Our PR24 Enhancement Strategies

PR24 Draft Determination Representations – August 2024

Part 3: A carbon neutral business

PR24 Enhancement Strategies Part 3: A Carbon neutral business

A carbon neutral business

1 Overview

This document sets out our Representations on the enhancement investments that we propose to make to help us achieve the ambitions set out in our Strategic Direction Statement. This specific section sets out investment to be a carbon neutral business. It follows on from our 'Carbon Neutral' (ANH28) enhancement strategies published alongside our original PR24 business plan. For each enhancement strategy we set out:

- **Investment summary** - In this section we summarise our requested totex for each enhancement strategy and highlight where these costs are reported in our updated data tables. We set out how our requested totex compares with our original plan (as at March 2024) and Ofwat's Draft Determination allowance
- **Context** - In this section, we summarise the investments that were included in our enhancement strategy in our business plan submission, and how this was assessed by Ofwat in its Draft Determination.
- **Our representations** - This section contains our Representations on Ofwat's Draft Determination. Here, we set out whether our Representations align with Ofwat's Draft Determination; or whether we are providing further evidence or presenting new information such as updated cost data, evidence of need or wider drivers such as new obligations.

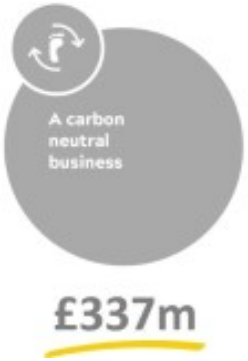
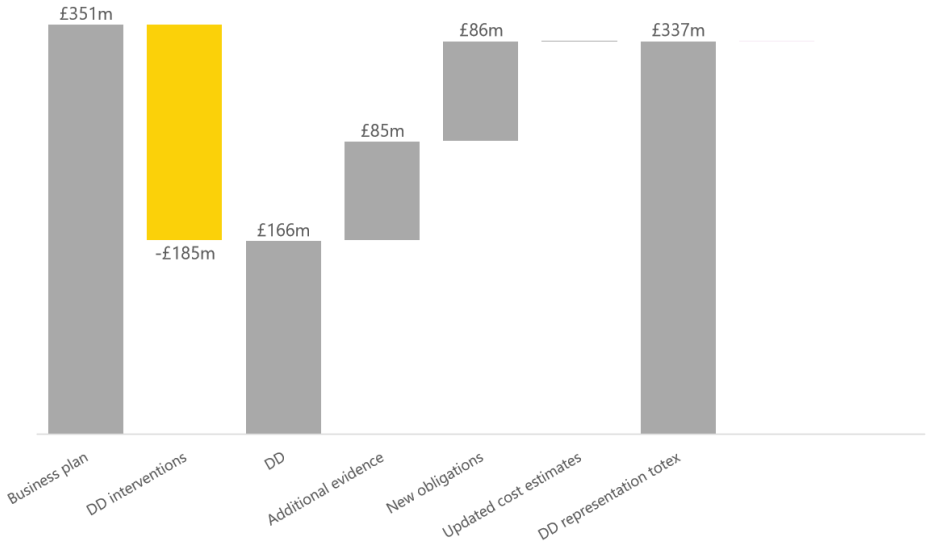


Figure 1 Representations investment summary



2 Greenhouse Gas Reduction

2.1 Investment Summary

	March 24 Business Plan (£m)	DD Ofwat position (£m)	Representation (£m)
Capex	152.4		75.9
Opex	-0.2		0.4
Totex	152.2	64.4	76.2

In our updated data tables, these costs are reported against lines CWW3.177-CWW3.179 (Greenhouse gas reduction (net zero)) and associated CWW12 and CWW17 lines

2.2 Context

Our PR24 investments were developed to deliver on our SDS ambition to be a carbon neutral business, as well as to align with our Net Zero Routemap and our Long-Term Delivery Strategy. We proposed to invest £153m to reduce process emissions at 17 of our largestWater Recycling Centres, replacing 12 Heavy Goods Vehicles (HGVs), 26 tractor units, fourhook-lifts and four tippers with electric equivalents, and three gas-to-gridprojects.

2.2.1 Ofwat's DD approach

Ofwat determined cost allowances for our net zero schemes through a three-phase assessment process. Our schemes were assessed through the following phases:

1. Net zero challenge eligibility, to determine if schemes were considered eligible and not related to other cost drivers
2. Best value assessment, to determine the ability of schemes to support sector innovation and learning. A deep dive was conducted into proposed process emissions schemes.
3. Unit ranking cost, based on: 1) unit rate of emission abatement for each investment, and 2) the lifetime unit costs of carbon abatement.

Ofwat's DD permitted totex allowance for our net zero programme is £64.418m.

2.2.2 Process emissions - Nitrous oxide

During stage 1 of assessment, Ofwat rejected the following schemes where they perceived that schemes should be delivered through base expenditure.

All the rejected schemes related to delivering Real Time Nitrous Oxide Control sensors and monitoring equipment.

- Cotton Valley WRC Fugitive emissions N2O
- Basildon WRC Fugitive Emissions N2O
- Bedford WRC Fugitive Emissions N2O
- Kings Lynn WRC Fugitive Emissions N2O
- Newton Marsh WRC Fugitive Emissions N2O
- Broadholme WRC Fugitive Emissions N2O
- Great Billing WRC Fugitive Emissions N2O

During stage 2 of assessment, the following schemes were rejected for the reasons outlined below:

Table 1 Schemes rejected in the Draft Determination

Scheme name	Ofwat reasoning for rejecting scheme
Whitlingham STC Fugitive Emissions N2O	Overlap with IED, as scheme is connected to a covered liquor treatment plan.
Hitchin WRC Fugitive emissions N2O	Ofwat state these schemes use existing proven technology to manage and improve the operations of the asset, therefore come under general maintenance and base spending.
Huntingdon WRC Fugitive Emissions N2O	
Whitlingham WRC Fugitive Emissions N2O	Ofwat states these schemes propose to use technology which is represents an improvement in operations of the asset, and therefore come under general maintenance and base spending.
Colchester WRC Fugitive Emissions N2O	

2.2.3 Process emissions - Methane

During the stage 1 of assessment of our CH4 fugitive emissions schemes, Ofwat states that the primary driver for methane capture in the bioresources stage of wastewater treatment is Industrial Emission Directive (IED) methane requirements, although they acknowledge these schemes also have net zero benefits. Therefore, the requested totex for methane reduction is disallowed as net zero enhancement driven expenditure.

2.2.4 Gas-to-grid

During stage 1, Ofwat rejected the full allowance for the 8 gas-to-grid schemes. Ofwat state they expect these schemes to be funded by base expenditure.

2.2.5 HGV electrification

During stage 1 of assessment, Ofwat rejected the schemes included on lines CWW22.31-35 inclusive for the electrification of our HGVs, stating transport has historically been considered base expenditure.

2.3 Our Representations

2.3.1 Process emissions: nitrous oxide

We welcome that Ofwat has permitted an allowance for our nitrous oxide reduction schemes at 8 sites. However, we request that at Final Determination Ofwat also makes an allowance for the nitrous oxide schemes which relate to the provision of Real Time nitrous oxide (N20) Control where an allowance has not been made at Draft Determination (which equates to £10.345m).

Ofwat's Draft Determination allows expenditure for Severn Trent 'Digital Twin' solutions for N2O. We consider that our proposal considers the same range of N2O solutions which includes 'digital twin' concepts for N2O real time control and should be treated the same as Severn Trent's 'Digital Twin' schemes.

The Real Time N2O Control (as defined in the Ofwat Net Zero Transition Report, including 'Digital Twin' N2O solutions) which we propose for these schemes differs substantially from current real time control implementation. Traditional RTC focuses on effluent quality and energy usage through manual set point optimisation, therefore we agree optimising WRFs for effluent quality and energy is business as usual and should be funded through base allowances.

Whereas, for N2O optimisation, which presents an innovative approach to monitoring for the purposes of process optimisation. Real Time N2O control includes digital tools such as Machine learning/Artificial intelligence and mechanistic modelling, therefore Real Time N2O control is within the 'digital twin' family of solutions. For N20 control, monitoring is connected to online monitoring and process control systems, such as adjusting air flow or ammonia-based aeration control (ABAC). Our trial real time N2O control monitoring programme (trial monitors installed at Cambridge, Cotton Valley, Cliff Quay and installing at Whitlingham) and knowledge from other studies has shown that accurate, continuous nitrous oxide monitoring of treatment processes will allow insight and understanding into patterns of production and enable identification of operational changes to mitigate. Combined with monitoring other operational parameters (Dissolved Oxygen, flow, load etc), an optimised operating regime can be developed and implemented using an advanced process control system. Long term monitoring will be essential to maintain the optimisation, calculate the benefit, and also to develop a more accurate understanding of emissions over time, informing future emissions reduction and deriving an accurate emission factor for the sector when reviewed alongside data from other sites.

This represents a significant step-change in our ability to minimise N20 emissions through this innovative approach, exploring how machine learning and AI optimise processes to reduce the emissions associated with our operations in real time. Based on emerging global evidence these emerging advanced or real time control solutions will move from trial and innovation scale to implementation scale over the course of AMP8; we believe these real time N2O control solutions are our best opportunity to reduce N2O. As this technology is not currently widespread and presents a novel approach to N20 emissions which will build industry understanding for the development of solutions in AMP9, we continue to believe that the costs associated with instruments, control software and hardware is not currently base expenditure and should be reflected as enhancement expenditure.

Ofwat should therefore permit an allowance for our Real Time Control N2O solutions as these are aligned with best available solutions and include digital twin options.

Therefore, we request Ofwat make an enhancement allowance at Final Determination for the following schemes:

1. CWW22.5 Whitlingham STC Fugitive Emissions N2O
2. CWW22.6 Cotton Valley WRC Fugitive Emissions N2O
3. CWW22.7 Great Billing WRC Fugitive Emissions N2O
4. CWW22.8 Basildon WRC Fugitive Emissions N2O
5. CWW22.9 Bedford WRC Fugitive Emissions N2O
6. CWW22.10 Kings Lynn WRC Fugitive Emissions N2O
7. CWW22.11 Newton Marsh WRC Fugitive Emissions N2O
8. CWW22.12 Broadholme WRC Fugitive Emissions N2O
9. CWW22.15 Hitchin WRC Fugitive Emissions N2O
10. CWW22.18 Huntingdon WRC Fugitive Emissions N2O

If Ofwat requires any further information to support these investments, we would be happy to provide this through the query process.

2.3.2 Process Emissions: methane

We recognise that Ofwat views IED as the primary driver of our proposed investment to address CH4 fugitive emissions. On this basis, we have reallocated our proposed totex for our CH4 fugitive emissions schemes to our bioresources (IED) enhancement strategy. We request our totex for CH4 fugitive emissions schemes to be assessed by Ofwat as part of our bioresources enhancement strategy following our representations.

2.3.3 Gas-to-grid

In line with Ofwat's assessment, we remove the costs associated with gas-to-grid from our requested net zero totex.

As outlined further in our representations related to the Operational GHG Emissions (WR) performance commitment, although we accept that we should deliver gas-to-grid schemes from base expenditure, this creates a challenge for the calibration of our performance commitment level due to the lost net zero benefit from export of bio-methane. With delivery of our G2G schemes through base expenditure, we would look to secure investment for these schemes through the sale of Renewable Gas Guarantees of Origin (RGGOs) to third parties. This is in line with the approach taken by the companies that delivered their gas-to-grid scheme through base expenditure at PR19. Under the performance commitment definition and guidance, it is stated that the export of biomethane is only a benefit that is measurable against the PCL if the RGGOs are retained. Reaching the proposed target for the Operational GHG Emissions (WR) PC would therefore be unachievable if we are required to sell our RGGOs to deliver these investment as we would no longer able to account for the export of biomethane which is a significant driver of our benefit against this PCL. We request the PCL is adjusted to account for the reallocation of gas-to-grid schemes to base expenditure allowances. More detail is available in our PC specific representations for the Operational GHG Emissions PC [1].

2.3.4 HGV Electrification

We recognise that Ofwat has introduced an uplift in base expenditure of approximately £7m to cover investment into EV infrastructure and low carbon heat to support the transition from fossil fuel to low carbon vehicles. Given this uplift is broadly in line with the expenditure requested through enhancement cost assessment, we believe we can deliver our programme to decarbonise our HGV fleet through this base allowance uplift. Therefore we remove £7.617 from our requested enhancement allowance.

We note that as a result of the uplift in base expenditure, Ofwat apply a 2.5% efficiency challenge for the Operational GHG Emissions (water recycling) PCL to account for this. As we had already accounted for the benefits of our HGV electrification programme in OUT1-3, there is a risk of accounting for the benefits of this programme twice when calibrating the PCL for this performance commitment. We address this further in our PC specific representations for the Operational GHG Emissions PC.

1 see ANH-DD-017

3 Sludge

3.1 Investment summary

	March 24 Business Plan (£m)	DD Ofwat position (£m)	Representation (£m)
Capex	169.9		235.2
Opex	28.7		25.3
Totex	198.5	101.5	260.5

In our updated data tables, these costs are reported against lines:

- CWW3.137-CWW3.139 (Sludge storage - Cake pads / bays / other; (WINEP/NEP)) and associated CWW12 and CWW17 lines [2]
- CWW3.143-CWW3.145 (Sludge treatment - Thickening and/or dewatering; (WINEP/NEP)) and associated CWW12 and CWW17 lines
- CWW3.146-CWW3.148 (Sludge treatment - Other; (WINEP/NEP)) and associated CWW12 and CWW17 lines
- CWW3.162-CWW3.164 (Sludge enhancement (growth)) and associated CWW12 and CWW17 lines
- CWW3.185-CWW3.186 (Additional line 3; Bioresources Resilience) and associated CWW12 and CWW17 lines
- CWW3.187-CWW3.188 (Additional line 4; Bioresources - Non WINEP cake pads) and associated CWW12 and CWW17 lines
- CWW3.189-CWW3.190 (Additional line 5; Bioresources - IED and Reg changes) and associated CWW12 and CWW17 lines

3.2 Context

This investment in our business plan comprised five elements:

- New Sludge Treatment Centre (STC) capacity
- Adaptive planning
- WINEP investments related to the no deterioration driver
- IED containment
- Enhancements to open cake storage

Sludge is a valuable output of our water recycling process which should be treated as a resource that can deliver environmental and economic benefits rather than a waste. Sludge enhancement is specified by the EA under the WINEP no-deterioration and improvement drivers. Further to this, additional resilience capacity is required within our STC network to mitigate against seasonal sludge production peaks, improve operational resilience, reduce environmental compliance risks associated with buffering and manage sludge stocks.

3.3 Ofwat's DD approach

3.3.1 Bioresources WINEP

Ofwat assessed the efficiency of costs relating to drivers included in the WINEP to enable improvements in bioresources. The following table summarises the assessment method and Ofwat determination by bioresources WINEP area:

Table 2 Summary of Ofwat assessment method and determination

WINEP Investment area	Ofwat assessment method	Ofwat determination	DD allowance (£m)
WINEP sludge storage cake	Modelled	Ofwat used a median unit cost approach, using the area of cake pad required (m2) as the cost driver. WINEP efficiency adjustment is applied	53.2
WINEP sludge treatment thickening	Shallow dive	Ofwat permit our full requested totex through the shallow dive assessment. WINEP efficiency adjustment is applied	15.6
WINEP sludge treatment other	Deep dive	Failed on need for enhancement investment. Ofwat state there is a possible investment need, however state we have not provided sufficient evidence of how this investment overlaps with base maintenance activities, so the need for this investment under enhancement is unclear.	0

2 Note that in the table above and in the data tables we have included our original business plan totex of £42.36m on this investment line. This is an error and should be £53.22m, aligning with Ofwat's Draft Determination view of costs. This is reflected in the enhancement strategy below.

3.3.2 Industrial Emissions Directive (IED)

Ofwat determined its view of an efficient allowance for achieving compliance with IED requirements through a hybrid approach to modelling, using scheme level econometric modelling for secondary containment and tank covering costs, alongside company level unit cost benchmarking for all other IED costs.

This approach led Ofwat to determine our efficient allowance for IED enhancement is £29.1m.

3.3.3 Other bioresources enhancement

Where required to improve resilience during seasonal production peaks and increase capacity to cater for new housing growth in our region, we also made an enhancement totex request. Ofwat assessed this investment through a deep dive, with sub components assessed separately:

Table 3 Summary Ofwat deep dive assessment

Investment area	Ofwat determination	DD allowance (£m)
Bioresources resilience	Investment rejected at need for enhancement investment assessment stage. Ofwat state that although this investment aligns to our wider bioresources strategy and our Long Term Delivery Strategy, there is not sufficient evidence of the issue being quantified or evidence that there will be a notable step change in service. Ofwat requests further evidence that throughput will outstrip capacity in AMP8 due to changes in asset uptime strategy. Ofwat state further evidence is needed on why growth cannot be managed through base activity. On cost efficiency, Ofwat ask for further detail on the cost estimation approach, as well as asset sizing calculations. They also request detail on why the location is suitable for investment at Colchester.	0
Bioresources non WINEP cake pad	Most investment was rejected at the need for enhancement investment assessment stage. Ofwat allowed the costs relating to increasing the height of storage walls where required to provide additional storage capacity, but disallowed the costs relating to fixing bases, stating this should be funded by base expenditure.	3.59
	All other costs relating to the refurbishment of existing cake storage areas are disallowed, as Ofwat stated insufficient evidence is given of changes in regulations to cake storage areas that would require enhancement expenditure.	

3.4 Our Representations

This relates to the proposed 23,000TDS/yr of additional capacity to be delivered at Colchester in a new co-located STC to be operated under a separate permit alongside the existing Colchester STC (this will increase the total combined treatment capacity of Colchester to 37,800TDS/yr).

The Draft Determination allowed no costs for the proposed increase in capacity at Colchester Sludge Treatment Centre to accommodate growth and deliver a step-change in bioresources resilience. For the Sludge enhancement (growth) portion of the costs, Ofwat considered that costs are included in base allowances. For the Bioresources resilience portion of the costs, Ofwat conducted a deep-dive which challenged the need for investment, whether it is the best option for customers, and the cost efficiency of the scheme.

We have reviewed both the investment and Ofwat's assessment of it to consider whether we should align our costs with Ofwat's Draft Determination and remove these costs from our enhancement request. We consider that the allowance to deliver the full increase in capacity is required through enhancement allowances, and we have provided further evidence in relation to this investment to respond to Ofwat's challenges on this scheme. We have reduced our requested allowance to reflect the removal of gas-to-grid scheme costs, aligning with Ofwat's assessment of gas-to-grid schemes in its net zero assessment.

We have split the £69.4m enhancement totex required to deliver this additional capacity between 'Sludge enhancement (growth)' (CWW3.162-3.164) and 'Bioresources resilience' (Additional line 3, CWW3.185-186), reflecting the duel drivers of the need for the scheme. Ofwat assesses the two components of the scheme separately. As this is a single scheme, we consider that the whole scheme should be assessed as one.

We acknowledge the challenge that Ofwat has made in these areas. Below we provide representations to provide additional evidence on each of the areas of Ofwat's cost challenge in turn:

- Implicit base allowance for sludge enhancement (growth) costs
- Need for investment
- Best option for customers
- Cost efficiency

The evidence below directly responds to the challenges Ofwat raised in its Draft Determination. This information supports our £69.4m expenditure allowance. Given the importance and materiality of this investment, we request that Ofwat asks for further information if requires additional information.

Implicit base allowance for sludge enhancement (growth) costs

Ofwat made no allowance for growth pressure on bioresources through enhancement allowances. Instead, it suggests that this expenditure is reflected in the bioresources base cost allowance.

To understand the net enhancement requirement of the increase growth capacity, we have calculated the implicit allowance for bioresources in the the Draft Determination base cost models. The Implicit Allowance (IA) for Bioresources Growth in the Ofwat Draft Determination (DD) base cost models is -£4million (after the application of Frontier Shift and Real Price Effects). In other words, the models forecast that the costs of treating our total sludge production will fall by £4m with the addition of an additional 23,000 tds/yr (15% of current production) to our sludge make. Given this negative allowance, we are confident that the growth element of our bioresources costs have not been allowed within the published DD Bioresources base cost allowances.

In the Final Methodology Ofwat excluded growth at WRCs from the waste water network plus base cost models. We supported Ofwat's decision as we think the absence of any cost drivers capturing the required step change in costs created significant limitations at PR19 on the ability of the models to properly fund the expected growth. We consider that the same approach should be taken on bioresources growth costs given the evident failure of the base cost models to control for a step-change in capacity due to growth.

We request that Ofwat addresses this by assessing sludge growth through a deep dive enhancement assessment, reflecting that the additional capacity requested at Colchester is a single scheme. Alternatively, if feasible, Ofwat could assess growth costs through a separate cost model.

Need for investment

In its Bioresources deep-dive Ofwat challenged the need for enhancement investment on three points:

- The need for a step change to deliver resilience:*The company has not sufficiently quantified the problem requiring investment. The company has not provided evidence that demonstrates a notable step change in service or performance within this enhancement case.*
- The need for enhancement:*The company does not provide sufficient and convincing evidence for enhancement need.*
- The need for additional capacity beyond growth:*The company has not explained why the proposed investment could not be managed through growth as an ongoing base activity. A portion of the spend within this scheme is allocated to the Sludge Growth cost line, and it is not clear why this portion is not sufficient to manage sludge growth and deliver the required capacity.*

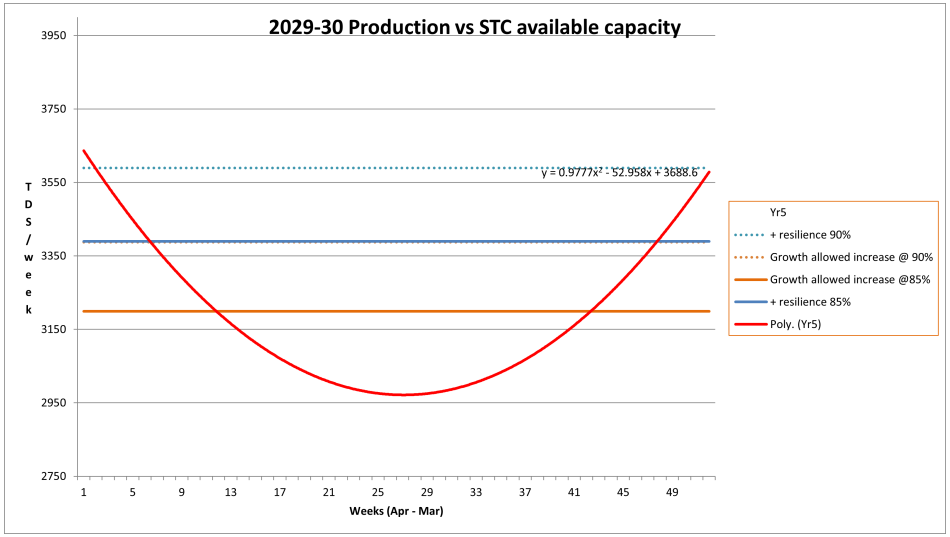
We set out further evidence to address these three points below.

The need for a step change to deliver resilience

Context

Sludge production is not constant and varies across the year. Greater volumes of sludge are produced in winter months through to mid/late spring than in summer/autumn. This is because of seasonal changes in behaviour in catchments, changes in the biological processes used in treatment and the impact of temperature on the volatilisation of organic compounds. During the peak season sludge production - and therefore demand for sludge treatment capacity - can be up to 12% higher than the daily average production over the whole year. In summer months, sludge production can be 12% below average. This is shown in the graph below with the expected 2029/30 production volumes (red solid line).

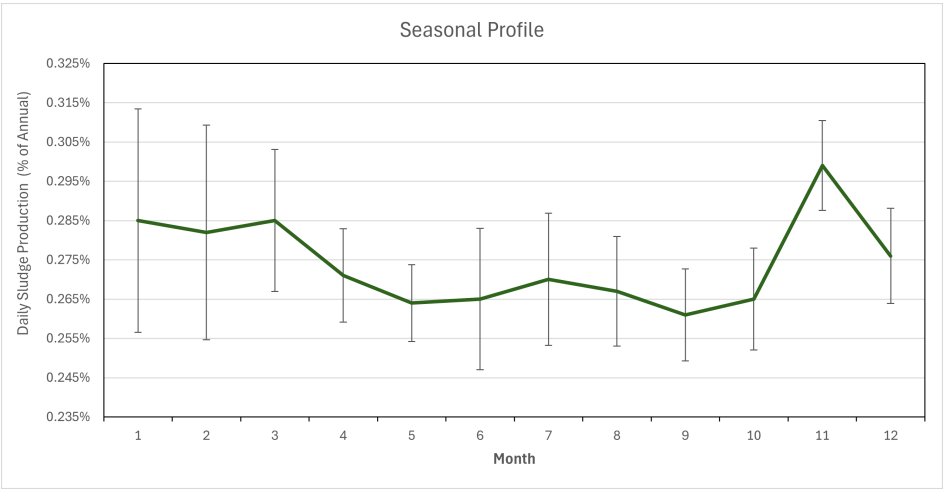
Figure 2 2029-30 sludge production versus STC available capacity



- The blue solid line shows total STC capacity, assuming an average STC uptime of 85% and including the proposed 23ttds/yr additional capacity. In this scenario 99.5% of sludge produced can be accommodated when operating at 85% capacity utilisation.
- The solid orange line shows the capacity without the additional resilience capacity and includes only the 11.304 ttds/yr additional capacity to cater for the extra sludge production arising from WINEP. In this scenario sludge production is greater than available capacity for 25 weeks of the year. If this sludge cannot be buffered and stored then circa. 4.660 ttds/yr (which equates to more than 18,500 wet tonnes of raw cake) would need to be traded out to third parties for treatment or treated by mobile lime stabilisation.

This profile is typical of what is experienced by all WaSCs as shown in the chart below showing the collated seasonal profiles across WaSCs. The relevance of this is that peaks of demand occur simultaneously across all companies. This severely impacts any company's ability to treat the sludge of another and is a major obstacle to inter-company trading.[3]

Figure 3 Seasonal sludge production profile



In AMP6 and AMP7 we have taken an approach to creating additional treatment capacity when sludge production is forecast to exceed 90% of the installed capacity. We did this in the expectation that we could find alternative ways to manage through seasonal production peaks, including by making use of third party treatment providers. Some of these workarounds have failed to materialise and others are becoming less reliable. We see little prospect of change in the foreseeable future. The primary reason for the resilience investment we have proposed is therefore to ensure we have sufficient capacity and headroom to manage our bioresources asset base whilst sustainably discharging our obligations in the treatment and safe disposal of sludge produced.

The means we hoped to employ to get us though seasonal production peaks are set out below. Over AMP7 we have seen pressures on our ability to rely on these, which mean that we now need to increase our own treatment capacity to improve the resilience of our bioresources operations.

- Industry-wide sludge treatment capacity
- Market trading capacity
- Permitting requirements

The challenges associated with each of these are explored further below.

3 Thiswas demonstrated in the report commissioned by WaterUK from AtkinsRealis (March 2023). The figure is an extract from the report, representing data collected for seasonal profiles from the sewerage companies.

Industry-wide sludge treatment capacity

WaterUK commissioned a project (Final Report - Mar 2023) on behalf of all WaSCs to support companies in preparing their business plans. AtkinsRealis were engaged to assess sludge treatment capacity on a national level and compare the approaches taken by WaSCs to balancing treatment supply and demand. This report concluded that there is insufficient capacity nationally to treat all the sludge produced during the peak months of sludge production.

For Anglian Water, AtkinsRealis found that we currently have insufficient installed sludge treatment capacity to treat all sludge produced during peak months as we have to store/buffer, use mobile temporary treatment or look for short term trades with neighbours to manage this risk. However this is not a sustainable approach.

The AtkinRealis analysis supports our own analysis that to reduce operational risks and ensure a stable, resilient service for the sustainable treatment and disposal of sludge we require additional resilience capacity.

Market trading capacity

At PR19 we set a 90% capacity utilisation target, which was a significant increase compared with the industry norm and with targets set by comparable sectors. This target was set on the assumption that we could make use of increased inter-company / third-party trading. The scale of this was anticipated to increase as a result of changes made by Ofwat to the bioresources price control and planned changes to environmental regulations by the EA which would enable the co-treatment of bioresources and other organic wastes. We considered that trading would enable the risk associated with this greater capacity utilisation target to be balanced against the construction of new STC capacity.

The sludge trading market has not established as was anticipated at that time. Regulatory uncertainty associated with interpretation of the Farming Rules for Water (FrfW), the introduction of the Industrial Emissions Directive (IED) for anaerobic treatment of sewage sludge, the delay of the introduction of the EA sludge strategy and limited capacity within neighbouring WaSC's have all contributed to limiting trading to short term mutual aid type trades between companies. No guaranteed capacity trades under long term contracts have been established.

This was recognised by the CMA during its PR19 Redetermination. In allowing funding for additional capacity at Whitlingham STC it said "*there are likely to be limited or no third-party suppliers in the foreseeable future to which it is able to outsource these services (either other WASCs or non-WASCs).*"

This was also highlighted by Jacobs in a report for Ofwat on the Bioresources market. "*Water companies [make use of the unused appointed capacity of another water company]already but usually for "emergencies". We consider this to have limited potential due to transport distance and lack of tradeable capacity."*Jacobs considered that the key reasons for this were the lack of industry headroom capacity and that third-party entrants were not entering the market. Our view is since the time of Jacobs report market conditions for long-term bioresources trades has become more challenging.

We continue to actively explore market options. For example, Project Firefly is a project to turn sewage sludge to sustainable aviation fuel (SAF) using an advanced thermal conversion process known as Hydrothermal Liquifaction (HTL) to create a bio-crude oil that can be further processed at an oil refinery to create SAF. In this exciting, ambitious and innovative project, our intent is to provide Firefly with biosolids as a feedstock for their planned demonstration facility at Harwich. If this proves successful, this has potential as an alternative future alternative outlet for sludge. However, this is highly innovative, involves complex planning and engineering and the demonstration plant will not be operational until 2028/29. The process must be proven and the fuel must pass stringent testing to prove it can be safely used in aircraft. As a result whilst this is clearly an opportunity to explore, it does not have the certainty and market readiness to address the capacity and resilience needs in AMP8.

Permitting requirements

Operational and regulatory pressures have arisen over AMP7 and placed additional pressures on our treatment capacity for sludge. Our operational planning across AMP7 for management of sludge during peak production has been to dewater and store the raw cake material. This is then most commonly treated and deployed to agriculture by hiring mobile lime stabilisation treatment systems. During AMP7, our ability to store raw cake and treat with lime stabilisation has become increasingly difficult. On some sites where we have historically undertaken lime stabilisation this activity has become impossible due to changes in permitting requirements.

Need for a step change - conclusion

In practice during AMP7 we have had to rely on buffering and storage of dewatered raw sludge cake and temporary mobile lime stabilisation to deal with periods when sludge production exceed our treatment capacity. Looking forward, we see:

- an increase in the volumes of sludge we have to treat
- more weeks in the year when production exceeds our treatment capacity
- little prospect of an increase in third party capacity to handle our excess, and
- threats to our ability to store raw cake and lime treat.

We have concluded that the 90% base utilisation target is not sustainable as a long-term target and this risk cannot be mitigated as we originally envisaged. We are therefore adjusting to a 85% utilisation target, in line with other companies and other similar process industries with production-type plants.

We consider that we have followed the right approach historically to encourage the use of markets to treat additional sludge production during peak periods. Following this approach, assuming capacity utilisation of 90% meant that we could allow for no capacity increases where it was expected that this would be provided through market mechanisms. Now that it is clear that these markets have not developed, there is a clear need to return to a capacity utilisation assumption of 85% to avoid the negative customer impacts.

The need for enhancement

The sections above, highlighted the factors driving the need for an increase in bioresources resilience capacity. Here we highlight why this additional resilience capacity is important.

In our business plan enhancement strategy (ANH28), we quantified the risk of not providing the additional capacity (using our Value Framework to quantify this risk) and the benefit from our proposed investment in reducing this risk. We quantified the benefits of building capacity in line with our resilience position, as well as the baseline and growth only position. Our Value Framework was developed to enable us to express different risks, benefits and disbenefits in a common language (£). This allows us to appraise and compare the benefits of different investments or options leading to more informed, better value decisions.We quoted the total benefit of providing 23 ttds/yr of additional capacity but did not break down the risk benefit between the growth and resilience capacity investment lines. We have now reviewed values and broken down the risk benefits by investment, as presented in the table below:

Table 4 Risk and benefits assessment

Measure	Level	Baseline (£k)	Growth only (£k)	Growth Resilience (£k)
Pollution	Cat 4	358.6	418.4	2.1
Permit Failures & Discharges	WRC Quality Compliance OSM Sample Fail	4,977.6	4,977.0	33.2
Customer	Odour	667.8	667.8	1.1
Total risk		6,003.9	6,063.1	36.1
Risk benefit from investment		n/a	-59.2	5,968.0

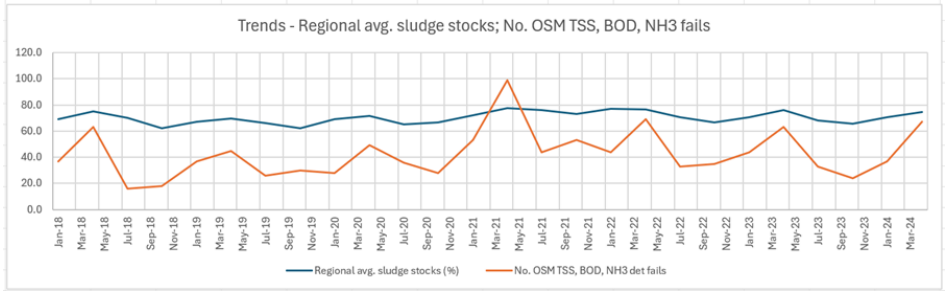
The table shows that investment to provide additional capacity for only relating to growth fails to provide any risk mitigation, as providing additional capacity that merely matches projected growth over the period erodes percentage headroom capacity. Eroding headroom increases the likelihood of category 4 pollution events as it means more sludge needs to be buffered and stored as raw untreated cake at times when sludge production outstrips available treatment capacity.

Therefore, the findings of this process showed us that building to a growth only position would not deliver any benefits in relation to existing/anticipated issues relating to pollution, water recycling centre compliance and odour and therefore does not represent value for money. Building to a resilient position delivers a significant reduction in CAT4 pollution incidents, OSM sample failures at our Water Recycling Centres and Odour issues affecting customers. The baseline position would likely result in persistent pollutions to land from raw cake storage overspill/ run-off (contained at site boundaries), and the growth only scenario would also see a significant increase in stockpiling of raw cake during production periods. The resilient position would mean that storage of raw cake would be by exception only, and would reduce the risk of odour from persistent to one off.

Only the resilience investment provides the additional headroom capacity to deal with seasonal sludge production peaks and allows required planned outages of our assets to undertake required inspection and maintenance programmes. Accordingly nearly all the quantifiable benefit rests with resilience. With greater headroom the risk of having high sludge stocks in our WRCs over the critical winter/spring months of high sludge production reduces significantly. This reduces the need for storage of untreated raw sludge cake and mobile lime treatment. The resilience capacity reduces the risk of compliance failures by enabling improved management of sludge stocks, reduces pollution in the form of run-off from raw cake storage and reduces odour risks associated with raw cake handling and lime treatment.

To illustrate, we have analysed WRC compliance data over recent years.

Figure 4 Regional sludge stocks and compliance failures



The graphs show an increase in regulatory sample failures each year over winter / spring periods when sludge production is at its highest and exceeds treatment capacity. In these periods we will typically be mitigating this risk through enhanced operational practices and management intervention to reduce stock levels by dewatering and storing as raw cake.

To illustrate this note the sharp increase in failures in the late spring / summer of 2021 when sludge stocks remained higher than typically seen at this time of year. The cause of this deterioration was that our largest STC at Gt Billing was offline for urgent maintenance. The STC at Gt Billing provides over 20% of the installed capacity available, meaning whilst the site was offline sludge production exceeded available capacity. Compliance issues over that period were significantly higher than normal, replicating what we normally see over the winter / spring period and reinforcing the need and benefits of having sufficient resilience capacity available.

The learning from the data is that as headroom capacity falls the risk of compliance failures rises.

Growth capacity

Each pair of rows in the following table represents a different investment scenario. For each we show the resulting STC maximum capacity and percentage required uptime for each year across AMP8. The Growth & Resilience scenario (yellow highlight) is as submitted in our October 2023 business plan. In our view, in which no allowance for growth is provided by the base cost models, the Draft Determination position is represented by the No Investment (blue) scenario.

Table 5

AMP8 year	Scenario	1	2	3	4	5
TTDS	No Investment	180.97	180.97	180.97	184.94	184.94
Required uptime		89.7%	90.3%	90.7%	90.9%	93.6%
TTDS	Growth Only	180.97	180.97	180.97	196.24	196.24
Required uptime		89.7%	90.3%	90.7%	85.7%	88.2%
TTDS	Growth plus headroom	180.97	180.97	180.97	198.23	198.23
Required uptime		89.7%	90.3%	90.7%	84.5%	87.3%
TTDS	Growth & Resilience	180.97	180.97	180.97	207.94	207.94
Required uptime		89.7%	90.3%	90.7%	80.9%	83.2%

This table demonstrates that without resilience investment there will be a deterioration in headroom capacity. It also shows that under the Growth only scenario the required 15% headroom allowance is not provided. Therefore, investment for resilience would have a significant benefit by reducing the potential need to store, export or temporarily treat sludge if sludge production outstrips treatment capacity. Where headroom is above 85%, there is a significant risk that we will be required to undertake these activities which, as outlined previously, is not sustainable.

Summary

In summary, resilience capacity is needed to ultimately remove the requirement to stockpile raw sludge cake during peak production periods for redistribution and treatment during the summer months, and to remove the need to lime treat surplus raw sludge cake in this period. Only the full additional capacity of 23ttds/yr included in our original plans meet the business need and the challenges faces by the sector. Therefore this cannot be delivered through growth driven capacity only.

Additional growth capacity alone will expose our operations (and therefore the service we provide to customers) to unacceptable levels of risk, resulting in erosion of the existing limited headroom and increasing capacity risks for the business. We have demonstrated we have adequately invested to provide capacity in previous AMPs, and that looking forward in AMP8 we cannot guarantee that viable and

resilient market solutions can be provided to address the required need. Therefore, this additional capacity provides a step-change in performance from current operations and ensure that the sufficient treatment capacity is delivered to meet the identified need.

Permitting an allowance for delivery of additional capacity of only 11.3ttds/yr would significantly increase operational risks associated with the bioresources price control due to the erosion of headroom. As reaffirmed by CIWEM and Atkins' report into capacity and headroom across the industry, STC treatment capacity is a significant risk across the sector. Lack of capacity to manage seasonal variations in sludge production and capacity to undertake required maintenance also presents a risk to the network plus price control because without a resilient outlet for onward sludge treatment and disposal, sludge would likely accumulate on wastewater sites in process units. This leads to a increased risk to sewage treatment compliance and/or would require temporary storage as raw dewatered cake, giving an increased risk of pollution to land, air and water as a result of liquor run off and odours.

The delivery of additional capacity of 23ttds/yr is the right customer outcome, as it supports us to mitigate seasonal production peaks and associated sludge storage, and therefore to reduce potential pollution from raw cake storage and reduce odour risks associated with raw cake handling and lime treatment.

We request that Ofwat permit the full allowance for our Bioresources Resilience investment on this basis.

Natural Capital and Carbon Values

Ofwat requested further evidence that carbon and natural capital values of options have been considered. We provide this evidence here.

Carbon and Natural Capital solutions are considered in all options assessed. These metrics are key criteria in our investment planning process, from initial option identification and selection through detailed design, construction to project completion. For business planning we identified and assessed options through our Bioresources Technical Working Group responsible for area of PR24 investment planning. Long list of options was assessed at a desk top level using our value framework and options shortlisted were fully scoped, costed and assessed using our Copperleaf C55 investment management system. The value framework and the Copperleaf system uses the same framework and both will value carbon and natural capital.

Specifically for this investment the key driver was the need to increase our sludge treatment capacity. From a natural capital and carbon view point the following was assessed and concluded;

- Natural capital: there are not viable no build or nature based natural capital solution for new biosolids treatment capacity. However, our evaluation carefully considers the impact on the environment of the respective options. For example, selecting the option to **not** create any new resilience capacity would most likely result in the need to treat surplus sludge via lime stabilisation as we have stated. With lime stabilisation there is no organic reduction across the treatment process and the volume of product increases with the addition of lime.
  Our preferred resilience option using Advanced Anaerobic Digestion deploys current state of the art technology maximising organic conversion across the treatment process. Comparing these options, lime treatment for every raw tonne dry solid of sludge treated produces 4.2 wet tonnes of biosolids cake, whereas for our preferred resilience solution for every raw tonne treated just 1.68 wet tonnes of biosolids will be produced. Therefore, considerably greater volumes of sludge will need to be stored and transported with a significantly larger area of agricultural land will also be required for deployments.
  With available agricultural land modelled to reduce over time as nutrient management rules to reduce diffuse pollution from agriculture are applied under Farming Rules for Water. Whilst this deployment activity is outside the scope of our value framework this is a significant influencing factor in decision making to ensure the option is sustainable and provides resilience solutions for the future.
- Carbon: Each option is assessed for both capital (carbon embedded in the construction of new assets) and operational (carbon for scope 1 & 2 emissions for operation of the asset) carbon over the asset over its design life. Carbon is part of our Natural Capital one of the 6 capital headings that make up the value framework.
  These factors together with Whole life cost, risk benefit and other metrics from our value framework are combined to assess and select the preferred option to be recommended for investment to give the overall best value solution for meeting the stated business need.

Cost efficiency

We provide a full cost breakdown to support assessment - in ANH_DD_22

Rationale for Colchester as the preferred location

Long term strategic planning

At PR19 we commissioned Business Modelling Applications (BMA) to build a 25 year long term strategic planning tool for our end-to-end bioresources operations. The tool created a digital twin of the bioresources operations from our >1,100 water recycling centres where the sludge is produced, transportation, satellite dewatering operations through to the regional sludge treatment centres then onward transport and recycling of biosolids product to agriculture. The model

considered location, capacity, asset life and all operating costs and revenue streams associated with the full operational activities set within the defined boundaries of the bioresources price control.

The model was used to test a number of scenarios, including immediate term investments that formed part of the PR19 business plan for AMP7 but also longer term investment needs over the full 25 year cycle as capacity demand increased over time and as some STC assets approach end of life. Scenarios considered when and where future sludge treatment capacity should be constructed.

Additional Capacity Location Scenarios

We identified and selected a number of candidate sites that the model could select as a preferred location, with the model configured to give the lowest whole life cost option as the recommended outcome.

The candidate sites were selected against the following criteria:

- Land availability - sufficient available land required to build a new STC
- Size / capacity of prospective host WRC - Consideration given to whether host works was of sufficient scale and capacity to host a STC, in terms of having sufficient infrastructure capacity for items such as:
- Tankered liquid and cake imports
- Receipt of return liquors
- WRC consent risk
- Power and site services infrastructure
- Town & Country Planning Risk.

The result of the screening identified nine of our existing 10 STCs as candidates for expansion (Chelmsford excluded due transport restrictions). Flag Fen (Peterborough) and Tilbury, which are current satellite dewatering facilities, were also deemed suitable for expansion to a full STC.

An initial unconstrained run of the model identified Cambridge as the recommended location for new STC capacity. However, as is well documented there is an active live project that is currently being considered at the planning stage to re-locate Cambridge WRC to a new location. This strategic project to unlock housing development land for Cambridge is being progressed through a Development Consent Order, meaning the planning approval process in more complex in nature. Only a like-for-like replacement is funded and would obtain planning consent by the Secretary of State. This essentially rules out any expansion of the Sludge Treatment Centre at Cambridge over that included in the application in the medium to long term.

The BMA model was re-run with Cambridge removed from the options. Colchester was then identified as the next best available location. This choice has then been adopted as part of our PR24 planning.

PR24 Validation

As part of the PR24 process we re-tested this conclusion using our more granular annual planning BMA model and have confirmed the value of installing the additional capacity at Colchester. We considered sites at Colchester, Whitlingham (Norwich) and Gt Billing (Northampton). These are the only STC sites with available land and capacity to host 23ttds/yr of additional capacity.

Our PR24 assessment also reviewed the feasibility of options for incremental capacity increase at all existing STCs. Whilst this could in theory accommodate the population growth-only element of the new capacity required, it does not open up sufficient additional capacity and would further erode our headroom and resilience position. In addition, it is not possible to practically deliver new capacity in the timeframe required across multiple STC site interventions. This is because STC assets would need to be offline on a number of sites at the same time which would result in significant capacity loss during the construction and commissioning period. There is not sufficient existing headroom capacity to achieve this using the existing asset base.

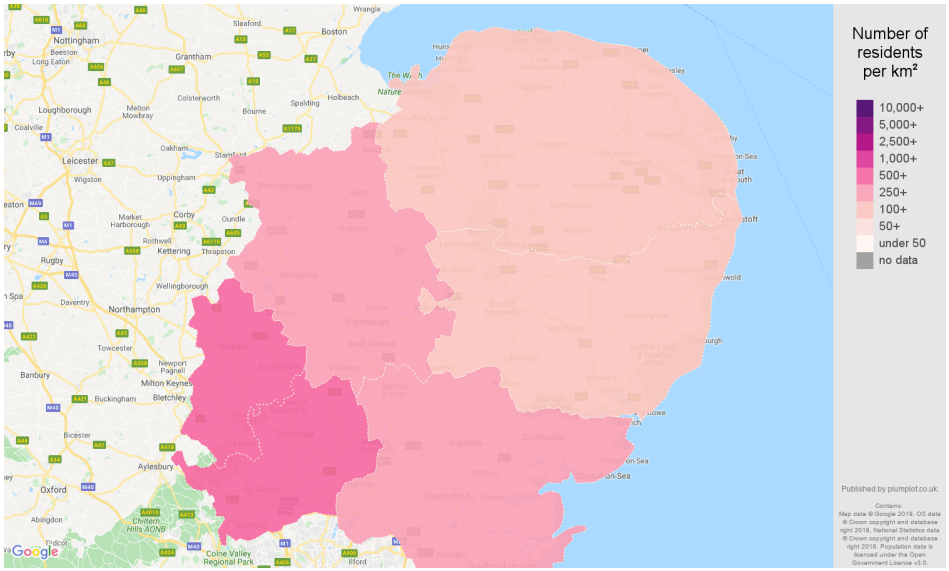
The assessment confirmed Colchester as the preferred choice to provide the lowest whole life cost solution. We will undertake a more detailed study around location risks and repeat the modelling prior to scheme commencement and detailed design.

Supporting Rationale

It is important to note that we operate our bioresources treatment centres in a network and manage sludge production and sludge treatment capacity to achieve the lowest end-to-end network unit cost. As a result, adding new capacity to a location means re-modelling the network and re-planning typical import routes to achieve the optimal outcome.

The map below shows population density for East Anglia:

Figure 5 East of England population density map shows a number of residents per square kilometer(km2), estimates from 2020.



Whilst it shows population density is greatest in the west of our operational area, this is also on the edge of our operating boundary and where we have our largest STC sites. We increased capacity at Cottonvalley STC (Milton Keynes) in 2020/21 to deal with local growth in the west.

As a result of this, locations for new STC capacity favour the central belt (Peterborough, Cambridge, Essex and the Thames gateway). This central area also is where many of the known growth hotspots exists. Areas to the east and north of our region are less population dense and have lower growth rates.

The growth rates and impact on sludge production are a significant influencing factor in the preferred location for new STC capacity. The modelling outcome which recommended Colchester is therefore consistent with prior expectations.

3.4.1 Sludge thickening

As our requested totex for sludge thickening matches the permitted shallow dive allowance, we retain £17.03m totex as our efficient view of costs for this investment.

3.4.2 Sludge storage - WINEP cake pads

As outlined within our enhancement strategy, we applied our double-lock cost efficiency approach in the development of our bioresources investment. Alongside commissioning the COCE Alliance to undertake a review of the bottom-up efficiency of our costs, as part of the double-lock efficiency challenge we also sought to use all available external cost benchmarking evidence to challenge our own costs. More details of our benchmarking activities can be found in section 3.3.2 of our enhancement strategy (ANH28).

Ofwat's PR24 cost model for sludge storage cake pads presents a significant external benchmark to support our double-lock approach, and provides a strong benchmark for our costs which was not available to us ahead of the Draft Determination. The model suggests that the industry benchmark for the scope of our cake pad investment is £55.84m, £13.48m more than the costs we included in our business plan.

As such, we adjust our enhancement request for cake pads to £55.84m to align with the allowance permitted through Ofwat's cost model.

3.4.3 WINEP sludge treatment - other

We confirm we remove our requested enhancement totex for the expansion of our spreading fleet. We will instead deliver this investment through base allowances.

3.4.4 Bioresources Future Technology Investment

We remove the £10m requested for the Bioresources Future Technology Investment from our plan, and instead will seek funding for research into deployable technologies through Ofwat's Innovation Fund.

We confirm we have reduced our requested totex for non WINEP cake pads to £3.59m, in line with Ofwat's deep dive allowance.

Ofwat has disallowed our costs associated with Farming rules for Water on the basis that it considers these to be covered under WINEP allowances (SUiAR). In Ofwat's WINEP allowances for bioresources, there are no allowances that cover the cost driver for this investment which is the regulatory uncertainty over landbank availability. We have therefore retained these costs in our business plan. We have reallocated theses costs from the IED and reg changes line to 'Sludge treatment - other'.

3.4.5 Industrial Emissions Directive (IED)

We have ten STCs which fall under the criteria for IED permitting.We have been an active member of the IED Task and Finish group which includes the other WaSCs where IED permitting is a requirement, alongside stakeholders from the

Environment Agency, Defra and Ofwat. The purpose of this group is to guide and develop industry standard guidelines to allow WaSCs to meet the requirements of IED. To support with decision making from this group, a UKWIR group has been established and has added the required further guidance and support to allow WaSCs to move forward with the implementation of IED into their respective businesses.

We have updated our costs in line with new IED requirements. The changes to the individual cost drivers are reflected in ADD14. This relates to increased scope requirements relating to:

- Secondary containment
- Tank covering for abatement of fugitive emissions
- Liquor sampling and other sampling requirements.

Because of these increasing cost pressures we have updated our requested totex for Industrial Emissions Directive investments from £29.1m to £115.2m. The details of the scope of our IED investments are set out in table ADD14, and below we provide an overview of the reasons driving this cost uplift.

Secondary containment

In the original business plan submission we assumed that the bund for secondary containment could be of lined earthen embankment construction and that a scrape and line technique could be used for the provision of the impermeable surface. In light of the updated risk assessment, and with notable concerns over the ability to maintain the integrity of these liners in an operational setting, we have produced our designs for approval on the basis of providing concrete surfaces. Alternative lower carbon materials will be considered for lightly trafficked areas. Earthen bunds may still be used in limited areas (site boundaries and areas with limited foot traffic) but they will be capped with concrete canvas to facilitate washing down in the event of any loss of primary containment.

Rainfall modelling was undertaken as part of the design process. This highlighted a requirement for significant drainage capacity to be installed into the bunded areas, and for existing drainage to be isolated and re-routed to control the risk of uncontrolled discharge of sludge in the event of a loss of primary containment. We have updated our costs for drainage channels, collecting drains and stormwater pump stations (sized to match a 1 in 30 rainfall event).

The scope of our IED investments have also been updated for the attenuation of rainwater in the event that it cannot be discharged to the head of works under storm conditions. This has been sized for eight days of containment as it is anticipated that flows from these tanks will not be returned in preference to flows from the site stormwater storage tanks.

We have also updated costs for the sealing of existing roadways within the bund. This includes for the formation of access ramps into the bunded area. Ramps have been specified wherever practicable in lieu of the previously selected flood gates. This is to minimise the likelihood of bund integrity being compromised through human error.

Tank covering for abatement of fugitive emissions

In our original business plan, we had been working to the principal of cover and abatement in line with the improvement condition in our issued permit. We undertook PAS110 Residual Biomethane Potential testing at each of the ten STC sites. The samples taken demonstrated consistently low level of residual methane production.

However, updated guidance around improvement conditions for new permits issued to the IED Task and Finish group on the 24th of July 2024, indicates that the EA expects any tanks post primary digestion to be connected to the gas header system. Our revised costs are now built up in line with providing this connection.

We had previously excluded our sites at Whitlingham, Cliff Quay and Kings Lynn from this line as the tanks at these sites are already covered and connected to odour control systems. In light of the revised guidance we will now be required to replace the existing tank covers with new covers suitable for the containment of gas above atmospheric pressure. On all tanks which now require covering the existing air mixing systems will need to be removed and replaced with gas mixing. We also propose to implement a mechanical degassing process prior to the post digestion storage tanks to minimise the levels of residual gas. The digestate will then be passed through a flash aeration stage to inhibit methanogenesis prior to dewatering. The flash aeration process will be connected to an odour abatement unit which will be required to be compliant with the stack emissions limit of 20mg/m3 TVOC (Total Volatile Organic Compounds) as per the permit.

Liquor sampling and other sampling requirements

Our original business plan made assumptions around the number of determinants to be tested per sample and the frequency of sampling. These estimates have been revised on the basis of work undertaken by the IED TAF group. There remains a degree of uncertainty over these costs as the determinants to be sampled and sample frequency are both subject to review after the first 12 months of data has been reported. We have made some assumptions that not all 150 determinants will continue to be sampled beyond this time. An independent laboratory has been engaged through the IED TAF group to undertake test samples. Costs are estimated to be approximately £5,000 per sample submitted for testing, with monthly samples required for three points per STC per month.

Additional sample points will be required to take the individual process samples required. Continuous flow monitoring of the individual discharges is required to establish the proportionality of the samples.

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