12	12	16	16	20	25
4	4	8	10	12	12	16	20	25	25
5	5	9	12	12	16	16	20	25	25
6	6	10	12	12	16	20	20	25	25
8	8	10	12	16	16	20	25	25	25
9	9	12	12	16	20	20	25	25	25
10	10	12	16	16	20	25	25	25	25
12	12	16	16	20	20	25	25	25	25
16	16	16	20	20	25	25	25	25	25
20	20	20	20	25	25	25	25	25	25
25	25	25	25	25	25	25	25	25	25

Low risk – no or minor action required
Medium risk – can be managed under a 'risk mitigation plan'
High risk – immediate action required

2.3. Evidence to support the modelling approach

2.3.1. Revised modelling allowances based on updated programme data

We have updated Ofwat's forecast models to reflect our updated phosphorus removal programme, as set out above. Specifically, we have replaced our original scheme costs and cost driver information with the new information contained within CWW19, and replicated Ofwat's modelling approach (including the removal of outliers based on Cook's distance method) for its forecast models. For the reasons set out above, we consider that efficient cost allowances are more accurately set based on forecast data.

The updated model parameters with this new data are set out in Table 1 below. The parameters and adjusted R-squared have changed slightly but are broadly similar to the original model.

Table 1 – Scheme level phosphorus removal enhancement totex models

Explanatory variable	PR1	PR2
PE served	0.209	0.208
Historical consent	0.295	0.277
Enhanced consent	-3.566	-0.629
Enhanced consent squared	0.692	
TAL dummy		1.714
Constant	4.123	2.061

Adjusted R-squared	0.661	0.661
Observations	837	837

Our revised modelling allowance under this specification is £622 million[5]. This is set against a requested allowance of £767 million, because not all phosphorus schemes are included (due to the removal of some schemes for data reasons and after the application of Cook's distance method to identify outliers).

However, we consider that this does not appropriately reflect an efficient cost allowance for this scheme.

Firstly, this model includes Dorchester WRC. This phosphorus removal scheme is a highly complex scheme with very challenging regulatory dates. We have previously provided evidence to Ofwat and Defra about the site-specific issues associated with this upgrade. This scheme should continue to be treated as an outlier, as Ofwat has done in its draft determination, alongside Poole WRC which is the largest of all our phosphorus removal schemes and also has site-specific delivery challenges. We provide further evidence in the next section as to why we require the costs submitted in our updated plan for phosphorus removal upgrades at Poole and Dorchester WRC respectively.

On the basis that these schemes continue to be treated as outliers, our revised modelling allowance under this specification is £610 million, against a requested allowance of £732 million. But as previously explained in this section, and in our separate representation WSX-C02 (Enhancement costs), there remains a very high degree of uncertainty over the modelling results for other schemes. This is even the case for the forecast models.

- The difference between Ofwat's modelled allowance and the upper bound of its 95% confidence interval (for all parameters) is around £0.5 million (an average for PR1 and PR2 models). Given that this is a *scheme-level* estimate, this creates a material uncertainty range for the predicted costs at programme level, for a phosphorus removal programme of our size.

- The model is significantly more sensitive to the inclusion and weighting given to specific companies than other enhancement cost areas, partly reflecting company differences in programme size.

This is not to say that we believe modelled allowances should be set according to the top of a range implied by the most robust model specification, or should exclude certain data. Rather, it serves to illustrate the degree of uncertainty in determining efficient cost allowances for this enhancement programme, given the multiple factors driving costs as explained above.

In light of this uncertainty, we consider it would be appropriate to review the current approach and outputs to ensure there is an overall balance between supporting cost efficiency while ensuring that critical investment is delivered. An approach to assessing enhancement costs based purely on econometric benchmarking models, particularly in areas where the available evidence has weaknesses (as is the case with its cost benchmarking for phosphorus removal), and where a major industry-wide efficiency challenge is set, carries a high risk of disallowing necessary (efficient) costs than to allow unnecessary (inefficient) costs. To mitigate this, in circumstances where the available quantitative evidence is not compelling, it is appropriate to consider this evidence in the round alongside other forms of evidence.

To this end, further evidence of our costing approach is provided below – see in particular Section 2.5 and 2.6. This includes bottom-up evidence demonstrating how we have considered the full range of factors driving scheme-level costs for phosphorus upgrades, beyond those captured by a simple benchmarking model with a few cost drivers.

[5] £621.574 million is calculated as the average of the PR1 model and PR2 model totex allowances (PR1: £617.622 + PR2: £625.527) / 2.

This demonstrates why our assessment of the efficient costs may deviate from a point estimate provided by one or two econometric modelling specifications. We consider it would be more appropriate that this context is taken into consideration when determining how much weight to place on the outcome of its econometric modelling.

2.4. Evidence to support a deep dive assessment

2.4.1. Need for investment

The need to invest in phosphorus removal is governed by the Water Industry National Environment Programme (WINEP), which sets out specific environmental performance targets to be achieved in AMP8. Details of the WINEP drivers for our phosphorus removal schemes for PR24 are detailed in WSX16 Section 6.2 and are summarised below:

- HD_IMP – Actions to contribute to restoration of a European site or Ramsar site to move towards meeting the conservation objectives.
- HD_IMP_NN – Actions to reduce total phosphorus and/or total nitrogen levels to the Technically Achievable Limit (TAL) from discharges which drain to catchments where Nutrient Neutrality is advised.
- SSSI_IMP – Actions to contribute to restoration of a SSSI to favourable condition.
- WFD_ND – Actions to meet requirements to prevent deterioration.
- WFD_IMP_MOD – Actions to ensure no river, lake or estuary is in poor or bad ecological status due to the water industry.
- WFD_IMP – Implementation of actions to improve water quality in terms of relevant WFD status objectives. A subsequent suffix indicates what target the measure is aimed at achieving (i.e. g = Good status for the element).
- U_IMP1 – Actions to improve discharges from agglomerations that, through population growth, have crossed the population thresholds in the Urban Wastewater Treatment Regulations and therefore must achieve more stringent requirements.
- U_IMP2 – Actions to reduce total phosphorus and/or total nitrogen levels in qualifying discharges associated with the latest review of freshwater Sensitive Areas (Eutrophic).
- EnvAct_IMP1 – Actions to reduce phosphorus loading from treated wastewater by 80% by 2037 against a 2020 baseline.

It should be noted that there are a number of sites with multiple parameter tightening in WINEP. This will impact on both:

- options appraisal - the feasible options will be constrained by the need to meet all future permit conditions;
- scope of the preferred option - there may be process treatment units that support meeting multiple drivers or conversely each driver could require separate solutions such that in combination the optimal solution is a profound change at the site; and
- apparent cost efficiency - there are likely to be differences between companies in methods of cost allocation between different enhancement categories.

The apparent cost efficiency issue is pertinent where Ofwat has used comparative benchmarking for one of the drivers (for example Phosphorus removal) but a deep dive approach for another (Nitrogen removal). Differences in cost allocation between companies could lead to Ofwat rewarding or penalising companies according to their cost allocation methods. Those with a method that allocates lower costs to Phosphorus removal appear efficient on benchmarking, and relatively higher costs assessed for Nitrogen removal may be allowed through a deep dive. Conversely, a company allocating higher costs for the same scheme to Phosphorus removal see an efficiency challenge applied and receive a lower allowance through the deep dive.

2.4.2. Best option for customers

We are committed to providing our customers with the best possible service at the best possible value. As part of this commitment, we have conducted a rigorous optioneering appraisal to ensure that our final options for nutrients reduction are the most cost-effective and efficient solutions available.

We recognise that the information on our options appraisal may not be readily apparent in our submitted business plan documentation. The purpose of this document is to signpost to where the information exists and provide additional information where necessary.

Traditionally, we have taken a catchment-based approach when developing options for nutrient reduction. This approach was used in PR19 and was aligned with the expectations of our stakeholders and customers (as this is how we have usually presented the results). Table 19 in WSX16 outlines the catchment phosphorus load reduction targets. While this table may not be directly relevant to our current approach, it reflects the rationale behind the catchment-based approach at the time.

At each of our Phosphorus and Nitrogen removal sites, we have considered a range of intervention types (both traditional and non-tradition) to achieve our regulatory obligations. The options development process included a robust cost-benefit appraisal to ensure the selected solution provides best value for customers, communities, and the environment. This involved the consideration of:

- whole life costs
- carbon impact,
- natural capital benefits, and
- other benefits such as the total P load removed each year.

We conducted an intensive options appraisal as part of our wider WINEP development and business planning processes. WINEP development was carried out in collaboration with the EA and NE and in line with national guidance as described in WSX16 Section 3.3.

Our options development process follows our resilience, risk management and decision frameworks described in WSX37. These align with the WINEP development framework as set out by the EA. Once an investment need has been identified, we plan the response by identifying feasible options to address the root cause of the need. This involves identifying:

- Unconstrained options (long list of all possible options)
- Constrained options (coarse, qualitative screening of options)
- Feasible options (fine screening of options to determine a preferred list of interventions)

Unconstrained Options

We identify unconstrained options using a totex hierarchy approach we refer to as Tolerate, Operate, Collaborate, Optimise, and Build (TOCOB). In section 6.2.1 of WSX16, Table 20 groups the unconstrained list of options and these were assessed against the regulatory drivers. This assessment is shown in Table 22. Constrained options are assessed individually to determine their feasibility. These assessments are detailed in WSX16 pages 98 to 111.

For ease, we repeat some of the approach in the table below which outlines the unconstrained options initially considered when any WRC is identified as requiring improvements, be that for Phosphorus, Nitrogen, or Sanitary parameter tightening.

Table 2 – Unconstrained options

Option	Description
Modify consents/permits	Review/revise permits with the Environment Agency

River catchment/dynamic permitting	Work with the EA to spread loading across the catchment, or seasonal/flexible permitting.
Tolerate	Site already achieving new permit requirements
Optimise/Operate	Increase the efficient use of the existing capacity with the existing assets.
Treat/pre-treat in network	Reduce load transferred to the WRC, e.g., network chemical dosing
Rationalisation/centralisation	Close smaller treatment works and transfer flows to a larger one
De-centralisation	Remove flows from a treatment works and create localised treatment works.
Catchment management initiatives	Source Control – Treating either diffuse or point-source domestic elements of wastewater before they enter the sewer system.
	Catchment Nutrient Balancing – Treating and controlling the other contributors to the environment.
Discharge Relocation	Relocate effluent discharge to remove/reduce the need for other enhancement.
Increase treatment capacity	Green – Nature based solutions, such as integrated constructed wetlands.
	Grey – Invest in new assets to provide additional capacity

For both Phosphorus and Nitrogen removal, a range of different technologies were considered for grey solutions. We illustrate these in the sections below showing the results of the options appraisal for sites that Ofwat has assessed through a deep dive.

Constrained options

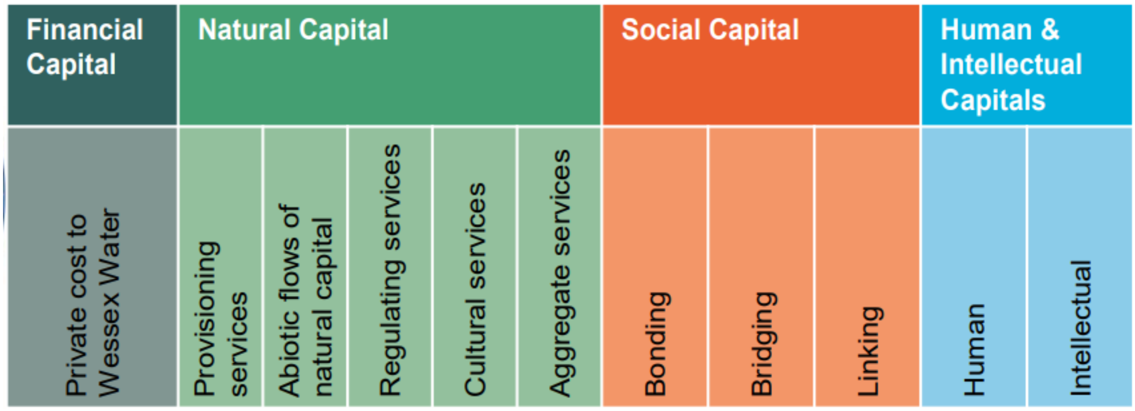
We engaged Stantec UK Ltd. to undertake a technical review of our wastewater treatment programme, in particular a review of our internal guidance for the basis of design and technologies for future permits for our proposed PR24 interventions. The assessment guidelines include generic guidelines and solution technology assessment guidance for varying permit/treatment requirements including phosphorus (itself including tertiary solids removal technologies to meet low limits), nitrogen, combined phosphorus and nitrogen. Stantec provided feedback, affirming that our approach was consistent with the wider water industry. Further details can be found in WSX17 A2-1

Feasible options

Feasible options are then considered in more detail at the individual sites. This assessment is achieved using our Arcadis Gen Enterprise Decision Analytics (EDA) portfolio optimisation tool (refer to WSX38 Annex A4-5). For each feasible option we detail the cost and benefits associated:

- Costs: we utilise standardised cost databases and curves captured in EDA (see WSX38 Annex A5).
- Benefits: we assign a frequency and consequence value to each service measure impact category to calculate the failure risk or added benefit. The monetised risk values are then calculated for each of the four capitals (Financial, Natural, Social, and Human & Intellectual) by multiplying their associated monetary weighting with failure risk or benefit opportunity. Our framework for assessing and valuing service impacts and is presented below and described in WSX37 Section 6.

Figure 2 – Approach used to define £ values within the Service Measure Framework (by capital area)



Valuation Type	Definition	Approach
Private Costs	'Private costs' which the business incurs in responding to failures of services	Developed through analysis and by consultation with members of staff from across Wessex Water various functions
Customers' valuations	Customers' Stated Preference values for changes in service	Derived from Wessex Waters Willingness to Pay evidence from 2022 Customer Valuation Research. We have undertaken a sensitivity test utilising Ofwat collaborative outcome delivery incentive rates research.
Social, human, Intellectual and environmental capital valuations	Social: Relationships between an organisation and communities, local government etc. Human: Includes trust, skills, well-being and safety of personnel. Environmental: Ecosystem services that are relevant to Wessex Water's activities. Intellectual: Includes routines, practises and structural resources	Consideration of social, human, environmental and intellectual values across the industry and broader literature/research at regional to global levels following good practice guidance, including: • Ofwat PR24 Methodology – including the WINEP Wider Environmental Outcomes Metrics • HM Treasury Green Book and supplementary guidance.

EDA then calculates the Net Present Value (NPV) of costs and benefits and the Benefit Cost Ratio (BCR) of each option in accordance with UKWIR's 2010 CBA guidance[6]. Our preferred options are those with the largest BCR subject to a review of the total variance in costs to ensure any options with the largest BCR but not lowest cost to ensure the added benefit (or mitigated dis-benefit) provided by additional expenditure is in customers interests. If the marginal cost is not deemed to be in customers interests we have proposed a lower cost alternative. Our alternative options are the lowest whole of life cost within performance target constraints. An overview of the optioneering process applied to P removal sites is provided below. EDA outputs for our outlier schemes are presented below. A technical assurance report by Mott Macdonald for our investment planning in EDA is provided in WSX45 Annex A1-5.

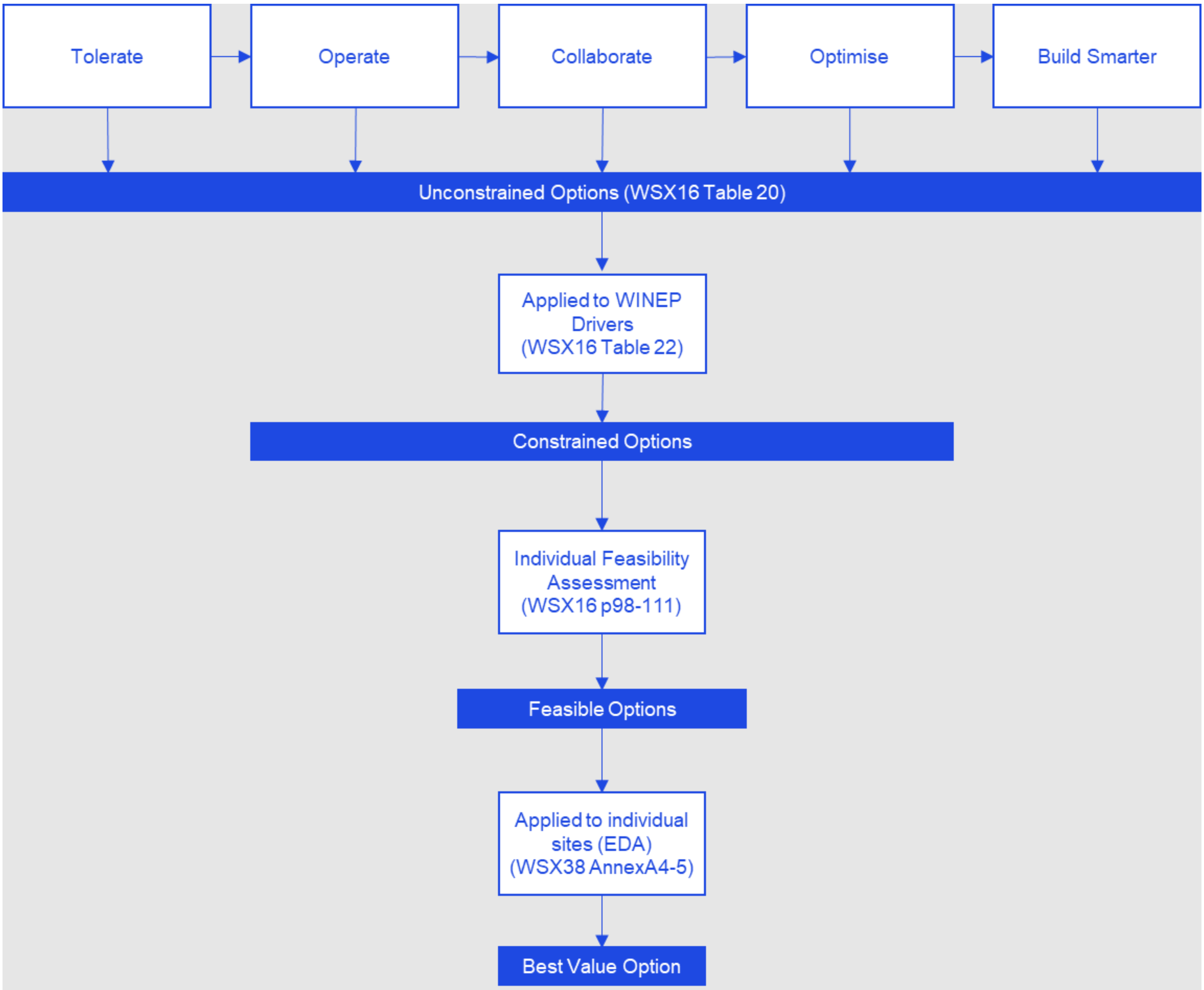
The results of our optioneering appraisal are detailed in WSX17, an annex to the wastewater networks plus strategy and investment (as part of the A8 WRC Screening reports).

[6] Review of Cost-Benefit Analysis and Benefit Valuation (ukwir.org)

WSX17 provides a comprehensive overview of the optioneering appraisal, including:

- Current permits
- Needs (i.e., drivers)
- Solutions and solution types
- RAG status
- Reasons for inclusion/exclusion
- Capacity and flow risks
- Best option and justification

Figure 3 – Option development process



In Section 2.5, we have demonstrated the results of our approach for two of our phosphorus removal schemes that Ofwat undertook a deep dive assessment for. In Section 3.4 we do similar for some nitrogen removal schemes, noting some of these also have a phosphorus driver.

Carbon impact

Carbon valuations have again been provided by an external consultancy (Mott MacDonald) using industry standard data and assumptions and using the Moata carbon tool. We have worked with Mott MacDonald to embed a process for quantifying whole life carbon as business-as-usual, as a pre-requisite for capital scheme evaluations and whole life emissions reductions. We estimated emissions from capital projects on a cradle-to-build basis. In each case, this calculates the carbon footprint of specific assets and components. This produced a detailed assessment of carbon / cost intensity ratios for categories of capital schemes which were applied to the top 80% of schemes by expenditure during 2022-23. For schemes covered by the remaining 20% of expenditure, an average carbon / cost intensity ratio was applied. Combined, these methods produced the embodied carbon related to each scheme category. There is further information on our carbon approach in section 6 of WSX02 of our October Business Plan submission, but this is the basis for the carbon values provided below.

Benefits

As part of our November 2022 WINEP submission to the Environment agency, we included Options Appraisal Reports (OAR). For each WINEP action, a number of options were assessed for risks, impacts and benefits. We developed these options in discussion with our regulators and, where relevant, informed by discussions with stakeholder organisations and taking account of customer preferences. Best value actions have been included in the WINEP, subject to direction imposed on us by our regulators. Actions included in the WINEP align with the Environment Agency and Natural England's vision for the water industry, set out in WISER.

Our WINEP benefits evaluation considered a wide range of environmental, natural capital and social benefits. For the WINEP submission we utilised our Service Measure Framework (SMF) to inform the assessment of the options for the WINEP and the Wessex Water business planning optimisation process and outlined the alignment of the WINEP wider outcomes metrics to the Wessex Water Multi-Capitals SMF in the submission to the EA. For the phosphorus programme the key service measures used were:

- River Quality - river improvement (WINEP) associated with phosphorus removal - kg/yr
- WRC compliance - numeric effluent & flow - Nr of failures / Nr of incidents
  - (if with an associated growth scheme on the same site)
- Greenhouse gases - tCO2
- Land-use change - *total area (ha) restored or protected*

Once the shortlist of interventions is identified, they are captured within the EDA Tool and evaluated using the SMF (user enters pre-intervention and post-intervention quantities). Using the SMF, for each feasible option we detail understanding the benefit (or value) of the investment, based upon the change in risk over a 30- year planning horizon (i.e. the post-intervention value minus the pre-intervention value). For each option, we identify any further service measures affected by the intervention.

However, when comparing costs and benefits across our multiple options we found the most material benefits which could impact the decision for whether a specific option is best value compared to another related to:

- carbon impacts, and
- the environmental benefits of green solutions such as integrated wetland solutions.

Valuations of the impacts relating to change in land use were insufficiently material to make a difference to which option was selected as best value.

Since the November 2022 submission, we have further refined our assessments and adjusted solutions as required with updates on LURA requirements and other wider catchment options which was used in further optimisation runs and option selections in EDA.

Cost Benefit Analysis

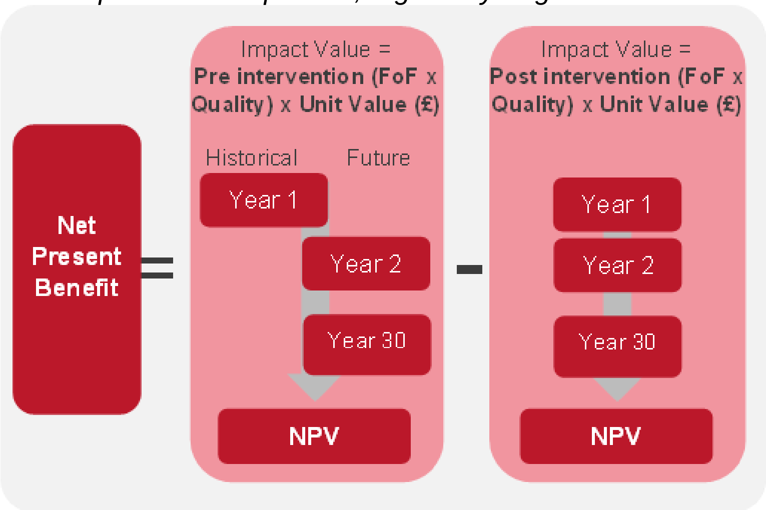
Costs and benefits for options in the phosphorus removal programme were developed as per the wider investment programme as outlined in section A4-4 and A5 of WSX38 of our October Business Plan submission. As with each investment area, in development of the internal investment process methods workshops identified the most material and quantifiable service measures (and associated data sources for quantification) for use in option selection in the phosphorus removal programme. EDA then calculates the Benefit Cost Ratio (BCR) and Net Present Value (NPV) in accordance with UKWIR's 2010 CBA guidance (where the sector agreed the use of the Spackman approach) and Ofwat's Price Review 24 (PR24) guidance. Our preferred plan is the plan with the best BCR, and our alternative plan was lowest whole life cost within performance target constraints. Inputs to and outputs from EDA have been reviewed as part of our external PR24 assurance (further details in section A4-4 of WSX38).

Results for each option.

For all feasible options, benefits and costs were calculated based on the methodology below:

Figure 4 – Principal benefit categories and assessment methodology for our phosphorus (and nitrogen) removal schemes

Category	Methodology
Embodied carbon	(From WSX02) We undertook *estimating emissions from capital projects is on a cradle-to-build basis. The procedure began with a "bottom-up" assessment of the carbon footprint of individual capital schemes for PR24 business plan preparation, using company information and Mott MacDonald's Moata carbon portal. In each case, this calculates the carbon footprint of specific assets and components. This produced a detailed assessment of carbon / cost intensity ratios for categories of capital schemes which were applied to the top 80% of schemes by expenditure during 2022-23. For schemes covered by the remaining 20% of expenditure, an average carbon / cost intensity ratio was applied. Combined, these methods produced the embodied carbon related to each scheme category.*
Operational carbon	(From WINEP Options Development Report – Phosphorus Reduction) *With the National Grid increasingly being supplied by renewable energy sources this will reduce our operational carbon emissions in the future. Using the Department for Business, Energy & Industrial Strategy's (BEIS) modelling based on the Intergovernmental Panel on Climate Change (IPCC) (2021), an agreed the power emission factor number used for the CO2e value is an average of the central figures from 2022-2050.* Quantities for each solution were determined by the various change or addition in operational elements of the solution (such as power, chemical dosing etc) using the consistent unit rate applied to each of these as per our standardised carbon accounting methodology.
P removal	(from WSX49, section 17.5) *For decision-making purposes, i.e. in the SMF/optimisations (EDA), we have optimised P removal schemes based on the EA's approach. This means for all sites where we could implement improvement schemes, we have included options in the optimisation that, where applicable, are able to meet the site-specific permit as a minimum (i,e. for WFD, NN etc site targets) plus more stringent removal permits. These are then optimised to be the wider sub or catchment targets for Env. Act etc. To align with the EA's approach, the service measure for phosphorus removal is in kg removed, based on the existing permit flow and concentration only with the quantified solution kg removed representing the permit flow times the P concentration for new permit.*
Land use change	(subset from query response OFW-OBQ-WSX-011) *This is associated with the land use change incurred by implementing the scheme, which result in the creation, protection or enhancement of various land types.* For the phosphorus programme the land-types used were: • Area of semi-natural grassland

	• Area of farmland • Area of wetlands and floodplains *For change from one land type to another, the existing land-type is representative by a negative quantity, with the new land type represented as a positive quantity. The quantities are estimated based on footprint and placement of the planned scheme.* *Whilst the benefit type captures biodiversity benefit value as part of the value-added (along with the impact on amenity, air pollution, flood regulations, carbon sequestration, water quality, recreation etc), this is different to the definition and units of the Biodiversity performance commitment as it is designed to quantify the value change to inform decision-making between options.*
Benefit values, Costs and BCR	(WSX38 section A4-5) *EDA has been used to run the following optimisations for Wessex Water:* • *Best BCR – a simple goal where the benefit cost ratio (BCR) is maximised as the only goal of the optimisation. The BCR is calculated as follows:* *(Pre-Risk NPV – Post Risk NPV) / (CAPEX NPV + OPEX NPV)* *Pre Risk NPV is the total risk based on the need and Post Risk NPV is the total risk of the solution, both across the NPV period. Pre-Risk NPV – Post Risk NPV therefore provides the benefit over the NPV period. OPEX and CAPEX NPV are described in more detail under Net Present Value Calculations.* • *Least Cost – two goals are applied where the OPEX NPV and CAPEX NPV are added together with equal weights. The objective of the optimisation is to minimise the total of these values.* *Constraints have been added where required on CAPEX and to optimise our plans to meet various performance profiles, regulatory targets and commitments.*  Illustration of net present benefit calculation  Illustration of Benefit Cost Ratio calculation

For Dorchester and Poole, these results are shown in Section 2.5.

2.4.3. Cost efficiency

Costing methodology

Accurate estimation of the final project costs, risks and project duration is essential for Wessex Water. We are unique in the industry in maintaining a strategy that retains an in-house engineering and construction delivery team. Our Sustainable Engineering and Operations Team (SOE), programmes and project manages main contractors and designers. This role encompasses pre-statement of need, concept, outline, and detail design; planning approval, consents, land access and acquisition; site investigation; public, press and stakeholder consultation, as well as overall project management. This internal capability means that we have direct insight of efficient delivery costs.

Our costing methodology is provided in WSX38 Annex A5. For our business plan, we have used four different pricing models:

1. Bottom-up estimates (BUE)
2. Unit rates built from historical project building blocks
3. Historical delivery costs
4. Strategic cost curves using available cost data and models (generated using a methodology that was assured by ChandlerKBS)

The pricing model chosen depends on the design information available. Costs for phosphorus removal schemes were derived through a mixture of bottom-up estimates and cost curves. A representative sample of solutions covering a range of technology types, sizes and complexities have been bottom-up costed by our in-house estimating team and third-party estimators, to inform the cost models and cost curves. The cost consultant, ChandlerKBS, has provided assurance on each of the pricing methodologies. Their report for P removal, WINEP and Growth Programmes PR24 Costing Estimating Methodology is provided in WSX45 Annex A4-2.

Market research

To ensure our costs were efficient and reflected the market, we conducted thorough research into the technologies available for phosphorus removal. This research involved reaching out to seven suppliers, three of which engaged with us: Bluewater Bio, Evoqua, and Veolia.

Our investigation covered the following aspects:

- Capital and operational expenditure (capex and opex) costs: We gathered detailed information on the costs associated with implementing and operating different P removal technologies.
- Process of P removal: We explored the specific processes involved in each technology, including the stages of treatment and the mechanisms by which P is removed.
- Review of technology against set criteria: We evaluated each technology against a set of predetermined criteria.

Furthermore, we carefully considered the technologies within the context of our own constraints and needs. This included factors such as the size and complexity of the existing treatment works, backwash capacity, the desired level of P removal, land requirements etc.

By engaging with multiple suppliers and conducting a comprehensive review of the available technologies, we were able to develop a cost estimate that accurately reflected the market. This ensured that our costs were efficient and aligned with industry standards.

Benchmarking

In section 2.5 we include the scope and cost benchmarking exercises we have completed for Dorchester and Poole. In section 3.4 we provide similar scope and cost benchmarking details for some nitrogen schemes, including some that have a phosphorus removal driver.

Cost allocation

We are aware that we have allocated costs to P or N removal where some companies may have attributed some costs to capital maintenance or growth. The approach we have taken aligns with Ofwat's guidelines on cost allocation principles, adopting the "causality" approach. For example, a number of schemes are at sites where the capacity headroom is limited and so the additional hydraulic capacity required to provide flow balancing and more certain treatment performance to provide the nutrient removal required for the new permit is not available within the existing headroom, however the additional growth in the catchment would not trigger a capacity upgrade at these sites within the same AMP. Similarly, we have undertaken asset reviews of existing critical assets at these sites for those assets linked to the processes subject to improvement due to the nutrient drivers. We have used this information to determine if assets are in need of replacement or only require upgrade to meet new performance requirements and are confident that we have allocated any replacement costs appropriately.

However, with that in mind, and since our PR24 submission, we have undertaken an external technical review of our scoping decision-making and associated cost allocation with AtkinsRéalis. This has fed into a review of our risk approach and associated scoping, alongside further development of our schemes to reassess allocation of costs against drivers. As a result of this exercise a small proportion of costs have been reduced and/or reallocated across regulatory purposes on a case-by-case situation.

2.4.4. Customer Protection

The scheme level PCD that Ofwat proposes to use will protect customers from under or late delivery of these WINEP Phosphorus removal schemes. Refer to WSX-O02 for our comments on this PCD.

2.5. Site specific evidence for P removal sites that Ofwat deep dived

The Phosphorus removal enhancement model identified three of our schemes as outliers, of which two were above the modelled allowance. For each of these two schemes, we are providing additional details on:

- Results of considering the unconstrained options to develop a constrained option list
- Results of qualitative assessment to develop feasible options
- Quantitative assessment of feasible options which results in preferred option

For the preferred option we also provide

- Cost breakdown
- Explanation of costs with reference to solution complexity
- Technical assurance

2.5.1. Dorchester WRC

The following sections are to be read alongside section A3-2.4 of WSX17 from our Business Plan submission.

Need for investment

Dorchester WRC is a site with drivers for Phosphorus and Nitrogen removal in the PR24 WINEP. Our options appraisal considered all investment drivers at the site to ensure a best value solution.

- Phosphorus
  - 0.25mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP, EnvAct_IMP1)
  - 2mg/l (U_IMP2)
- Nitrogen

  - 10mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP)
  - 15mg/l (U_IMP2)

Best option for customers

Based on the methodology outlined in section 2.4.2, the table below shows a list of all options considered for Dorchester. It illustrates:

- The results of qualitative assessment of the unconstrained options,
- Further qualitative assessment of the constrained option, and
- The assessment of feasible options to develop preferred (best value) and least cost options.

Table 3 – Options screening and selection process for Dorchester WRC

Unconstrained Options	RAG Assessment and progress to next stage	Reason for inclusion/exclusion
Modify consents/permits	Y	Subject to load reduction requirements and any regulatory constraints.
River catchment / dynamic permitting	Y	Subject to load reduction requirements and any regulatory constraints.
Tolerate	N	Has existing P removal but would not meet new limit. No N removal.
Optimise/Operate	N	Has existing P removal but would require new assets to meet new limit. No N removal.
Treat/pre-treat in network	N	No available treatment options.
Rationalisation/centralisation	Y	Subject to load reduction requirements.
De-centralisation	N	No opportunity for new, smaller WRC to discharge to alternative waterbody/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Catchment management initiatives - Source Control	N	No trader(s) within catchment that contribute dominant load of P or N (inc. ammonia) to the WRC that would sufficiently change any solution at the WRC.
Catchment management initiatives - CNB	Y	Subject to load reduction requirements and any regulatory constraints.
Discharge Relocation	N	No opportunity to relocate discharge to non-sensitive area/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Increase treatment capacity - Green	N	No land availability
Increase treatment capacity - Grey	Y	Various treatment options possible.
Constrained Options		**Reason for inclusion/exclusion**
Modify consents/permits	N	Permit set based on population (LURA > 2,000pe) and load target through Poole Harbour Consent Order. AMP7 scheme meets WFD P requirements.
River catchment / dynamic permitting	N	Permit (P&N) set based on population (LURA > 2,000pe) and load target. Have explored permutations across multiple sites.
Rationalisation/centralisation	N	No site within reasonable distance.

Catchment management initiatives - CNB	N	WINEP drivers (EnvAct P & LURA/UWWTR P/N) requires improvements to point source discharges.
Increase treatment capacity - Grey	Y	Various treatment options possible.
Feasible Options		**Solution/scope description**
1) Grey treatment solution - Activated Sludge Plant (ASP) with tertiary denitrification and phosphorus removal	Y	• Primary settlement tanks • ASP Final settlement tanks • De-nitrifying sand filters with methanol dosing • Tertiary solids removal (for P) • Additional sludge treatment and associated ancillaries including pumping stations, standby power provision, kiosks etc.
2) Biological Nutrient Removal (BNR) Plant with tertiary phosphorus removal	Y	• Primary settlement tanks • BNR • Final settlement tanks • Tertiary solids removal (for P) • Additional sludge treatment and associated ancillaries including pumping stations, standby power provision, kiosks etc.
3) Grey treatment solution – Sequencing Batching Reactors (SBR) with tertiary denitrification and phosphorus removal	Y	• Sequence Batch Reactors • De-nitrifying sand filters with methanol dosing • Tertiary solids removal (for P) with poly dosing • Additional sludge treatment associated ancillaries including pumping stations, standby power provision, kiosks etc.
Chosen Solution		
Preferred Option (best value)		3) Grey treatment solution – Sequencing Batching Reactors (SBR) with tertiary denitrification and phosphorus removal to achieve a 0.25mg/l phosphorus permit and 10mg/l nitrogen permit.
Least Cost Option		Same as Preferred Option

Quantitative assessment of feasible options

A summary of the feasible options considered for Dorchester is provided in the following table. The benefits assessment considered: carbon (embodied and operational), nutrient load reduction (phosphorus and nitrogen), land use change, discharge site compliance, amongst others. All solutions achieve the equivalent nutrient load reduction. The assessment is over a 30-year period.

Table 4 – Benefits assessment summary for Dorchester WRC - Nitrogen & Phosphorus Removal

Feasible option description	Driver	Capex (£m)	Opex (£m/yr)	PV (£m)	Total Benefit PV (£m)	BCR
1) Grey treatment solution - Activated Sludge Plant (ASP) with tertiary denitrification and phosphorus removal	P	33.9	1.5	172.9	-266.4	-1.5
	N	55.6	2.3			
2) Biological Nutrient Removal (BNR) Plant with tertiary phosphorus removal	P	50.8	1.1	187.1	-300.6	-1.6
	N	41.3	3.0			
3) Grey treatment solution – Sequencing Batching Reactors (SBR) with tertiary denitrification and phosphorus removal	P	55.1	1.2	151.8	-267.7	-1.8
	N	32.4	1.5			

Despite providing both nitrogen and phosphorus removal, due to the large embodied and operational carbon footprint impact of all feasible options, the total benefits are negative, leading to a negative benefit cost ratio (BCR) derived from Total Benefit Present Value (PV) divided by Cost PV. We have selected option 3, which has the lowest cost and largest BCR (close to smallest total dis-benefit PV).

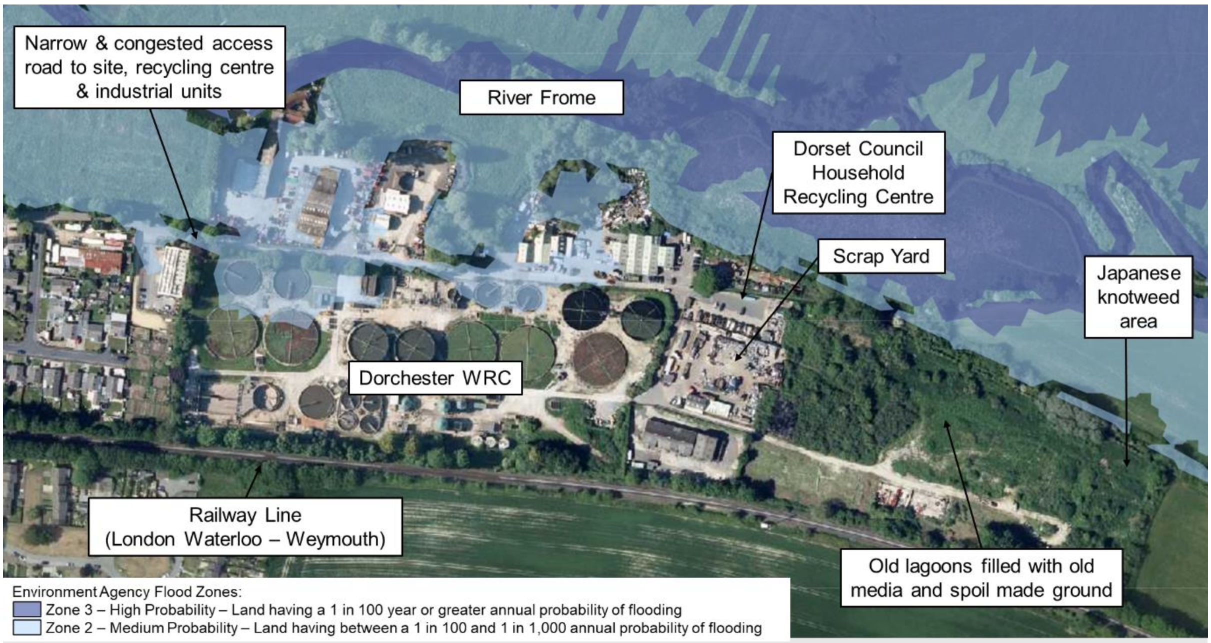
Site specific complexity areas

Dorchester WRC's unique layout necessitates a complex and expansive solution. The proposed side stream approach aims to address these challenges while minimising disruption and maximising efficiency.

Site Layout and ground:

There is limited available footprint within the existing operational boundary, with expansion required for any capital upgrades. Whilst the adjacent land is owned by Wessex Water, portions are leased to Dorset Council for an existing household recycling centre and a local private Scrap Yard. This land will require extensive groundworks and remediation. Furthermore, there is a material cost associated with the abandonment / demolition of assets on scheme completion.

Figure 5 – Dorchester WRC location plan



Hydraulic loading:

Hydraulic loading on this WRC exceeds our theoretical design standards, however, this has not triggered a capacity increase as we believe this does not impact treatment compliance with the existing permit conditions, which has been very good – the last regulatory sample exceedance was in February 2018 and was believed to be an anomalous sample. Adding phosphorus and nitrogen removal processes will generate significant backwash, further increasing the hydraulic loading. From review of our extensive non-regulatory sampling we believe effluent quality will decline as a result of the increased backwash. This increases the risk of future BOD and suspended solids failures, with risk scores of 25 and 20, respectively. This has resulted in additional hydraulic capacity being required.

Biological load and filter capability:

Increased sludge production from methanol and ferric dosing will overload some of the existing filters at the current flow split. Flow split modifications could address this, but this is not possible based on current filters used with extensive interstage pumping/pipework.

<u>Flow management:</u>

Dorchester is a long and thin site with no capacity to build additional HSTs or PSTs alongside existing assets. As a result, flows would need to be pumped to a new PST and then returned to the existing filter distribution. Flows would then need to be pumped again to new HSTs. The HST flows would all need to be recombined before being pumped into tertiary de-nitrifying sand filters.

<u>Side stream implementation:</u>

A full side stream was chosen to alleviate pressure on the existing plant and simplify pumping. Replacing existing PSTs, biofilters, and HSTs with a new BNR or ASP was considered but deemed less cost-effective. A side stream SBR was chosen to remove nitrogen simultaneously, reducing the need for tertiary denitrifying sand filters.

<u>Chemical dosing:</u>

A new chemical dosing unit is required for back-end dosing because the existing front-end dosing is geographically too far away from the TSR process, due to the nature of where we can build additional assets.

<u>Sludge Handling:</u>

With the additional sludge from the methanol and ferric dosing, the pre and post-thickened sludge storage will become significantly deficient of design standard (3 and 7 days, respectively), and new tanks are therefore included in the scheme. The scheme also includes for a new gravity belt thickener.

<u>Accepting risk:</u>

Accepting the risk of filter performance failure could avoid a full side stream but would cause hydraulic issues between the MCerts and the PSTs. If complicated pumping arrangements were acceptable, a PST and HST could be installed to accommodate the increased flows, but removal of the SBR from the side stream would result in a higher number of de-nitrifying sand filters required and increase reliance on existing assets, with reduced levels of redundancy.

Cost efficiency

In the following table we provide a breakdown of scope and cost for our selected option scheme, along with our purpose splits between cost drivers. As the costs were used at our stage 1 process, it means a bottom-up approach was used.

Table 5 – Scope and cost breakdown for Dorchester WRC - Phosphorus & Nitrogen removal

Scope Items	Phosphorus Capex (£k)	Nitrogen Capex (k)	Data Source
Inlet flow split c/w flow diversion to new pumping station and subsequent flow split between treatment streams.	119	634	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Chemical (ferric sulphate) dosing plant - c/w delivery area, storage tanks, dosing skid, LCP, dosing lines & associated equipment/instruments, emergency shower & eyebath.	3,680	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
2nr Primary settlement tank - c/w flow split chamber, auto desludging and scraper bridge	3,698	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
4nr denitrifying Sequence Batch Reactors - c/w feed pumping station, flow split, associated pipework, valves & instruments.	794	8,525	Internal bottom-up estimates.

Scope Items	Phosphorus Capex (£k)	Nitrogen Capex (k)	Data Source
15nr denitrying sand filters - c/w feed pumping station, flow split, Associated pipework, valves & instruments.	0	7,027	Internal bottom-up estimates.
TSR (N) polymer plant - c/w carrier water and dosing plant	8,328	0	Actual historical project cost data compiled by ChandlerKBS.
Methanol dosing plant - c/w delivery area, storage tanks, dosing skid, dosing lines & associated equipment/instruments, emergency shower & eyebath.	0	5,335	Internal bottom-up estimates.
1nr sludge storage tank - c/w mixer, roof and associated valves and pipework	1,128	0	Internal bottom-up estimates.
2nr Gravity belt thickener	3,528	307	Actual historical project cost data compiled by ChandlerKBS
Final effluent Pumping station - c/w D/A/S pumps. Associated pipework, valves & instruments.	387	348	Internal bottom-up estimates.
Monitors - P and N	179	161	Internal bottom-up estimates.
Sludge transfer pumping station - c/w D/S pumps and Associated pipework, valves & instruments.	311	0	Internal bottom-up estimates.
Tertiary solids removal (P) - c/w ballasted media technology, floculation and coagulation mixer and hydrocyclones for media recovery	1,119	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Works return pumping station - c/w D/A/S pumps. Associated pipework, valves & instruments.	220	198	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Abandonment of existing assets (make safe)	1,181	1,061	Internal bottom-up estimates.
General - 3rd party, land, environmental	929	889	%s based on recent historical costs, with site-specific adjustments following environmental and third party assessment.
Optimism Bias	8,267	7,906	Site-specific derivation, based on PR24 optimism bias methodology produced in conjunction with ChandlerKBS and based on the best practice process and templates generated for the Strategic Resource Options work.
Sub-Total:	33,870	32,391	
Total:	66,261		

As part of our PR24 October 2023 submission, ChandlerKBS provided some benchmarking for this scheme. Although scope and thus costs have change since, the benchmarking demonstrates that our costing did align (within reason) with what our cost consultant believed to be reasonable.

Table 6 – External cost benchmarking for Dorchester WRC

✂

2.5.2. Poole WRC

The following sections are to be read alongside section A3-2.7 of WSX17 from our Business Plan submission.

Need for investment

Poole WRC is a site with drivers for Phosphorus and Nitrogen removal in the PR24 WINEP. Our options appraisal considered all investment drivers at the site to ensure a best value solution.

- Phosphorus
    - 0.25mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP)
- Nitrogen
    - 5mg/l (HD_IMP, SSSI_IMP)
    - 10mg/l (HD_IMP_NN)

Best option for customers

We commissioned Stantec to complete an options appraisal for the Poole WRC, as part of an AMP7 WINEP investigations and options appraisal action (7WW300208). An excerpt from their report is provided in WSX17 A3.2.7. The full report is accessible via the EA's SharePoint site uploaded as part of our AMP7 WINEP sign off process, but it can separately be made available if required. The three main options (plus sub-options) considered were:

- Improvements to existing Poole WRC for an improved discharge quality through a tighter discharge consent reduced to a total phosphorus down to 0.25mg/l and total nitrogen of 5mg/l (tightened from the existing 10mg/l permit). Four side-stream options were considered:
    - Biological Aerated Flooded Filter (BAFF)
    - Granular Activated Sludge – Nereda®
    - Ballasted Activated Sludge – BioMag®
    - Membrane Bioreactor (MBR)
- Full relocation of discharge outfall from its current location in Holes Bay to a new location outside Poole Harbour, in the English Channel
- Partial relocation of discharge via an effluent reuse scheme taking flows to the River Stour in Dorset which would act as an environmental buffer and allow downstream re-abstraction and treatment for drinking water use. Flows into Poole Harbour and the Stour would require similar levels of nutrient removal.

The Stantec report determined that upgrades to the existing WRC was the preferred option. This is our PR24 proposal. The PR24 scheme principally includes the introduction of a tertiary solids removal (TSR) stage, additional chemical dosing provision, and additional treatment capacity to treat to backwash flows arising from the TSR stage. There is operational land available at Holdenhurst for the required scope.

The remit for the AMP7 appraisal, including the options under consideration, was agreed with the Environment Agency and Natural England through the Measure Specification Form for the AMP7 action. A number of options had been collaboratively discounted as part of this process. For completeness, however, we provide below a list of all options initially considered for Poole, based on the methodology outlined in section 2.4.2. Since this AMP7 appraisal report we have also considered a full site relocation, being an expansion of the partial relocation option but treating all flows but still discharging into Poole Harbour.

Table 7 – Options screening and selection process for Poole WRC

Unconstrained Options	RAG Assessment and progress to next stage	Reason for inclusion/exclusion
Modify consents/permits	Y	Subject to load reduction requirements and any regulatory constraints.
River catchment / dynamic permitting	Y	Subject to load reduction requirements and any regulatory constraints.
Tolerate	N	Has existing N removal but would not meet new limit. No P removal.
Optimise/Operate	N	Has existing N removal but would require new assets to meet new limit. No P removal.
Treat/pre-treat in network	N	No available treatment options.
Rationalisation/centralisation	N	Already largest WRC in area.
De-centralisation	N	No opportunity for new, smaller WRC to discharge to alternative waterbody/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Catchment management initiatives - Source Control	N	No trader(s) within catchment that contribute dominant load of P or N (inc. ammonia) to the WRC that would sufficiently change any solution at the WRC.
Catchment management initiatives - CNB	Y	Subject to load reduction requirements and any regulatory constraints.
Discharge Relocation	Y	Opportunity to transfer flows out of Poole Harbour via long sea outfall.
Increase treatment capacity - Green	N	No land availability
Increase treatment capacity - Grey	Y	Various treatment options possible.
Constrained Options		**Reason for inclusion/exclusion**
Modify consents/permits	N	Permit set based on population (LURA > 2,000pe) and load target through Poole Harbour Consent Order.
River catchment / dynamic permitting	N	Permit (P&N) set based on population (LURA > 2,000pe) and load target. Have explored permutations across multiple sites.
Catchment management initiatives - CNB	N	WINEP drivers (LURA P/N) requires improvements to point source discharges.
Discharge Relocation	Y	Design to be cognisant of Poole Strategic Resource Option
Increase treatment capacity - Grey	Y	Various treatment options possible.
Feasible Options		**Solution/scope description**
1a) Grey treatment solution - Biological Aerated Flooded Filter (BAFF)	Y	Option as considered as part of AMP7 WINEP investigation, with subsequent updates to reflect latest PR24 requirements.
1b) Grey treatment solution - Granular Activated Sludge - Nereda	Y	As above
1c) Grey treatment solution - Ballasted Activated Sludge - BioMag	Y	As above
1d) Grey treatment solution - Membrane Bioreactor (MBR)	Y	As above

2a) Full discharge relocation	Y	As above
2b) Partial discharge relocation (effluent transfer)	Y	As above
3) Full site relocation and new build site	Y	Full site relocation to Corfe Mullen, linking effluent transfer and sending flows to Dorset Stour. Would need substantially more treatment as introducing new loads into river with already stringent P requirements, along with N limitations.
Chosen Solution		
Preferred Option (best value)		1b) Grey treatment solution - Granular Activated Sludge - Nereda
Least Cost Option		Same as Preferred Option

Quantitative assessment of feasible options

A summary of the feasible options considered for Poole is provided in the following table. The benefits assessment considered: carbon (embodied and operational), nutrient load reduction (phosphorus and nitrogen), land use change, discharge site compliance, amongst others. All solutions achieve the equivalent nutrient load reduction. The assessment is over a 30-year period.

Table 8 – Benefits assessment summary for Poole WRC - Nitrogen & Phosphorus Removal

Feasible option description	Driver	Capex (£m)	Opex (£m/yr)	PV (£m)	Total Benefit PV (£m)	BCR
1b) Grey treatment solution - Granular Activated Sludge - Nereda	P	111.8	0.9	261.9	-2,887.1	-11.0
	N	78.5	0.8			
2a) Full discharge relocation	P&N	644.7	4.3	702.9	-491.6	-0.7
3) Full site relocation and new build site	P&N	414.5	3.1	557.3	-2,639.6	-4.7

Not presented in the table, but assessed, are the other sub-options for the grey treatment solution. Despite providing both nitrogen and phosphorus removal, due to the large embodied and operational carbon footprint impact of all feasible options, the total benefits are negative, leading to a negative benefit cost ratio (BCR) derived from Total Benefit Present Value (PV) divided by Cost PV. We have selected option 1b, which has substantially the lowest cost and the largest BCR. The solution with the smallest disbenefit PV is the full discharge relocation out of Poole Harbour, as despite having the significantly largest embodied carbon footprint due to tunnelling, it has the lowest ongoing operational carbon footprint compared to the other solutions as no additional treatment is being provided. This does, however, have significantly the largest capex and we note that the solution as presented does not include any additional treatment requirements that would therefore be required for the Poole Strategic Resource Option (SRO) scheme, given that this would not be receiving effluent already having had enhanced P&N treatment, and thus selection of this option would have the effect of significantly increased costs for the Poole SRO scheme.

Site specific complexity areas

We recognise that Poole has the highest capex of all schemes in our nutrients programme. However, considering the site-specific requirements of the site, our view remains that our PR24 cost estimate is robust and efficient.

<u>Spatial constraints:</u>

Poole WRC faces significant challenges in upgrading its facilities due to limited space for expansion. Surrounding industrial estates restrict the ability to build new treatment processes or expand existing ones. This necessitates a phased approach to the upgrade, involving relocation of existing infrastructure and construction of new treatment processes within the limited available space.

Existing works limitations:

The existing works are at maximum hydraulic and biological capacity. Whilst compliant with the current permits, the two existing aeration plants are incapable of meeting the new permit requirements for nitrogen and phosphorus removal. These plants cannot be augmented to meet the new permit requirements and must be replaced with a new, small footprint, high-rate treatment process. However, this new process generates large volumes of solids requiring additional treatment, further complicating the upgrade.

New treatment requirements and phased approach:

Due to the spatial constraints at Poole WRC, there is currently no space available to build a new treatment process, the additional tertiary solids removal required to meet the new TP permit or the biological assets to meet the new TN permit. As a result, one of the existing aeration plants will need to be demolished to make room for the new treatment plant and assets required. However, as the site is currently at maximum hydraulic and biological capacity we are unable to demolish this and maintain our current permit without first building something to treat the flows from the old aeration works. Consequently, the works required will need to be phased to allow us to maintain compliance with our current permit, whilst making space to upgrade the sewage treatment works. This will require:

- Re-location of the existing storm tanks onto land owned by Wessex Water but currently tenanted out to housing. This will free up space for the construction of the new treatment stream, enabling the demolition of one of the old aeration plants.
- Build of a new treatment stream in land occupied by existing storm tanks, car parking and portacabins to enable one of the aeration works to be demolished (note this would need to be built and fully commissioned before any demolition could occur;
- The new treatment stream will then be expanded to handle flows from the second old aeration plant and accommodate the additional solids treatment.
- Finally, new tertiary solids removal and sludge treatment assets will be installed.

The phased approach is necessary to maintain compliance with current permits during construction. The project involves significant relocation and construction activities within a constrained space, requiring careful planning and execution. Implementing new technologies like high-rate treatment and tertiary solids removal adds further complexity to the construction and commissioning which impact on the length of the programme.

External design and cost:

To ensure the robustness and efficiency of our option selection and cost estimates for the Poole scheme, we commissioned Stantec to provide a detailed optioneering appraisal report. This report included bottom-up cost estimates, sequencing methodology, and consideration of various technologies and approaches. Stantec further contracted Aqua Consultants to conduct the cost estimation element of the work, ensuring a thorough and independent review.

We are confident that the involvement of two reputable external consultants, followed by our own internal review, demonstrates the robustness and efficiency of the cost estimates. The methodology employed utilised supplier/market value numbers, ensuring alignment of costs with current market conditions.

Subsequent scope development:

Since the initial report which was produced for AMP7, however, the scope of the Poole scheme has expanded, and certain risks have materialised. We note that Stantec's report identified a number of areas of risk but realisation costs were not included in that report. For instance:

- The nature of high-rate technologies with small footprints requires additional protection upstream such as enhanced grit removal, no screens by-pass and FOG removal. This means the existing grit removal and screening are likely to require upgrading.
- The feasibility of simultaneous phosphorus and nitrogen removal is very dependent on the wastewater constituents in the catchment and the Stantec report assumed certain characteristics that are yet to be verified. Diurnal flow and load patterns also need to be considered. Sampling and monitoring is ongoing, but there remains a risk that the scheme will need larger reactors and/or additional chemical dosing requirements.
- Chemical dosing and tertiary solids removal results in large volume of additional sludge production and return liquor flows, which need to be treated and balanced before return.
- The Stantec report assumes that with a reduction in flow the existing de-nitrifying sand filters would be able to meet the new TN permit on the BAFF stream (which is to be retained). This has not been confirmed with the supplier and may result in additional units being required.

Given these significant risks – along with limited design timeframe to meet the WINEP regulatory output – our business plan submission included additional scope and risk mitigation above the scope in the Stantec report, including:

- Nereda Phase 2: Expansion of the Nereda plant for enhanced treatment.
- Land Purchase: To facilitate meeting the WINEP regulatory date, we need to be able to accelerate certain elements of the programme outside of sequential delivery, necessitating land acquisition. We are in discussions with council and other landowners adjacent to our site.

Cost efficiency

The cost breakdown of our Poole WRC solution is provided below. This was derived from a supplier quote received in 2021 to support our AMP7 options appraisal and has been adjusted for inflation. As explained above, we have added an additional Nereda package unit (Phase II) as well allowance for land purchase. Any adjustments for optimism bias and overheads are in line with our costing methodology, as described in WSX-C03.

Whilst we have previously provided costs in response to an Ofwat query (OFW-OBQ-WSX-184), in completing that table, we only listed main asset types/areas reflecting the relative stage of development of the schemes. Ancillaries and access provision have been pro-rated across each item. Design, supervision and preliminaries, land, environmental and planning considerations, and management overheads have similarly been pro-rated across the asset types. For the purposes of this updated table, we have redistributed risk / optimism bias to more appropriately reflect where this risk lies.

Table 9 – Scope and cost breakdown for Poole WRC - Phosphorus & Nitrogen removal

Item	Basis	Cost (£k)	P removal allocation	N removal allocation
Inlet works	Contractor quote (includes direct and indirect contractor costs). Quote prepared for Stantec by Aqua Consultants 27 May 2021. Solution description: Scheme covers the installation of a new side stream on Poole WRC to allow for growth and a new nutrient discharge consent. The site currently compromises 3No. streams - Western Works ASP, Eastern Works ASP and BAFF plant. The new stream is to be built in parallel to the existing BAFF stream and the BioMag upgraded Eastern Works ASP stream, which are to remain in operation for the duration of the work. To be able to build it, the storm tanks no. 4 and no.5 will need to be demolished, for which the first stage is to build an offline storm tank on the area where houses are currently built. The new process includes Nereda reactors, TSR filters (filter clear type - they will take the total of the site flows) and new UV unit installed within two new channels adjacent to existing plant, with an MCC installed between both channels. As a result of the new stream, new sludge assets will be required, including: pre-thickened sludge tanks, thickeners, digester feed tank (that will replace the existing with increased capacity), new additional primary and secondary digestors, new gas bag, new CHP and ancillaries (intercooler, siloxane removal, gas boosters), flare, de-waterers, and chemical dosing (polymer, ferric and methanol) for all this units.	2,404	50%	50%
Biomag (inc. magnetite recovery system)		9,707	65%	35%
FST Refurb		1,336	65%	35%
Modifications to BAFF		808	65%	35%
Storm Tanks		11,312	50%	50%
UV		9,718	50%	50%
Nereda (Phase 1)		58,491	53%	47%
MMFs		15,070	100%	
Ferric Sulphate Dosing		1,845	100%	
Methanol Dosing		865		100%
Pipework & Cabling		7,169	50%	50%
Sludge Storage, Handling & Treatment		20,956	70%	30%
CHPs and Gas		8,191	50%	50%
Nereda (Phase 2)		22,470	53%	47%
Land Purchase		20,000	50%	50%
	Total cost:	190,342	£111,818k	£78,524k

The optimism bias of is higher for Poole than many of the other traditional/simple schemes. Below is a summary of some of the key additional considerations for this specific site.

- Process quotations + 30% (as identified by Nereda)
- Significant process uncertainty with regards to upgrading the Eastern Works to temporarily treat the additional flows from Western works to maintain current site compliance during development of the Western works area. The feasibility of upgrading Eastern Works to BioMag has been based on several key assumptions and risks:
    - Unable to obtain process guarantees
    - Unknown electrical upgrades
    - Multiple refurbishments and replacements
    - Unknown hydraulic issues

- No process redundancy allowed on TSRs
- Unknown future performance for existing sandfilters
- Unknown future performance for existing BAFFs
- Numerous process risks around Nereda
- Increased screening required
- Salinity and FOG risks

For more details on our approach to optimism bias, refer to WSX-C03.

2.6. Further evidence – Technical assurance

To support out nutrients proposals we have completed several technical assurances (to varying levels) and we list them below, with a summary of the conclusions. We have also provided the detailed Stantec report and summary note from Galliford Try as annexes.

Stantec, February 2023.

During our PR24 preparation, we engaged Stantec UK Ltd. to undertake a technical review of our wastewater treatment programme, in particular a review of our internal guidance for the basis of design and technologies for future permits for our proposed PR24 interventions. Stantec provided a list of recommendations based on a technical benchmarking exercise conducted. Where appropriate, we took those considerations into account as part of the technical development of the schemes. Our response to the benchmarking exercise can be seen in Annex A1-1. This includes subsequent comment updates since our business plan submission.

Regarding nitrogen recommendation, there was only one recommendation which was relevant to our process, which we had already incorporated, as shown below:

> "The Nitrogen Guidelines for 15mg/l TN solutions include the statement "To meet 15 mg/L N and 0.25-1 mg/L P add tertiary plant to existing works to target 3 mg/l AmmN plus denitrification COUF sand filters + carbon source". Stantec believe that additional biological processes can also achieve these limits. ACTION for WxW to confirm that additional biological processes are considered."
>
> *This has been undertaken, original wording in guideline needs updating to reflect this, e.g. tertiary or additional secondary treatment has been reviewed where proven to be cost effective.*

Regarding phosphorus removal, there were several recommendations that were highlighted by Stantec which were either addressed by us or, we felt there was a specific reason why this would not need to be addressed. Please refer to Annex A1-1 for Stantec's recommendation and our commentary.

Galliford Try, August 2024

We engaged Galliford Try to review scopes and costs for a number of schemes that have progressed since Business Plan submission. Their review for us covered:

- Scope/cost purpose splits
- Costs and programme
- Site specific challenges
- Risk profile

Galliford Try's review concluded:

> *"We can confirm that, for a suite of nutrient removal projects, the costing methodology was appropriate for the stage of design and the estimate allowances were within expected industry norms."*

Refer to Annex A1-2 for more details, including Galliford Try's summary letter from their review.

<u>AtkinsRéalis & KPMG, July & August 2024</u>

Following the submission of our business plan, we conducted a comprehensive review of our scope and associated costs, resulting in several adjustments. Additionally, we commissioned AtkinsRéalis UK Ltd. and KPMG LLP to provide independent technical reviews of our phosphorus (and wider WINEP) schemes, providing them with the scopes and costs of a number of schemes where the draft determination modelled cost was significantly lower than our own estimate. We also provided AtkinsRéalis and KPMG with updated scopes and costs where available.

Their reviews produced valuable recommendations, many of which aligned with areas we had already identified for exploration as part of our internal review and revision process. These recommendations include:

- **Reallocation of scope and costs:** It was highlighted that some scope items (and thus costs) may have been misallocated to P removal. We have reallocated some scope items to capital maintenance and growth accordingly. We did, however, challenge in some areas where we maintain that our included scope is driven by the P scheme, for example the backwash generated by the tertiary solids removal stages either requires hydraulic upgrades to existing processes or a dedicated backwash-treatment stream.

- **Review of design standards:** It was highlighted that our risk approach was potentially conservative, with our design standards not necessarily being adjusted to reflect actual site performance where new assets were being considered for inclusion. We had already reviewed and revised our risk approach, as detailed in section 2.2.1 with the outcome reflected in the updated costs in our response to the draft determination.

- **Technology review:** We conducted an internal review of the technologies we intend to utilise, including the use of mixed media filters. We noted that this work had already been undertaken but remained ongoing at the time of business plan submission as part of AMP8 tender and framework engagement, particularly reflecting latest supplier prices.

<u>ChandlerKBS</u>

The cost consultant, ChandlerKBS, has provided assurance on each of the pricing methodologies. Their assurance reports are provided in WSX45 in annexes A1-5 (Solutions process), A4-1 (Wastewater Treatment) and A4-2 (P-Removal, WINEP and Growth Programme).

ChandlerKBS were also engaged to provide external cost estimates for benchmarking. This was done at a WRC site level to encompass all wastewater enhancement scope. Using their internal Cost Information Database, ChandlerKBS provided Capex estimates using scope details provided by us, to compare with our own estimates. The results are presented in WSX45 Annex A4-3. Of the 14 sites subject to benchmarking, only three of our estimates were above the benchmark and in all three cases, by less than 10%. The total variance of the Wessex Water option estimates to the ChandlerKBS benchmark estimates was -15.1%.

For the benchmarking conducted, we provided ChandlerKBS with the same scope of works which we provided to our internal teams and they provided an estimate for these same schemes. In addition to the above we have used ChandlerKBS to provide us with the estimates that have gone directly into the business plan, hence those estimates have been generated by an independent source.

As we do not have our own evidence for historical levels of optimism bias, we have used the generic levels provided in the green book. For PR24 we have used the templates recommended in the Cost Consistency Methodology and, dependent on the complexity of any given project, we have, in conjunction with the independent cost consultant ChandlerKBS, produced an average and complex set of scores based around the Green Book and Cost Consistency Methodology descriptions. We have then looked at each individual project and identified the mix of standard and non-standard assets then applied this mix to the scores to generate the optimism bias % which is then added to the central estimate. Where appropriate, the benchmarking results for the schemes discussed is provided.

3. Nitrogen removal

Data table line	Business Plan request	Draft Determination allowance	Our requested allowance
CWW3.57 & 60 – Treatment for total nitrogen removal (biological/chemical) (&CWW12.57 & 60)	£218.83m	£131.30m	£209.93m

Ofwat has applied material cost challenge to our programme of nitrogen removal, based on its assessment of scheme-specific options appraisal and cost efficiency evidence. We expand on the business plan information and demonstrate a robust appraisal approach to the limited feasible options available that deliver nitrogen removal to the required tight permit levels. We also illustrate our approach to ensuring our costs are efficient.

This representation builds on information provided in our business plan, and particularly in the following key documents and appropriate sections:

- WSX16 – Waste water networks plus strategy and investment
  - 6.2 Nutrients (Phosphorus & Nitrogen)
- WSX17 – Annexes – Wastewater networks plus strategy and investment
  - A1 Enhancement Cases
  - A3-1 WRC Assessments – Technical Assurance/Benchmarking
  - A3-2 WRC Assessments – Nutrients
  - A8 WRC Screening Reports
- WSX45 – Annexes – assurance reports
  - A1-5 Solutions process
  - A4-1 Wastewater Treatment
  - A4-2 P-Removal, WINEP and Growth Programme
- WSX50 – Costs wholesale waste water tables commentary
- Responses to related Ofwat queries

In this section, we explain our concern's with Ofwat's methodology of assessing our nutrient removal schemes and provide additional evidence for the identified outlier schemes. All additional information on methodology and changes since the October submission can be found in the Phosphorus removal section above.

3.1. Ofwat's approach to setting cost allowances

There are relatively few sites in the UK where nitrogen removal is operational. Even though there is a material programme of nitrogen removal in AMP8, only four companies have sites with tightening total nitrogen permit levels. Ofwat attempted to model Nitrogen enhancement (at both company programme level and scheme level), but it found *"little or no relationship between the cost drivers and requested expenditure across the industry, or at company level".* This confirms our experience of the bespoke nature of the investment required to meet tightened permit levels, which is highly dependent on the existing permit levels for other quality parameters and the existing treatment processes on the site, as well as the interaction of the tightening of other parameters alongside new or tightened total nitrogen permit levels. We note that these factors also influence our costs for meeting tightened phosphorus and sanitary permit levels.

For nitrogen removal Ofwat therefore undertook a deep dive of each company's plans, with the following reductions our statutory enhancement programme:

Best option for customers: - 20%

> Ofwat stated it had "Some Concerns" – *"The company has provided limited evidence of alternative options considered for each site. The company has not provided sufficient and convincing evidence to support the decision for the chosen solution at each site."*

Cost efficiency: -20%

> Ofwat stated it had "Some concerns" – *"The company does not provide sufficient and convincing evidence that the proposed costs are efficient."*

With a total of 40% reduction to our proposed costs, we would be unable to deliver on our statutory requirements within the cost allowance provided in the draft determination.

We support Ofwat's deep dive approach given the uniqueness of the solutions needed to meet tight nitrogen permit levels at each site on the WINEP.

We had undertaken individual site assessments of our 8 sites under this driver, with the overarching solution development as described in our business plan documents:

- WSX16 section 6.2.2,
- site assessment reports in WSX17 section A3-2, and
- Screening reports in WSX17 section A8.

We have considered our solutions for WINEP at the site-level in order to meet all drivers of investment. As shown below, many of the schemes with nitrogen drivers, have other improvement drivers. Of particular note is that 6 of our 8 nitrogen schemes also have a phosphorus removal driver, with one also have a sanitary removal driver. Solutions and appropriate cost allocation/purpose splits have taken all this into consideration.

N removal schemes are less familiar to the sector which should be considered as part the overall assessment. Given such complexities, there are two schemes which make up 70% of total nitrogen removal budget.

Where there are multiple drivers of investment, the combination can make the difference between the optimal solution being the addition of tertiary treatment stages to existing assets and a complete change of secondary treatment process.

Table 10 – Nitrogen scheme permit changes

	Total N permit level (annual mean, mg/l)		**Total P permit level (annual mean, mg/l)**		**Amm-N permit level (95%ile, mg/l)**	
	2025	2030	2025	2030	2025	2030
Blackheath	N/A	10.0	N/A	0.25	7.0	4.2
Collingbourne Ducis	N/A	9.5			20	20
Dorchester	N/A	10.0	0.70	0.25	5	5
Lytchett Minster	N/A	10.0	N/A	0.25	50	50
Maiden Bradley	N/A	15.5				
Poole	10.0	5.0	N/A	0.25	10	10

Wareham	15.0	10.0	N/A	0.25	15	15
Wool	N/A	10.0	1.00	0.25	20	20

3.2. Required adjustment to cost allowance

We request Ofwat allows our nitrogen removal costs of **£209.93 million** in full based on our evidence of robust options appraisal and efficient costing approaches.

3.2.1. Changes since October 2023 business plan submission

Updated WINEP

We have continued to engage with the Environment Agency and other regulators since our business plan submission. Our updated submission reflects the EA's latest snapshot of the WINEP (5th July 2024) along with any agreed changes since (up to 16th August 2024).

October 2023 Business Plan vs September 2023 WINEP

Our PR24 Business Plan submitted in October 2023 did not fully align with the WINEP version (September 2023) or guidance at time of submission, as described in section 6.2.2 of WSX16. Particularly for our nitrogen removal programme, we had phased delivery of some large/complex schemes to complete by 2033.

Ofwat's Draft Determination assessment was based on an updated data table submission to align with the September 2023 version of the WINEP, including meeting all dates as stated in the WINEP. Ofwat's assessment was based on AMP8 (inc. transition) totex plus any AMP9 capex to complete schemes.

Levelling-up and Regeneration Act

The Levelling-up and Regeneration Act (LURA) came into law on 26th October 2023. It introduced new nutrient pollution provisions for sensitive catchments, that are designated due to the habitats site related to the catchment being in an unfavourable condition as a result of phosphorus and/or nitrogen pollution in water. The sensitive areas and list of WRCs requiring upgrade are as published by Defra on 25th January 2024 (and updated 24th May 2024). The relevant sensitive areas[7] within the Wessex Water region are:

- Somerset Levels and Moors Special Protection Area – Phosphorus
- Poole Harbour Special Protection Area / Ramsar site – Phosphorus and Nitrogen
- Hampshire Avon Special Area of Conservation – Phosphorus

LURA places a requirement on water companies to upgrade WRCs, in designated areas, to the 'technically achievable limit' (TAL) for nitrogen (N) and/or phosphorus (P). The technically achievable limit (TAL) has been determined by the EA as 0.25mg/l for phosphorus and 10mg/l for nitrogen. WRCs ≥2,000 population equivalent (pe)

[7] At the time of our PR24 Business Plan submission (Oct 2023), it had been assumed that the Chesil and the Fleet SAC/SPA site would be designated for both phosphorus and nitrogen, although this was not included in the Government's notice of designation of sensitive catchment areas on 25th January 2024. This non-inclusion, however, does not affect our plan as our WRCs within this area are all less than 2,000pe and had thus already been considered as exempt from upgrades under LURA.

are required to achieve TAL; <250pe are exempt; WRCs between 250-2,000pe are by default exempt but can be designated as requiring improvement by the Secretary of State.

Under provisions within the LURA, water companies can use a catchment permitting (CP) approach to achieve the required nutrient load reductions, subject to approval by the Secretary of State. Furthermore, the LURA allows the Secretary of State to consider alternatives to site-based permits – such as catchment nutrient balancing (CNB) – subject to secondary legislation being put in place.

We were invited by Defra in November 2023 to respond to an opportunity to promote CP and/or CNB in LURA-affected catchments. Our response in January 2024 offered alternative CP and hybrid CP and CNB proposals for the sensitive areas within our region, to achieve at least the equivalent nutrient load reduction for lower cost and wider environmental benefits. Our proposals built upon our successful CP and CNB delivered in AMP6 and AMP7, but we recognised that constraints for other regulatory drivers limited our ability to offer even greater overall benefit from a full catchment-based approach.

Whilst developed and presented in good faith, our alternative LURA proposals, however, did not meet regulator expectations without what we felt would leave us with excessive financial and performance risk for the amount of environmental benefit compared to the original LURA proposal.

Revised Costs

Refer to 'Revised Costs' paragraphs in section 2.2.1 above, which covers both nitrogen and phosphorus removal.

3.3. Evidence to support the required adjustment to cost allowances

3.3.1. Need for investment

The need to invest in nitrogen removal is governed by the Water Industry National Environment Programme (WINEP), which sets out specific environmental performance targets to be achieved in AMP8. Details of the WINEP drivers for our nitrogen removal schemes for PR24 are detailed in WSX16 Section 6.2 and are summarised below:

- DrWPA_IMP – Implementation of actions through a scheme to improve water quality so the level of purification treatment can be reduced over time.
- HD_IMP – Actions to contribute to restoration of a European site or Ramsar site to move towards meeting the conservation objectives.
- HD_IMP_NN – Actions to reduce total phosphorus and/or total nitrogen levels to the Technically Achievable Limit (TAL) from discharges which drain to catchments where Nutrient Neutrality is advised.
- SSSI_IMP – Actions to contribute to restoration of a SSSI to favourable condition.
- WFDGW_IMP – Groundwater Good Status improvement measure relating to water resource or water quality
- U_IMP1 – Actions to improve discharges from agglomerations that, through population growth, have crossed the population thresholds in the Urban Wastewater Treatment Regulations and therefore must achieve more stringent requirements.

3.3.2. Best option for customers

We explain our approach to developing the best option for customers in section 2.4.2.

3.3.3. Cost efficiency

We explain our approach to demonstrating cost efficiency in section 2.4.3.

3.3.4. Customer Protection

The scheme level PCD that Ofwat proposes to use will protect customers from under or late delivery of these WINEP Nitrogen removal schemes. Refer to WSX-O02 for our comments on this PCD.

3.4. Site specific evidence for N removal sites

For each of the nitrogen removal schemes, we have provided an overview of:

- Regulatory driver(s) for each scheme
- The schemes involved in the optioneering appraisal and a summary of inclusion/exclusion of the schemes.

3.4.1. Blackheath WRC

The following sections are to be read alongside section A3-2.2 of WSX17 from our Business Plan submission.

Need for investment

Blackheath WRC is a site with drivers for Nitrogen, Phosphorus and Sanitary (Ammonia) removal in the PR24 WINEP. Our options appraisal considered all investment drivers at the site to ensure a best value solution.

- Nitrogen
    - 10mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP)
- Phosphorus
    - 0.25mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP, WFD_IMPg, EnvAct_IMP1)
- Sanitary (ammonia)
    - 4.2mg/l (WFD_ND)

Best option for customers

Based on the methodology outlined in section 2.4.2, below is a list of all options considered for Blackheath:

Table 11 - Options screening and selection process for Blackheath WRC

Unconstrained Options	RAG Assessment and progress to next stage	Reason for inclusion/exclusion
Modify consents/permits	Y	Subject to load reduction requirements and any regulatory constraints.
River catchment / dynamic permitting	Y	Subject to load reduction requirements and any regulatory constraints.
Tolerate	N	No existing P or N removal.
Optimise/Operate	N	No existing P or N removal.
Treat/pre-treat in network	N	No available treatment options.
Rationalisation/centralisation	Y	Subject to load reduction requirements.
De-centralisation	N	No opportunity for new, smaller WRC to discharge to alternative waterbody/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Catchment management initiatives - Source Control	N	No trader(s) within catchment that contribute dominant load of P or N (inc. ammonia) to the WRC that would sufficiently change any solution at the WRC.

Catchment management initiatives - CNB	Y	Subject to load reduction requirements and any regulatory constraints.
Discharge Relocation	N	No opportunity to relocate discharge to non-sensitive area/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Increase treatment capacity - Green	Y	Subject to load reduction requirements.
Increase treatment capacity - Grey	Y	Various treatment options possible.
Constrained Options		**Reason for inclusion/exclusion**
Modify consents/permits	N	Permit set based on population (LURA > 2,000pe) and load target through Poole Harbour Consent Order. No localised WFD requirement, but able to contribute to downstream targets.
River catchment / dynamic permitting	N	Permit (P&N) set based on population (LURA > 2,000pe) and load target. Have explored permutations across multiple sites.
Rationalisation/centralisation	N	No site within reasonable distance.
Catchment management initiatives - CNB	N	WINEP drivers (EnvAct P & LURA P/N) requires improvements to point source discharges.
Increase treatment capacity - Green	N	NbS unable to achieve stringent permit limits.
Increase treatment capacity - Grey	Y	Various treatment options possible.
Feasible Options		**Solution/scope description**
1) Grey treatment solution	Y	• De-nitrifying sand filters with methanol dosing • Tertiary solids removal (for P) • Additional sludge treatment and associated ancillaries including pumping stations, standby power provision, kiosks etc. as well as land purchase of the field to the north of the WRC.
Chosen Solution		
Preferred Option (best value)		Grey asset solution at the WRC to achieve a 0.25mg/l phosphorus permit, 10mg/l nitrogen permit and 4.2mg/l ammonia permit.
Least Cost Option		Same as Preferred Option

3.4.2. Collingbourne Ducis WRC

The following sections are to be read alongside section A3-2.3 of WSX17 from our Business Plan submission.

Need for investment

Collingbourne Ducis WRC is a site with a driver for Nitrogen removal in the PR24 WINEP. The need for improvement had been identified through an AMP7 investigation.

- Nitrogen
    - 9.5mg/l (DrWPA_IMP, WFDGW_IMP)

Best option for customers

Based on the methodology outlined in section 2.4.2, below is a list of all options considered for Collingbourne Ducis:

Table 12 - Options screening and selection process for Collingbourne Ducis WRC

Unconstrained Options	RAG Assessment and progress to next stage	Reason for inclusion/exclusion
Modify consents/permits	Y	Scheme need and permit determined following AMP7 WINEP investigation.
River catchment / dynamic permitting	N	N/A - Groundwater discharge site
Tolerate	N	No existing N removal.
Optimise/Operate	N	No existing N removal.
Treat/pre-treat in network	N	No available treatment options.
Rationalisation/centralisation	Y	Subject to load reduction requirements.
De-centralisation	N	WRC is already small. Any de-centralised site would also require new permit limits.
Catchment management initiatives - Source Control	N	No traders within catchments.
Catchment management initiatives - CNB	Y	Subject to load reduction requirements and any regulatory constraints.
Discharge Relocation	N	No nearby alternative watercourses - WRC discharges into winterbourne, and thus acts as a soakway dependent on season (hence WINEP improvement driver).
Increase treatment capacity - Green	Y	Subject to load reduction requirements.
Increase treatment capacity - Grey	Y	Various treatment options possible.
Constrained Options		**Reason for inclusion/exclusion**
Modify consents/permits	N	Have continued to challenge EA on rationale for permit, including making use of in-ground treatment above water table, but has not removed need for permit.
Rationalisation/centralisation	N	No site within reasonable distance.
Catchment management initiatives - CNB	N	Have already explored the use of CNB through AMP7 WINEP investigation, and deemed unviable due to local topography and landuses.
Increase treatment capacity - Green	Y	Potential need to be supplemented with additional treatment.
Increase treatment capacity - Grey	Y	Various treatment options possible.
Feasible Options		**Solution/scope description**
1a) Green treatment solution - within existing land ownership	N	Further analysis of water quality has determined insufficient carbon within influent and available through wetlands. Alternative carbon source options were considered as part of AMP7 WINEP investigation, and again for this scheme, but deemed too novel/emergent with high risk of material degradation and performance concerns.
1b) Green treatment solution - land to meet performance requirements	N	As above, but with sufficient land to meet performance target.
2) Hybrid Grey and Green treatment solution	Y	• Secondary biological treatment (to reduce AmmN) • Tertiary lagoon, supplemented with some methanol dosing

3) Grey treatment solution	Y	• Secondary biological treatment (to reduce AmmN) • De-nitrifying sand filters with methanol dosing and associated ancillaries including pumping stations, standby power provision, kiosks etc.
Chosen Solution		
Preferred Option (best value)		Hybrid Grey and Green treatment solution – Grey asset solution at the WRC making use of existing tertiary lagoon for polishing to achieve a 9.5mg/l nitrogen permit.
Least Cost Option		Same as Preferred Option

3.4.3. Lytchett Minster WRC

The following sections are to be read alongside section A3-2.5 of WSX17 from our Business Plan submission.

Need for investment

Lytchett Minster WRC is a site with drivers for Nitrogen and Phosphorus removal in the PR24 WINEP. Our options appraisal considered all investment drivers at the site to ensure a best value solution.

- Nitrogen
  - 10mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP)
- Phosphorus
  - 0.25mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP)

Best option for customers

Based on the methodology outlined in section 2.4.2, below is a list of all options considered for Lytchett Minster:

Table 13 - Options screening and selection process for Lytchett Minster WRC

Unconstrained Options	RAG Assessment and progress to next stage	Reason for inclusion/exclusion
Modify consents/permits	Y	Subject to load reduction requirements and any regulatory constraints.
River catchment / dynamic permitting	Y	Subject to load reduction requirements and any regulatory constraints.
Tolerate	N	No existing P or N removal.
Optimise/Operate	N	No existing P or N removal.
Treat/pre-treat in network	N	No available treatment options.
Rationalisation/centralisation	Y	Subject to load reduction requirements.
De-centralisation	N	No opportunity for new, smaller WRC to discharge to alternative waterbody/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Catchment management initiatives - Source Control	N	No trader(s) within catchment that contribute dominant load of P or N (inc. ammonia) to the WRC that would sufficiently change any solution at the WRC.
Catchment management initiatives - CNB	Y	Subject to load reduction requirements and any regulatory constraints.

Discharge Relocation	N	No opportunity to relocate discharge to non-sensitive area/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Increase treatment capacity - Green	Y	Subject to load reduction requirements.
Increase treatment capacity - Grey	Y	Various treatment options possible.
Constrained Options		**Reason for inclusion/exclusion**
Modify consents/permits	N	Permit set based on population (LURA > 2,000pe) and load target through Poole Harbour Consent Order.
River catchment / dynamic permitting	N	Permit (P&N) set based on population (LURA > 2,000pe) and load target. Have explored permutations across multiple sites.
Rationalisation/centralisation	Y	Opportunity to transfer flows to Poole WRC (direct to WRC or indirect to catchment).
Catchment management initiatives - CNB	N	WINEP drivers (LURA P/N) requires improvements to point source discharges.
Increase treatment capacity - Green	N	NbS unable to achieve stringent permit limits.
Increase treatment capacity - Grey	Y	Various treatment options possible.
Feasible Options		**Solution/scope description**
1) Grey treatment solution - Retention of existing Oxidation Ditch with tertiary denitrification and phosphorus removal	Y	• Retain existing oxidation ditch • De-nitrifying sand filters with methanol dosing • Tertiary solids removal (for P) • Additional sludge treatment and associated ancillaries including pumping stations, standby power provision, kiosks etc.
2) Grey treatment solution - Activated Sludge Plant (ASP) with tertiary denitrification and phosphorus removal	Y	• Primary settlement tanks • ASP • Final settlement tanks • De-nitrifying sand filters with methanol dosing • Tertiary solids removal (for P) • Additional sludge treatment and associated ancillaries including pumping stations, standby power provision, kiosks etc.
3) Grey treatment solution - Biological Nutrient Removal (BNR) Plant with tertiary phosphorus removal	Y	• Primary settlement tanks • BNR • Final settlement tanks • Tertiary solids removal (for P) • Additional sludge treatment and associated ancillaries including pumping stations, standby power provision, kiosks etc.
4) Transfer - Indirect transfer to Poole WRC	Y	Transfer to Poole WRC, via Moorlands Way SPS and Turlin Main SPS, with appropriate rising mains and SPS storage upgrades.
Chosen Solution		
Preferred Option (best value)		Transfer to Poole WRC, via Moorlands Way SPS and Turlin Main SPS.
Least Cost Option		Same as Preferred Option

3.4.4. Maiden Bradley WRC

The following sections are to be read alongside section A3-2.6 of WSX17 from our Business Plan submission.

Need for investment

Maiden Bradley WRC is a site with a driver for Nitrogen removal in the PR24 WINEP. The need for improvement had been identified through an AMP7 investigation.

- Nitrogen
  - 15.5mg/l (WFDGW_IMP)

Best option for customers

Based on the methodology outlined in section 2.4.2, below is a list of all options considered for Maiden Bradley:

Table 14 - Options screening and selection process for Maiden Bradley WRC

Unconstrained Options	RAG Assessment and progress to next stage	Reason for inclusion/exclusion
Modify consents/permits	Y	Scheme need and permit determined following AMP7 WINEP investigation.
River catchment / dynamic permitting	N	N/A - Groundwater discharge site
Tolerate	N	No existing N removal.
Optimise/Operate	N	No existing N removal.
Treat/pre-treat in network	N	No available treatment options.
Rationalisation/centralisation	Y	Subject to load reduction requirements.
De-centralisation	N	WRC is already small. Any de-centralised site would also require new permit limits.
Catchment management initiatives - Source Control	N	No traders within catchments.
Catchment management initiatives - CNB	Y	Subject to load reduction requirements and any regulatory constraints.
Discharge Relocation	N	No nearby alternative watercourses - WRC discharges to ground via soakway (hence WINEP improvement driver).
Increase treatment capacity - Green	Y	Subject to load reduction requirements.
Increase treatment capacity - Grey	Y	Various treatment options possible.
Constrained Options		**Reason for inclusion/exclusion**
Modify consents/permits	N	Have continued to challenge EA on rationale for permit, including making use of in-ground treatment above water table, but has not removed need for permit.
Rationalisation/centralisation	N	No site within reasonable distance.
Catchment management initiatives - CNB	N	Have already explored the use of CNB through AMP7 WINEP investigation, and deemed unviable due to local topography and landuses.
Increase treatment capacity - Green	Y	Potential need to be supplemented with additional treatment.
Increase treatment capacity - Grey	Y	Various treatment options possible.

Feasible Options		Solution/scope description
1a) Green treatment solution - land east of WRC	N	Further analysis of water quality has determined insufficient carbon within influent and available through wetlands. Alternative carbon source options were considered as part of AMP7 WINEP investigation, and again for this scheme, but deemed too novel/emergent with high risk of material degradation and performance concerns.
1b) Green treatment solution - land northeast of WRC	N	As above
2) Hybrid Grey and Green treatment solution	Y	• Secondary biological treatment (to reduce AmmN) • Improvements to soakaway to gain more beneficial use from unsaturated above groundwater level.
3) Grey treatment solution	Y	• Secondary biological treatment (to reduce AmmN) • De-nitrifying sand filters with methanol dosing and associated ancillaries including pumping stations, standby power provision, kiosks etc.
Chosen Solution		
Preferred Option (best value)		Hybrid Grey and Green treatment solution – Grey asset solution at the WRC alongside improvements to soakaway to achieve a 15.5mg/l nitrogen permit.
Least Cost Option		Same as Preferred Option

3.4.5. Wareham WRC

The following sections are to be read alongside section A3-2.8 of WSX17 from our Business Plan submission.

Need for investment

Wareham WRC is a site with drivers for Nitrogen and Phosphorus removal in the PR24 WINEP. Our options appraisal considered all investment drivers at the site to ensure a best value solution.

- Nitrogen
  - 10mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP)
- Phosphorus
  - 0.25mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP)

Best option for customers

Based on the methodology outlined in section 2.4.2, below is a list of all options considered for Wareham. Wareham WRC was enhanced in AMP7 for a new nitrogen permit. At that time, we considered the following treatment options:

- 1a) Tertiary anoxic denitrifying sand filters with methanol dosing
- 1b) Grey treatment solution - Modified Ludzack-Ettinger (MLE) activated sludge process including final tanks
- 1c) Grey treatment solution - Granular activated sludge (e.g. Nereda)
- 2) Diluting effluent with potable water

We progressed with option 1a, which included primary settlement tanks, ASP, final settlement tanks, tertiary solids removal (for P), additional sludge treatment, and associated ancillaries including pumping stations, standby power provision, kiosks etc.

Our PR24 proposal has thus taken into consideration prior option development and interfacing with the newly constructed assets.

Table 15 - Options screening and selection process for Wareham WRC

Unconstrained Options	RAG Assessment and progress to next stage	Reason for inclusion/exclusion
Modify consents/permits	Y	Subject to load reduction requirements and any regulatory constraints.
River catchment / dynamic permitting	Y	Subject to load reduction requirements and any regulatory constraints.
Tolerate	Y	Has existing N removal and possibly could be stretch to meet new limit. No P removal.
Optimise/Operate	Y	Has existing N removal and possibly could be stretch to meet new limit. No P removal.
Treat/pre-treat in network	N	No available treatment options.
Rationalisation/centralisation	Y	Subject to load reduction requirements.
De-centralisation	N	No opportunity for new, smaller WRC to discharge to alternative waterbody/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Catchment management initiatives - Source Control	N	No trader(s) within catchment that contribute dominant load of P or N (inc. ammonia) to the WRC that would sufficiently change any solution at the WRC.
Catchment management initiatives - CNB	Y	Subject to load reduction requirements and any regulatory constraints.
Discharge Relocation	N	No opportunity to relocate discharge to non-sensitive area/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Increase treatment capacity - Green	N	No land availability
Increase treatment capacity - Grey	Y	Various treatment options possible.
Constrained Options		**Reason for inclusion/exclusion**
Modify consents/permits	N	Permit set based on population (LURA > 2,000pe) and load target through Poole Harbour Consent Order.
River catchment / dynamic permitting	N	Permit (P&N) set based on population (LURA > 2,000pe) and load target. Have explored permutations across multiple sites.
Tolerate	N	Needs new assets to meet P removal.
Optimise/Operate	N	Needs new assets to meet P removal.
Rationalisation/centralisation	N	No site within reasonable distance.
Catchment management initiatives - CNB	N	WINEP drivers (LURA P/N) requires improvements to point source discharges.
Increase treatment capacity - Grey	Y	Various treatment options possible.
Feasible Options		**Solution/scope description**
1) Grey treatment solution	Y	• Expansion to existing de-nitrifying sand filters with methanol dosing • Tertiary solids removal (for P) • Additional side stream treatment for TSR backwash (existing site at hydraulic limit) • Additional sludge treatment

		and associated ancillaries including pumping stations, standby power provision, kiosks etc. as well as land purchase.
Chosen Solution		
Preferred Option (best value)		Grey asset solution at the WRC to achieve a 0.25mg/l phosphorus permit and 10mg/l nitrogen permit.
Least Cost Option		Same as Preferred Option

3.4.6. Wool WRC

The following sections are to be read alongside section A3-2.9 of WSX17 from our Business Plan submission.

Need for investment

Wool WRC is a site with drivers for Nitrogen and Phosphorus removal in the PR24 WINEP. Our options appraisal considered all investment drivers at the site to ensure a best value solution.

- Nitrogen
  - 10mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP)
- Phosphorus
  - 0.25mg/l (HD_IMP_NN, HD_IMP, SSSI_IMP, EnvAct_IMP1)
  - 2mg/l (U_IMP1)

Best option for customers

Based on the methodology outlined in section 2.4.2, below is a list of all options considered for Wool:

Table 16 - Options screening and selection process for Wool WRC

Unconstrained Options	RAG Assessment and progress to next stage	Reason for inclusion/exclusion
Modify consents/permits	Y	Subject to load reduction requirements and any regulatory constraints.
River catchment / dynamic permitting	Y	Subject to load reduction requirements and any regulatory constraints.
Tolerate	N	Has existing P removal but would not meet new limit. No N removal.
Optimise/Operate	N	Has existing P removal but would require new assets to meet new limit. No N removal.
Treat/pre-treat in network	N	No available treatment options.
Rationalisation/centralisation	Y	Subject to load reduction requirements.
De-centralisation	N	No opportunity for new, smaller WRC to discharge to alternative waterbody/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Catchment management initiatives - Source Control	N	No trader(s) within catchment that contribute dominant load of P or N (inc. ammonia) to the WRC that would sufficiently change any solution at the WRC.
Catchment management initiatives - CNB	Y	Subject to load reduction requirements and any regulatory constraints.

Discharge Relocation	N	No opportunity to relocate discharge to non-sensitive area/catchment, otherwise actual load entering the designated area would be unchanged, providing no environmental benefit.
Increase treatment capacity - Green	N	No land availability
Increase treatment capacity - Grey	Y	Various treatment options possible.
Constrained Options		**Reason for inclusion/exclusion**
Modify consents/permits	N	Permit set based on population (LURA > 2,000pe) and load target through Poole Harbour Consent Order.
River catchment / dynamic permitting	N	Permit (P&N) set based on population (LURA > 2,000pe) and load target. Have explored permutations across multiple sites.
Rationalisation/centralisation	N	No site within reasonable distance.
Catchment management initiatives - CNB	N	WINEP drivers (EnvAct P & LURA P/N) requires improvements to point source discharges.
Increase treatment capacity - Grey	Y	Various treatment options possible.
Feasible Options		**Solution/scope description**
1) Grey treatment solution	Y	• Primary settlement tanks • ASP • Final settlement tanks • De-nitrifying sand filters with methanol dosing • Tertiary solids removal (for P) • Additional sludge treatment and associated ancillaries including pumping stations, standby power provision, kiosks etc.
Chosen Solution		
Preferred Option (best value)		Grey asset solution at the WRC to achieve a 0.25mg/l phosphorus permit, 10mg/l nitrogen permit.
Least Cost Option		Same as Preferred Option

3.4.7. Best option for customers

Please refer to section 2.4.2 in the Phosphorus section for details on the optioneering appraisal.

Quantitative assessment of feasible options

A summary of the benefits assessments for the feasible options for our nitrogen removal schemes is provided in the following tables. The benefits assessment considered: carbon (embodied and operational), nutrient load reduction (phosphorus and nitrogen), land use change, discharge site compliance, amongst others. All solutions achieve the equivalent nutrient load reduction. The assessment is over a 30-year period.

Blackheath

Table 17 - Benefits assessment summary for Blackheath WRC - Nitrogen & Phosphorus Removal

Feasible option description	Driver	Capex (£m)	Opex (£m/yr)	PV (£m)	Total Benefit PV (£m)	BCR
Sand filters and methanol dosing, MMF and chemical dosing	P	7.9	0.2	40.4	-14.5	-0.4
	N	13.8	0.2			
	Sanitary	4.5	0.1			

Despite providing nitrogen and phosphorus removal, and increased ammonia treatment, due to the large embodied and operational carbon footprint impact the total benefit is negative, leading to a negative benefit cost ratio (BCR) derived from Total Benefit Present Value (PV) divided by Cost PV.

Collingbourne Ducis

Table 18 - Benefits assessment summary for Collingbourne Ducis WRC - Nitrogen Removal

Feasible option description	Driver	Capex (£m)	Opex (£m/yr)	PV (£m)	Total Benefit PV (£m)	BCR
Grey solution	N	10.8	0.2	13.4	-20.2	-1.5
Hybrid green and grey solution	N	7.6	0.1	10.5	-1.2	-0.1

Despite providing nitrogen removal, due to the large embodied and operational carbon footprint impact of all feasible options, the total benefits are negative, leading to a negative BCR. We have selected the hybrid green and grey solution, which has the lowest cost, and smallest disbenefit PV, and thus the best BCR.

Lytchett Minster

Table 19 - Benefits assessment summary for Lytchett Minster WRC - Nitrogen & Phosphorus Removal

Feasible option description	Driver	Capex (£m)	Opex (£m/yr)	PV (£m)	Total Benefit PV (£m)	BCR
1) Grey treatment solution - Retention of existing Oxidation Ditch with tertiary denitrification and phosphorus removal	P	18.3	0.1	63.0	-31.0	-0.5
	N	20.1	0.5			
2) Grey treatment solution - Activated Sludge Plant (ASP) with tertiary denitrification and phosphorus removal	P	18.3	0.1	91.7	-49.5	-0.5
	N	38.9	0.8			
3) Grey treatment solution - Biological Nutrient Removal (BNR) Plant with tertiary phosphorus removal	P	18.3	0.1	90.0	-58.2	-0.6
	N	35.5	1.0			
4) Transfer - Indirect transfer to Poole WRC	P	10.9	0.1	29.9	-106.4	-3.6
	N	10.9	0.1			

Despite providing both nitrogen and phosphorus removal, due to the large embodied and operational carbon footprint impact of all feasible options, the total benefits are negative, leading to a negative BCR. We have selected option 4, which has substantially the lowest cost. Whilst having the largest disbenefit PV, is has the largest BCR due to this option having lowest totex PV, which is less than half the value of the next lowest totex PV option. This is attributed to the initial embodied carbon footprint of the network upgrades, associated with transporting excavation arisings for disposal elsewhere. When considered over a longer timeframe than 30 years – as well as considering the lower initial capex – the lower opex and operational carbon support the choice of this solution.

Maiden Bradley

Table 20 - Benefits assessment summary for Maiden Bradley WRC - Nitrogen Removal

Feasible option description	Driver	Capex (£m)	Opex (£m/yr)	PV (£m)	Total Benefit PV (£m)	BCR
Grey solution	N	6.4	0.1	11.4	-4.7	-0.4
Hybrid green and grey solution	N	3.2	0.0	7.7	-2.4	-0.3

Despite providing nitrogen removal, due to the large embodied and operational carbon footprint impact of all feasible options, the total benefits are negative, leading to a negative BCR. We have selected the hybrid green and grey solution, which has the lowest cost. It does not have the largest BCR (a small variation) but has a smaller total disbenefit PV, has over 30% lower totex PV than the alternative and is 50% less capex, thus we consider this is the best option for customers.

Wareham

Table 21 - Benefits assessment summary for Wareham WRC - Nitrogen & Phosphorus Removal

Feasible option description	Driver	Capex (£m)	Opex (£m/yr)	PV (£m)	Total Benefit PV (£m)	BCR
Grey treatment solution	P	13.0	0.4	50.5	-11.0	-0.2
	N	19.5	0.3			

Despite providing nitrogen and phosphorus removal, due to the large embodied and operational carbon footprint impact the total benefit is negative, leading to a negative BCR.

Wool

Table 22 - Benefits assessment summary for Wool WRC - Nitrogen & Phosphorus Removal

Feasible option description	Driver	Capex (£m)	Opex (£m/yr)	PV (£m)	Total Benefit PV (£m)	BCR
Grey treatment solution	P	11.5	0.2	71.3	-35.9	-0.5
	N	37.4	0.5			

Despite providing nitrogen and phosphorus removal, due to the large embodied and operational carbon footprint impact the total benefit is negative, leading to a negative BCR.

3.4.8. Cost efficiency

For each scheme, a schedule is produced with a list of line items. The line items are then grouped and costed based on the categories below. The table identifies what is included in the categories, what the cost source is and the source of assurance we have had for our costs.

Table 23 - Capex categories and costing sources

Categories of cost	Description	What is Included	Cost Source	Assurance source
Optioneering and Outline Design	This consists of: • Internal design team • Input from internal/external contractors • Project management • Associated commercial costs	All internal and external staff who traditionally input into the optioneering and outline design stage of a project.	%s based on historical costs, for similar types/scales of schemes	ChandlerKBS as part of non-construction cost benchmarking
Detailed Design	This consists of: • Internal design team / external design consultants • Input from internal/external contractors • Project management • Associated commercial costs	All internal and external staff who traditionally input into detailed design stage of a project.	%s based on historical costs, for similar types/scales of schemes	ChandlerKBS as part of non-construction cost benchmarking
Civil Work Items	The civil works required to deliver the solution	All civil works required to deliver the defined scope of works	Bottom-up estimates or cost models (internal/external)	ChandlerKBS and AECOM
M&E Work Items	The M&E works required to deliver the solution	All M&E works required to deliver the defined scope of works	M&E tenderbooks, bottom-up estimates or cost models (internal/external)	ChandlerKBS and AECOM
Supervision and Preliminaries	This consists of: • Construction supervision • Construction preliminary items • Enabling works • Main contractor overhead, profit and insurance	See description	M&E tenderbooks, bottom-up estimates or cost models (internal/external)	ChandlerKBS and AECOM
Third Party Costs	This consists of: • Investigations	All costs that can form part of typical project	%s based on historical costs, with site-specific adjustments if appropriate.	Based on historical costs

Categories of cost	Description	What is Included	Cost Source	Assurance source
	• Surveys • Environmental mitigation • Route proving • Land purchase • Temporary rental • Biodiversity Net Gain • Power Reinforcement	delivery following desktop study by environmental and land teams, beyond those included as part of external design contracts.	Land, environmental and BNG estimates from subject matter experts.	
Risk Items	Optimism bias is the demonstrated systematic tendency for appraisers to be over optimistic about key project parameters, including capital costs, operating costs, project duration and benefits delivery. Over optimistic estimates can lock in undeliverable targets. To reduce this tendency appraisals should make explicit adjustment for optimism bias. The Green Book recommends applying overall percentage adjustments at the outset of an appraisal. The initial optimism bias estimate should not be locked in but can be reduced as an appraisal develops and the cost of specific risks are identified."	Uncertainty on needs, solution scope, costing methodology, delivery, site specifics and external 3rd party influences	The methodology used incorporates the recommendations and templates produced from the water industry wide Cost Consistency Methodology report February 2022, produced by Mott MacDonald as part of the SRO strategy. The recommendations predominantly follow the Government's Green Book which recommends that optimism bias is accounted for in investment appraisal. The methodology was refined in conjunction with external cost consultant ChandlerKBS to allow for site specific asset solutions	No assurance, but methodology produced in conjunction with ChandlerKBS
Overheads	Uplift to cover business' ongoing costs (e.g. office, HR, IT) not specific or otherwise captured against capital projects.	See description	Provided by Management Accounts	None
Price base indexing	Any CPI-H adjustments to align estimates with relevant price base.	See description	For PR24 Business Plan, all costs indexed to 2022/23 price base.	Not needed

Bottom-up opex estimates are derived from a number of categories, as summarised in the following table.

Table 24 – Opex categories and costing sources

Categories of cost	Description of what this includes	Source
Labour	All scientist, M&E and Operational staff required to maintain the asset as per Operation & Maintenance requirements. Forecast requirements based on actual Operational experience for similar assets/activities.	Operations
Power	Power usage calculated by the design engineers and an agreed unit rate applied.	Design Engineers / Unit Rate
Chemicals	Chemical usage calculated by the design engineers and an agreed unit rate applied, dependent on tanker delivery sizes.	Design Engineers / Unit Rate
Sludge	Sludge usage calculated by the design engineers, and site-specific unit rate dependent on distance to nearest Bioresources Centre.	Design Engineers / Unit Rates
M&E maintenance	Spares.	Outturn %
Other	Anything not included above, such as potable water – very rarely used.	Design Engineers

Cost Estimate Breakdowns

The following tables provide a breakdown of scope and costs for our selected options for some of our nitrogen removal schemes, along with our purpose splits between cost drivers. Third party costs and risk has been taken out separately, but we have pro-rated supervision/preliminaries, overheads etc. across the scope items.

Blackheath WRC

Table 25 – Scope and cost breakdown for Blackheath WRC – Nitrogen, Phosphorus & Sanitary removal

Scope Items	Phosphorus Capex (£k)	Nitrogen Capex (k)	Sanitary Capex (k)	Data Source
Chemical (ferric sulphate) dosing plant - c/w delivery area, storage tanks, dosing skid, LCP, dosing lines & associated equipment/instruments, emergency shower & eyebath.	1,111	0	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Primary Settlement Tank auto-desludging	157	0	0	Internal bottom-up estimates.
2nr Tertiary MBBR - c/w feed pumping station and associated equipment/instrumentation	0	2,369	2,985	Internal bottom-up estimates.
Recirculation pumping station	0	424	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).

Scope Items	Phosphorus Capex (£k)	Nitrogen Capex (k)	Sanitary Capex (k)	Data Source
1nr Humus settlement tank - c/w flow split chamber, auto desludging and scraper bridge	1,566	0	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Abandonment of lagoons and backfilling to allow building of new assets	147	261	107	Internal bottom-up estimates.
Hydraulic upgrades to existing works to accommodate backwash	149	153	0	Internal bottom-up estimates.
4nr denitrifying sand filters - c/w feed pumping station, flow split, associated pipework, valves & instruments.	0	3,416	0	Internal bottom-up estimates.
Methanol dosing plant - c/w delivery area, storage tanks, dosing skid, dosing lines & associated equipment/instruments, emergency shower & eyebath.	0	2,887	0	Internal bottom-up estimates.
Tertiary solids removal (P) - c/w ballasted media technology, feed pumping station, floculation mixer and associated equipement/instrumentation	2,523	0	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Upgrade of existing washwater supply for new assets	409	726	297	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Works return pumping station required for backwash from new assets	79	141	58	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Standby generator required for new assets	88	157	64	Internal bottom-up estimates.
General - 3rd party, land, environmental	455	880	259	%s based on recent historical costs, with site-specific adjustments following environmental and third party assessment.
Optimism Bias	1,247	2,413	710	Site-specific derivation, based on PR24 optimism bias methodology produced in conjunction with ChandlerKBS and based on the best practice process and templates generated for the Strategic Resource Options work.
Sub-Total:	7,931	13,827	4,479	
Total:	26,237			

Lytchett Minster WRC

Table 26 – Scope and cost breakdown for Lytchett Minster WRC – Nitrogen & Phosphorus removal

Scope Items	Phosphorus Capex (£k)	Nitrogen Capex (k)	Data Source
Lytchett Minster SPS - c/w MCC, septicity control, roads & paths, and abandonment of existing WRC	1,918	1,914	Internal bottom-up estimates.

Scope Items	Phosphorus Capex (£k)	Nitrogen Capex (k)	Data Source
Lytchett Minster WRC - Conversion of Final settlement tank to storm tank	67	67	Internal bottom-up estimates.
Moorlands Way SPS (Extension of existing SPS) - c/w storm tank, septicity control, and roads & paths	1,862	1,858	Internal bottom-up estimates.
Networks - new pipelines	2,199	2,195	Internal bottom-up estimates.
Turlin Main SPS (Extension of exsisting SPS) - c/w storm tank, septicity control, and roads & paths	2,111	2,107	Internal bottom-up estimates.
General - 3rd party, land, environmental	679	678	%s based on recent historical costs, with site-specific adjustments following environmental and third party assessment.
Optimism Bias	2,073	2,069	Site-specific derivation, based on PR24 optimism bias methodology produced in conjunction with ChandlerKBS and based on the best practice process and templates generated for the Strategic Resource Options work.
Lytchett Minster SPS - c/w MCC, septicity control, roads & paths, and abandonment of existing WRC	1,918	1,914	Internal bottom-up estimates.
Lytchett Minster WRC - Conversion of Final settlement tank to storm tank	67	67	Internal bottom-up estimates.
Moorlands Way SPS (Extension of existing SPS) - c/w storm tank, septicity control, and roads & paths	1,862	1,858	Internal bottom-up estimates.
Networks - new pipelines	2,199	2,195	Internal bottom-up estimates.
Turlin Main SPS (Extension of exsisting SPS) - c/w storm tank, septicity control, and roads & paths	2,111	2,107	Internal bottom-up estimates.
General - 3rd party, land, environmental	679	678	%s based on recent historical costs, with site-specific adjustments following environmental and third party assessment.
Optimism Bias	2,073	2,069	Site-specific derivation, based on PR24 optimism bias methodology produced in conjunction with ChandlerKBS and based on the best practice process and templates generated for the Strategic Resource Options work.
Sub-Total:	10,910	10,887	
Total:	21,798		

Wool WRC

Table 27 – Scope and cost breakdown for Wool WRC – Nitrogen & Phosphorus removal

Scope Items	Phosphorus Capex (£k)	Nitrogen Capex (k)	Data Source
Chemical (ferric sulphate) dosing plant - c/w delivery area, storage tanks, dosing skid, LCP, dosing lines & associated equipment/instruments, emergency shower & eyebath.	463	950	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
2nr Primary settlement tank - c/w flow split chamber, auto desludging and scraper bridge	0	2,507	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Interstage PS - c/w D/A/S submersible VSD pumps	1,927	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
ASP - c/w RAS PS, SAS PS	0	5,954	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
3nr Final settlement tank - c/w flow split chamber, auto desludging and scraper bridge	0	4,545	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
6nr denitrying sand filters - c/w Feed pumping station, flow split, Associated pipework, valves & instruments.	0	5,376	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Methanol dosing plant - c/w delivery area, storage tanks, dosing skid, dosing lines & associated equipment/instruments, emergency shower & eyebath.	0	3,562	Actual historical project cost data compiled by ChandlerKBS.
Tertiary solids removal (P) - c/w ballasted media technology, feed pumping station, floculation mixer and associated equipement/instrumentation	2,244	4,603	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
1nr sludge storage tank - c/w mixer, roof and associated valves and pipework	314	645	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Sludge transfer pumping station - c/w D/S pumps and Associated pipework, valves & instruments.	0	350	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Pipework	1,461	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Ducting	321	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Roads & Paths	570	0	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).
Abandonment of existing assets (make safe)	612	0	Internal bottom-up estimates.
Upgrade of existing washwater supply for new assets	177	363	Internal cost model based on actual historical cost data for similar scope (verified by ChandlerKBS).

Scope Items	Phosphorus Capex (£k)	Nitrogen Capex (k)	Data Source
General - 3rd party, land, environmental	598	1,506	%s based on recent historical costs, with site-specific adjustments following environmental and third party assessment.
Optimism Bias	2,777	6,996	Site-specific derivation, based on PR24 optimism bias methodology produced in conjunction with ChandlerKBS and based on the best practice process and templates generated for the Strategic Resource Options work.
Sub-Total:	11,465	37,358	
Total:	48,823		

Scope and technical benchmarking

As part of our PR24 October 2023 submission, ChandlerKBS provided some benchmarking for a representative sample of our schemes. Refer to annex A4-2 of WSX45 for details of this. Although scopes and thus costs may have changed for some schemes since, the benchmarking demonstrates that our costing did align (within reason) with what our cost consultant believed to be reasonable. We also note that this scheme-level benchmarking was on project costs and did not include corporate overheads. Below is a sample of the results of our cost benchmarking exercise for our nitrogen removal programme.

Table 28 – External cost benchmarking for Nitrogen removal schemes

✂

4. Sanitary parameters

Data table line	Business Plan request	Draft Determination allowance	Our requested allowance
CWW3.75 (and CWW12.75) – Treatment for tightening of sanitary parameters	£100.50m	£48.92m	£87.30m

Ofwat's approach to assessing costs for sanitary parameters applied a substantial challenge to our costs, based on company-level benchmarking. It did not remove from its benchmarking approach the large number of schemes for which the solutions are "no additional treatment capacity", which means an inappropriately low allowance when all our sites require investment in treatment capacity.

Based on our latest information, we consider that the efficient cost of delivering the 12 sanitary parameter tightening schemes is **£87.3 million**. We request that Ofwat allows these requested costs in its final determination.

This representation builds on information provided in our business plan, and particularly in the following key documents and appropriate sections:

- WSX16 – Wastewater networks plus strategy and investment (6.3 - Sanitary drivers)
- WSX17 – Annexes – Wastewater networks plus strategy and investment
  - A1 Enhancement Cases
  - A3-1 WRC Assessments – Technical Assurance/Benchmarking
  - A3-3 WRC Assessments – Sanitary
  - A8 WRC Screening Reports
- WSX45 – Annexes – assurance reports
  - A1-5 Solutions process
  - A4-1 Wastewater Treatment
  - A4-2 P-Removal, WINEP and Growth Programme
- WSX50 – Costs wholesale waste water tables commentary
- Responses to related Ofwat queries

4.1. Ofwat's approach to setting cost allowances

In PR19, Ofwat sought to set cost allowances for sanitary parameters using company level models, with one observation per wastewater company. However, it said it could not develop sufficiently robust econometric models and so it funded company requests in full (before an in-the-round efficiency challenge).

For PR24, Ofwat has attempted to use cost benchmarking to set cost allowances for this area. Ofwat considered both company level and scheme level approaches to model efficient sanitary parameters enhancement costs, but said it was not able to develop robust scheme level models that control for the main cost drivers of volume (population equivalent of each scheme) and different sanitary parameters (BOD, ammonia and suspended solids). As such, unlike in other similar enhancement areas, Ofwat has modelled cost allowances for sanitary parameters using a model at company rather than scheme level.

Ofwat used a linear modelling approach to estimate companies' costs, with PE served by the sites with tightened sanitary parameters as the only volume cost driver. It defined the PE served for each company as an aggregated total of the average PE served over the modelling period at each site. Its modelling was based on the fully WINEP / NEP compliant data tables companies submitted in January/February 2024.

However, Ofwat did use scheme level data to identify and exclude outliers from its modelling and modify the data it used to develop the company level model. Ofwat identified outliers based on Cook's distance approach and assessed these schemes via a deep dive to assess whether there is compelling evidence to adjust the modelled allowance.

Based on this approach, Ofwat has proposed a cost allowance for sanitary parameters of **£49.92 million** in AMP8, compared to assessed costs of **£100.5 million**.

4.1.1. Ofwat's modelling approach

Having reviewed Ofwat's modelling approach, and having regard to the underlying engineering rationale for sanitary parameter schemes, we have identified two aspects of Ofwat's proposed modelling approach which we consider warrant further consideration. These are:

- The focus on **company-level** rather than scheme-level data; and
- The inclusion of a high number of **low-cost sites** categorised as where no additional treatment capacity is required.

We discuss these points below.

Focus on company-level data

Unlike in other areas where Ofwat has scheme-level data, Ofwat has benchmarked sanitary parameter costs at company level. This is on the basis that it was not able to develop robust scheme level models that control for the main cost drivers, and that defaulting to company-level modelling is "partly due to the relatively smaller sample of schemes in the sanitary parameters dataset compared to other areas covered by scheme level models".

We note that Ofwat has more observations for sanitary parameters schemes (287, or 214 when observations are screened) than for WRC growth schemes (201) where it has continued to use a scheme-level approach. We also find that a scheme-level approach also does not appear to produce less robust parameters (in terms of the sign and magnitude of the coefficients) than a company-level model, or other scheme-level models used elsewhere.

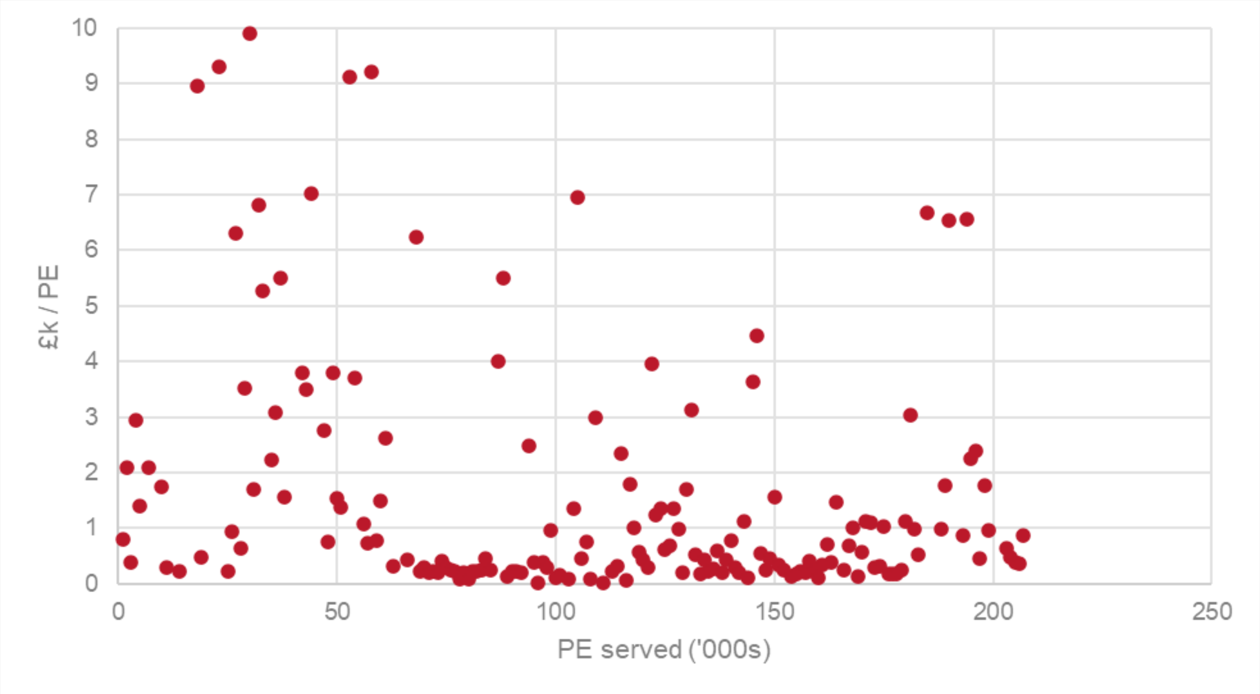
Moreover, if scheme level data is considered unreliable because the available data cannot adequately control for the main cost drivers, aggregating to company level won't necessarily alleviate that issue. Given that companies' programme of works is ultimately comprised of individual schemes, the issue of unexplained cost drivers will still be present in a company-level model, but may be obfuscated when looking at company-level allowances.

This is apparent from the available scheme-level data. If sanitary parameter costs scaled broadly linearly with PE served, we would expect the unit cost of sanitary schemes (in £ / PE) to be broadly similar across schemes, at least for a given company. However, when looking at Ofwat's scheme-level data, there is significant variation in unit costs for individual sanitary schemes. This can be seen by comparing the scheme-level £ / PE against PE served, as shown in Figure 6. This indicates that there are important factors driving scheme-level variation in unit costs that Ofwat's model would not capture.

Overall, it is not clear that a company-level approach to benchmarking costs is any more robust than a scheme-level approach. Furthermore, given that the relationship between cost and size is different at scheme level compared to company level, the distribution and type of schemes within a company's programme of sanitary parameter work will also be relevant to the efficient cost of delivering that programme of work.

If Ofwat continues to use cost benchmarking to set allowances, we consider that it should consider the available scheme-level data and at a minimum cross-check its results with this information.

*Figure 6 – Sanitary schemes comparison of unit cost to PE served.**



*This chart excludes sites with no additional treatment capacity, as explained below, and presents all observations with a maximum £k/PE of £10k and a maximum PE served of 250,000.

Inclusion of sites with no additional treatment capacity

The programme of sanitary parameters included a high number of sites companies have listed with the solution being “no additional treatment capacity” which are therefore low-cost and mostly operational solutions.

We consider there is a clear engineering rationale for treating these operational solutions separately, for instance through a shallow dive. This is because they will have very different characteristics and cost drivers compared to sites where treatment capacity is required and where existing headroom capacity is not available. Customers have previously paid for the investment at sites where there is headroom capacity to accommodate the permit tightening. Companies should not be penalised for not having installed such headroom capacity in the past, and investment only being triggered in this period.

This issue is particularly important in the sanitary parameter model because its impact varies considerably between companies, as illustrated in the table below. There are 53 sites in Ofwat’s modelling sample that are listed with a solution of “no additional treatment”, but there is considerable variability between companies as to how many of their sites are impacted (we have no sites where the tightening of sanitary parameters does not require investment). As such, the impact of this would not be expected to average out in any company-level analysis.

Table 29 – % of PE of schemes with tightened sanitary parameters where solution is “No additional treatment capacity”

Company	% of PE of schemes where solution is “No additional treatment capacity”
WSX	0.0%
ANH	66.1%
NES	20.7%

SRN	22.9%
SVE	1.1%
SWB	97.3%
TMS	10.2%
NWT	21.1%
WSH	41.3%
YKY	0.3%

Although these observations are not identified as outliers using Cook's distance statistic, this is to be expected as data points closer to the origin of a linear model are unlikely to trigger as outliers through the Cooks Distance approach. We consider these low-cost solutions should nevertheless be removed because there is:

- compelling engineering logic that these lower costs due to headroom within existing performance are not representative of the costs of investing to meet tightened permit levels,
- evidence that a model which includes such low cost "solutions" will underestimate the efficient cost for a scheme where investment is required, and
- evidence that a model which includes sites where investment is required will equally overestimate the efficient cost where the solution is to optimise existing treatment processes.

We also note that in the scheme-level approach to making cost allowances for Phosphorus removal, Ofwat has excluded the equivalent sites where there is a "permit change only" and with no or low forecast investment from its model input data prior to developing its models based on forecast data. Ofwat should apply a consistent approach across its WINEP models and make the same exclusions for these outliers in the sanitary parameters model.

4.2. Required adjustment to cost allowance

Since our business plan submission, we have reviewed our sanitary parameter costs in light of new information that we have obtained since then as we continue to develop the design of the schemes ready for construction. This has resulted in some changes to scope and costs. These changes are shown in data table ADD17. This also reflects the exclusion of one scheme originally included in our PR24 business plan (Cannington).

Based on the latest information, we consider that the efficient cost of delivering the 12 sanitary parameter tightening schemes is **£87.3 million**. We request that Ofwat allows these requested costs in its final determination.

4.3. Rationale

In PR19, Ofwat estimated company level models with forecast data, with one observation per wastewater company. Ofwat said it could not develop sufficiently robust econometric models and funded company requests in full in the PR19 final determination (before an in-the round efficiency challenge).

Based on the evidence set out above, we are concerned that a company-level modelling approach remains insufficiently robust to set cost allowances with sufficient confidence. This reflects the following:

- Ofwat concluded at PR19 that the variety of existing assets on a site and variations across the industry in terms of current and future consents imposed by WINEP/NEP means that there is often little homogeneity across interventions, and that this programme does not lend itself to econometric modelling. We agree with this. We also consider these features are inherent to sanitary parameter tightening schemes and will make any benchmarking exercise to predict efficient cost allowances difficult to reliably carry out.

- This is supported by the available scheme-level data which, as shown above, demonstrates significant variation in scheme-level costs both within and between companies, and when normalised by size of scheme. This level of variation indicates the presence of other – potentially scheme-specific – cost drivers besides PE served affecting scheme-level costs.

- Ofwat's company-level model also implies a very wide range of uncertainty in its predicated allowances. Ofwat does not report the confidence intervals for the parameters in its sanitary parameters model, but we have estimated them. Their constant term has a very wide standard error – within a 95% confidence interval, Ofwat can only be confident that company-level allowances lie within £25 million of its predicted allowance[8].

For these reasons, and considering the need to balance cost efficiency while also ensuring that companies are adequately funded for the efficient cost of their programmes, we consider that setting cost allowances based on the outputs of a company-level model would risk underfunding some companies.

If Ofwat considers it is appropriate to continue with its modelling approach to setting a cost allowance, we recommend it makes the following changes:

- Firstly, we request that it splits the data into two cohorts - one to capture where companies have sufficient headroom capacity to meet tightened sanitary parameter permits without investment, removing their influence from the model; and the second to benchmark where companies are needing to invest to meet new permit requirements. Alternatively, it could include a dummy variable for these low-cost sites to capture the differential impact of these sites, though this would be less preferable.

- Secondly, we consider that Ofwat should have regard to the available scheme-level data. As explained above, this captures additional variation in costs which are likely to reflect other determinants of efficient costs.

- A scheme-level approach would also allow Ofwat to consider more fully the presence of economies of scale. Engineering logic holds that it is highly likely to cost more per PE to invest at 10 different sites with a total PE of 12,000 than investing at one site with a total PE of 12,000. Reflecting this, Ofwat's PR19 model used number of sewage treatment works with new or tightened sanitary parameter consents as a separate cost driver, and also used a log-model (adjusted for log bias) to allow for economies of scale.

If Ofwat makes these adjustments, and updates its modelling to also take into account our updated cost and other information provided as part of our draft determination response, our allowance is much more in line with our requested allowance derived for the purposes of our business plan. Given the unexplained variation that remains present in the scheme-level data, in circumstances where the available quantitative evidence is not compelling, we consider it would be appropriate to allow this request in full. At a minimum, we consider that Ofwat should consider the full range of available evidence from company level and scheme level data in deriving modelled allowances.

[8] This contrasts with Ofwat's smart metering model where the confidence intervals are significantly narrower.

5. Chemicals removal

Data table line	Business Plan request	Draft Determination allowance	Our requested allowance
CWW3.51 – Treatment for chemical removal (&CWW12.51)	£3.67m	£13.55m	£11.68m

This representation builds on information provided in our business plan, and particularly in the following key documents and appropriate sections:

- WSX16 – Waste water networks plus strategy and investment
    - 6.4 Chemicals
- WSX17 – Annexes – Wastewater networks plus strategy and investment
    - A1 Enhancement Cases
    - A3-1 WRC Assessments – Technical Assurance/Benchmarking
- WSX45 – Annexes – assurance reports
    - A1-5 Solutions process
    - A4-1 Wastewater Treatment
    - A4-2 P-Removal, WINEP and Growth Programme
- WSX50 – Costs wholesale waste water tables commentary
- Responses to related Ofwat queries

5.1. Ofwat's approach to setting cost allowances

We acknowledge that Ofwat's DD allowance for this enhancement line gave Wessex Water more than our request.

Ofwat has assessed treatment schemes and non-treatment schemes separately due to the large difference in cost per scheme. Treatment schemes are modelled (linear regression) while all non-treatment schemes are shallow dived due to the low industry totex.

Whilst Ofwat acknowledged that this enhancement line covered differing permits for a range of determinants, these by necessity would have different and potentially incomparable treatment solutions. No account within the chemical model is also taken of other drivers where scope/costs could be allocated to.

5.2. Required adjustment to cost allowance

Since business plan submission, we have reviewed our chemical costs and amended our cost allocation and purpose splits for those with other drivers (i.e. phosphorus removal) to more appropriately reflect the scope/costs to meet the chemical removal requirements. This is as summarised in the following table.

Table 30 – Chemicals removal change to PR24 proposal

	Oct'23 BP Submission	Aug'24 DD Response
Capex	£3.502m	£11.447m
Opex	£0.168m	£0.231m
Totex	£3.670m	£11.678m

5.3. Rationale

We note that all of our chemical removal sites have other enhancement WINEP drivers in PR24, as listed below. We have followed Ofwat's costing and reporting methodology in determining appropriate purpose splits.

- Castle Cary WRC – Phosphorus
- Crewkerne WRC – Phosphorus – *updated purpose split*
- Devizes WRC – Phosphorus & Sanitary
- Merriott WRC – Phosphorus – *updated purpose split*
- Royal Wootton Bassett WRC - Phosphorus
- Shepton Mallet WRC – Phosphorus
- Somerton WRC – Phosphorus
- Sparkford WRC – Phosphorus
- Tetbury WRC – Phosphorus

Other than Crewkerne and Merriott, and any cost changes due to delivery profiling, we have not made any other changes to chemical removal costs in our re-submission. Costs for Thingley WRC remain against the CWW3.54 Chemicals investigations cost line, as per our BP submission.

6. Flow capacity

Data table line	Business Plan request	Draft Determination allowance	Our requested allowance
CWW3.15 – Increase flow to full treatment (&CWW12.15)	£61.04m	Nil	£61.04m

This representation builds on information provided in our business plan, and particularly in the following key documents and appropriate sections:

- WSX16 – Waste water networks plus strategy and investment
  - 6.5 Flow
- WSX17 – Annexes – Wastewater networks plus strategy and investment
  - A1 Enhancement Cases
- WSX50 – Costs wholesale waste water tables commentary
- Responses to related Ofwat queries

6.1. Ofwat's approach to setting allowances

Wessex Water requested enhancement funding of £60m to complete the U_IMP5 improvements at Avonmouth WRC to recognise the scale of the scheme when compared to the original PR19 proposals. However, Ofwat have considered this to be fully funded via the PR19 determination and that the consequences of any subsequent changes in design sit with Wessex Water as the company accepted PR19 Final Determination.

6.2. Required adjustment to cost allowance

We request that Ofwat accepts our request against this enhancement line and adjusts our cost allowance to the level that we proposed in our business plan.

6.3. Rationale

We agree with Ofwat's view that the consequences of design changes were Wessex Water's responsibility once the PR19 FD had been accepted; and generally we have managed such changes within the overall funding allowances that have been made available. However, this assumes that the base data used in any design has also been agreed with the relevant regulatory authority at that point in time.

This is not the case with the U_IMP5 scheme at Avonmouth WRC, where the basic design parameters were altered following the PR19 FD as a result of ongoing discussion with the EA. As stated in WSX16, for the PR19 WINEP the EA asked water companies to identify for inclusion those WRCs that were at risk of spilling to storm on a dry day. However, while the PR19 Guidance for the U_IMP5 FFT requirements was finally issued in November 2017, water companies had to complete an EA WINEP Tracker by January 2018 that essentially set the design FFT for the PR19 business plan (effectively 2 months).

It was only during subsequent scheme development during AMP7 that the significant difference between the FFT derived using Wessex Water's previous standard approach and the new EA requirements was identified. The scale (and timing) of this confirmed change resulted in a substantial increase in cost and time for the scheme.

Additionally, the WRC was also forecast to exceed its DWF permit towards the end of AMP8 and we proposed to the EA that further FPF capacity be provided to bring forward the AMP8/9 DWF driver. An extension to the U_IMP5 completion date from 31/03/2025 to 31/03/2028 was subsequently agreed with the EA in recognition of these combined changes.

It is for these reasons that the increased scale and costs, which are mainly due to the late confirmation by the EA of the PR19 U_IMP5 requirements, should not be considered as a ‘normal’ design change that Wessex Water can be expected to absorb and the proposed funding should be reinstated.

We confirm that under this enhancement line we are only seeking the over-and-above difference from Ofwat’s implicit allowance for this scheme in the PR19 FD to complete the WINEP FFT increase element of this scheme. Any costs associated with DWF changes are considered separately and detailed in WSX-C10. We confirm that customers are not paying twice for this work, and also that our PR24 base submission does not include costs for the WINEP or DWF-related elements of this scheme.

The scheme has started construction on site, and the stated cost relates to the latest scheme estimate, which includes up-to-date tendered costs and detailed construction estimates.

7. Flow monitoring

Data table line	Business Plan request	Draft Determination allowance	Our requested allowance
CWW3.6 – Flow monitoring at sewage treatment works (&CWW12.6)	£21.41m	£17.13m	£29.75m

This representation builds on information provided in our business plan, and particularly in the following key documents and appropriate sections:

- WSX16 – Waste water networks plus strategy and investment
  - 7.6 Monitoring for Flow Compliance at WRCs
- WSX17 – Annexes – Wastewater networks plus strategy and investment
  - A1 Enhancement Cases
- WSX50 – Costs wholesale waste water tables commentary
- Responses to related Ofwat queries

7.1. Ofwat's approach to setting allowances

Ofwat assessed investment using shallow dives and deep dives, informed by how closely companies are to the industry mean unit costs for each of the three subcategories: permit changes only, simple meter installations or complex civils installations. A modelled approach was not suitable due to the broad range of costs and numbers of schemes, as well as concern around potential misallocation of schemes between categories.

Ofwat assessed our enhancement costs in this area through a shallow dive, on the basis that we were *"Overall efficient compared to unit cost benchmark assessment."*

Indeed, despite being below the industry median unit costs against two of the subcategories (simple meter installations and complex civils installations) which comprised over 95% of our costs for this enhancement area, Ofwat still imposed a 20% shallow dive cut on our submission.

We note – and as stated in our Business Plan – that our submission excluded £1.5m already spent against this driver in 2022/23 and thus outside of transition years for PR24.

Ofwat has not been consistent in its assessment approach to flow monitoring proposals across the sector. It shallow dived three companies' costs despite them being over the deep dive threshold of 0.5% of wholesale totex. For all three companies it justified its approach by stating "*Overall efficient compared to unit cost benchmark*". To both Anglian Water's and South West water's costs it applied no cost challenge (due to the companies having a 0 shallow dive efficiency challenge), but to our costs, which it states are demonstrably efficient, it applied a 20% shallow dive efficiency challenge. We request Ofwat allows our efficient flow monitoring costs in full, by considering the evidence we provide.

7.2. Required adjustment to cost allowance

An additional site/scheme has been added to the WINEP since the Sept'23 snapshot used for our Oct'23 BP submission (08WW100897 Over Stratton WRC).

In our Business Plan we included scope and cost details as developed through the AMP7 U_INV2 reports. Since submission, we have found that the certain sites are requiring substantially different/expanded enhancements than those initially envisaged. This is generally attributed to an overly optimistic assumption about what existing assets on site could be re-purposed, which at the time led to reduced scope and costs. Our costings have been revised accordingly, and we are now seeking £29.751m through PR24 (having already accepted not receiving an allowance for the £1.5m as described earlier).

7.3. Rationale

U_MON4c – PR24 U_MON4 from U_INV2 investigation

Of our 91 U_MON4c schemes in the PR24 WINEP (installation and MCERTS certification of flow monitor following AMP7 U_INV2 investigation), 49 have the same or comparable scopes as envisaged through the U_INV2 reports but 41 have seen a design/scope change. The following table is an expansion of table 71 from WSX16, providing a summary of the latest scope and rationale from change from the U_INV2 reports.

Table 31 – Changes to PR24 U_MON4 flow monitoring scopes since initial AMP7 U_INV2 scoping reports as included in business plan

PR24 WINEP Action ID	Site	U_INV2 identified work required	Latest PR24 Scope (if different from U_INV2), and reason for change
08WW100630	Almondsbury WRC	Install high-level alarm and float switch on overflow at filter distribution chamber.	Re-certify existing arrangement only. Filter O/F diverted to works PS by others, does not cause MCERTS issue in new location.
08WW100631	Alveston WRC	New bypass with Magflow, demolition of existing flume, new washwater flowmeter.	
08WW100633	Avonmouth WRC	Installation of new magflow arrangement on the food waste compost pad drainage pipework.	
08WW100637	Bishops Caundle WRC	Breakout inlet channel and install new standard stainless-steel flume to comply with BS ISO 4359. Divert storm returns upstream.	As INV2, plus new PLC. Existing site apparatus insufficient.
08WW100639	Blackheath WRC	New MCERTS FPF Magflow installation and diversion of works return and recirculation mains	Flow control plug valve also added
08WW100640	Blagdon WRC	Remove Hand Valve.	
08WW100642	Bowerhill WRC	New flowmeter on washwater supply, metalwork modifications and PLC work.	
08WW100643	Box WRC	Diversion of road drainage.	
08WW100646	Bridport WRC	Install 2 new flowmeters	
08WW100648	Broadmayne WRC	New Inlet Channel with flume & level sensor, new weir, and level sensor in Inlet PS.	
08WW100651	Buckland Newton WRC	Manhole weir plate to be raised	
08WW100652	Burton WRC	New Magflow with pipeline diversions and temporary pumping.	Ultrasonic clamp-on flow meters on each feed pump. Removed need to complete pipe mods.
08WW100653	Butleigh WRC	Install new overflow outlet chamber pipework to include MCERTS magflow and actuated penstock. Pipework to discharge into PST DC. Permanently close post-PST overflow valve. Install alarm on emergency overflow at Filter DC.	AS there is a main scheme in Amp8 any work done to meet FPF Mcert standards would be redundant in 18 months at a cost of <£500K so it was agreed to install flowmeters to allow better data to be provided to the main scheme, installed EO in PS wet well

PR24 WINEP Action ID	Site	U_INV2 identified work required	Latest PR24 Scope (if different from U_INV2), and reason for change
08WW100656	Cannington WRC	New Flowmeter on washwater main, trace heating, replace FPF penstock, move pipework, new magflow chamber, new isolation valves.	As INV2, plus flow meter on works return PS overflow and modify PS control. Required to ensure liqours not double counted, missed by INV2
08WW100657	Castle Cary WRC	Replace channel with prefabricated channel & flume.	
08WW100658	Chard WRC	New Flowmeter on washwater and ultrasonic alarm on intermediate PS	
08WW100662	Cheddar WRC	New Flowmeter on washwater, civil modifications to inlet structure.	
08WW100666	Chilthorne Domer WRC	Remove existing inlet flume, install new stainless-steel channel with FPF flume. Install ultrasonic and actuated penstock for flow control.	As INV2, plus new PLC. Existing site apparatus insufficient
08WW100667	Chippenham WRC	Certify existing double flume channel and divert SAS and site drainage returns.	As INV2, plus new access walkway. Required to safely certify and access flume and flow meter
08WW100668	Christchurch WRC	Install a high-level alarm on the emergency overflow pipe at the works return PS wet well.	
08WW100669	Coleford WRC	Divert screening liquors downstream of existing MCERTS flume and ultrasonic.	
08WW100680	Crewkerne East WRC	Divert dewatering liquor pipework to discharge downstream of the MCERT.	
08WW100682	Croscombe WRC	Certify existing FPF flume with ultrasonic in the inlet channel downstream of balance tank, re-screed inlet channel and build a new dedicated works return PS. Use FE measurement for DWF. Divert all works liquors to discharge into the new works return PS and return new rising main downstream of new MCERTS flume.	Install new S/S FFT flume with ultrasonic and flow control penstock in the inlet channel downstream of balance tank, re-screed inlet channel and build a new dedicated works return PS. Use FE measurement for DWF. Divert all works liquors to discharge into the new works return PS and return new rising main downstream of new MCERTS flume. Installation of generator to provide electrical back up.
08WW100684	Devizes WRC	Liquors from dewatering unit to be diverted upstream of the MCERTS flume and ultrasonic.	
08WW100688	Donyatt WRC	Install MCERTS magflow on new inlet pipework to PST feed chamber. Install actuated penstock in inlet channel, downstream of storm overflow weir. Divert works return rising main into PST feed chamber.	As INV2, plus new PLC. Existing site apparatus insufficient
08WW100690	Dowlish Wake WRC	Install new FPF MCERTS magflow. Separate return liquors from inlet flow, constructing a new works return PS	
08WW100691	Downton WRC	Magflow on washwater supply to inlet works.	
08WW100692	Doynton WRC	New raised inlet structure with MCERTS flume and ultrasonic	

PR24 WINEP Action ID	Site	U_INV2 identified work required	Latest PR24 Scope (if different from U_INV2), and reason for change
08WW100694	East Chinnock WRC	Construct either storm or works return PS (assuming FPF flowmeter is installed as part of AMP7 P scheme).	
08WW100696	East Harptree WRC	New Flume & ultrasonic on Inlet, retain outlet for DWF. New signals via cellular comms PLC system	
08WW100697	Edford WRC	Magflow meter to be installed in the location of existing bypass pipework with modifications to pipework and PST distribution channel. Works returns diversion downstream of MCERTS magflow and associated pipework.	Solution still TBC. Filter arms undersized, backing up through PST and inlet.
08WW100699	Evercreech WRC	Install new 100 mm dia. pipework, magflow and chamber. New actuated penstock for flow control.	As INV2, plus new ceullar comms. Existing site apparatus insufficient
08WW100700	Evershot WRC	Install new 100 mm dia. pipework, magflow and chamber. New actuated penstock for flow control.	
08WW100701	Farmborough WRC	Install a MCERTS Magflow meter into the PST feed pipe, with a jet-point/ automatic flush downstream of the magflow. Magflow mounted on a slab at ground level. Divert works returns downstream of magflow.	
08WW100706	Frome WRC	Magflow on washwater supply to inlet works.	Recertified existing arrangement. Washwater volumes within error margin didn't need measurement
08WW100710	Great Badminton WRC	Install 4 new flowmeters	Independent certificator unable to physically certify as per INV2 proposal. Diverted inlet flow into SFF pumping station, Swap pumps to VSD control and Magflows to monitor FPF. Install new storm wave screen, new storm return pump. New main incomer MCC with new pump starters and Generator back up.
08WW100713	Halstock WRC	New Inlet PS & Magflow Chamber	
08WW100716	Hatch Beauchamp WRC	New works return pumping station and rising main to primary settlement tank distribution chamber. New front-end flume certified to FPF	
08WW100720	Holdenhurst WRC	Substantive works return diversions and flow measurement.	Main Scheme undertaking all work
08WW100732	Keynsham WRC	New Flowmeter on washwater.	Other AMP7 scheme making significant modifications to site, with U_MON4 delivered alongside this.
08WW100734	Kinson WRC	New Liquors Return Pumping Station.	Wedge sensor required
08WW100737	Leigh On Mendip WRC	Replace Flume and move returns to correct locations or install Magflow	
08WW100738	Long Dean WRC	Replace existing inlet flume for compliant flume arrangement, modulating penstock, storm weir	As per INV 2 plus access walkway. Required for safe access/maintenance.

PR24 WINEP Action ID	Site	U_INV2 identified work required	Latest PR24 Scope (if different from U_INV2), and reason for change
		shortening, & dewatered sludge liquors diversion.	
08WW100739	Longbridge WRC	MCERT of re-located electromagnetic flow meter on inlet & installation of new access platform.	As per INV 2 plus MagFlo on screen high-level recirc overflow. O/F in use too often to be able to disregard recirc'd flows
08WW100743	Maiden Bradley WRC	FPF Rectangular Flume, FPF Penstock, Concrete Flume Chamber & Works Liquors Pumping Station. Outlet MCERT to be retained and recertified for dry weather flows.	Flume changed to S/S to allow off site build and quicker c/o
08WW100746	Marnhull Common Lane WRC	Recertify existing arrangement	MagFlo and control valve on tanker imports system. Licencsed septic tank site, needed controlling for FPF.
08WW100749	Martock New WRC	New Flowmeter on washwater.	
08WW100750	Meare WRC	Divert storm return rising main to discharge downstream of overflow weir. Install new Sludge Liquor Pumping Station in existing chamber. Relocate the ultrasonic further upstream of the existing FPF flume and certify to MCERTS	New PS not constructed, liqours diverted in existing works PS. Hydraulics allowed easier solution
08WW100751	Melksham WRC	Divert works return to downstream of flume.	
08WW100752	Mells WRC	Install FPF crump weir with ultrasonic in the inlet channel downstream of balance tank and divert works returns downstream of new MCERTS crump weir.	
08WW100753	Mere WRC	Magflow installation at the inlet and MCERTS certification,	
08WW100754	Merriott WRC	Lower inlet screen and bypasses. Replace existing flume arrangement for certification.	Use of in-channel wedge sensor. Grit content making closed-pipe undesirable
08WW100757	Milverton WRC	Break out existing flumes and install SS steel channel with new MCERTS flume and storm overflow. Separate return liquors from storm return and inlet flow, constructing new works return PS.	
08WW100760	North Cadbury WRC	New arrangement and rectangular flume installation. New, storm feed PS and storm return rising main modifications.	New combined inlet & storm Pumping station with increased power supply, MCC and generator size. Modification of existing pumping station to become works return pumping station.
08WW100761	North Nibley WRC	New works return pumping station and rising main to primary settlement tank distribution chamber. New front end magflow certified to FPF	New inlet pumping station from Nibley Green, modification of existing PS to works return PS, Wedge sensor and penstock added due to P Scheme installation after surveys undertaken meant that Magfow could not be used.
08WW100764	Nunney WRC	New flowmeter on screenings rising main and measured flow to be added to	

PR24 WINEP Action ID	Site	U_INV2 identified work required	Latest PR24 Scope (if different from U_INV2), and reason for change
		the MCERTS measurement at the flume.	
08WW100765	Oakhill WRC	Replace existing flume arrangement for MCERTS certification and install modulating penstock.	
08WW100767	Paulton WRC	Storm returns discharge relocation upstream of the MCERTS flowmeter.	
08WW100769	Pilton WRC	Break out existing flume and remove channel material. Install new SS channel, including MCERTS flume	
08WW100772	Portbury Wharf WRC	Magflow on washwater supply to inlet works	
08WW100773	Potterne WRC	New MCERTS flowmeter on screen washwater supply. FPF compliance recommendation to install new MCERTS flume and storm separation chamber.	New MCERTS flume and storm chamber modifications
08WW100774	Pucklechurch WRC	Replacement of existing flume with new MCERTS flume.	
08WW100777	Radstock WRC	Magflow on washwater supply to inlet works.	
08WW100778	Ratfyn WRC	Diversion of used screen washwater upstream of the MCERTS installation.	
08WW100782	Rowde WRC	New flowmeter on screenings pumping main and measured flow to be added to the MCERTS measurement at the flume.	Replacement of inlet flume only. Screenings don't need adding for FPF purposes. INV2 didn't identify flume needed replacing due to insufficient hydraulic capacity.
08WW100783	Royal Wootton Bassett WRC	New inlet pumping station to divert incoming gravity sewer from Marlborough Road.	
08WW100784	Salisbury WRC	Certification of existing flume, new returns PS to divert sludge liquor returns downstream of MCERTS.	Additional Sludge return Pumping station required on PST autodrain down required
08WW100785	Sandhill Park WRC	Modification and certification of replacement flume, new humus desludge pumping station and rising main with MCERTS magflow.	Inlet works modified to include combined screen to screen both normal and storm flows with raw water screen wash down pump, new flow control penstock, MCert flume and spill point
08WW100786	Seend WRC	Install new SS inlet channel and replace the existing inlet flume with an MCERTS flume. Separate storm water returns from the humus descum and divert storm rising main to return upstream of the MCERTS flume. Discharge humus descum to works returns PS.	Just flume replacement completed. Works/storm diverts not required for FPF, TDV retained on back-end
08WW100787	Shaftesbury WRC	Washwater Electromagnetic Flow Meter.	
08WW100789	Sherborne WRC	Certify existing magflows on crude pumping mains, install magflow on the washwater pumping main to the inlet and construct new sludge decant liquor PS.	Wedge sensor to be installed in inlet channel with platform to allow access. Investigation currently taking place on sludge decant requirements

PR24 WINEP Action ID	Site	U_INV2 identified work required	Latest PR24 Scope (if different from U_INV2), and reason for change
08WW100791	Shillingstone WRC	Install a high-level alarm on the emergency overflow at the interstage pumping station.	
08WW100792	Shoscombe WRC	FPF Electromagnetic Flow Meter, FPF Control Eccentric Plug Valve & Works Liquors Electromagnetic Flowmeter.	
08WW100796	South Perrott WRC	Remove existing inlet flume, install new stainless channel with FPF flume, ultrasonic and actuated penstock for flow control. Divert works return rising main into chamber upstream of PST distribution chamber. Install new ultrasonic monitor with EO high-level alarm at the PST effluent channel.	
08WW100798	South Wraxall WRC	Replace existing flume arrangement for MCERTS certification and install modulating penstock.	Recertified existing arrangement. Washwater volumes within error margin didn't need measurement
08WW100799	Sparkford WRC	New MCERTS flowmeter on filter feed pumping main and washwater rising main; replacement of existing 2 no. filter feed pumps with variable speed pumps to regulate FPF. Humus sludge return flow estimated by drop test and FPF increased accordingly.	New raw washwater pump on screen, move spill point to between Screen & existing Magflow, install of flow control valve and move Mon 3 monitor to this loacation. One PST taken out of service, sludge return pump to upstream of PST modified
08WW100807	Sutton Benger WRC	Replace existing flume, divert sludge decant liquors and install ultrasonic on secondary PS overflow.	
08WW100809	Sydling St Nicholas WRC	Replace existing flume ultrasonic with an MCERTS device and certify arrangement to FPF.	New balance tank, pipework, diversion of works returns and high-level alarms. Very poor existing site hydraulics, inlet drowns regularly.
08WW100815	Tintinhull Ash WRC	Construct new storm return pumping station, lay associated return pipework. Replace existing FPF magflow by approved MCERTS device. Monitoring of emergency overflow	Installation of Huber screen in inlet with new Flow control valve
08WW100818	Trowbridge WRC	New PST3 Return Pumping Station and monitoring of humus desludge overflow, recertification of flowmeter on tanker imports.	3rd PST tank to be brought on line 365 dyas of year so emptying will become an abnormal operation so does not need intercepting, install new flow monitoring on screen WW to allow FPF to be certified.
08WW100820	Urchfont WRC	New extending inlet channel and new flume.	As per INV 2 but with considerable enabling works to modify site generator and washwater systems and walkway modifications. INV2 didn't account for construction logistics, walkway required to safely access/maintain flume
08WW100827	Wellow WRC	Ultrasonic monitor with EO high-level alarm to be installed in the filter effluent chamber	
08WW100828	Wells WRC	Installation of Magflow on washwater pipework	

PR24 WINEP Action ID	Site	U_INV2 identified work required	Latest PR24 Scope (if different from U_INV2), and reason for change
08WW100832	Westwood WRC	New inlet works, constructed offline next to existing	
08WW100835	Wick WRC	New Electromagnetic Flowmeter (Magflow) installation at Inlet Works.	
08WW100838	Wincanton WRC	Divert dewatering liquor pipework to discharge to site drainage. Divert fine screen liquors to discharge to proposed mixing chamber.	As per INV2, plus tanker imports MagFlo and control, plus new MagFlo on PST feed. Inlet flume drowns, licensed septic imports centre
08WW100840	Winsley WRC	Repositioning of penstock to the channel entrance and replacement of flume.	New MagFlo and PST feed re-levelled. Site hydraulics not suitable for flume solution
08WW100841	Wiveliscombe (Hillsmoor) WRC	Measure and subtract washwater supply to compactor from current MCERTS.	Diversion of washwater downstream of existing flow meter. Lower TOTEX as no additional maintenable asset
08WW100848	Worth Matravers WRC	Install FPF MCERTS Magflow on aeration tanks feed pipe and divert sludge dewatering liquors downstream of the MCERTS Magflow.	
08WW100850	Yeovil Pen Mill WRC	Magflow on FE washwater supply to inlet screens. Relocation of tanker connection point upstream of the MCERTS flume	
08WW100851	Yeovil Without WRC	MCERTS magflow on inlet screen washwater.	Diversion of washwater downstream of existing flow meter. Lower TOTEX as no additional maintenable asset

U_MON4e – U_MON4e – MCERTS certified Flow passed forward flow monitor

We have also undertaken scoping reports for the 23 new U_MON4e sites for PR24 (installation and MCERTS certification of flow monitor which was not included in AMP7). This includes the additional Over Stratton WRC added to the WINEP since our Oct'23 Business Plan submission.

Table 32 – PR24 U_MON4 flow monitoring scopes for new sites not in AMP7 WINEP

PR24 WINEP Action ID	Site	Identified PR24 Scope
08WW100874	Alderton WRC	Option 1: Replace hydroslide and extend chamber to accommodate new MCERTs FPF flume. Penstock to control flow instead of hydroslide. Option 2: Combine twin rising mains, and install magflow flowmeter.
08WW100875	Alford WRC	Incoming pipework to septic tank is deep, so recommend magflow (in new chamber) on rising main.
08WW100876	Ashill Main WRC	Option 1: Replace inlet chamber with a new inlet pumping station. Option 2: Replace existing inlet chamber and channel with a new flume and channel with penstock flow control and new storm weirs. Option 3: Replace final effluent flume with a new certifiable structure. If it can be demonstrated that there is less than a 30 minute delay between a storm spill and this meter recording FPF then it may be possible to certify this meter for FPF measurement.
08WW100877	Butcombe WRC	Relocate magflow flowmeter. Requires pipework modifications to create sufficient upstream/downstream lengths.
08WW100878	Chaffcombe WRC	Option 1: Install a new inlet PS in place of the current inlet chamber

PR24 WINEP Action ID	Site	Identified PR24 Scope
		Option 2: Install a new flume and channel between the septic tank and the RBC where the existing flow control chamber is located.
08WW100879	Charlton Musgrove (Barrow Lane) WRC	Option 1: Combine twin rising mains, and install magflow flowmeter. Install VSD's onto the inlet pumps to control pumped flow to FPF. Option 2: Install a new flume and channel in the flow control chamber.
08WW100880	Combe Florey WRC	Option 1: Combine twin rising mains, and install magflow flowmeter. Option 2: Install a new flume and channel in or downstream of flow control chamber.
08WW100881	Godmanstone WRC	Combine twin rising mains, and install magflow flowmeter. Install VSD's onto the inlet pumps to control pumped flow to FPF. Block off the overflow weir in the flow control chamber to prevent double counted flows. This overflow would be redundant if only FPF were being pumped.
08WW100882	Halse WRC	Magflow on rising main feeding SAF, with second maglow on SAF desludge line, or this return would need to be inhibited at FPF, as these flows cannot be included in the FPF value.
08WW100883	Hinton St Mary WRC	Install mag flow meter on the pipework between septic tank outlet and tipping tray. A hydraulic survey would need to be carried out to ensure these modifications do not have any effect on the upstream process. The site telemetry would need to be upgraded.
08WW100884	Kingstag WRC	Magflow on filter feed PS rising main, and magflow and rising main upgrade on humus desludge return.
08WW100885	Langton Herring WRC	Option 1: Modify inlet works to include a new channel and flume, aloing with new storm overflow weir and flow control penstock. To achieve this the pipework and macerator would need to be reconfigured or removed and a new automatic screen installed. Option 2: Measure flows at the final effluent. Would need to confirm the delay between the site spilling to storm and flows reaching the FE was less than 30minutes. This option would not aid in flow control, it would only provide flow measurement for the site so if the site is not achieving FPF work may still be required at the inlet. To measure flows at the FE, the existing V-notch weir plate would need to be replaced, and the storm overflow pipe would need to be diverted so it discharged downstream of the new weir.
08WW100886	Loxton WRC	Combine twin rising mains, and install magflow flowmeter. Install VSD's onto the inlet pumps to control pumped flow to FPF, to allow existing Dutch wheel to be removed to ensure gravity flow through to primary treatment.
08WW100887	Lydlynch WRC	Replace existing flume with a new certifiable structure. Chamber to be extended to allow for the required approach length to the flume. New flow control penstock.
08WW100888	Monkton Deverill WRC	Replace existing flume with a new certifiable structure. New flow control penstock.
08WW100897	Over Stratton WRC	New flowmeter and flow control penstock on inlet. Relocate storm return to downstream of inlet flowmeter, or have secondary flowmeter on main.
08WW100889	Parbrook WRC	Magflow on inlet PS rising main. Divert humus desludge return, with potential pump upgrade given additional headloss.
08WW100890	Poyntington WRC	Option 1: Existing flume to be fully surveyed to assess if it could be used for Mcerts FPF. If suitable, modifications to approach channel. Option 2: Replace channel and flume with a new certifiable structure. Divert humus returns. New flow control penstock.
08WW100891	Ringstead WRC	Option 1: Replace existing flume with a new certifiable structure. New flow control penstock. Option 2: Existing magflow does record flows in excess of FPF in wet weather. If it can be demonstrated that there is less than a 30 minute delay

PR24 WINEP Action ID	Site	Identified PR24 Scope
		between a storm spill and this meter recording FPF then it may be possible to certify this meter for FPF measurement.
08WW100892	Sandford Orcas WRC	Option 1: Replace existing flume with a new certifiable structure. Adjustments to storm weirs length/height, and new flow control penstock. Option 2: Certify existing FE v-notch for FPF measurement if it can be demonstrated there is no more than a 30min delay between storm spills and FPF being seen at the FE.
08WW100893	Tockenham WRC	Replace existing flume with a new certifiable structure. New flow control penstock.
08WW100894	West Bagborough WRC	Option 1: Certify existing FE v-notch for FPF measurement if it can be demonstrated there is no more than a 30min delay between storm spills and FPF being seen at the FE. Option 2: Install magflow between septic tanks and RBC distribution chamber.
08WW100895	West Milton WRC	Option 1: Magflow on inlet PS rising main. Option 2: Modify existing pipework by septic tank to ensure pipe full, to allow magflow on this line.

On the following pages we provide copies of the scoping reports for the first two of these U_MON4e sites (Alderton and Alford WRCs). These provide details of the current flow monitoring and control set up of the sites along with description of the flow monitoring option(s) considered. As can be seen, the uniqueness of each site limits the ability for benchmarking scope or cost comparison with other sites or other companies.

UMON4 Scoping Report

Site: 17237 Alderton WRC

Author: D Barritt

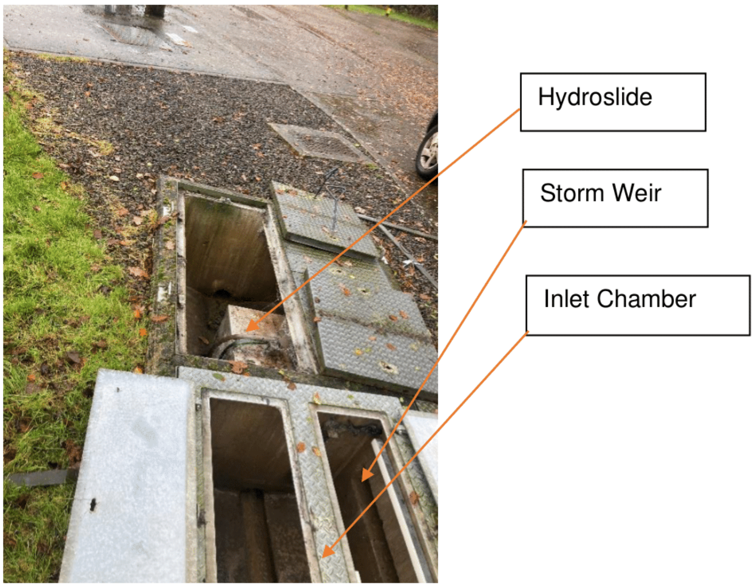
FPF: 2.1 l/s

Current FPF Flow Control Setup

Flows enter the site via gravity sewer and enter the inlet chamber. Located in this chamber is a storm overflow weir and EDM. Flows then pass into a flow control chamber where a hydroslide is located. Excess flows back up from the hydroslide and weir over into a copasac chamber before discharging to the environment.

FPF passes to a septic tank, then on to the reed bed feed PS, where all flows are pumped to the first set of reed beds.

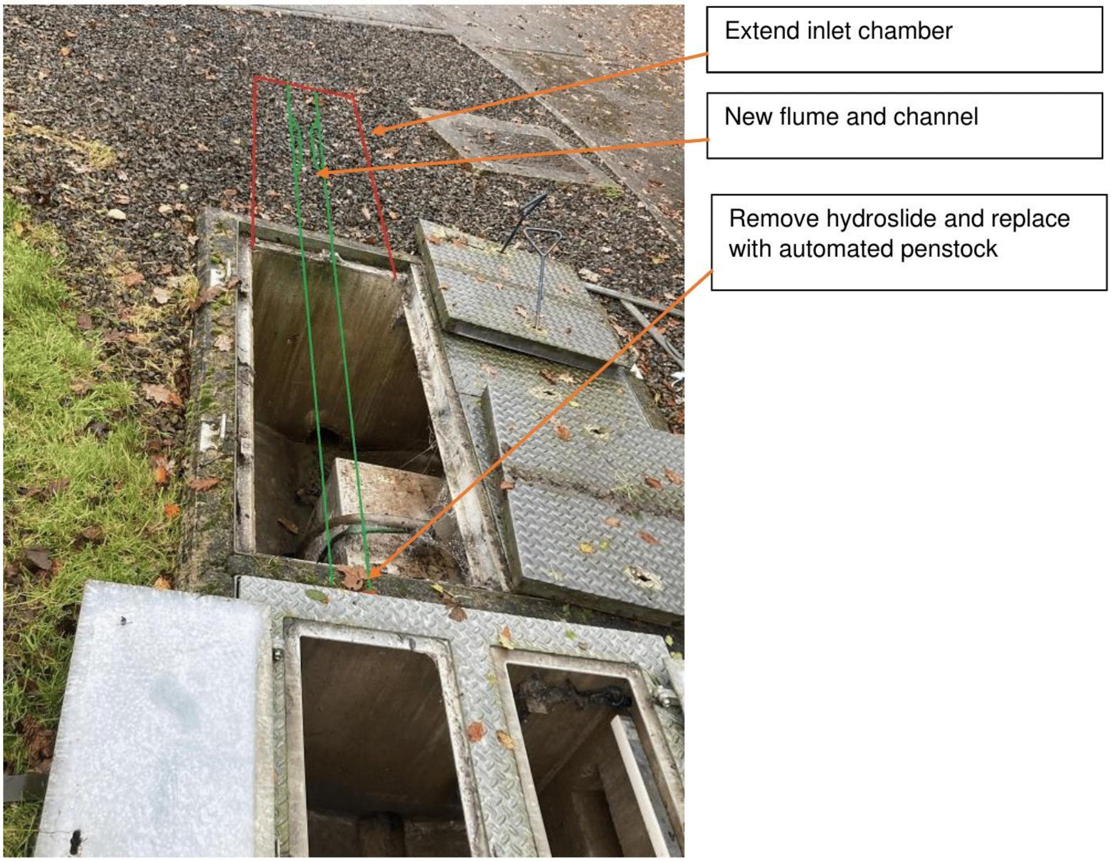
There is currently no flow measurement on the site. Due to the setup of the inlet it is not possible to determine currently what flow rate is passed forward to treatment.



Potential Option for FPF Measurement

Option 1

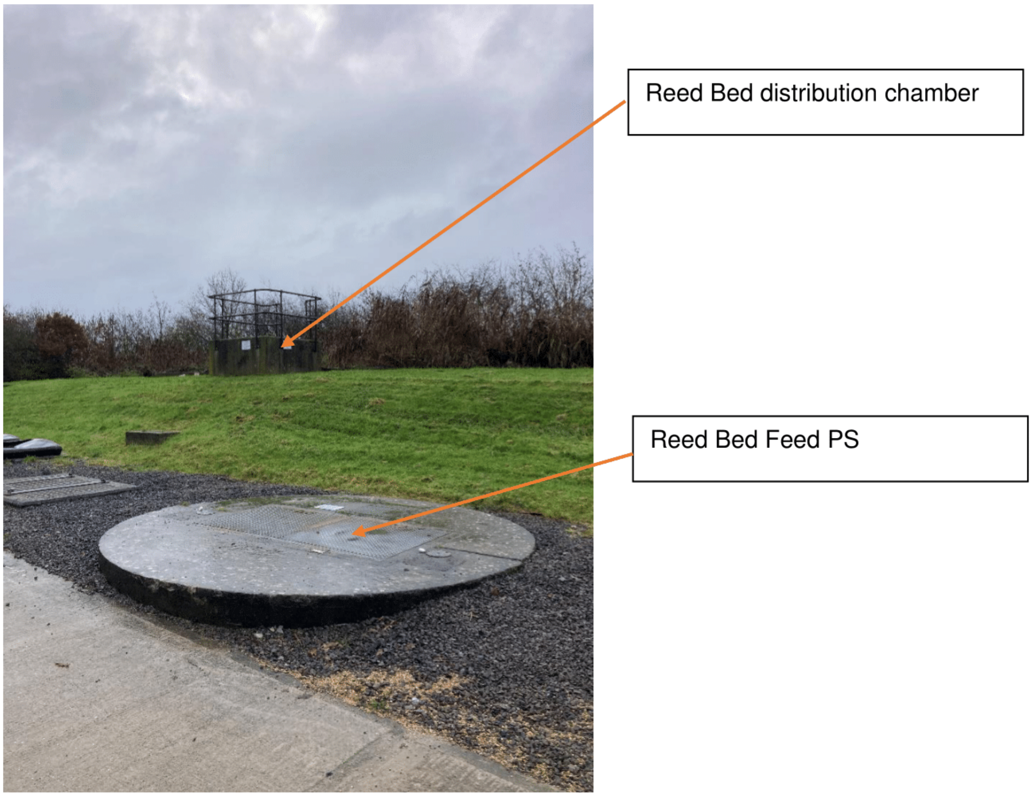
Remove the hydroslide and extend the hydroslide chamber to accommodate a new Mcerts channel and flume built to BS. A penstock could be installed in place of the hydroslide to control FPF. A hydraulic check should be carried out to ensure flows will not back up from the septic tank and cause the flume to drown, however there was no evidence of this on site. There are no return flows that need to be considered.



Option 2

This option would provide FPF flow measurement and would be easier to construct, however it would not aid in FPF flow control.

All flows enter the reed bed feed PS and are pumped via 2no. DN80 rising mains to the reed bed distribution chamber. The 2 rising mains could be combined as they leave the PS and then a magnetic flow meter could be installed on the common main before it discharges into the distribution chamber. There would potentially be a small delay between flows picking up at the inlet, and being seen at the PS, however in wet weather the PS should be pumping FPF before the site spills to storm.



Additional Photos

UMON4 Scoping Report

Site: 19837 Alford WRC

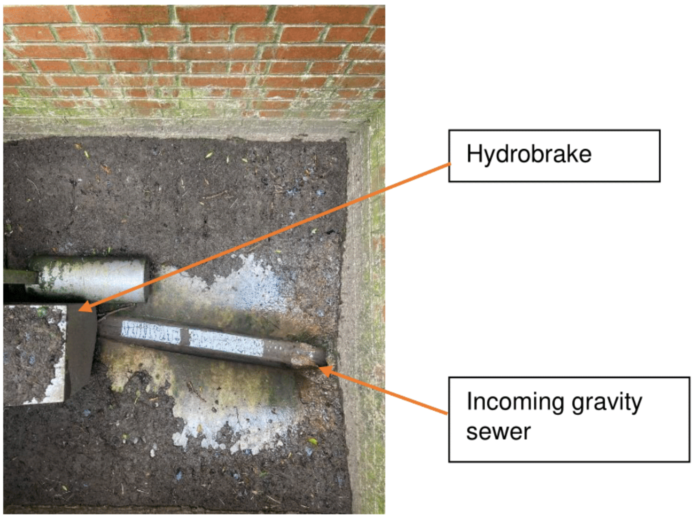
Author: D Barritt

FPF: 0.85 l/s

Current FPF Flow Control Setup

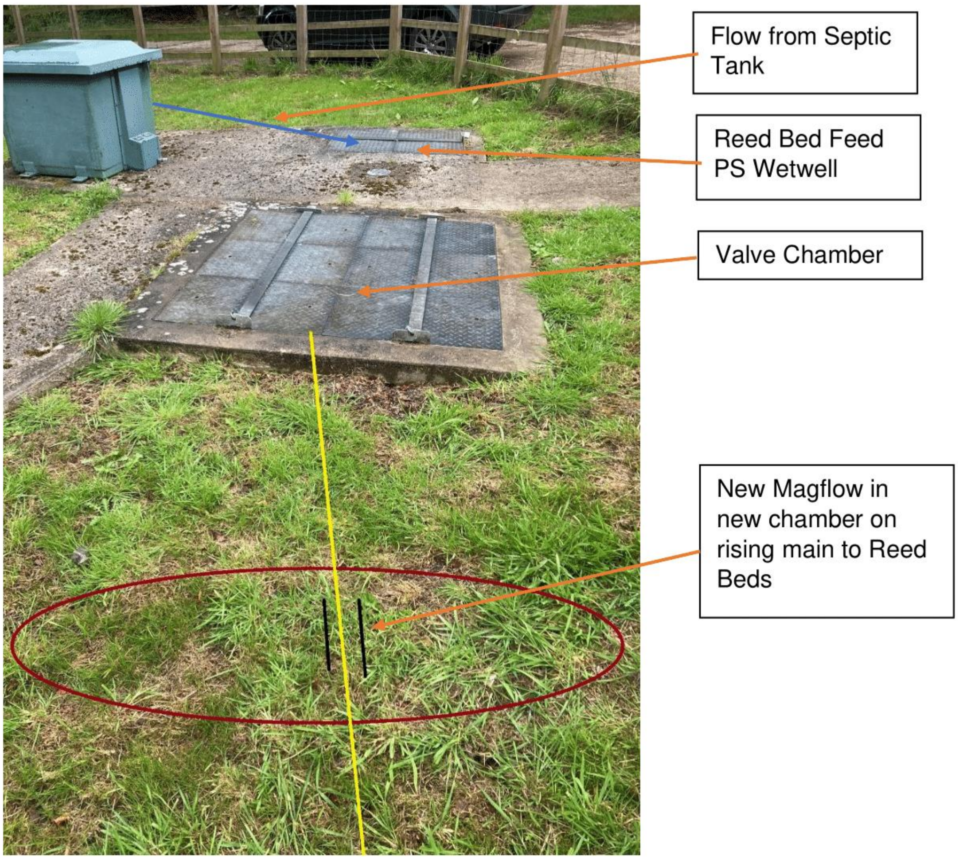
Flow enters the site via a gravity sewer into an inlet chamber. This chamber contains a hydrobrake. FPF is passed forward through the hydrobrake to a septic tank, then into the Reed Bed Feed PS. Flows are then pumped up to the reed beds.

FPF is controlled by the hydrobrake, in storm conditions excess flow build up in the inlet chamber before spilling through a high level pipe and out to the watercourse via a copasac chamber. A cello EDM monitors the inlet chamber. There is currently no flow measurement on site and no way to measure if the site is currently passing forward FPF.

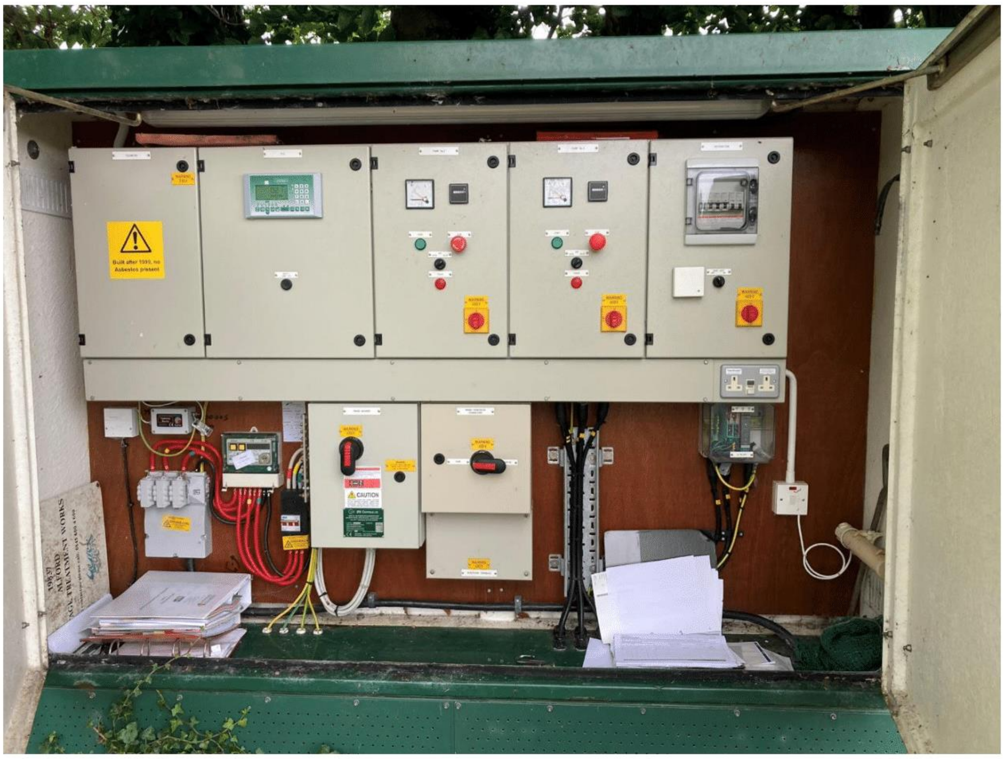


Potential Options for FPF Measurement

The incoming channel and pipework to the septic tank are quite deep and there is limited space to install any flow measurement at this location. However, all flows pass through the septic tank and are then pumped to the reed beds, so a mag flow could be installed on the rising main to the reed beds which would show what flow is being passed forward to full treatment. Data from Prism indicates that when the inlet chamber is high the pumps run continuously so this location would be suitable for Mcerts FPF measurement. There are no works return flows at this site.



Additional Photos



8. Bathing water

Data table line	Business Plan request	Draft Determination allowance	Our requested allowance
CWW3.111 – Investigations - multiple surveys, and/or monitoring locations, and/or complex modelling (&CWW12.111)	£1.52m*	£0.91m*	£1.52m
CWW3.90 – Microbiological treatment - bathing waters, coastal and inland (&CWW12.90)	New requirement since BP submission	New requirement since BP submission	£10.17m
CWW3.24 – Storage schemes to reduce spill frequency at CSOs etc - grey solution (&CWW12.24)	New requirement since BP submission	New requirement since BP submission	£9.80m

*Assessed in BP when included in 08WW1000014a Realtime water quality monitoring of amenity waters investigations, with overall wastewater programme receiving a 40% reduction.

8.1. Need for investment

In May 2024 Defra announced the outcome of its consultation on proposals to designate 27 new sites as bathing waters under the Bathing Water Regulations 2013 (S.I. 2013/1675)[9]. In the Wessex Water region, three new bathing waters were designated on the River Avon at Fordingbridge, Hampshire, the River Frome at Farleigh Hungerford, Somerset and on the River Tone at French Weir Park, Somerset. see Figures 9, 10 & 11 respectively on the subsequent pages for the catchment maps. Defra acknowledged our response to the consultation:

> *"Wessex Water broadly supported the applications for the River Avon at Fordingbridge, the River Frome at Farleigh Hungerford and the River Tone in French Weir Park, which are all within the region served by Wessex Water. Wessex Water's response confirmed it has already been working with stakeholders at each site to improve public understanding of water quality".*

Designation means that these bathing waters will be subject to Environment Agency monitoring during the 2024 bathing season from 15th May to 30th of September to determine a classification ranging from Poor to Excellent. The EA's monitoring will only determine water quality and not any rationale or source apportionment for the levels.

In response to the designations, the Environment Agency has added three WINEP Actions for each designated site (nine total):

- BW_IMP2 – Actions to improve waters at risk of deterioration to a planning class of Poor (>20% risk of failing Sufficient) by 30/04/2028 (statutory driver)
- BW_INV2 – Investigations for waters at risk of deterioration to a planning class of Poor (>20% risk of failing Sufficient) by 30/04/2027 (statutory driver)

[9] Summary of responses and government response - GOV.UK (www.gov.uk)

- EnvAct_IMP3 - Improvements to reduce storm overflows that spill to designated bathing waters to protect public health by 31/03/2030

The outcome of the classification for 2024, expected to be announced in November 2024, is important as it will determine the next steps for each bathing water. If the bathing water is classified as Poor then the actions with BW_IMP2 and BW_INV2 will be changed to BW_IMP1 and BW_INV1 drivers (Actions to improve and Investigations for waters with current planning class of Poor), respectively. If the bathing waters are classified as Good or Excellent in late 2024 the WINEP actions can either be removed from the WINEP or given BW_IMP3 and BW_INV3 drivers (Actions to improve and Investigations to lead to improving waters from Good to Excellent), respectively, where there is evidence of customer support.

8.2. Best option for customers

8.2.1. Investigations

Wessex Water has been proactively engaging with customers and wider stakeholders about non-designated waters used for amenity purposes across our region. Our AMP7 Warleigh Weir investigation explored the influences on water quality at Warleigh Weir, a site on the Bristol Avon popular with bathers, paddleboarders and canoeists. The investigation included an extensive monitoring programme of more than 30 upstream locations to identify and quantify sources of bacterial contamination from our assets and catchment influences. A key part of this investigation was the development of our award-winning real-time water quality notification system for water users, which has been made available in the form of a web-based application. The system uses real-time water quality data and artificial intelligence and machine learning to infer bacterial water quality at the weir. It was developed in direct response to the needs of water users to be able to access information about water quality and allow them to make informed decisions about whether to enter the water.

Our AMP8 WINEP includes the investigation action *08WW100014a Realtime water quality monitoring of amenity waters*, to be delivered by 30th April 2027. We proposed this investigation for inclusion in the WINEP under a BW_INV_5 driver in recognition of increasing public concern about water quality in waters used for amenity purposes. The 2021 study of Wessex Water customers identified “Protecting and improving river and beach water quality” as a priority for customers. As part of the willingness to pay survey, customers were asked if they would be happy for bills to increase to improve river and coastal water quality. It was found that approximately 52% of customers surveyed stated they would be willing to accept an increase in their bill to see an improvement above and beyond the status quo, compared to approximately 41% of customers willing to accept the status quo.

This investigation builds on the success of our work at Warleigh Weir and aims to provide information on real-time risk from bacterial contamination at locations where rivers and coastal areas are used recreationally at a minimum of 20 sites in AMP8. The real time water quality monitoring will be supported by a programme of spot water quality sampling and investigations in the upstream catchment to understand the key influences on bacterial water quality at each location and identify any improvements that may be required. The intention is for spot sampling data to be used to train AI models which will provide continuous, real-time estimates of water quality from sensor data.

The newly designated sites had already been identified as three of the 20 locations for inclusion in the 20 sites under the planned *Realtime water quality monitoring of amenity waters* investigation. Consequently, we had already made provision for investigations at these three sites in our October 2023 business plan. For our post-draft determination update, we have reduced the scope and cost of the investigation by 3/20^{ths} and re-assigned the 3/20^{ths} to the following new WINEP actions:

- 08WW102226a BW_INV2 ***Holding line for newly designated bathing water at River Avon at Fordingbridge***
- 08WW102233a BW_INV2 ***Holding line for newly designated bathing water at River Frome at Farleigh Hungerford***

- 08WW102230a BW_INV2 ***Holding line for newly designated bathing water at River Tone at French Weir Park***

We are able to demonstrate significant engagement and support for our work at these three bathing waters and more widely for our proposed *Realtime water quality monitoring of amenity waters* investigation. We have already engaged with stakeholders for each of these sites and have briefed them on our intentions through the delivery of this project, this has been well received. We have had feedback from swimming groups, local Councils and other interested stakeholders.

We are currently in the process of installing the monitoring equipment at Farleigh Hungerford and Fordingbridge with French Weir following, after completion of the first two installations. The other sites are currently not designated as bathing waters, although from discussions with recreational groups associated with these waters, we know that some groups are considering pursuing Bathing Water designation.

Figure 7 – Evidence of customer support for investigations and actions at newly designated bathing waters

"We do appreciate your support in this project which will make a big difference to so many people's experience of swimming at the club. Having that real time data recorded will be essential in enabling trending knowledge to be gained which will be invaluable for all sorts of reasons".

"Very excited about the planned installation of the Sonde monitoring equipment and please keep in touch with the latest news."

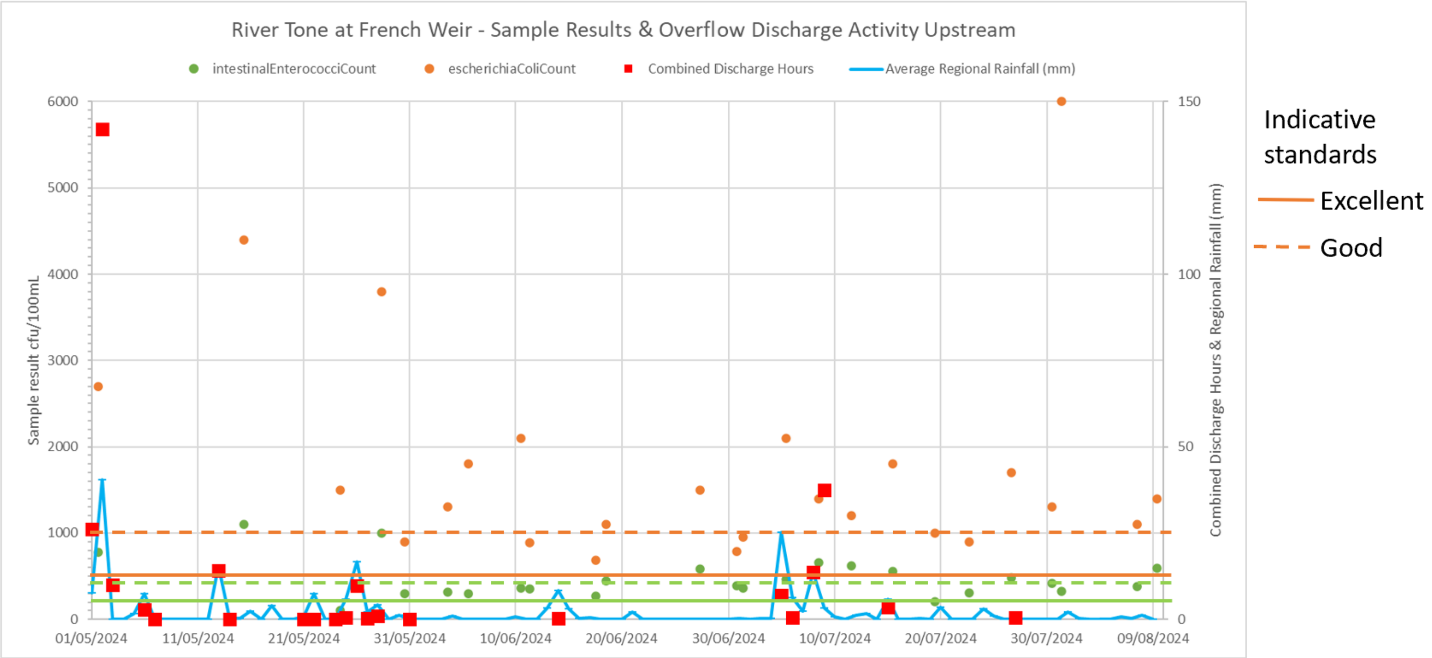
"Thanks for meeting up, we are very excited at the potential of getting the AI system set up in Fordingbridge."

"We have been liaising with the local Friends of Group regarding this matter and the ward member and would be happy to involve the new Local MP in that further discussion. From my perspective I can only think real-time monitoring would be of benefit, if information on how the public can interpret it is also there to aid in people making that decision or not to swim."

Left: Flyer on a notice board in a supermarket in Fordingbridge, February 2024. Right: Meeting with representatives of Farleigh Hungerford Swimming Club at Warleigh Weir, spring 2023.

The below chart for River Tone at French Weir shows the EA formal water quality samples, along with upstream storm overflow discharges (within 15km upstream), since the start of the 2024 bathing water season. This shows the bathing water exceeding the classification limits even on dry days.

Figure 8 – Water quality samples at new River Tone bathing water



8.2.2. Improvements

The following maps show the location of the three newly designated inland bathing waters, the upstream river catchment and our upstream assets – continuous and intermittent discharges – that could potentially have an influence on the river water quality at the bathing water location itself. In the absence of findings from the investigations, but in accordance with the EA's and Ofwat's requirements to include improvements in our Draft Determination response to meet the WINEP actions as stated, we have undertaken a risk-based prioritisation of improvements to make in AMP8, as low/no regrets solutions.

For prioritisation for improvements we have assessed using a number of criteria:

- Continuous Discharges
  - Dilution (WRC percentage of river flow) – Based on WRC daily volumes discharged, as assessed at the bathing water location under different WRC and river flow conditions.
  - Dilution (Microbiological decay) – Based on indicative bacterial load and travel time from WRC to bathing water, as assessed at the bathing water location under different WRC discharge and river flow conditions.
  - Distance – Distance of asset discharge point upstream of bathing water location.
  - Other recent/planning improvements at site – Either AMP7 or AMP8, particularly noting many WRCs have phosphorus removal using ferric ion compounds, which – without appropriate mitigation/protection measures – would rapidly foul any ultraviolet disinfection lamps. And also existing concerns of deliverability in meeting completion dates for other/existing AMP8 WINEP regulatory outputs, even before scope uncertainty for any bathing water related improvements.
- Intermittent Discharges
  - Spill frequency – Using recent EDM and modelled spill data
  - Distance – Distance of asset discharge point upstream of bathing water location.

Figure 9 – River catchment upstream of newly designated inland bathing water at Fordingbridge, Hampshire Avon

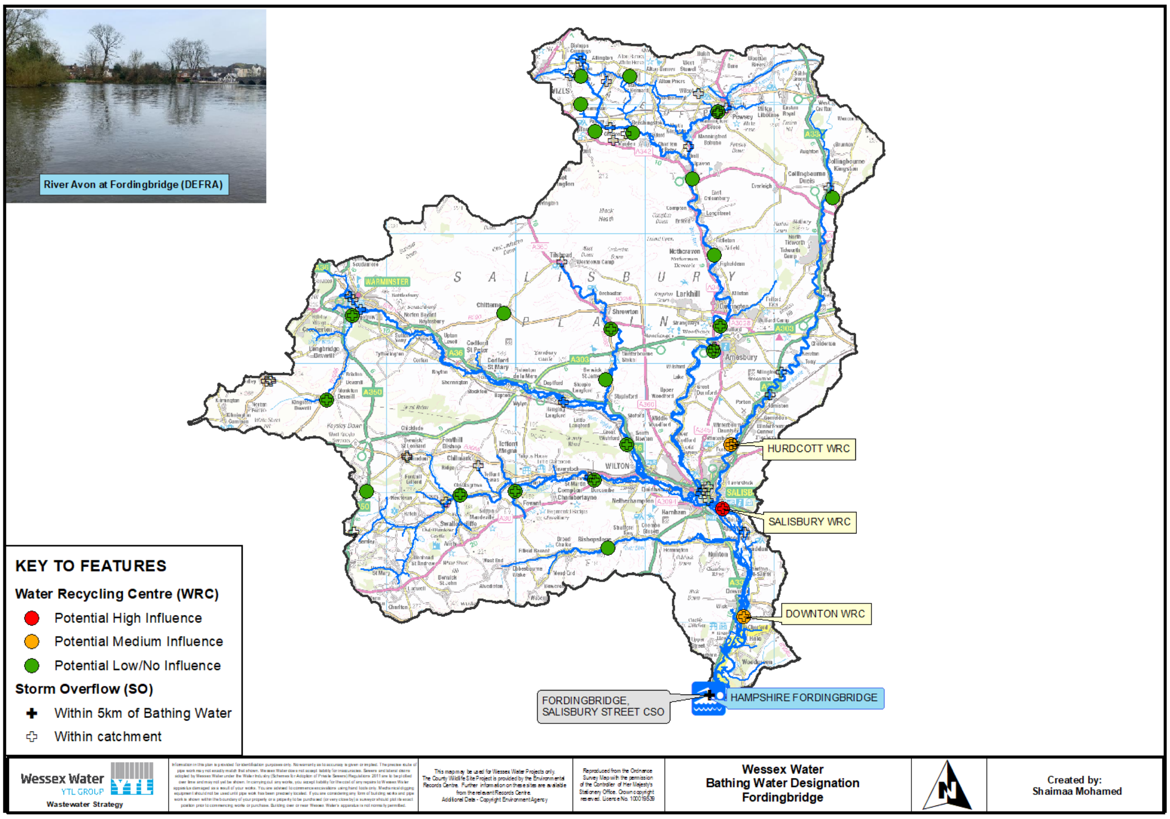


Figure 10 – River catchment upstream of newly designated inland bathing water at Farleigh Hungerford, Bristol Avon

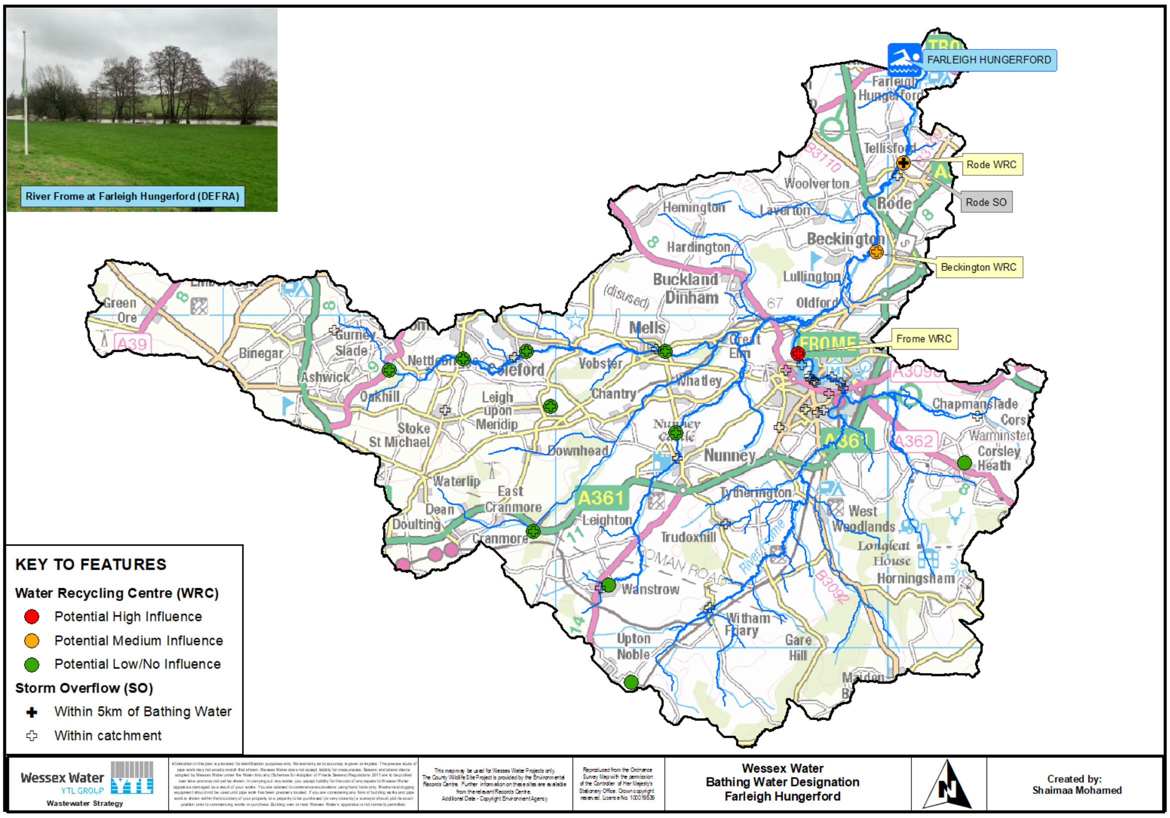
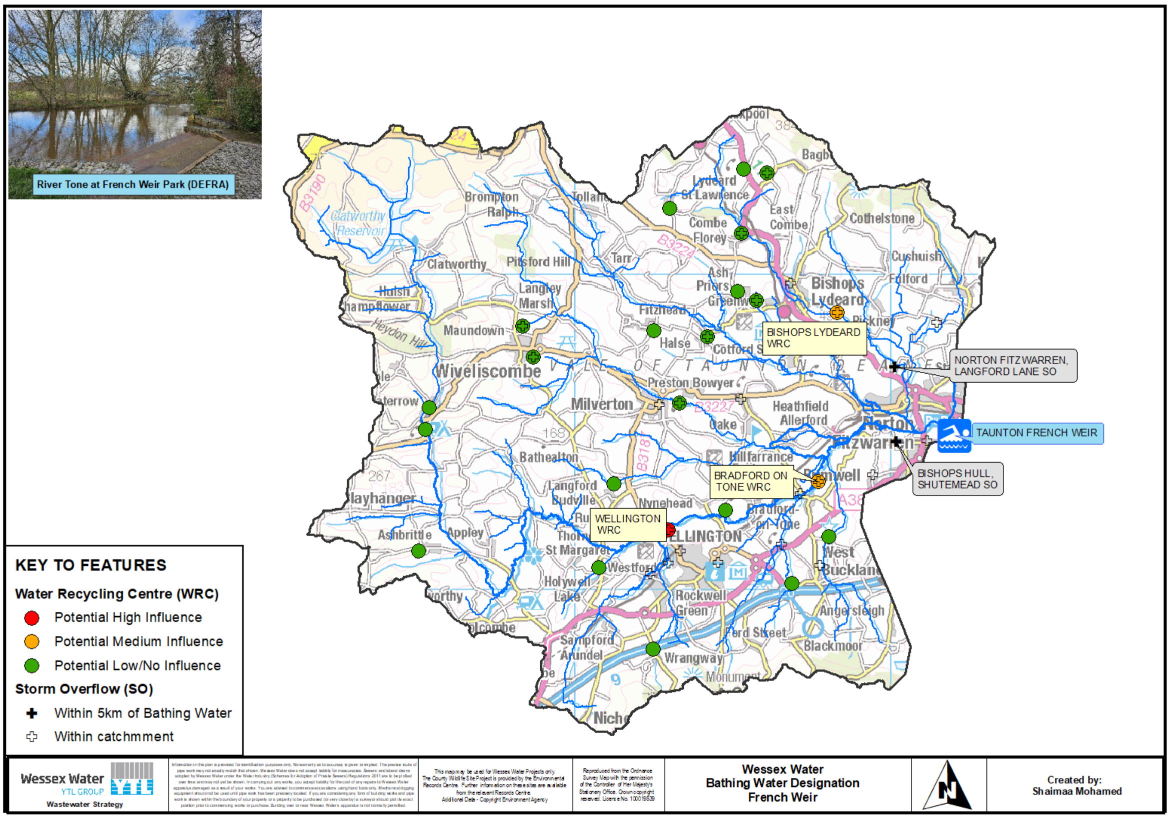


Figure 11 – River catchment upstream of newly designated inland bathing water at French Weir, River Tone



Our plan for PR24 includes:

- Storm overflow improvement at assets discharging within 5km upstream of bathing waters.
- Disinfection at Rode WRC
- Design of disinfection at other WRCs (to be considered alongside AMP8 schemes), to allow for implementation early in AMP9 (possibly funded through AMP9 transition). In PR24 we include for 10% of a high level estimate for the relevant WRCs.

We consider this proposed approach to be low/no regrets to facilitate the timely improvements of our discharge – should they be required – whilst we await the outcome of the investigations, to ensure more substantial investment is based on sound science.

For details on the storm overflow improvements, refer to WSX-C11 – Enhancement costs – storm overflows. For the remainder of this chapter we provide more detail on our proposal to improve continuous discharges.

8.2.3. Options Development

As we are in the early stages of defining the improvement needed, we have considered potential options for strategic level inclusion in the revised business plan, prior to completion of the associated investigation for these new bathing waters. Once the improvement required at each site is better known, these options will be refined and assessed using our standard approach to investment decision-making (See WSX38 for further detail), determining benefits and costs for each feasible option in order to select the preferred solution, in conjunction with approval from the EA that the solution meets the improvement requiremetns. Options such as discharge relocation to downstream of the bathing water location or into a neighbouring river catchment may be technically viable – albeit with long pipelines – but we are cognisant of the desire for further inland bathing waters to be designated, which could make these solutions null.

For continuous discharges to bathing waters the Environment Agency requires the following between the crude influent to a WRC and the bathing water monitoring point (BWMP):

- log reduction in viruses
- 5.4 log reduction in faecal coliforms - we use E. coli and intestinal enterococci (IE)

There is also a requirement to meet a minimum 1 log reduction in viruses and a 2 log reduction in both E.coli and IE through the disinfection stage.

How to calculate how much disinfection is required using viruses as an example:

- log virus reduction = disinfection through WRC + receiving water dilution factor + additional disinfection requirement (e.g UV or chemical disinfection)
- So, if the disinfection through the WRC is 1.0 log and the dilution factor is 1.5 log then the additional disinfection requirement would be 4.4 - 1.0 -1.5 = 1.9 log, so the UV of PFA would have to achieve a 1.9 log reduction by itself.
- This is important because the log reduction through various treatment types (e.g ASP of trickling filters) is already well established, which then makes the dilution factor critical. The dilution part is discussed in more detail later.

<u>Performic Acid (PFA)</u>

PFA is used in a few locations in Europe, but in Europe there is only a requirement for E.coli and not IE reduction. This is important as there is no requirement for virus reduction and therefore there has been no work undertaken on viral reduction (viral efficacy) for PFA in Europe.

The EA have allowed Anglian Water to use PFA for disinfection as a trial only. The Anglian Water trial managed to demonstrate a 2 log reduction in E.coli and IE as per the EA's requirement for the trial but was unable to demonstrate any reduction in viruses (viral efficacy). To demonstrate viral efficacy, UKWIR are funding a project to determine the viral efficacy of chemical disinfection systems which will include PFA, ozone and peracetic acid (PAA). This project is due to start late 2024 and is anticipated to take a minimum of 2 years to complete. Until this study is concluded the EA will not approve any more site-based trials. At the completion of the study, the EA are looking to issue a similar disinfection policy and guidelines as per the UV validated dose reactor design.

The Anglian trial also demonstrated that to achieve the 2 log bacti kill a PFA a dose of around 2.5 – 3.5 mg/l was required with a contact time of 12 – 15 mins.

There are some important points for consideration:

- PFA is harmful to the aquatic environment at concentrations at ≥ 0.34 mg/l which means that a 10x (or 1 log) reduction is required in the concentration at the end of the final effluent discharge pipe – this is not the BWMP; Anglian Water were fortunate as they were discharging into the sea so had > 1 log dilution.
- The 12 – 15 min contact time will require the use of a purpose-built contact tank or contact main similar to supply disinfection. The Anglian Water trial got away with dosing into a part-full outfall pipe but was accepted as it was a trial only but it wouldn't have been acceptable for a permitted scheme.
- The Anglian Water results were similar to those results already undertaken from previously published literature – including 2x Scottish Water trials undertaken by Stantec.

<u>Ultraviolet (UV)</u>

The required guidance for UV disinfection systems is already established by the EA.

The log reduction of viruses and bacteria as described in the first bullet points applies.

UV is massively influenced by iron solids as iron absorbs UV light and fouls the UV tubes. The UV suppliers generally stipulate a maximum of 2 mg/l particulate iron and 0.3 mg/l of dissolved iron, of which the particulate iron is generally the problem. Most Wessex Water sites where we use ferric sulphate as primary dose will exceed the 2 mg/l limit which will consequently mean that we need a tertiary solids removal stage to get the solids out.

Using aluminium based coagulant is an alternative, but there are serious concerns on its widespread use – particularly related to Habitats Sites, of which there are many in the Wessex Water region – on the basis of its toxicity to salmonoids.

The following information is required to both enable and validate the design of the UV system:

- 3 – 5 years of flow data.
- UV transmittance (UVT), 12 months online monitoring – requiring a UVT monitor in the final effluent.
- Water quality sampling (crude and final) every 2 weeks of 1 year giving a minimum of 25 samples.
- Collimated beam testing (CBT) to determine the target dose for the bacteria and virus identified – minimum of 10 separate samples taken over the expected range of UVT, SS and flow. Testing is specialist with very few laboratories in the country qualified to undertake this work.

<u>Solution type feasibilities</u>

Whilst other treatment solutions are possible – such as membranes and chlorination – we do not consider these viable without wholesale rebuilds of existing WRCs (significantly more costly than the tertiary disinfection solutions) or without unrequired health and safety concerns and will likely be discounted as not the best/appropriate options for customers or the environment (and hence have been excluded in the strategic options included in our updated Business Plan). Using PFA cannot commence until the UKWIR trial is completed and even then it is unlikely to be suitable for inland waterways as the dilution factor at the end of the final effluent pipe is likely to be too low. If using iron based coagulants there is a need for TSRs upstream of the UV plant. Advanced sampling and installation of UVT online monitors is required to ensure sufficient data on which to base any treatment designs, as well as to inform permitting discussing with the EA.

8.3. Cost efficiency

In the below table we summarise key factors that could influence the scope, and thus cost, of treatment at the list WRCs. These have been identified as having a potential medium/high influence on water quality at the bathing water, based on the criteria described earlier.

Table 33 – Cost scoping for continuous discharge (WRC) improvements related to newly designated bathing waters

Bathing Water	WRC	Other AMP8 Scheme?	TSR Stage	Land Purchase required?	FPF (l/s)	Indicative Capex (key assets)
River Frome at Farleigh Hungerford	Rode	No (AMP7 P scheme)	No	No	8	TSR: £2.3m UV: £3.5m
	Beckington	Yes (P removal)	Not proposed for AMP8 P scheme (1mg/l)	Likely	12	TSR: £2.2m UV: £3.5m Land: £0.5m
	Frome	Yes (P removal)	Proposed for AMP8 P scheme	No	405	UV: £8.0m
River Avon at Fordingbridge	Downton	Yes (P removal)	Proposed for AMP8 P scheme	Likely	42.2	UV: £3.8m
	Salisbury	Yes (P removal)	Proposed for AMP8 P scheme	Yes	492	UV: £8.4m
	Hurdcott	Yes (P removal)	Proposed for AMP8 P scheme	Yes	38.9	UV: £3.8m

River Tone at French Weir Park	Bradford on Tone	Yes (P removal)	Proposed for AMP8 P scheme	Likely, AMP8 scheme layout constrained	17	UV: £3.2m
	Bishops Lydeard	No (AMP7 P scheme)	Installed for AMP7 P scheme	Likely, AMP8 scheme layout constrained	28	UV: £4m Land: £0.5m
	Wellington	Yes (P removal)	Proposed for AMP8 P scheme	Likely, AMP8 scheme layout constrained	153	UV: £6.2m

The above indicative costs were derived from outturn costs of recent UV schemes we have undertaken, including:

- Swanage WRC
  £800k (2023) for 15l/s
  Replacement of temporary UV plant with new system to meet design standards for permanent installations, and those of the EA (particularly with respect to control and data recording). Cannister UV system (duty/standby) installed within existing building taking partial site flow; majority of flow is membrane treated.

- Corfe Castle WRC
  £3.5m (2021) for 12l/s
  New UV system to meet AMP7 WINEP shellfish water disinfection requirements. Delivered alongside P removal scheme, with TSR installed for UV protection.

- Minehead WRC
  £2.7m (2019) for 200l/s
  Replacement of existing duty/assist UV to meet modern standards within existing channels and utilising existing control kiosk. Site only has secondary treatment.

- Cannington WRC
  £2.2m (2019) + £800k (2021) for 26l/s
  New pump-fed UV channel system to meet AMP6 NEP bathing water disinfection requirements. Site doesn't have P removal but duty-only TSR added subsequently, however, as the UV channel has been the subject of significant sludge settlement and under warm, dry weather conditions experienced during the summer the settled sludge has been gassing and lifting, putting the works UV permit at risk.

As described earlier, our PR24 proposal is for delivery of UV treatment at Rode WRC (c.£6m capex) along with design for improvements at the other listed sites (c.£4.5m, being 10% of estimated capex, to cover outline design). Actual estimates for scheme delivery in PR29 will be dependent on design parameters, as determined through the bating water investigations and discussions with the EA.

8.4. Customer protection

As described earlier, the outcome of the classification for 2024, expected to be announced in November 2024, is important as it will determine the next steps for each bathing water. If the bathing water is classified as Poor then the actions with BW_IMP2 and BW_INV2 will be changed to BW_IMP1 and BW_INV1 drivers (Actions to improve and Investigations for waters with current planning class of Poor), respectively. If the bathing waters are classified as Good or Excellent in late 2024 the WINEP actions can either be removed from the WINEP or given BW_IMP3 and BW_INV3 drivers (Actions to improve and Investigations to lead to improving waters from Good to Excellent), respectively, where there is evidence of customer support.

We consider our proposed investigation and improvement (at continuous discharges and storm overflows) approach to be low/no regrets to facilitate the timely improvements of our discharge – should they be required – whilst we await the outcome of the investigations, to ensure more substantial investment is based on sound science. We also consider this uncertainty provides further support for our proposals on uncertainty mechanisms which are set out in WSX-M07.

Annex 1 – Technical assurance / benchmarking

We have engaged with a number of external consultants and contractors, both ahead and subsequent to our original Business Plan submission, to review both our scope and costing approach.

The following sub-annexes should be read in conjunction with section 2.6.

- A1-1 - Stantec
- A1-2 - Galliford Try

A1-1. Stantec

We engaged Stantec UK Ltd. to undertake a technical review of our wastewater treatment programme, in particular a review of our internal guidance for the basis of design and technologies for future permits for our proposed PR24 interventions. The assessment guidelines include generic guidelines and solution technology assessment guidance for varying permit/treatment requirements including phosphorus (itself including tertiary solids removal technologies to meet low limits), nitrogen, combined phosphorus and nitrogen, ammonia and chemical micropollutants. For each area, Stantec provided feedback, affirming that our approach was consistent with the wider water industry.

The review by Stantec also included a more in-depth review of scope for several schemes, although it should be noted that these scopes may have been superseded by more detailed optioneering and/or emergent risks and issues subsequent to Stantec's review. We included Stantec's technical memos in WSX17 section A3-1 as part of our Oct'23 submission, along with our comments/actions in response. We include below an update, with original comments in red and updated / more recent comments in blue, reflecting further development.

Stantec **Memo**

To:	Andrew Gulliford	From:	Daniel Rusev Birchwood
Project/File:	Wessex Water PR24 Benchmarking	Date:	7 February 2023

Reference: Process Benchmarking - Stantec comments

Wessex Water shared their Enhanced Driver Delivery Scope spreadsheet and its wastewater treatment solution assessment guidance with Stantec for comments and responses to their PR24 proposed interventions. This MS Excel spreadsheet lists WxW wastewater solution guidance for PR24 in rows and this memo refers to Stantec's review of the specific guidelines in the row numbers as *lines (i.e., line number stated = source spreadsheet row number)*.

The assessment guidelines include Generic Guidelines and solution technology assessment guidance for categories of pollution including Phosphorous (itself including TSR technologies to meet low limits), Nitrogen, Nitrogen and Phosphorous, Ammonia and Chemical Micropollutants. For each section Stantec have provided feedback outlined below and Actions for Wessex Water to respond / confirm queries on the design approach.

Generic Guidelines:
For line 7 on TP chemical dosing Iron and Aluminium permits, Stantec questioned whether the assumed Aluminium permit of 2 mg/L was correct as it was a high value. The Wessex response was that if the limit is any lower than that, aluminium dosing would not be used. **ACTION** for WxW to review this guideline against a 1 mg/L Al permit.

Typically based on receiving waters forming part of SSSI and approach taken by Natural England excluding use of Aluminium in these environments.

Where we have previously used aluminium coagulants, residual concentrations of Al in the FE has been greater than 1 mg/l. Given that aluminium permits are absolute concentrations, then the risk of not achieving a 1 mg/l permit is very high and hence the 2 mg/l stipulation.

Natural England's current position is that there should be no deterioration in water quality in receiving water courses with "salmonid" populations, this effectively means that aluminium could not be used.

WxW assessment guidelines (Line 9) state that growth of 0.5% for domestic/commercial and 1% for trade be used as standard assumptions. Stantec recommend running analytical scenarios to determine what the impacts of the growth will be. A more accurate assessment should ideally consider planning permissions granted and housing projects that have started construction. Analytical scenarios should vary the percentages of growth expected. **ACTION** for WxW to run scenarios and include outputs into the guideline.

Sensitivity exercise to be undertaken at different growth predictions.

For AMP8 feasibility, specific growth rates have been assessed on a site by site basis rather than using the default 0.5% and 1.0% assumption

Design with community in mind

7 February 2023
Andrew Gulliford
Page 2 of 8

Reference: Process Benchmarking - Stantec comments

The assessment guideline of Line 16 requires that where DWF is exceeded, all permits will be tightened. Stantec's observation is that tightening of permits resulting from DWF exceedance will also impact SAGIS modelling undertaken by the EA and/or Wessex Water. This may lead to changes in consents and would affect the overall river body. **ACTION** for WxW to input DWF increases into SAGIS.

SAGIS modelling to be run on all sites with DWF increase, process model to be re-run for any subsequent permit changes.

SAGIS modelling has been completed for all DWF increase schemes and process models developed on this basis.

The Line 19 assessment guidelines state that by 2050, all process units must be less than or equal to their relevant wastewater design standard loading rates. Stantec recommend that some sensitivity analysis is added to these assessments (for example a 10% reduction in headroom (10% increase in loading) on design standards), as design standards are typically conservative. **ACTION** for WxW to implement some sensitivity analysis for design guidance.

Sensitivity exercise to be undertaken.

For AMP8 feasibility, all sites are being assessed on both loading rates and performance based on sample data. We have developed a risk evaluation guidance document to allow an element of risk to be used in this evaluation in which different % overloading rates are used.

The Line 20 assessment guideline states that "Where additional biological capacity is required then assume in the first instance that a 'like for like' process is used" Stantec recommends also considering staging of treatment, e.g., use of tertiary treatment, as it may be more cost effective and produce better value outcomes. **ACTION** for WxW to confirm if alternative treatment processes have been considered.

This has been undertaken, original wording in guideline needs updating to reflect this, e.g. tertiary or alternative secondary treatment has been reviewed where proven to be cost effective.

The Line 21 WxW Assessment Guideline states that "Any temporary plant will be removed and replaced by appropriately sized assets (like for like) to comply with the design standard loadings rates at 2050." Stantec questioned how these replacements are going to be funded. **ACTION** for WxW to confirm that the new asset funding for temporary plant replacement will come from the capital maintenance budget, rather than WINEP.

WxW to confirm.

Temporary plant replacement is being costed as capital maintenance.

The Line 23 WxW assessment guideline states that "when a site has a septic tank and the PE is predicted to exceed 250 by 2050, in this instance allow for the wholesale replacement of the septic tank with a PST (line 23)." Stantec recommends that sludge storage is also added where septic tanks are replaced with PSTs. **ACTION** for WxW to confirm that they have considered the sludge storage requirement and access arrangements.

Sludge storage has been allowed for.

For the WxW activated sludge plant process assessment guidelines presented on lines 24 and 25 of WxW process assessment guidance Stantec recommends that the mass flux of the final tanks is also included as part of these assessments. **ACTION** for WxW to confirm that they have considered mass flux.

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Reference: Process Benchmarking - Stantec comments

Mass flux has been assessed on all ASP sites.

The Line 26 guideline states that “For sites with fixed film biological processes with a tightening of the ammonia permit, assume a "like for like" process can achieve a 95%ile permit concentration of 5 mg/l AmmN” . Stantec believes that there is an opportunity to use increased recirculation to achieve an ammonia compliance with 3 mg/L 95%ile. **ACTION** for WxW to respond to this.

WW design standards allow for any fixed film process to achieve 5mg/l AmmN permit on 95%ile basis, and hence the guidance given in statement. Recirculation is only really appropriate for TFs which have sufficient media volume to achieve a 5 mg/l permit. WxW experience is that new build TFs can achieve 3-4 mg/l provided that: no trade, consistent load, etc. Existing TF sites designed for 5 mg/l, tend to much closer to the permit and this is likely to be a consequence of older media, reduced ventilation capacity, some collapsed floor tiles, shallower depth, etc., etc.; therefore for these older sites I wouldn’t be convinced that recirc would improve their performance dramatically unless the TFs were refurbished & updated to meet our existing design standards.

The Line 27 guideline states that “Where an existing tertiary nitrification plant needs replacement, size an MBBR as the replacement process (line 27).” Stantec believes there is an alternative biofilm technology option to use nitrifying SAFFs. **ACTION** for WxW to respond to this.

MBBR as WxW experience is that they have better resilience to load fluctuations than SAFs & RBCs

The line 28 guideline states that “Assume sites with aerated COUFs installed for nitrification can only achieve a 50% reduction in the applied ammonia load Stantec has asked for a reference to the data for the claim of effective limit of nitrification being 50%. **ACTION** for WxW to reference data used for this assumption.

Data is available – Glastonbury good example. Also shows poor response to fluctuating loads.

Phosphorous Guidelines:

For permits higher than 1.5 mg/L, Stantec believe that algae bioreactors and wetlands can be considered. **ACTION** for WxW to confirm if these are being considered.

Wetlands have been considered.

The Phosphorus Guidelines for treating down to 1.0mg/l average TP include the statement that “Grit removal to comply with DS422 where grit identified as an issue.” Stantec advise that other water companies install grit removal for sites >5k PE. **ACTION** for WxW to confirm for what PE is grit removal considered for these TP solutions.

This is a miss understanding of DS422. Grit removal is removed for sites >5000PE but for smaller sites with a known grit problem or with mechanical screens being installed then grit removal is required.

The Phosphorus Guidelines for treating down to 1.0mg/l average TP include the statement that “Total P monitor is installed on sites with new P permits”. Stantec advise that this can be omitted for sites with permits >1 mg/L, as it is lower risk. **ACTION** for WxW to confirm if P monitor is needed for limits >1 mg/L.

Guidance in DS438 is that TP monitors are only installed on sites with Permits <1mg/l unless site specific conditions occur which require one.

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7 February 2023
Andrew Gulliford
Page 4 of 8

Reference: Process Benchmarking - Stantec comments

The Phosphorus Guidelines for treating down to 1.0mg/l average TP include the statement that "If existing FE has SS > 20 mg/l on 95%ile basis then a tertiary solids removal (TSR) process to be installed, either PCF or MMF." Stantec believe that reed beds or enhanced reed beds can also be installed. **ACTION** for WxW to confirm if reed beds are considered for SS removal.

Reed beds have been considered but discounted due to large land take required.

In addition, where we have historically used reed beds as TSRs, we have experienced iron solids accumulation which tend to leach out at high flows giving a peak concentration greater that the site permit.

The Phosphorus Guidelines for treating down to 1.0mg/l average TP include the statement "Provide 2mm 6D screening if not present on site." Stantec are questioning what drives this need. **ACTION** for WxW to confirm why 6mm 2D screens are installed and to confirm that this is not impacting the scope as screens are already installed.

Related to rag blocking desludge pumps in PSTs leading to iron rich sludge carry over to downstream processes. Has caused problems with iron breakthrough in FE.

The Phosphorus Guidelines for treating 0.8mg/l down to 0.25mg/l average TP include the statement that "Potable water supply (if not available on site) should be connected for sites with P permits" Stantec recommends that water bowsers may be used instead of potable water. **ACTION** for WxW to confirm where new potable water supply is far away, will water bowser be considered.

Need to review what our current policy is with respect to mobile water bowsers.

Design standards have been updated to include mobile water bowsers to be used for safety showers where appropriate.

The Phosphorus Guidelines for treating 0.8mg/l down to 0.25mg/l average TP include the statement "Additional upstream treatment process capacity to be provided when backwash flows cause the existing process units to exceed their hydraulic loading capacity; in the case of biological treatment then "Like for Like process". Stantec recommends that Lamella backwash treatment can also be provided. **ACTION** for WxW to confirm that Lamella is considered for backwash treatment instead of increasing the biological treatment capacity.

Siltbuster have done some trials based on samples from an existing MMF site (chase Will up on this?). Concern that recycling lamella effluent back through TSR plant will lead an accumulation of fine solids that will break through the TSR and lead to permit failure.

In the first instance, where a specific TSR process drives the need for additional process capacity, we then look at alternative TSR technology which has a lesser backwash volume and hence no additional process capacity, to see if the same permit can be achieved with the alternative technology.

We have undertaken a recent costing exercise to determine the cost of lamella backwash treatment which enables us then to compare with any additional process capacity proposed and determine the most cost effective solution.

The Phosphorus Guidelines for treating 0.8mg/l down to 0.25mg/l average TP include the statement "For sites with multiple Dortmund HSTs, check that one tank can be taken off line for cleaning and that the remaining online tanks can pass winter Qav whilst staying compliant with the DS retention and HLR requirements; if this is not possible then add additional capacity to achieve the DS requirements (either

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Reference: Process Benchmarking - Stantec comments

UFC or radial flow tanks) (line 43).” Stantec recommends that the Opex lines for Dortmund tanks are increased to include complete emptying. **ACTION** for WxW to confirm that it is possible for Dortmund tanks to be desludged and increase opex lines.

The assumption is that tanks will be taken off line and completely emptied for cleaning on a quarterly basis. Cheek this is allowed for in Opex estimate.

It is being allowed for in the Opex costs.

The Phosphorus Guidelines for TSR technologies include the statement “Where existing aerated or unaerated COUF sand filters are in use …, the existing technology will be retained.” Stantec recommends that RTC is installed to prevent nutrient deficiency. **ACTION** for WxW to confirm that RTC is added to prevent nutrient deficiency. **ACTION** for Narinder Sunner to send paper to Andrew Gulliford.

Not required as guidelines state this rule is only applicable if the site is already achieving the proposed TP permit.

The Phosphorus Guidelines for TSR technologies include the statement “TSR technologies to meet >0.25 mg/L P permits are Ballasted media - either Comag or Actiflo” Stantec recommend that Filterclear or Mecana on ASP can be used as an alternative technology solution. **ACTION** for WxW to confirm that Mecana can be used on ASP only down to 0.2 mg/L.

This category is <0.25 to 0.1 mg/l TP, we don’t have any 0.2 TP permits proposed. Permits so far are either 0.25 or 0.1 mg/l TP. We would also need to understand what evidence the 0.2 mg/l assertion for Filterclear or Mecana is based upon. We would rule out Mecana with a direct ferric dose.

Filterclear being allowed for permits down to 0.2 mg/l TP. Our recent TSR tender review has demonstrated that MMFs are cheaper than Mecana and so we would typically rule Mecana out on cost basis unless the MMF backwash led to additional process capacity. We don’t have any 0.2 mg/l TP permits on any ASP sites.

Nitrogen Guidelines:

The Nitrogen Guidelines for 15mg/l TN solutions include the statement “To meet 15 mg/L N and 0.25-1 mg/L P add tertiary plant to existing works to target 3 mg/l AmmN plus denitrification COUF sand filters + carbon source”. Stantec believe that additional biological processes can also achieve these limits. **ACTION** for WxW to confirm that additional biological processes are considered.

This has been undertaken, original wording in guideline needs updating to reflect this, e.g. tertiary or additional secondary treatment has been reviewed where proven to be cost effective.

The Nitrogen Guidelines for 5mg/l TN solutions include the statement “ASP (4 stage Bardenpho). Assume carbon source required.” Stantec believe that Tertiary treatment is also required if a permit lower than 5mg/L is implemented. **ACTION** for WxW to add TSR if a permit lower than 5mg/L is implemented.

Lowest permit is 8.4 mg/l so action not required.

Our lowest AMP8 permit is 5 mg/l TN for Poole, all other sites are 8.4 mg/l TN or above. For Poole a Nereda SBR plant is being considered for which the supplier states a TSR is not required.

Nitrogen and Phosphorous Guidelines:

The Nitrogen and Phosphorus Guidelines for 15mg/l TN and 0.25-1mg/l TP solutions include the statement "To meet 15 mg/L N and 0.25-1 mg/L P add tertiary plant to existing works to target 3 mg/l AmmN plus denitrification COUF sand filters + carbon source". Stantec believe that additional biological processes can also achieve these limits. **ACTION** for WxW to confirm that additional biological processes are considered.

This has been undertaken, original wording in guideline needs updating to reflect this, e.g. tertiary or additional secondary treatment has been reviewed where proven to be cost effective.

The Nitrogen and Phosphorus Guidelines for 15mg/l TN and 0.25-1mg/l TP solutions include the statement Guidelines state that "ASP (5 stage Bardenpho) - assume EBPR can achieve 1.0 mg/l P and for <1.0 mg/l P coag. dosing u/s of a tertiary MMF is required." Stantec believe that dosing into ASP is also possible. **ACTION** for WxW to confirm if they have considered dosing into ASP.

It has been considered but discounted where FSTs have insufficient capacity to accommodate the additional inert solids loading. In addition, still a level of uncertainty whether achieving <1 mg/l TP is viable without tertiary TSR.

The Nitrogen and Phosphorus Guidelines for 15mg/l TN and 0.25-1mg/l TP solutions and for 15mg/l TN and 0.25-1mg/l TP solution guidelines do not mention the Nereda batch- granular sludge technology as an option for achieving 8.4-10 mg/L N and 0.25 - 1 mg/L P permits. Stantec believe that a Nereda type process combined with downstream tertiary treatment can achieve these limits. **ACTION** for WxW to confirm if they have considered Nereda plus TSR.

Nereda has been considered but discounted due to ongoing concerns with effluent quality in terms of recycling solids from TSR back through Nereda plant. In addition, complexity of plant and operational input make the process onerous to operate.

Nereda is now being considered for Poole.

Chemical (Micropollutant) Guidelines:

The Chemical (Micropollutant) Guidelines do not take into account the need to pilot technologies for the removal of chemicals and Stantec's risk assessments on these solutions recommends piloting due to site specific chemical micropollutant profile variations and source and partitioning uncertainties. **ACTION** for WxW to include pilot trial in the CAPEX for each chemical.

Pilot plants to be included in scope.

The Chemical (Micropollutant) Guidelines are missing a strategy to handle the sludge that will contain the various micropollutants. **ACTION** for WxW to confirm their sludge strategy and how they will manage the liquors route to avoid build-up of micropollutants. The main emerging risks are PFAS and in addition to chemical micropollutants, microplastics are also an emerging risk. Advanced thermal technologies are capable of treating digested sludge to remove both but the requirement to treat these pollutants if required, will probably lead to the biosolids to land beginning to close and any N and P recycling to come from N and P recovery technologies.

We don't have any PFAS permits. Sludge strategy to manage chemicals – what is our strategy? In theory all of the micro pollutants removed by on site processes will be transported off site via the sludge route - Question for JR / Wesley ?

Reference: Process Benchmarking - Stantec comments

The Chemical (Micropollutant) Cypermethrin Guidelines state that to meet cypermethrin permits, ASP sites will implement multimedia filter (MMF). Stantec's approach allows for the opportunity to install a GAC bed as well if the particular treatment works discharge EQS and cypermethrin profile also needs dissolved cypermethrin to be removed. **ACTION** for WxW to confirm if they want to include GAC and add a risk reserve fund for solution development at cypermethrin sites. For example, Cypermethrin treatment to permit requirements may be satisfied by use of Filterclear as quaternary solids removal and GAC media adsorption provision at some wastewater treatment works. Cypermethrin is both hydrophobic and lipophilic and so strongly absorbs into organic solids (VSS). If a wastewater treatment works has very low EQS, treatment provisions at other wastewater treatment works might need to include upgrading biotreatment to MBR, to provide membrane filtration to exclude solids.

Do we want to include GAC as an additional process?

GAC being costed as a mitigation measure (reserve fund) should dissolved cypermethrin prove to be problematic.

The Chemical (Micropollutant) Cypermethrin Guidelines state that to meet cypermethrin permits, fixed film sites will implement primary and secondary coagulant dosing + MMF. Stantec believes that a conversion to ASP + GAC may be required depending on the permit. **ACTION** for WxW to confirm if they want to include ASP conversion and GAC for trickling filters sites.

I don't think we do, as it strongly absorbs to biosolids then coag dosing plus TSR should prove effective. However residual risk that insufficient removal without conversion to ASP. WxW to manage risk?

As above, GAC only being considered as mitigation measure.

The Chemical (Micropollutant) Fluoranthene Guidelines state that to meet fluoranthene permits, ASP sites will employ primary and secondary coagulant dosing + MMF. Fluoranthene is hydrophobic but does not partition as strongly as cypermethrin into VSS. However, 70% Fluoranthene removal has been reported for conventional primary and secondary wastewater treatment. Stantec believe that the addition of GAC is also a possible requirement depending on the sources, load and partitioning of fluoranthene at a given wastewater treatment works. **ACTION** for WxW to confirm if they wish to consider GAC as part of the solution set for fluoranthene removal.

Do we want to include GAC as an additional process?

Same approach as cypermethrin being undertaken, with GAC being proposed as mitigation measure.

The Chemical (Micropollutant) Fluoranthene Guidelines have not referenced emerging technologies that have demonstrated for fluoranthene. Stantec has recommended Arvia Rosalox process.

The Chemical (Micropollutant) Heavy Metals Guidelines state that to meet the Zinc permits, Fe dosing will be replaced with Al based dosing. Most transition metals are capable of biosorption into activated sludge floc and biofilm which is also affected by pH. Other fates for some transition metals in sewage is deposition as metal sulphides when sulphate is reduced to sulphide in the sewer or in the hoppers of primary treatment settlement tanks if these are septic. These lead to a need to provide a mass balance of metals across a wastewater treatment works, including return liquors, for micropollutants that can partition into organic solids or precipitate out, which includes heavy metals as well hydrophobic and lipophilic organic carbon compounds. Stantec asked WxW if such a study has been undertaken in development of the micropollutant solutions and in particular, for the heavy metals. **ACTION** for WxW to confirm if mass balance has been undertaken with respect to Zinc, Copper and Nickel. This will also include interstage sampling to understand the fate of metals on site. **ACTION** for WxW to confirm if they

Reference: Process Benchmarking - Stantec comments

want to consider precipitation + tertiary treatment for the removal of zinc should a mass balance show that switching dosing chemicals is not sufficient. **ACTION** for Narinder Sunner to send precipitation curves to Andrew Gulliford.

Mass balance has not been undertaken. Interstage sampling has not been undertaken, sampling limited to crude and FE only. Conversion to ASP + TSR seems the most appropriate solution at this stage. Only 2 sites under consideration: Devizes (Nickel + zinc, Ni looks compliant with permit already, Zn border line potential switch from ferric to PAC) and Castle Cary (copper, Cu currently borderline with permit – Amp7 scheme of coag dosing + TSR will improve performance).

Sampling ongoing to determine heavy metals concentration on the stated sites. Castle Cary AMP7 TSR (Filterclear) in construction and will help determine efficacy of heavy metals removal via TSR.

The Chemical (Micropollutant) Heavy Metals Guidelines do not mention specific strategies to handle copper (Cu). Stantec recommend pH adjustment to precipitate the metal followed by tertiary treatment and/or use of specific precipitants. Stantec note that metal sulphide precipitation is used in the mining industry but in wastewater treatment, this is likely to require low REDOX precipitation followed by reaeration before final discharge, to restore dissolved oxygen levels. **ACTION** for WxW to confirm if they want to include jar testing and coagulation testing for Metal removal. This will show if this is a viable strategy for copper removal.

As above Castle Cary the only site for Cu, given site is currently borderline achieving proposed permit the Amp7 scheme will improve this. Worst case convert to ASP to maximise bio-flocculation. Therefore jar testing not proposed – cost for ASP conversion?

US EPA report ASP removal efficiencies of 50-79% Cu & 74-95% Zn.

Castle Cary AMP7 TSR (Filterclear) in construction and will help determine efficacy of heavy metals removal via TSR.

The Chemical (Micropollutant) Guidelines mention technologies for the removal of PFOS. A PFOS permit was not shared with Stantec in the list of PR24 chemical limits. **ACTION** for WxW to confirm that the PFOS site has dropped off the list.

Dropped from list

Best regards,

Stantec UK Limited

Daniel Rusev
Process Engineer
daniel.rusev@stantec.com

Attachment: [Attachment]

Design with community in mind

A1-2. Galliford Try

We engaged Galliford Try Construction Ltd. to review scopes and costs for a number of schemes that have progressed since Business Plan submission.

Galliford Try work with a number of water companies within the UK. Their review for us covered:

- Scope/cost purpose splits
- Costs and programme
- Site specific challenges
- Risk profile

The following sites were reviewed, with the identified enhancement drivers:

- All Cannings WRC – Phosphorus & Growth
- Blackheath WRC – Nitrogen, Phosphorus & Sanitary
- Buckland Newton WRC – Phosphorus & Growth
- Butleigh WRC – Phosphorus
- Cannington WRC – Phosphorus
- Christchurch WRC – Phosphorus
- Compton Bassett WRC – Phosphorus & Growth
- Devizes WRC – Phosphorus & Sanitary
- Dorchester WRC – Nitrogen & Phosphorus
- Fordingbridge WRC – Phosphorus
- Glastonbury WRC – Phosphorus
- Hurdcott WRC – Phosphorus & Growth
- Leyhill WRC – Sanitary & Growth
- Pewsey WRC – Phosphorus & Growth
- Ringwood WRC – Phosphorus, Sanitary & Growth
- Wells WRC – Phosphorus & Growth

On the following page we provide their summary letter.

Galliford Try
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www.gallifordtry.co.uk

Robert Sankey
Wessex Water
Claverton Down Road
Claverton Down
Bath
BA2 7WW

22 August 2024

RE: WESSEX WATER - GALLIFORD TRY P REMOVAL SCHEMES - REVIEW TO SUPPORT PR24 DRAFT DETERMINATION RESPONSE

Robert

Further to our letter dated 12 August 2023, we can confirm that Galliford Try together together a multidisciplinary team of peers from our GT5C partnership agreement (WSP, Binnies and SWECO) undertook a review of fourteen P removal schemes to provide confidence with Wessex Water's approach to their PR24 submission.

As part of the task our team, at a high level, reviewed Wessex Water's costing methodology and estimate allowances. This exercise being undertaken by two independents from our pre-construction / estimating team.

We can confirm that, for a suite of nutrient removal projects, the costing methodology was appropriate for the stage of design and the estimate allowances were within expected industry norms.

If you require any further support or questions regarding our review, please do not hesitate to contact me.

SIGNED

Stewart Evans

....

Name:	Stewart Evans		
Position:	Head of Consultancy	Dated:	22 August 2024