SRN-DDR-016: Bioresources AAD

Cost Adjustment Claim

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Version 1.0

from Southern Water

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Glossary

Term	Explanation
AAD	Advanced Anaerobic Digestion
ATC	Advanced Thermal Conversion
BAS	Biosolids Assurance Scheme
CAD	Conventional Anaerobic Digestion
CapEx	Capital Expenditure
CHP	Combined Heat and Power
DB	Design-Build
DBF	Design-Build-Finance
DBFOM	Design-Build-Finance-Operate-Maintain
DD	Draft Determination
DPC	Direct Procurement for Customers
EA	Environmental Agency
EIA	Environmental Impact Assessment
FRfW	Farming Rules for Water
IED	Industrial Emissions Directive
OpEx	Operational Expenditure
PCD	Price Control Deliverable
PIN	Prior Information Notice
RFI	Request For Information
SPV	Special Purpose Vehicle
STC	Sewage Treatment Centre
TDS	Tonnes Dried Solids
Totex	Total Expenditure
UK	United Kingdom
WaSCs	Water and Sewage Companies
WINEP	Water Industry National Environment Programme
WTW	Water Treatment Works
WwTW	Wastewater Treatment Works

1 Executive summary

Overview of claim:
In our October 2023 business plan submission, we requested £112.8m to fund a step-change investment in advanced anaerobic digestion (AAD) technology at two of our Sludge Treatment Centres (STCs) in Kent. We requested this funding as an adjustment to base via our Bioresources Cost Adjustment Claim (SRN21), acknowledging that this type of investment is best covered by base but that step-changes in technology are not captured by Ofwat's base models. In its Draft Determination (DD), Ofwat reallocated our base funding request to enhancement and then rejected it due to not meeting the enhancement criteria.

Because this funding request was rejected as enhancement and is not captured in Ofwat's modelled base allowance, our DD allowances provide insufficient funding to deliver this investment. Our DD allowances for both base and enhancement bioresource expenditure are presented in Table 1.

	Requested (£m)	Allowance (£m)	Delta (£m)	Delta (%)
Base	271	276	5	2%
Enhancement	204	108	-96	-47%
Kent AAD CAC	113	0	-119	-100%
Total	**588**	**384**	**-204**	**-35%**

Table 1: Southern water DD bioresources allowances.

Our cost estimate for this investment has reduced from £112.8m to £107.6m due to the inclusion of an implicit allowance for avoided future capital maintenance in AMP8 owing to the closure/upgrade of existing CAD assets.

There is regulatory precedent for funding transformative changes in sludge strategy through adjustments to base. However, step-change AAD conversions are not currently captured by Ofwat's model allowance as the model reflects industry costs from 2012 onwards, during which time there has been incremental uptake of AAD. Prior to this, Northumbrian and Welsh Water delivered significant AAD investments that were funded through adjustments to base on the basis that these were 'exceptional' capital maintenance items.

We are committed to providing best value for money for customers. In our October 2023 business plan, we identified the potential to provide enhanced benefits to customers by delivering this project through a third party. We have since conducted extensive market engagement to develop this option. Under our proposed market-based delivery framework, the required adjustment to our AMP8 base allowance will decrease from £107.6m (to deliver the whole project in house) to £19.49m (for pre-construction activities). This results in a significantly reduced impact to customer bills in AMP8. Third-party delivery offers competitive pricing, efficient execution, and cost distribution across multiple price reviews.

This document serves as our response to Ofwat's DD assessment and restates the need for adjustment to bioresources base allowance to deliver the Kent AAD project. This document supersedes our original cost adjustment claim for this project (SNR21), incorporating all necessary information for Ofwat's evaluation in line with its published criteria. This includes:

- Original evidence submitted in SRN21.
- Additional evidence addressing gaps identified by Ofwat in its DD assessment.
- Assessment of market opportunities and updated costs for our preferred third-party delivery option.

This document refers to and should be considered in line with the following documents:

- SRN36 Bioresources Strategy
- SRN-DDR-039 Market-based Delivery

- Notified Item for landbank risk (Appendix 9)

Investment need and timing:
This investment will help us to address our unique challenges relating to our reliance on conventional anaerobic digestion (CAD) and disproportionate landbank availability, which drive higher sludge treatment and disposal costs.

External needs are driving the scope of this investment outside of management control. Decreasing farmer satisfaction of our biosolids and upcoming changes in environmental regulations require significant upgrades to our biosolids treatment process. Additionally, new, and innovative sludge treatment technologies offer the potential for improved efficiency, reduced environmental impact, and increased resource recovery. To leverage these benefits requires a step change in our approach.

The timing of this investment is in line with our PR19 sludge strategy, driven by our desire to leverage cost efficiencies. By transforming our assets when replacement is timely, we will avoid costly and inefficient interim upgrades, ensure compliance with future environmental regulations, and achieve better outcomes for our customers and the environment.

'No regret' solution:
We have conducted comprehensive options appraisals for both solution type and delivery route. In addition to a range of sludge treatment technologies, we have considered market-based delivery mechanisms such as co-treatment, co-location, and outsourcing. Our options appraisals were supported by extensive customer and market engagement including surveys, in-depth interviews, workshops, and bilateral meetings with potential delivery partners.

AAD was chosen as our preferred technology as the result of a comprehensive technology appraisal, supported by Atkins. We consider AAD to be a 'no regret' solution as it delivers significant benefits over CAD and can support Advanced Thermal Conversion (ATC) technologies should they become viable in the future. This is aligned to our long-term Bioresources Strategy.

Our proposed solution is to consolidate our seven STCs in Kent into two AAD facilities at Ashford and Ham Hill. Consolidation offers significant cost benefits through economies of scale, as well as avoided future capital maintenance and reduced Industrial Emissions Directive (IED) compliance costs at the five sites set to be decommissioned. Ashford and Ham Hill sites were both selected as the result of a modelling exercise that considered a vast array of potential scenarios to determine the optimum solution based on cost and carbon data.

Our proposed AAD solution will delivery significant benefits for customers and the environment, including:

- Greater operational flexibility and resilience.
- Improved operational efficiencies.
- Improved environmental performance.

Value for money:
Third party delivery offers better value for customers through potentially reduced project costs and the ability to spread this cost over multiple price reviews. The Net Present Value (NPV) of this project could reduce by £11.8m if delivered by a specialised third party, due to cost efficiencies gained through streamlined delivery and operation in line with their specific capabilities and expertise. However, a payment certainty mechanism is required to realise these cost benefits. Without certainty of payment, the risk to investors and debt providers is increased. Interested parties have indicated this would lead to higher bid prices and reduced project interest.

At DD, Ofwat said existing regulatory frameworks allow us to go ahead with the Kent project without further adaptations. We understand this to mean that we can competitively tender the project, but without the assurance of long-term cost recovery from customers. We consider this approach to be counterproductive as the primary purpose of third-party delivery is to generate better value for customers, and, without an agreed payment mechanism, this is less likely to be achieved. We instead propose a market-base delivery framework for the Kent AAD project which, like DPC, includes a mechanism like the Allowed Revenue Direction (ARD), enabling us to recover costs payable to the third party from customers outside price reviews.

If Ofwat agrees to our proposed market-based delivery framework for the Kent AAD project, the necessary adjustment to our base cost allowance will decrease from £107.6m to £19.49m for AMP8. This reflects the cost that would be incurred by us for pre-construction activities. This is a significant funding reduction and therefore to customer bills in AMP8. We hope to work with Ofwat to agree on an approach that will best protect customers whilst also encouraging interested parties to bid and commit to the investment.

2 Response to Ofwat's DD Assessment

At Draft Determination (DD), Ofwat reallocated our cost adjustment claim (SRN21) to enhancement and subsequently rejected it on the basis that the technology change is at management discretion and should be funded through base expenditure. We agree that this investment does not meet Ofwat's enhancement assessment criteria, which is why we have requested funding as an adjustment to base.

No assessment of our cost adjustment claim was provided by Ofwat at DD. We therefore sent a query requesting more information as to why it was rejected. Ofwat answered with an enhancement assessment in August 2024. Our response to Ofwat's enhancement assessment is presented and summarised in Table 2 below.

Ofwat Assessment	Response	Evidence
Need for enhancement investment		
The investment does not meet the criteria for enhancement investment.	We are requesting this investment as an adjustment to our base allowance. We have structured this document in line with Ofwat's criteria for cost adjustment claims to show how it meets this.	Entire document
The company does not demonstrate why its current operations could not continue with an adequately maintained current asset base and funded via base and other allowances.	Most digestion assets across the seven STCs in Kent are near or beyond their useful life (Section 4.2 and 5.3). Replacing these assets on a like for like basis (i.e., typical capital maintenance activities) is a significant and material exercise that may be a sunk cost, considering CAD is unlikely to produce biosolids of a sufficient quality to meet evolving customer and regulatory needs. A transformative change in our approach to bioresources is required due to meet external investment drivers (Section 5.2). It aligns with engineering and economic rationale to deliver this change once the existing assets have been fully utilised and are at the end of their economic life.	Sections 4.2, 5.2 and 5.3
The company outlines the need to deal with ageing assets and poor condition. However, it does not explain why this has not been addressed historically under base allowances.	Refer to Section 5.2. Our approach to bioresources management has historically been to keep costs as low as possible, recognising our relative position on customer bills. We have operated in line with our long-term bioresources strategy as communicated to Ofwat in previous price reviews. At PR19, we identified the need for investment in Kent and made a strategic decision to defer it and focus on other delivery objectives such as improved energy generation and biosolids quality. This decision enabled us to achieve maximum utilisation of Kent assets, avoid sunk costs, and remain flexible to uncertain regulatory change, market opportunities, and customer needs. Anticipated capacity shortfalls now necessitate investment in modern digestion technology, meaning now is the right time for us to deliver on our commitment made at PR19. This section should be read in conjunction with SRN-DDR-019, an Economic Insight report addressing the need for customers not to pay twice.	Section 5.2
The company states that the schemes were initially included as part of its WINEP submission for bioresources in November 2022 but were	The EA did not consider that implementation of AAD would fall under the scope for WINEP, under the various sludge drivers. The approved schemes	-

marked as "removed" by the Environment Agency.	under our Bioresources WINEP is the implementation of additional cake storage.	
The company does not provide sufficient and convincing evidence in its proposal around the need for an increase in capacity, as the company's current sludge production forecast for 2035 is similar to sludge forecast during PR19 (in 2025). The company provides limited supporting evidence of the interventions that it carried out to meet headroom requirements for its sludge production forecast for PR19, comparable to company's 2035 forecast.	As described above, we made a strategic decision to defer investment in Kent so that we could implement a transformative upgrade once the existing assets had been fully utilised and replacement is timely. As Ofwat points out, our sludge production forecast for 2035 is comparable to our PR19 forecast. We did not plan to deliver headroom interventions at Kent STCs in AMP7, in line with our decision at PR19 to defer investment in accordance with our long-term sludge strategy. We have not experienced significant increase in sludge volumes over AMP7, in line with the rest of industry. However, capacity upgrades at Ashford and Ham Hill sites are required as they will receive significantly more sludge volumes as the result of our consolidation approach (refer to Section 5.3). We have scoped the proposed upgrades in line with this consolidation and our 2035 forecast (Section 7.2).	Section 5.3, 7.2, 9.3.3
There is also limited supporting evidence of the potential opex savings because of site rationalisation and the move to Advanced Anaerobic Digestion (AAD). A high proportion of the AAD capacity investments in the sector have been via bioresources base costs on a "spend-to-save" basis where initial cost of assets is offset by opex and / or capex savings due to more opportunities for economies of scale, higher renewable energy production, more renewable energy subsidies, lower sludge disposal volumes, etc. The company does not provide sufficient and convincing evidence that it has accounted for base overlap by netting off the whole life cost savings that will be achieved against the cost requested.	We have considered potential OpEx savings as part of our WLC assessment (see Section 4.4.4). We have also considered potential savings associated with avoided future capital maintenance and reduced IED compliance. We have accounted for this through an implicit allowance and reduction in our IED funding request. AAD conversion incentives that have historically been available are closed (or are closing) to new capacity and therefore not relevant to this investment. This is evidenced in Section 5.4.	Section 4.4.4, 5.4
In addition, bioresources growth enhancement expenditure is in scope of PR24 bioresources base costs, providing a long-term allowance for growth. That also serves to provide an additional efficient allowance for AAD capacity. The company provided limited evidence of how it took account of this interaction.	We understand that bioresources growth expenditure is included in base allowance. We are requesting this additional funding as an adjustment to base allowance. Our consideration of growth costs is detailed in Section 7.2.1 and Section 9.3.3.	Sections 7.2.1, 9.3.3.
Best option		
We have some concerns that the investment is the best option for customers. The company provides limited evidence of how it has considered alternative options to address the capacity shortfall, poor asset condition and increasing resilience of sludge to land.	We have conducted comprehensive options appraisals for both solution type and delivery route. In addition to a range of sludge treatment technologies, we have considered market-based delivery mechanisms such as co-treatment, co-location, and outsourcing. Our options appraisals were supported by extensive customer and market engagement including surveys, in-depth interviews, workshops, and bilateral meetings with potential delivery partners. This is evidenced in Sections 4.4 and 9.3.	Sections 4.4, 9.3
The company outlines that the two proposed schemes would only address a percentage of the sludge treatment capacity, leaving the balance of operations to continue to operate as currently. There is limited evidence of cost evaluation of alternative options such as alleviating bottlenecking on existing sites to free up capacity.		
Additionally, there is limited supporting evidence how the proposed funding request would overlap with any funding received under Industrial	Optioneering activities for IED related interventions are evidenced in our IED Enhancement Business Case (SRN37) and DD response SRN-DDR-042.	Section 4.4.2

Emissions Directive (IED). The company provides limited supporting evidence of the optioneering associated to IED related interventions and how these costs may overlap with the proposed site rationalisation.	The consolidation of our STCs in Kent provides an opportunity for cost efficiencies by reducing the compliance requirements to IED. For sites intended to be decommissioned as part of our Kent strategy, we are proposing to deliver 'risk proportional' solutions which balance the level of investment for IED compliance against the remaining asset life. We have accounted for this potential savings through a £54m reduction in our IED enhancement funding request (refer to Section 5.4.2). IED costs for Ashford and Ham Hill sites have been included under our IED enhancement funding request.	
Cost efficiency		
We have some concerns whether the investment is efficient. The company does not provide sufficient and convincing evidence that the proposed costs are efficient. There is limited supporting evidence of the cost breakdown and efficiency for the two schemes proposed and a lack of fully detailed current baseline costs.	We have provided detailed cost breakdowns for both AAD schemes and explained adjustments to these in Section 7.2. Design assumptions have been validated through scope benchmarking as described in Section 7.3. Cost assumptions have been validated through external cost benchmarking described in Section 7.2.	Sections 7.2, 7.3
The company provides external assurance and some cost benchmarking, but it provides limited supporting evidence of the potential capex and opex savings because of site rationalisation.	Potential capex and opex savings because of site rationalisation have been considered through our WLC and VfM assessments, evidenced in Section 4.4.4 and 9.3.4. We have accounted for potential cost savings through avoided future capital maintenance through an implicit allowance (see Section 5.4.3)	Sections 4.4.4, 5.4.3, 9.3.4

Table 2: Response to Ofwat's enhancement assessment.

3 Changes since the October Submission

Further to providing additional evidence in response to Ofwat's DD assessment, we have also updated the claim to include:

- **An updated implicit allowance.** In the October submission of this claim, we stated that we would "estimate any possible allowance related to capital maintenance for all sludge sites in Kent that is implicit in the econometric models," once we had clarity from Ofwat of the bioresources econometric model. Following review of the model, we propose that an implicit allowance of £5.152m would be a reasonable and acceptable deduction from the claim. Details of the methodology we have used to derive the implicit allowance and the additional cost risk we face over AMP8 are provided in Section 6.4.
- **Additional benchmarking.** We have conducted further benchmarking of the THP plant cost estimate included in our October submission. This is evidenced in Section 7.3 and confirms our cost estimate, which was based on high level supplier quote, is within the acceptable tolerance level.
- **Market engagement strategy.** We have conducted extensive market engagement to further understand the potential for third party delivery of the Kent AAD project. Details of our Market Engagement programme is available in Section 9.3. Our Kent AAD delivery proposal and overall engagement have been well received. This has provided assurance of the chosen solution and there is clear interest for delivering this project through a Design-Build-Finance-Operate-Maintain (DBFOM) model. However, concerns were raised regarding payment certainty throughout the operational phase of the contract. The non-inclusion of a customer-funded payment mechanism, such as the Allowed Revenue Direction (ARD) for Ofwat's Direct Procurement for Customers (DPC) process, is very much seen as a risk by the market and would result in higher prices and therefore less value for money. Therefore, if accepted by Ofwat, we intend to deliver this project through our proposed Market-based Delivery Framework which includes a similar ARD payment mechanism. This is discussed in Section 9.3.
- **Updated delivery cost.** Delivering the project through our proposed Market-based Delivery Framework will spread the cost to customers over the lifetime of the assets. Therefore, the funding adjustment required by Southern Water in AMP8 will reduce as we will only incur costs related to pre-construction activities. In Section 9.3 we have calculated the cost adjustment required for AMP8 and documented the need for an Alternative Revenue Direction to ensure continued funding beyond AMP8.

4 Unique Circumstances

4.1 Section Overview

This section provides evidence to support our response to Ofwat's cost adjustment claim criteria relating to unique circumstances, presented in Table 3.

Ofwat criteria	Response
Is there compelling evidence that the company has unique circumstances that warrant a separate cost adjustment?	We face unique circumstances relating to our reliance on CAD and disproportionate landbank availability, as evidenced in Sections 4.2 and 4.3. These circumstances warrant a separate cost adjustment to enable us to transition our operation so that it is more aligned with the rest of the industry.
Is there compelling evidence that the company faces higher efficient costs in the round compared to its peers (considering, where relevant, circumstances that drive higher costs for other companies that the company does not face)?	Our disproportionate use of CAD technology means we have higher bioresources costs than most of industry who have adopted AAD. Our peers who use AAD are operating newer, more efficient assets and benefiting from enhanced energy and biosolids yield. We also face higher biosolids disposal costs due to our limited and disjointed nature of our available landbank. This is evidenced in Sections 4.2 and 4.3.
Is there compelling evidence of alternative options being considered, where relevant?	We have considered a wide range of options including wider, market-based solutions in collaboration with industry. Our options appraisal has been informed by in-depth stakeholder engagement, including feedback from famers and customers. This is evidenced in Section 4.4.

Table 3: Response to Ofwat assessment criteria for unique circumstances.

Southern Water operates under unique circumstances which drive higher costs in the round compared to other WaSCs. We are the only WaSC that treats 100% of our sludge through conventional anaerobic digestion (CAD), as of August 2024. Like other companies, we are completely reliant on recycling biosolids to land. However, land available in the Southeast for sludge recycling is disproportionately limited compared to the rest of industry (see Section 4.3 below for further evidence). Using the landbank that is available to us drives higher storage and transport costs. We have explored a range of options to mitigate the impact of these circumstances on our costs and ultimately determined that AAD is the best option for our customers and the environment.

The following subsections evidence the impacts of these unique circumstances on our bioresources costs. It also describes the range of solutions considered to mitigate these impacts.

4.2 Reliance on Conventional Anaerobic Digestion

As shown in Figure 1, we are the only WaSC that treats 100% of our sludge through conventional anaerobic digestion (CAD). Currently at an industry level, only 33% of the industry's raw sludge is treated through CAD and 55% of the industry's raw sludge is treated through AAD.

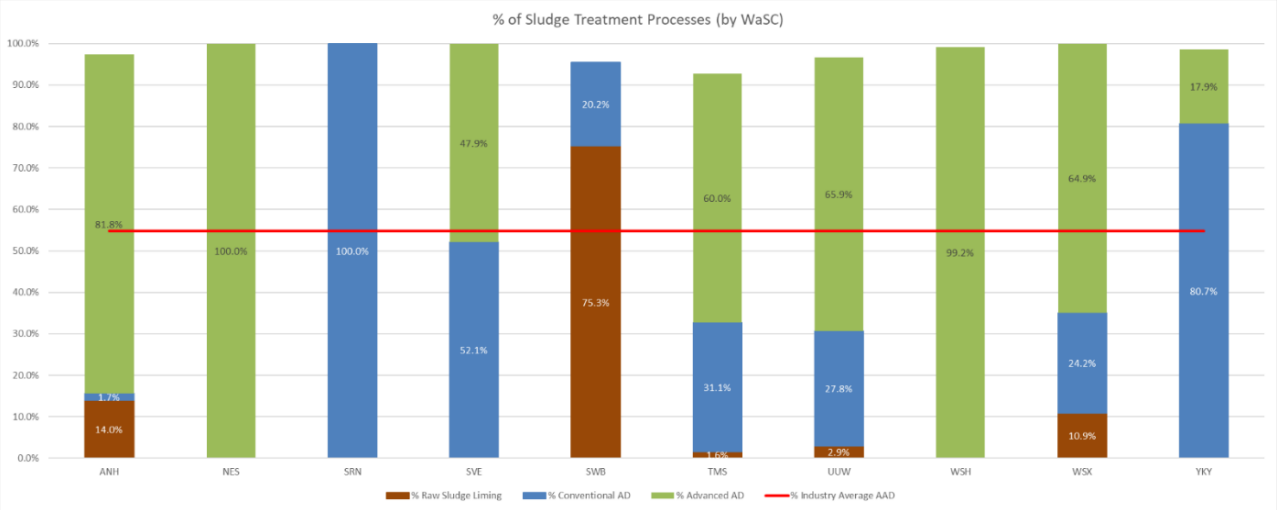


Figure 1: Sludge treatment process (by percentage – APR Industry Datashare 2022)

Our disproportionate use of CAD means we have higher bioresources costs than other companies who have adopted AAD incrementally over time (i.e., most of the industry), or, in the case of Northumbrian Water and Welsh Water, who received additional allowances for step-change transitions towards AAD from previous price reviews (see Section 6.2). This is due to the following reasons, as further evidenced in the paragraphs that follow:

- Our CAD assets are older than new AAD technology and therefore incur higher maintenance costs.
- CAD produces lower biogas yields than AAD, meaning we produce less energy.
- Our CAD operation produces lower quality biosolids which require additional treatment to achieve BAS compliance (and therefore additional cost). The final produce has less revenue potential than higher quality biosolids such as those produced by AAD.

Higher maintenance costs

AAD is a relatively new technology and companies who use it are therefore operating relatively new assets. The maintenance costs of digester assets follow a predictable economic lifecycle, whereby costs are low in the early years and increase exponentially over time. This is demonstrated in Figure 2 below, using Combined Heat and Power (CHP) engines as an example. Conversely, much of our asset base is approaching the end of its design life. This is particularly true for our Kent STCs. As demonstrated in Table 4, most key assets in Kent are near or beyond their useful life. Therefore, unlike recent AAD adopters, we are experiencing increasingly high maintenance costs.

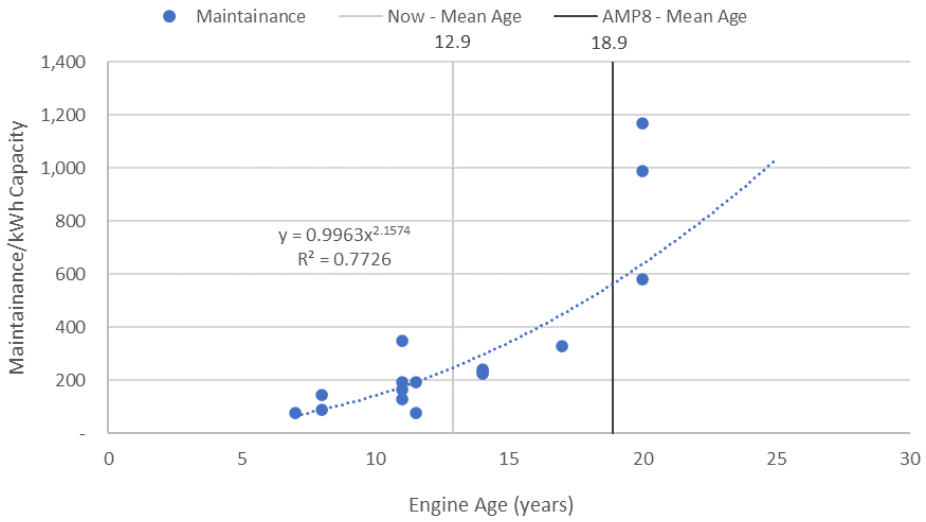


Figure 2: Maintenance costs per kWh of capacity of Southern Water's CHP engines over their lifetime.

Table 4 presents the age of key digestion assets and each Kent STC as a portion of their expected life. This shows that ancillary assets (centrifuges, CHPs, dewatering systems) are approaching or past their expected life at all Kent STCs. This is also true for digesters, except for Ashford and Queenborough STCs.

STC	TDS/year	Digesters				Centrifuges		CHP	Cake reception	
		1	2	3	4	1	2	1	1	2
Ashford	18,287	125%	42%	42%	20%	95%	95%	117%	80%	120%
Ham Hill	4,325	97%	97%			100%	100%	117%		
Aylesford	6,468	102%	102%			150%	150%	117%		
Canterbury	5,293	170%	57%			135%	135%	167%		
Gravesend	4,709	80%				95%		67%		
Motney Hill	14,722	93%	93%			130%	130%	142%		
Queenborough	6,745	43%	43%			80%	80%	167%		

Table 4: Asset age as a percentage of expected life[1].

Lower energy generation

AAD can yield up to 20% more methane compared to CAD[2]. This translates to increased energy production which can be used to offset operational costs or generate revenue. As discussed in our Bioresources Strategy (SRN36), energy costs have been rising and are forecast to remain well above the pre-2021 average for the foreseeable future. A key part of our long-term strategy is to recover as much energy as technically possible from our bioresources operation and – where possible - go beyond energy neutrality. Transitioning from CAD to AAD is a crucial step in achieving these goals.

Lower biosolids quality

AAD biosolids are of significantly higher quality than those produced by CAD. They can be applied to a wider range of agricultural soils and potentially sold at a higher price.

[1] Expected life for concrete digesters is 60 years. All digesters are concrete digesters except for Ashford 1 and Canterbury 1 digesters which are SGCT and have an expected life of 20 years. Expected life for centrifuges, CHP and cake reception assets are 20, 12 and 20 years respectively.
[2] U.S. Department of Energy. (2019). *Advanced Anaerobic Digestion: A Technology Review*

In the UK, biosolids are classified according to their level of treatment and risk, as defined by the Biosolids and Sewage Sludge (England and Wales) Regulations 2012 (BAS). Our current CAD assets produce Class B biosolids that are suitable for restricted use in agriculture and land reclamation. However, compliance requires lime stabilisation, which has drawbacks such as a high carbon footprint, material costs, unreliability, odour, and health and safety risks. The industry is moving away from lime treatment, as exemplified by South-West Water's cost adjustment claim at PR24 to transition from lime to AAD.

In addition to eliminating the need for lime stabilisation, AAD can produce Class A biosolids which can be used without restriction in agriculture, horticulture, and land reclamation. Class A products typically generate greater revenue compared to Class B biosolids from CAD. For instance, a US case study reported an average revenue of $45 per dry tonne for AAD biosolids, compared to $20 per dry tonne for CAD biosolids[3]. Similarly, a European case study found AAD biosolids sold for an average of €60 per dry tonne, while CAD biosolids averaged €40 per dry tonne[4].

We have explored a range of alternative technologies to reduce our reliance on CAD. This is described in Section 4.4.

4.3 Disproportionately Limited Landbank Availability

Over the last 5 years, 99.7% of our sludge produced has been recycled to agriculture with the remaining 0.3% going to land restoration. Our biosolids are typically recycled to cereal crops farming, particularly wheat, as this is where there is demand.

Our sludge landbank is significantly smaller than the rest of the industry when normalised by population, and further limited with respect to suitability and access. This drives higher disposal complexity and therefore cost. The Kent area is currently the most stressed area for our bioresources operation, and this is expected to worsen in AMP8 due to anticipated regulatory change. The following sub sections present evidence which shows that we are disproportionately affected by limited landbank availability. Anticipated regulatory changes are described in Section 5.2.

4.3.1 Southern Region

Our proximity to London puts additional pressure on our landbank. A proportion of Greater London's biosolids is transported to our region. This increases the total volume of biosolids that is disposed of in our region. Furthermore, our position between London in the north and the coast in the south and east means our landbank border is set and we cannot expand. Compounding this challenge is more varied topography which drives smaller field sizes. Approximately 46% of farmed area comprising our landbank is less than 20 Ha and 80% is less than 100 Ha. Spreading across multiple small sites is less efficient than one large site due to additional transport requirements and increased stakeholder (famer) management.

Figure 3 demonstrates the available land area for biosolids recycling by region, adjusted by population. As described above, we are predominantly limited to cereals, particularly wheat, due to farmer demand. Figure 3 shows that the South East region has the second lowest area of farmed cereals and wheat and the smallest farmed area in total.

[3] Smith, J., Jones, R., & Brown, K. (2019). *Economic Analysis of Advanced Anaerobic Digestion for Biosolids Management.* Journal of Environmental Engineering, 145(10), 04019072.
[4] Schmidt, M., Müller, B., & Schneider, R. (2020). *A Comparative Study of the Revenue Potential of AAD and CAD Biosolids Products in Europe.* Proceedings of the 15th European Biosolids & Organic Resources Conference, Vienna, Austria.

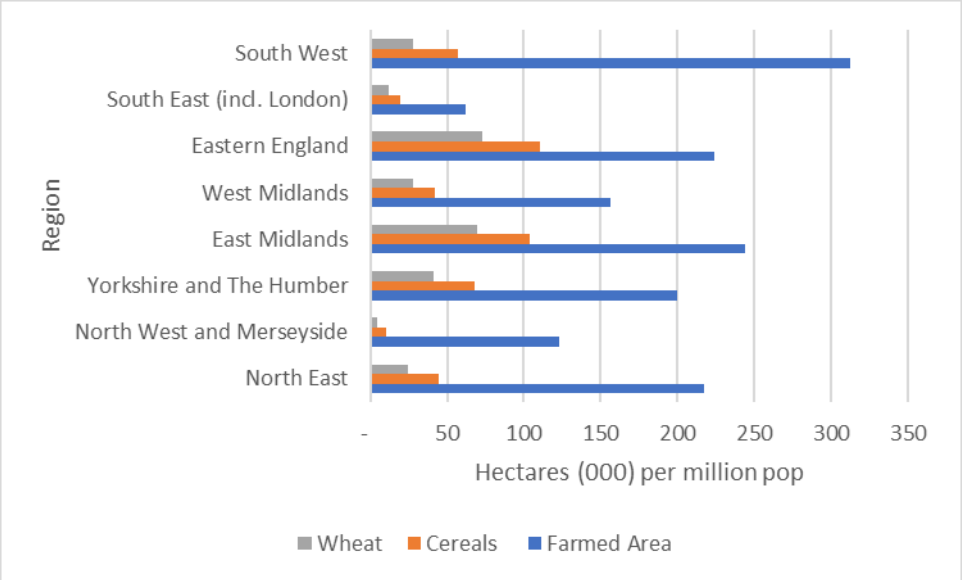


Figure 3: Farmed area by region[5]

The physical limitations of our landbank and dense biosolids load means we must store and transport higher volumes of biosolids. This leads to increased disposal costs. In 2022/23, we used approximately 5.8m litres of diesel moving sludge and biosolids between our sites and disposal fields. This equates to approximately. £8.3m per year. Our 2022/23 diesel consumption equates to approximately 15,000 tonnes of CO2e emissions (based on emission factors for diesel biofuel blends). The price volatility of diesel presents a large risk to maintaining our current operational costs[6]. We do not consider our diesel consumption to be sustainable both from an environmental and economic lens.

We are considering ways to reduce the environmental cost associated with transporting our biosolids through use of electric vehicles and adoption of green fuels, such as biomethane. However, the best way to reduce both the environmental and economic cost of our biosolids transport activities is to reduce the volume of biosolids that we produce.

4.3.2 Kent Area

Kent is our most stressed area for our bioresources operation in terms of landbank availability. As shown in Figure 4 below, the landbank available in Kent is severely limited in the North West area. Other landbank area in our service region is already fully utilised, and we cannot expand due to our coastal border and proximity to London. This challenge is exacerbated by the biosolids volumes transported from Greater London into our region.

[5] OFWAT PR24 operational greenhouse gas emissions performance commitment (wastewater) https://www.ofwat.gov.uk/publication/pr24-operational-greenhouse-gas-emissions-performance-commitment-wastewater/
[6] Weekly road fuel prices - GOV.UK (www.gov.uk)

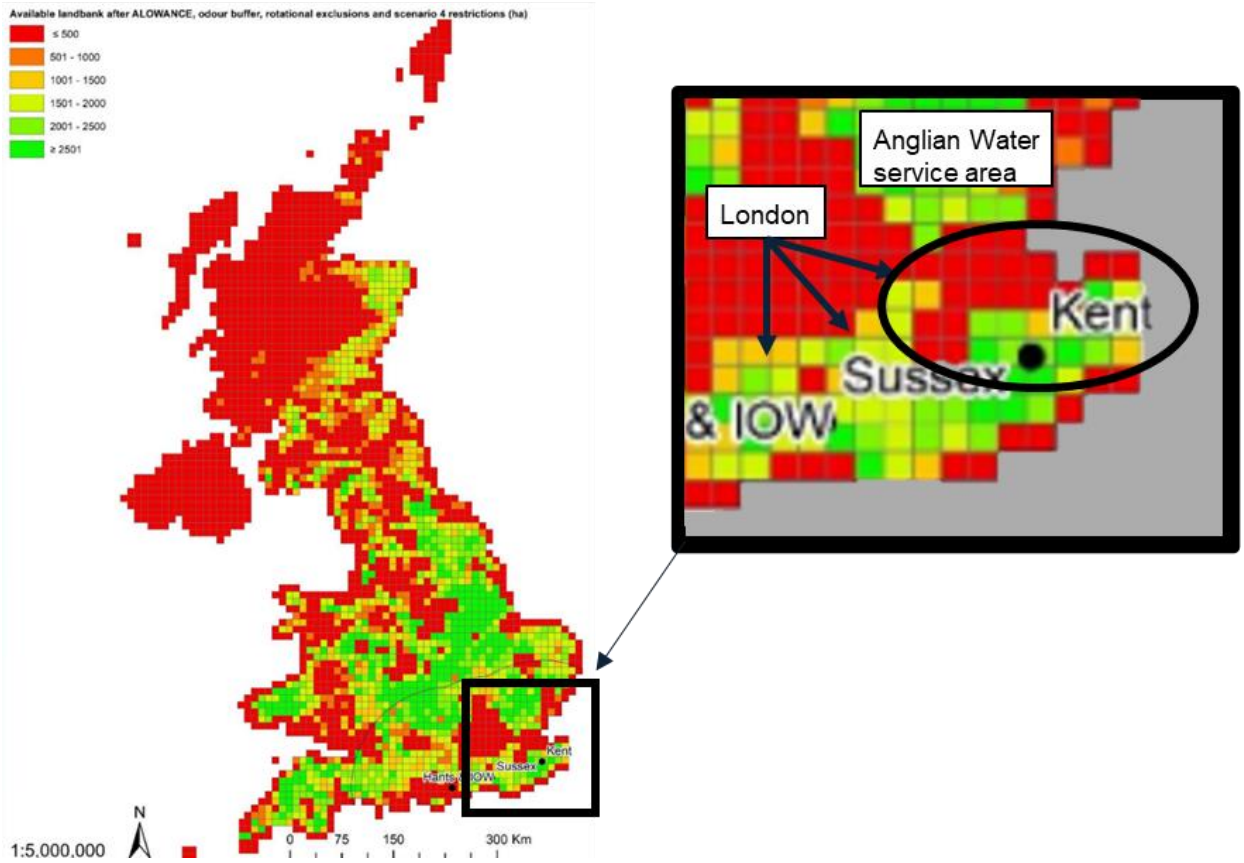


Figure 4: Agricultural land available to Southern Water with current operation (incl. impact of FRfW level 4 restrictions[7]).

Because we have the smallest landbank area when adjusted for population, we face higher pressure than the rest of the industry to find an alternative solution to sludge spreading. We have considered transporting biosolids outside of our region, however the associated transport and on-site storage costs (including carbon) make this an expensive and unsustainable solution. This issue is most severe in Kent, which is why we are focused on reducing biosolids generation in this area.

4.4 Alternatives Considered

We have collaborated extensively with other WaSCs, the EA, Ofwat, and various stakeholders, to identify broader solutions to common industry challenges[8]. The insights gained from this collaboration have significantly shaped our PR24 Bioresources Strategy (SRN36) and this cost adjustment claim.

This section describes comprehensive technology appraisal we conducted as part of our PR24 Bioresources Strategy, supported by third-party consultant Atkins. This identified the consolidation of our Kent STCs and conversion to AAD as the preferred solution to address challenges relating to our unique reliance on CAD and limited landbank availability in Kent. We have also explored market-based delivery mechanisms to fund the implementation of this solution. Our appraisal of delivery options is presented in Section 9.

[7] Image sourced from ADAS & Grieve Strategic National Landbank Study
[8] This collaboration includes participation in WaterUK groups (e.g., Biosolids Network, IED Task and Finish Group), projects, and working groups, including the Water UK Bioresources Strategy for England, PR24 Bioresources WINEP Issues, Ofwat econometric model development group, Market development group, and Business in the Community (BITC).

4.4.1 Technology Appraisal

Supported by Atkins' specialist bioresources team, we engaged extensively with relevant stakeholders to determine an appropriate solution for our Kent bioresources operation. To this effect, we conducted a two-phase technology appraisal comprised of an initial online questionnaire followed by a workshop. In parallel, we undertook extensive customer engagement. This included interviews and surveys with farmers as well as our wholesale water and wastewater customers.

Technology appraisal:
An online questionnaire was circulated to stakeholders from across the bioresources value chain. This included subject matter experts from our asset strategy, operations, carbon, energy, and innovation teams. The questionnaire requested stakeholders to rate various treatment technologies against criteria aligned to our corporate strategic objectives and operational resilience. Table 5 presents the technologies considered and Table 6 presents the assessment criteria.

Technology
Conventional anaerobic digestion (CAD) - current
Advanced anaerobic digestion (AAD)
Advanced thermal conversion (ATC)
Incineration
Lime stabilisation
Drying
Drying and pelletizing
Composting

Table 5: Technology considered.

Alignment with our corporate strategic objectives	Operational resilience
Confidence in producing compliant biosolids	Complexity of operation
Deliverability within programme	System availability (shut downs, etc.)
Reference facilities available	Energy generation potential
Constructability (permitting, planning, land, etc.)	Resource recovery potential
Innovation	Environmental and customer impact (emissions, noise, odour, vehicle movements, etc.)
Cost (CapEx, OpEx and whole life cost)	Associated Carbon impact
Operability and maintainability (availability of consumables, spares, chemicals, etc.)	Customer feedback

Table 6: Appraisal criteria

The questionnaire showed AAD as the most preferred technology and incineration as the least preferred technology, with these technologies receiving the highest and lowest overall scores, respectively. A weighted assessment was then conducted to stress test these scores. This was done in a workshop facilitated by Atkins and attended by multiple stakeholders' groups across the business. Participants firstly weighted criteria on their own, and then as a group. The highest weighted criteria resulting from individual weightings were Associated Carbon Impact and Confidence in Producing Compliant Biosolids. When the individual

weightings were applied to the questionnaire scores, no significant changes in the overall process selection were observed.

Criteria weightings were then determined as a group with respect to our corporate strategy. This resulted in an increased weighting for Environmental and Customer Impact, so that it was comparable to Confidence in Producing Compliant Biosolids. Again, applying group weightings to the questionnaire scores showed no significant change in the overall technology rankings. The results of this exercise are presented in Appendix 3 of our Bioresources Strategy (SRN36).

Customer engagement:
Our technology appraisal was informed through customer engagement, including in-depth interviews and surveys. We sought feedback from farmers on our biosolids product and approached wholesale water and wastewater customers for their views on investing in advanced treatment technologies. The results of this engagement are provided in Appendix 1. The key takeaways were:

- The farming community is generally supportive of recycling treated biosolids to agriculture as this avoids extensive use of manufactured fertilisers that can harm the environment.
- Our customers are mindful that the product should not be damaging to the environment / soil when compared to traditional inorganic fertilisers.
- Famers highlighted that the quality of our product at present is inconsistent, not dry enough and odorous.
- Farmers are supported of AAD to achieve levels of quality, like those of other neighbouring companies already treating their bioresources through AAD processes.
- Our customers broadly felt that changes in regulations (e.g., Farming Rules for Water) are a positive step to protect the environment.
- Our customers expressed concerns that if a significant proportion of our biosolids cannot be recycled to agriculture, the industry would therefore be implementing incineration plants as fall-back solution in the medium-term.

4.4.2 Long List Options Assessment

We used the findings of our technology appraisal and customer engagement activities to develop possible solutions for our Kent STCs. The key findings were:

1. AAD is the preferred technology at this stage, as shown through its high score in the technology questionnaire.
2. Our current lime operation has low capital cost but is not sustainable, has known limitations (e.g., odour complaints) and does not enable us to extract the maximum possible value from our sludge.
3. AAD and drying are perceived as the best technologies to ensure biosolids is consistently produced to highest bacteriological standards. However, we are reluctant to reinvest in dryer technology based on our own previous experience of high energy consumption, as well as its fire and explosion risk[9].
4. ATC and incineration are the only technologies capable of fully mitigating the landbank risk by converting the sludge to an inert material. ATC did not score highly in the technology appraisal as it due to lack of full-scale industry implementation. However, it did score significantly higher than incineration and therefore carried forward for further evaluation as a preferred thermal disposal option.

[9] *Sewage Sludge Drying: A Review of Fire and Explosion Hazards Over the Last Decade.* (n.d.). Aqua Enviro International Conference. https://conferences.aquaenviro.co.uk/proceedings/sewage-sludge-drying-a-review-of-fire-and-explosion-hazards-over-the-last-decade/

5. Local planning for incineration is known to be a challenge[10] and our customers feel this would be a step back for Southern Water. While it is a well understood process, it is known to be expensive, partly due to low resource recovery potential.

We initially considered treatment upgrades at all STCs and then explored the option of consolidating our sites. The Kent area has high potential for consolidation as 7 STCs are currently in operation and some of them are less than 10 miles apart.

The final list of seven options was considered our 'long list' of options and subject to qualitative assessment to generate a short list of options for a more detailed, quantitative assessment. The long list options assessment is presented in Table 7 below. The outcome was a short list of three options to be progressed for further development and analysis.

No.	Option	Assessment	Decision
1	Do Nothing	Continuation of current operation. This is not viable as we are already facing serious disposal risks relating to BAS compliance, farmer acceptance, and landbank issues. Model analysis shows that the impact of the application of FrFW would increase overall OpEx for Kent from c. £10.0m pa to £19.5m pa (not including carbon).	Discounted
2	Incineration	Removes the need for biosolids disposal. However, incineration is undeliverable for at least 10 years and does not align with our carbon strategy. It is also seen by our customers as a "step back."	Discounted
3	Advanced Thermal Conversion	Relatively new and novel technology which has the potential to mitigate landbank issues. However, this technology is not proven in industry. ATC can be bolted onto AAD as a future mitigation to landbank issues, should more prominent risks materialise.	Discounted
4	Develop Lime stabilisation further	Extenuation of current operation. Generates more volume of biosolids post-treatment and is highly odorous due to the release of ammonia. Requires chemicals that are energy and carbon intensive in their production. Liming is not considered a long-term sustainable solution under our Biosolids Strategy (SRN36).	Discounted
5	Conventional Anaerobic Digestion (incl. secondary digestion)	Continuation of current operation with the addition of secondary digestion on all STCs to achieve BAS compliance. The resulting product is of similar quality to that currently produced (but without double handling). Lower farmer acceptance landbank issues still present. Higher level of carbon emissions compared to AAD, according to the Carbon Accounting Workbook,	**Progressed**
6	Conversion to Advanced Anaerobic Digestion	Addition of AAD to provide better product quality and volume reduction. AAD also offers increased digester throughput and has better overall gas contaminant (fugitive emissions). AAD biosolids also have reduced emissions from biosolids cake due to improved solids processing.	**Progressed**
7	Conversion to Advanced Anaerobic Digestion & Consolidation of sites	Option 6, but at consolidate site(s) rather than all existing Kent STCS. There is also an opportunity to consolidate our sites to reduce upgrade needs and gain operational efficiency. This will also reduce scope requirements related to IED, as fewer AD sites would remain in operation in AMP8.	**Progressed**

Table 7: Long list options assessment for Kent STCs.

[10] House of Commons Library. (2022, February 23). *UK Climate Change Act 2008: 2022 Progress Report (CDP 2022-0223)*. UK Parliament. https://commonslibrary.parliament.uk/research-briefings/cdp-2022-0223/

4.4.3 Short List Options Development

Options 5, 6 and 7 passed our initial long list assessment and were progressed for further development. Option 5 is considered our new baseline scenario, as the true 'Do Nothing' scenario (Option 1) is not viable due to compliance and supply chain risks.

Progressing Option 7 required us to develop our consolidation strategy. To do this, we used Decisio, a digital decision-making tool developed for us by third party consultants Business Modelling Applications (BMA). Decisio models our bioresources operation under a vast array of potential scenarios to determine the optimum solution based on cost and carbon data. Physical constraints were also introduced to the model including available space and proximity to Sites of Special Scientific Interest. The result was the identification of Ashford and Ham Hill as suitable upgrade sites.

We explored the possibility of creating one STC for the whole Kent are at either Ashford or Ham Hill, but ultimately decided to create two large STCs for the Kent area, one at each of these sites. Again, the Decisio model was used to inform this decision by modelling sludge movements and the associated carbon and economic cost. Results of resulting sludge movement available from the Decisio model is shown in Figure 5. At the level of accuracy considered for this assessment, the cost of having one or two STCs was essentially the same. However, having two STCs offers increased operational resilience and was therefore chosen as the preferred arrangement for Option 7. Additional information is available in our SRN36 Bioresources Strategy document.

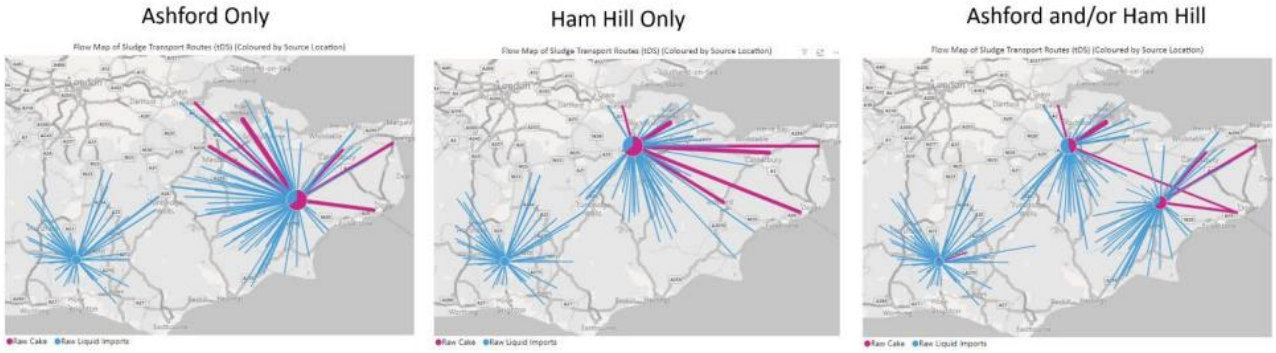


Figure 5: Model sludge movement from possible consolidated sites.

4.4.4 Whole Life Cost Assessment

Once we had decided on our arrangement for Option 7, we derived a WLC for this option as well as the other two options on the short list. Option 6 was modified to include AAD implementation at 6 STCs, rather than all 7. This is because the model showed that Aylesford is too close to Ham Hill to benefit from AAD conversion. Cost and carbon values were for each option were derived from Decisio and input into our internal WLC model too. Our WLC methodology is described below:

- CapEx is calculated within Decisio as the total capital cost over 25 years of operation, including asset replacement and capital maintenance. Decisio uses bottom-up cost curves and input information related to remaining life of current assets to derive a representative WLC cost.
- OpEx is calculated within Decisio as the average annual operational cost over 25 years of operation (including energy, transport, disposal) using typical process assumptions (including availability, capacity, performance). This does not include carbon.
- Carbon is calculated within Decisio as the average annual monetised value of carbon emissions over 25 years of operation, using emissions factors from the latest version available of the Carbon Accounting Workbook.

- WLC is calculated based on the values above, using our internal WLC tool. This considers the above values and a 20-year design horizon.

The WLC resulting from this exercise is presented in Table 8 below. This was submitted as Table 6 in the October submission of this cost adjustment claim (SRN21).

Option	CapEx (Total across 25 y £m)	OpEx (Average across 25 y - £m/y)	Carbon (Average across 25y t CO_2/y	Whole Life Cost (Across 20 years £m)
5 – Conventional Anaerobic Digestion (incl. Secondary Digesters)	219.1	14.6	9,575	**351.32**
6 - Conversion to Advanced Anaerobic Digestion of 6 sites in Kent	315.0	13.6	5,968	**375.49**
7 - Conversion to Advanced Anaerobic Digestion & Consolidation of sites	257.6	13.8	7,461	**350.98**

Table 8: Short list WLC analysis submitted in October cost adjustment claim (SRN21).

Table 8 shows that consolidating our sites is the most cost-effective way to implement AAD. However, cost is not a clear differentiator between options 5 and 7. We acknowledged this in our October submission (SRN21) and provided a qualitative explanation of why option 7 is preferred based on non-cost criteria. To summarise, we said:

- Option 7 is preferable to Option 5 as it reduces reliance on CAD, alleviates pressure on our limited landbank, and addresses external investment needs related to farmer satisfaction and evolving regulations. AAD-produced biosolids are preferred by farmers and have wider crop applicability. Reducing biosolids volumes better positions us for anticipated regulatory changes like FRfW and the EA's new Sludge Strategy. These external investment drivers are discussed in Section 5.2.
- Option 7 is a "no-regret" solution offering immediate benefits and future-proofing our operations. If landbank issues necessitate thermal destruction of biosolids, ATC processes can be easily integrated downstream of AAD with beneficial synergies. Conversely, Option 5 involves investing in assets unlikely to meet future needs, potentially leading to sunk costs if anticipated customer and regulatory expectations materialize.

Updated WLC assessment:
Since our October submission, we have done more work to quantify the benefits described above. We have calculated new WLC for each of the short list options considering the monetised impacts of reduced landbank availability and farmer acceptance. We have calculated different OpEx values for each option under three possible future disposal scenarios:

- **Current:** assumes all biosolids can be recycled to agricultural land, as per our current operation
- **Most likely:** assumes only one third of biosolids can be recycled to land and the remaining two thirds is sent to landfill/existing incineration facilities. A factor of one third was derived based on a combination of landbank modelling outputs and assumption that our advanced digested biosolids would be easier to send to agriculture than our conventionally digested biosolids (higher farmer acceptance).
- **Worst case scenario:** assumes no biosolids can be recycled to land and instead must go to landfill/incineration facilities. This is an extreme but plausible case, considering external factors farmer refusal to accept our biosolids and no available landbank.

We have also updated the CapEx for Options 5 and 6 to account for IED compliance at non-consolidated sites. For sites intended to be decommissioned under Option 7, we propose to deliver ‘risk proportional’

solutions which balance the level of investment for IED compliance against the remaining asset life. These solutions are described in our IED Enhancement Business Case (SRN37) and DD Response (SNR-DD-044) and result in £54m savings (which has been removed from our IED enhancement funding request). Under Options 5 and 6, these cost savings will not be realised so £54m CapEx has been added to these options.

We have also added £8.9m to Option 7 for biomethane upgrades, rather than CHP. Our base cost estimate assumes both Ashford and Ham Hill will operate CHPs as per current site operation. However, the new facilities will be of sufficient capacity for a biomethane upgrade which, if implemented, could achieve a significant CO2e reduction. We have investigated this option and found that choosing biomethane over CHP would result in a 100kT reduction in CO2e over a 20-year lifecycle for Ham Hill alone. However, it also drives an additional £1.4m annual cost. This investigation is provided in Appendix 2. In our October submission, we considered this cost prohibitive. However, our post-October work (including market engagement) has driven us to reconsider this option. We have therefore included the additional CapEx in our WLC assessment. We have not increased our cost estimate (and therefore funding request), in lieu of internal confirmation. If we are to deliver this project in house, we will absorb this additional CapEx.

Our updated WLC analysis is presented in Table 9. This shows that Option 5 is the lowest WLC solution under our current disposal model (i.e., 100% of biosolids to land), followed very closely by Option 7 (our current strategy). Option 5 then becomes the most expensive under the most likely and worst-case future scenarios. Conversely, Option 7 is the lowest WLC option under these future scenarios. While Option 7 has a higher WLC than Option 5 under our current disposal model, it is still more affordable than Option 6. We consider this to be the best value solution due to its relatively consistent performance under multiple future scenarios.

			Current		Most likely		Worst Case Scenario	
	CapEx (£m)	Carbon (£m pa)	OpEx (£m pa)	WLC (20y)	OpEx (£m pa)	WLC (20y)	OpEx (£m pa)	WLC (20y)
Option 5	248.1	2.4	10.1	317.8	19.5	433.0	24.3	492.8
Option 6	351.5	1.5	10.2	357.8	13.2	395.6	19.5	477.1
Option 7	249.2	1.9	12.1	327.8	15.1	365.6	21.4	442.3

Table 9: Updated WLC assessment

4.4.5 Market Opportunities

We have also considered alternative market-based approaches as part of our Bioresources Strategy (SRN36) and specifically in relation to the Kent bioresources strategy. Our market research and options appraisal are presented in Section 9.

5 Management Control

5.1 Section Overview

This section provides evidence to support our response to Ofwat's cost adjustment claim criteria relating to management control, presented in Table 10.

Ofwat criteria	Response
Is the investment driven by factors outside of management control?	The scope of the investment is being driven by external drivers that are outside of management control. These are evidenced in Section 5.2. The timing of the investment is being triggered by aging assets, which is within management control as evidenced in Section 5.3. Our proposed solution addresses external and internal drivers simultaneously to keep costs low for customers.
Have steps been taken to control costs and have potential cost savings (e.g., spend to save) been accounted for?	We have considered the potential savings associated with avoided future capital maintenance and reduced IED compliance. We have accounted for this through an implicit allowance and reduction in our IED funding request. AAD conversion incentives that have historically been available are closed (or are closing) to new capacity and therefore not relevant to this investment. This is evidenced in Section 5.4.

Table 10: Response to Ofwat assessment criteria for management control.

AMP8 presents a unique opportunity for a transformative step change in our biosolids operation due to a convergence of both internal and external investment drivers. Our strategy has historically been to keep impact on customers' bills low by maximising the use of our existing assets. As a result, our existing biosolids treatment facilities are deteriorating through age and, in some cases, exceeding the end of their useful life. These assets could be maintained or renewed through incremental upgrades funded by capital maintenance. However, this investment approach would not address the external drivers that are outside of management control and likely result in higher whole life costs and a risk of stranded assets due to impending legislative change and / or long-term supply chain viability.

Our proposed solution for Kent addresses both internal and external investment needs simultaneously. By investing in AAD now, we can avoid the need for costly and inefficient interim upgrades, ensure compliance with current and known future environmental regulations, and achieve better outcomes for our customers and the environment.

Decreasing farmer satisfaction of our biosolids and upcoming changes in environmental regulations require significant upgrades to our biosolids treatment process. Additionally, newer and innovative sludge treatment technologies offer the potential for improved efficiency, reduced environmental impact, and increased resource recovery. To leverage these benefits requires a step change in our approach.

We acknowledge that this investment is atypical and material and, consequently, have taken practical steps to control costs. We also acknowledge that this investment, if approved, will provide cost savings in the form of avoided future capital maintenance and reduced IED requirements. We have accounted for this through an implicit allowance and reduction in our IED funding request.

The following subsections provide evidence of our external and internal investment drivers and cost control methods.

5.2 Investment Drivers Outside Management Control

The following paragraphs describe the three key external drivers for the Kent AAD project.

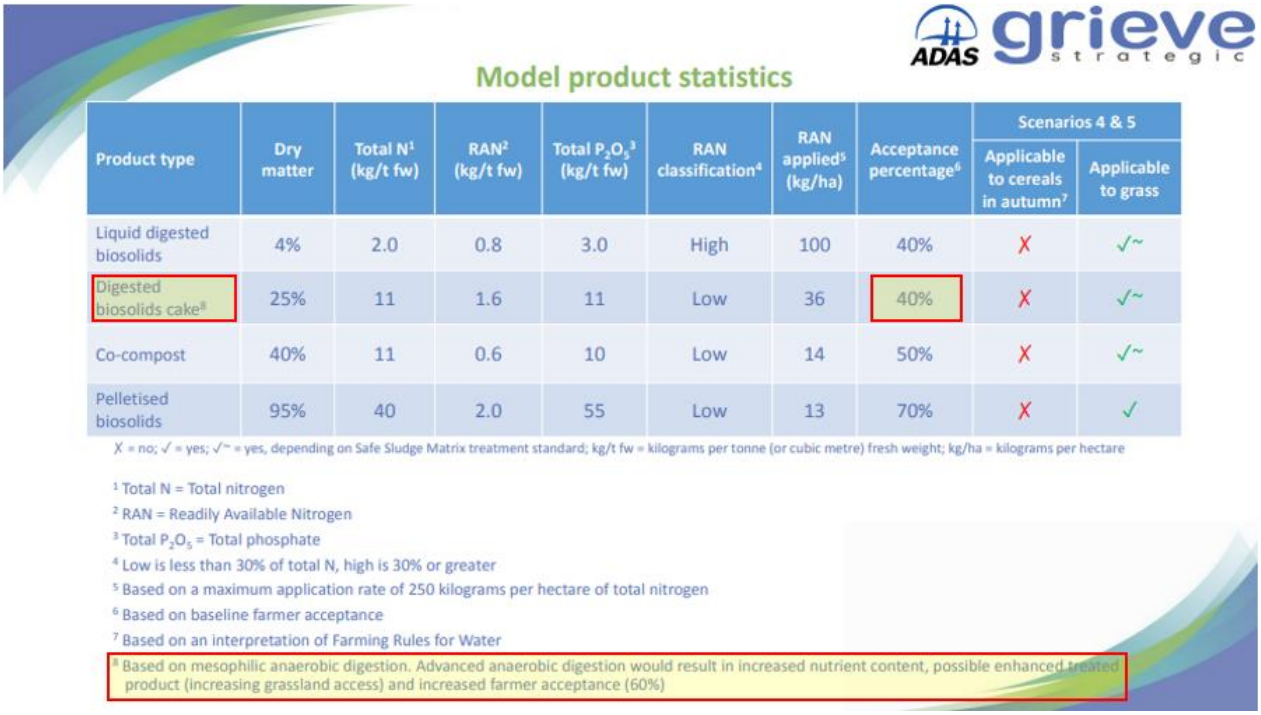
- **Customer requirements:** decreasing farmer satisfaction with our biosolids product
- **Evolving regulatory landscape:** anticipated policy developments and uncertainties relevant to sludge sewage management, e.g., Farming Rules for Water (FRfW), Industrial Emissions Directive (IED), and emerging contaminants
- **Innovation opportunities:** new and innovative sludge treatment technologies

5.2.1 Decreasing satisfaction with our biosolids product:

Our biosolids operation ultimately depends on the ability to apply the final product to agricultural land. However, farmers are becoming less satisfied with our biosolids product. Although they recognise the benefits and the value of our biosolids in comparison to inorganic fertilisers, farmers have highlighted significant issues with consistency and odour. They have expressed interest in a higher quality product with greater dryness to improve stockpile stability, more consistent nutrient content, and ability to apply to great variety of crops outside ploughing periods. This is achievable with the proposed AAD technology investment. This is evidenced through our customer engagement survey, the results of which are presented in Appendix 1 and Figure 6 below.

Figure 6: Customer engagement responses relating to biosolids quality.

Farmer acceptance of our product is a key investment driver and is outside of management control. If farmers are not willing to buy our product, we must either upgrade it or find an alternative means of disposal. Our exploration of these options has led to the selection of our proposed Kent consolidation strategy as detailed in Section 4.4. Improved famer acceptance of biosolids because of AAD is generally acknowledged across industry. This is evidenced by the ADAS & Grieve Strategic National Landbank Study, which assumed a 40% acceptance rate for CAD biosolids and a 60% acceptance rate for AAD biosolids, as shown in Figure 7.



Model product statistics

Product type	Dry matter	Total N[1] (kg/t fw)	RAN[2] (kg/t fw)	Total P_2O_5[3] (kg/t fw)	RAN classification[4]	RAN applied[5] (kg/ha)	Acceptance percentage[6]	Scenarios 4 & 5	
								Applicable to cereals in autumn[7]	Applicable to grass
Liquid digested biosolids	4%	2.0	0.8	3.0	High	100	40%	✗	✓~
Digested biosolids cake[8]	25%	11	1.6	11	Low	36	40%	✗	✓~
Co-compost	40%	11	0.6	10	Low	14	50%	✗	✓~
Pelletised biosolids	95%	40	2.0	55	Low	13	70%	✗	✓

✗ = no; ✓ = yes; ✓~ = yes, depending on Safe Sludge Matrix treatment standard; kg/t fw = kilograms per tonne (or cubic metre) fresh weight; kg/ha = kilograms per hectare

[1] Total N = Total nitrogen
[2] RAN = Readily Available Nitrogen
[3] Total P_2O_5 = Total phosphate
[4] Low is less than 30% of total N, high is 30% or greater
[5] Based on a maximum application rate of 250 kilograms per hectare of total nitrogen
[6] Based on baseline farmer acceptance
[7] Based on an interpretation of Farming Rules for Water
[8] Based on mesophilic anaerobic digestion. Advanced anaerobic digestion would result in increased nutrient content, possible enhanced treated product (increasing grassland access) and increased farmer acceptance (60%)

Figure 7: National Landbank Study which identifies farmer acceptance of biosolids is lower for mesophilic anaerobic digestion (CAD) than for AAD.

5.2.2 Evolving Regulatory Landscape

Our bioresources operation is governed by a substantial amount of regulation, much of which has been recently introduced or is anticipated to change. As explained in our Bioresources Strategy (SRN36), we need a flexible bioresources operation to ensure continued compliance with new strategies such as DEFRA's Chemicals Strategy and the EA's Sustainable Sludge Strategy. The key challenge at present is continued uncertainty around landbank availability. As discussed in Section 4.3.2, we are already disproportionately impacted by landbank availability issues. The introduction of Farming Rules for Water (FRfW)[11] legislation and its related statutory guidance (which is due for review the Secretary of State no later than September 2025) is likely to exacerbate this issue.

Ofwat has recognised the uncertainty surrounding landbank availability and proposed a Notified Item for costs resulting from changes to legal requirements in respect of sludge spreading. Our response to this proposal is detailed in our Notified Item for landbank risk document (see Appendix 9), which includes the common uncertainty mechanism proposed by the industry that we endorse. However, legislative changes relating to sludge spreading is not the only regulatory driver underpinning this investment, and Ofwat's Notified Item proposal does not address the convergence of multiple investment drivers unique to Southern Water, driving the need for an immediate, atypical investment.

In addition to addressing farmer dissatisfaction described in the earlier section, upgrades are also required to address other regulatory drivers not related to sludge, such as the Industrial Emissions Directive (IED). Our proposed solution avoids unnecessary spend on IED compliance at sites planned for decommission and enables us to deliver efficient IED improvements alongside treatment technology upgrades at our strategic sites. If approved, this offers improved cost efficiency which has been accounted for by a £54m reduction to our IED enhancement funding request (see SRN 37, section 4). A step change in our bioresources operation

[11] The Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018'

also addresses regulatory drivers not necessarily related to sludge spreading, such as meeting net zero targets and removing microplastics from sludge. Other regulatory drivers for improved bioresources treatment are outlined in Section 3 of our Bioresources Strategy (SRN36).

Rather than invest in interim solutions with a high risk of asset redundancy, we intend to pre-empt this challenge and deliver a combined, no-regret solution which meets our current and future regulatory requirements. This is a cost-effective approach avoiding unnecessary spend on interim solutions and uses cost efficiencies associated with simultaneous delivery of capital upgrades. Furthermore, proactively investing ahead of new regulations avoids the inevitable supply chain premiums that arise when the whole industry must deliver legislative change.

5.2.3 Technology improvements:

As highlighted in Section 4.2, we currently rely solely on CAD with additional lime treatment or maturation to ensure compliance with BAS regulations. However, recent advancements in sludge treatment technologies offer promising alternatives and ATC is gaining traction within the UK water industry. ATC technologies, such as gasification and pyrolysis, hold significant potential for enhanced nutrient recovery from sludge liquors.

Harnessing these new technologies requires a transformative shift in our bioresources operation. While ATC technologies are yet to be proven at a large scale, we plan to collaborate with the industry in AMP8 to test ATC-type technologies as part of our investigation work under the WINEP driver for microplastics. This will allow us to assess their feasibility and potential for future implementation.

AAD offers a proven and reliable solution that meets current farmer and anticipated regulatory needs. Moreover, it can be used as a pretreatment step for ATC[12]. As such, implementing this technology now will enable us to leverage AAD benefits now while exploring the potential of ATC. We considered this a ‘no-regret’ step towards a more sustainable and innovative future for our bioresources operation.

5.3 Investment Drivers Within Management Control

There are also drivers for investment which are within management control, namely aging assets, and capacity limitations. While these drivers are triggering the need for investment in AMP8, they are not driving the solution scope.

A transformative change in our approach to bioresources is required due to the external investment drivers described above. It aligns with engineering and economic rationale to deliver this change once the existing assets have been fully utilised and are at the end of their economic life. This timing has been planned as part of our long term biosolids strategy and detailed in our PR19 Bioresource strategy.

As a business, we have operated in line with our long-term bioresources strategy as communicated to Ofwat in previous price reviews. Our approach to bioresources management has historically been to keep costs as low as possible, recognising our relative position on customer bills. To this effect, we have managed our assets so that they could be operated at full utilisation, maximising the natural economic lifecycle of the existing asset base while avoiding early decommissioning of healthy assets.

At PR19, we identified the need for investment in Kent and made a strategic decision to defer it and focus on other delivery objectives such as improved energy generation and biosolids quality. This decision enabled us to achieve maximum utilisation of Kent assets, avoid sunk costs, and remain flexible to uncertain regulatory change, market opportunities, and customer needs. Anticipated capacity shortfalls now necessitate

[12] Unlocking the full energy potential of sewage sludge. - University of Surrey

investment in modern digestion technology, meaning now is the right time for us to deliver on our commitment made at PR19:

"Our current projections show Kent will experience capacity shortfalls during AMP8. From 2020 we will explore cost-effective, collaborative market interventions to secure additional capacity… We are investigating possible economies of scale by rationalising 5 STC in North Kent, adopting advanced digestion technology and optimising transport routes."

Table 11 (first presented in Section 4.2 and repeated below) shows that most STCs have been operated to near the end of their useful life.

STC	TDS/year	Digesters				Centrifuges		CHP	Cake reception	
		1	2	3	4	1	2	1	1	2
Ashford	18,287	125%	42%	42%	20%	95%	95%	117%	80%	120%
Ham Hill	4,325	97%	97%			100%	100%	117%		
Aylesford	6,468	102%	102%			150%	150%	117%		
Canterbury	5,293	170%	57%			135%	135%	167%		
Gravesend	4,709	80%				95%		67%		
Motney Hill	14,722	93%	93%			130%	130%	142%		
Queenborough	6,745	43%	43%			80%	80%	167%		

Table 11: Asset age as a percentage of expected life[13]

Replacing all these assets on a like for like basis is a significant and material capital investment that may be a sunk cost, considering CAD is unlikely to produce biosolids of a sufficient quality to meet evolving customer and regulatory needs. Most of the Kent STCs have physical constraints (e.g., site space, located near SSSIs, etc.) which drive additional upgrade costs and, in some cases, make this unfeasible. Our modelling investigation (Section 4.4) showed that consolidating the Kent bioresources operation and upgrading the digestion technology to AAD at two sites is more cost-effective than upgrading all seven STCs.

As shown in Table 12, consolidating our bioresources operation in Kent to two sites will require significant capacity upgrades at these sites.

	Standard demand	Stressed demand
Total sludge volumes generated in Kent (TDS/year)	35,333	42,400
Ashford & Ham Hill design capacity (TDS/year)	22,612	14,344
Loading	156%	296%

Table 12: Digestion utilisation under standard (annual average) and stressed (annual peak) demand scenarios.

We will deliver the necessary upgrades through a pragmatic, 'no-regret' solution that addresses both internal and external investment needs, positions us for long-term success and contributes to a more sustainable future.

[13] Expected life for concrete digesters is 60 years. All digesters are concrete digesters except for Ashford 1 and Canterbury 1 digesters which are SGCT and have an expected life of 20 years. Expected life for centrifuges, CHP and cake reception assets are 20, 12 and 20 years respectively.

This section should also be read in conjunction with SRN-DDR-020 an Economic Insight report addressing the need for customers not to pay twice. It explains the wider context for decision making that need to be considered.

5.4 Cost Controls and Potential Savings

5.4.1 Cost Controls

Our proposed solution to consolidate our bioresources operation in Kent and implement AAD is a long-term cost control measure in and of itself. This solution has been developed off the back of a series of steps to control costs in the face of unique circumstances.

Reducing costs associated with our unique circumstances:
As discussed in Section 4, we face higher efficient costs than our peers due to 100% reliance on CAD and disproportionately limited landbank availability. Implementing AAD will reduce these by:

- **Higher maintenance costs due to reliance on aging CAD asset.** Converting to AAD will avoid increasing maintenance costs. It is also a more efficient technology with higher potential for revenue generation.
- **High disposal costs associated with limited landbank availability.** AAD produces significantly less volumes of biosolids than CAD and will therefore reduce our transport costs.

Steps taken to control costs:
In developing our preferred solution to meet both internal and external investment drivers, we have taken multiple steps to control costs, such as:

- **PR19 strategic deferral of investment.** We deferred investment in Kent at PR19 to explore cost-effective solutions and avoid sunk costs. This decision allowed for better utilisation of existing assets and flexibility to adapt to changing circumstances.
- **Maximised asset utilisation.** We have operated most CAD assets in Kent to the end of their useful life. This approach has mitigated early decommissioning and replacement and allowed us to gain maximum economic benefit from these assets.
- **Explored alternative solutions.** We have conducted in-depth technology appraisals and assessed WLC of alternative options under a range of possible future scenarios to identify the most cost-effective solution.
- **Avoided future capital maintenance.** A consolidated bioresources operation in Kent eliminates the need for costly upgrades of outdated assets that may not meet future needs. We have accounted for these potential savings in our implicit allowance, as detailed below.
- **Collaboration with industry.** We have collaborated with industry to investigate potential market solutions such as co-treatment to reduce costs. While these are not currently viable (see Section 9.3), we continue to work with industry to further develop these solutions. To this effect, we plan to collaborate with the industry in AMP8 to test ATC-type technologies, which are compatible with AAD digestion investment, as part of our investigation work under the WINEP driver for microplastics. This enables us to leverage collective expertise and share development costs.
- **Market based delivery approach.** We hope to delivery this project through an alternative delivery framework to generate additional cost efficiencies and spread the cost to customers over the lifetime of the assets. Our proposed market-based delivery approach is detailed in Section 9.3.

5.4.2 Potential Savings

We acknowledge our proposed AAD solution is likely to result in cost savings in relation to avoided future capital maintenance and reduced IED requirements in AMP8. We have considered the potential cost savings in each of these areas and consider the following measures to account for these:

- **£5.2m implicit allowance for avoided future capital maintenance:** In our original cost adjustment claim (SRN21), we stated that we would "estimate any possible allowance related to capital maintenance for all sludge sites in Kent that is implicit in the econometric models", once we had clarity from Ofwat of the bioresources econometric model. Following review of Ofwat's DD model, we propose that an implicit allowance of £5.152m would be a reasonable and acceptable deduction from the claim. Details of the methodology we have used to derive the implicit allowance are provided in the following sub section.
- **£54m reduction in IED enhancement funding request based on delivering 'risk proportional' IED solutions:** The consolidation of our STCs in Kent provides an opportunity for cost efficiencies by reducing the compliance requirements to IED. For sites intended to be decommissioned as part of our Kent strategy, we are proposing to deliver 'risk proportional' solutions which balance the level of investment for IED compliance against the remaining asset life. These solutions are described in our IED Enhancement Business Case SRN37 and DD response SRN-DDR-042. We have accounted for this potential savings through a £54m reduction in our IED enhancement funding request.

Ofwat has accounted for AAD conversion incentives, such as Renewable Obligation Credits (ROC), Renewable Heat Incentives (RHI), and Green Gas Support Schemes (GGSS), when making investment decisions. However, these incentives do not offer material financial benefit for our investment in Kent because they are closed to new capacity. The ROC scheme closed to new installations in 2017, the RHI scheme closed to new applications in 2021, GGSS will close to applicants in 2028. The new assets commissioned under the Kent strategy will therefore not be eligible for these incentives. While Southern Water has existing assets that are covered under these schemes, the majority of these will expire in AMP8 and AMP9. Therefore, any additional revenue generated from AAD conversion incentives is expected to reduce significantly.

5.4.3 Implicit Allowance

For this claim, any implicit allowances are related to capital maintenance of the existing CAD assets at seven STCs in Kent that is implicit in the econometric models. We estimate implicit allowances as the capital maintenance avoided in AMP8 owing to the closure/upgrade of existing CAD assets. Because all seven sites in Kent will remain in operation until the new assets are fully commissioned, and, as discussed in Section 9.3, the exact timescale is affected by the financing route, we considered a range of implicit allowances based on STC asset decommissioning scenarios as set out in Table 13 below.

Scenario 1	Scenario 2	Scenario 3
The existing digestion/biogas assets at the current seven Kent sites would be closed/upgraded in the last year of AMP8, meaning that we could avoid one year of capital maintenance with digestion/biogas assets in AMP8. All Kent sites would retain the existing dewatering assets for which we would require capital maintenance. Therefore, in Scenario 1 the implicit allowance would be the avoided capital maintenance with existing digestion/biogas assets in the seven Kent sites for one year.	The existing digestion/biogas assets at the two sites being upgraded to enhanced treatment (Ham Hill and Ashford) would require limited capital maintenance in the 5 years of AMP8 owing to the change of process in the last year of AMP8. All Kent sites would retain the existing dewatering facilities which would require capital maintenance. This means that in Scenario 2, the implicit allowance would be the avoided costs of maintaining digestion/biogas assets in two sites for five years.	The existing digestion/biogas assets at the current seven Kent sites would be closed/upgraded in the last year of AMP8. This scenario assumes one year of capital maintenance avoided (last year of AMP8) at the 5 sites to be closed. It also assumes limited capital maintenance at the 2 sites being upgraded (Ham hill & Ashford) for the duration of AMP8. All seven sites would retain the need for maintaining their dewatering assets. Effectively, this is a combination of scenarios 1 and 2. Therefore, in Scenario 3, the implicit allowance would be the avoided cost of maintaining the existing digestion/biogas assets at the 5 sites to be closed for 1 year (last year of AMP8) plus the limited cost of maintaining the existing assets at the two enhanced sites (Ham Hill and Ashford) for the duration of AMP8.

Table 13: STC asset decommissioning scenarios.

To estimate the implicit allowances, we use two alternative unit costs for maintaining digestion/biogas assets, both based on industry level data reported by the water companies and corrected for the maintenance costs of the dewatering assets that will continue, as follows:

- **Option A:** £75.3 per ton of dry solids (tds), in 2022/23 prices, corresponding to the industry upper quartile (UQ) over the historic period from 2011/12 to 2021/22, which is the period that Ofwat uses in its bioresources econometric models.
- **Option B:** £55.2 per tds, in 2022/23 prices, corresponding to the industry UQ over the AMP8 period, recognising that the forward-looking value is expected to better reflect the lower capital maintenance cost associated with AAD, as compared to other technologies more prevalent in the historic data.

We present the underlying data used to calculate these capital maintenance unit costs in Appendix 3.

Table 14 below shows the alternative estimated implicit allowance values. We consider an implicit allowance of £5.152m, which is the average of the estimated values to be a fair and reasonable implicit allowance for the following reasons:

- A bottom-up estimation using our engineering models of the capital maintenance that will not be required during AMP8 owing to the planned closure/upgrading of sites for the three scenarios above, ranges from £3.56m to £6.52m. Our bottom-up estimates are towards the bottom end of the range of implicit allowance estimates, meaning that we are calculating an implicit allowance that is greater than our underlying cost.
- The unit costs for maintaining digestion/biogas assets based on historic UQ use the underlying cost data for CAD rather than AAD. CAD is expected to have a higher capital maintenance than AAD, and therefore the implicit allowance based on historic UQ (option A) is again likely to be overstated.

Given that the alternative estimates are likely to overstate the value of the implicit allowance, there is good reason to consider the lower end of the range. However, to ensure a fair and reasonable allowance, we have assumed the average of the estimated implicit allowance values.

		STC asset decommissioning scenarios		
		Scenario 1: 7 sites for 1 year	**Scenario 2: 2 sites for 5 years**	**Scenario 3: 7 sites for 1 year and 2 sites for 4 years**
Range of unit costs for digestion/biogas capital maintenance (a)	Option A: historic UQ Option B: AMP8 UQ	£75.3 / tds 1 £55.2 / tds 1		
Existing annual digestion/biogas capacity still in use in AMP8 (b)		38,622 tds / year	17,735 tds / year	38,622 tds /year (7 sites) 17,735 tds /year (2 sites)
Number of years of digestion/biogas future capital maintenance avoided (c)		1 year	5 years	1 year (7 sites) 4 years (2 sites)
Total volume of digestion/biogas future capital maintenance avoided (d) = (b) x (c)		38,622 tds	88,677 tds	109,563 tds
Implicit allowance estimates (e) = (a) x (d)	Option A: historic UQ Option B: AMP8 UQ	£2.908m £2.132m	£6.677m £4.895m	£8.250m £6.048m
Implicit allowance used in the CAC (average of estimates)		£5.152m		

Table 14: Calculation of implicit allowance.

6 Adjustment to Allowances

6.1 Section Overview

This section provides evidence to support our response to Ofwat's cost adjustment claim criteria relating to allowance adjustments, presented in Table 15.

Ofwat criteria	Response
Is there compelling evidence that the cost claim is not included in our modelled baseline (or, if the models are not known, would be unlikely to be included)? Is there compelling evidence that the factor is not covered by one or more cost drivers included in the cost models?	A strategy change towards AAD is not included in our modelled baseline as the model reflects an incremental uptake of this technology, which has been the industry norm over the data period considered. Step changes in sludge treatment technologies have historically been considered "exceptional capital maintenance items" by Ofwat and companies such as Northumbrian Water and Welsh Water have previously benefited from additional allowances on top of their modelled baseline to deliver these, as evidenced in Section 6.2.
Is the claim material after deduction of an implicit allowance? Has the company considered a range of estimates for the implicit allowance?	Our cost adjustment claim is 29% of our total forecast costs for the bioresources price control after the deduction of an implicit allowance. This passes Ofwat's 6% materiality threshold. We have considered a range of estimates for the implicit allowance, as discussed in Section 5.4.
Has the company accounted for cost savings and/or benefits from offsetting circumstances, where relevant?	We have accounted for cost savings and benefits from offsetting circumstances related to avoided future capital maintenance and reduced IED compliance costs. These are discussed in Section 5.4.
Is it clear the cost allowances would, in the round, be insufficient to accommodate the factor without a claim?	We have received a modelled base cost allowance within 2% of our forecast bioresources costs excluding the proposed investment at Kent. We requested an additional £112.8m for this investment as part of our original cost adjustment claim, which was reallocated by Ofwat to enhancement and then rejected on the basis that it should be covered by base. Therefore, neither our base nor enhancement allowance is sufficient to cover this claim
Has the company taken a long-term view of the allowance and balanced expenditure requirements between multiple regulatory periods? Has the company considered whether our long-term allowance provides sufficient funding?	Modelled allowances have been sufficient to maintain the operational status quo over preceding Price Controls, allowing Southern Water to maximise the digestion assets in our Kent region. However, the need for an atypical investment in AAD is not readily captured in the model data given the incremental nature of technology investments in larger companies in the data period utilised.
If an alternative explanatory variable is used to calculate the cost adjustment, why is it superior to the explanatory variables in our cost models?	N/A.

Table 15: Response to Ofwat assessment criteria for adjustments to allowances.

The bioresources base and growth cost allowance calculated by Ofwat does not sufficiently fund Southern Water's bioresources operation considering the proposed technology change required to consolidate and rationalise our treatment sites for use of AAD.

The scale and nature of the investment proposed is atypical and addresses the need for a step change from current digestion technology to address external drivers outside of management control. We have assessed a wide range of alternative options which determined that shifting from seven CAD STCs to two AAD STCs in Kent is the most cost-effective, 'no-regret' solution. This is a strategic, long-term investment which is not funded through Ofwat's bioresources model. It should therefore be regarded and assessed as a separate cost adjustment claim, and there is regulatory precedent for this.

6.2 Exclusion from Modelled Allowance

Ofwat base model captures the incremental nature of the historical technology change investments undertaken by the sector since 2012. The data does not reflect, nor would appropriately fund, the step change investment required by Southern Water to deliver our Kent strategy.

Figure 8 shows the incremental nature of AAD uptake in industry over the model data period. As the model data does not reflect such a step change, it cannot appropriately fund it. Instead, we request that Ofwat allows a separate cost adjustment to enable this investment. There is regulatory precedent for such an adjustment.

Ofwat has made separate allowances for "exceptional items" in companies' capital maintenance plans in previous price reviews. At PR04, Ofwat specifically called out "a significant change in sludge treatment strategy" as an example of an exceptional capital maintenance item[14]. Both Northumbrian Water and Welsh Water have received additional allowances for step-change transitions towards AAD.

Northumbrian Water delivered two AAD facilities via two design and construct contracts worth more than £60m: one at Bran Sands in 2007 and one at Howdon in 2010[15]. Welsh Water was also funded to deliver a £70m investment comprised of two strategic AAD plants at Cardiff and Aran sites in 2011[16]. Ofwat holds Northumbrian Water's strategy change as exemplary bioresources investments[17].

Northumbrian and Welsh Water's step-change in technology occurred prior to 2012, so these peaks of atypical capital investment are not captured in the dataset used by Ofwat to derive efficient cost allowances. While some larger companies have incrementally installed AAD facilities during the base model data period, this has not been to the extent that it was a total strategy shift. These investments were typically 'spend to save' projects whereby companies converted to AAD at single sites to gain operational efficiencies and conversion incentives. As discussed in Section 5.4.2, these incentives are no longer available.

[14] Ofwat. (2020, October). *PR04 - Final Determinations Document*. cover.pdf (ofwat.gov.uk)
[15] Water Projects Online. (2012). *Howdon Bran Sands STW & AD Plants*. Howdon & Bran Sands STWs – AD Plants (2012) | (waterprojectsonline.com)
[16] Water Projects Online. (2011). *Cardiff Afan AAD Plants.* Cardiff & Afan AAD Plants (2011) | (waterprojectsonline.com)
[17] Ofwat. (2016, May,). *Water 2020: our regulatory approach for water and wastewater services in England and Wales Appendix 2 Moving beyond waste - further evidence and analysis.* Report (ofwat.gov.uk)

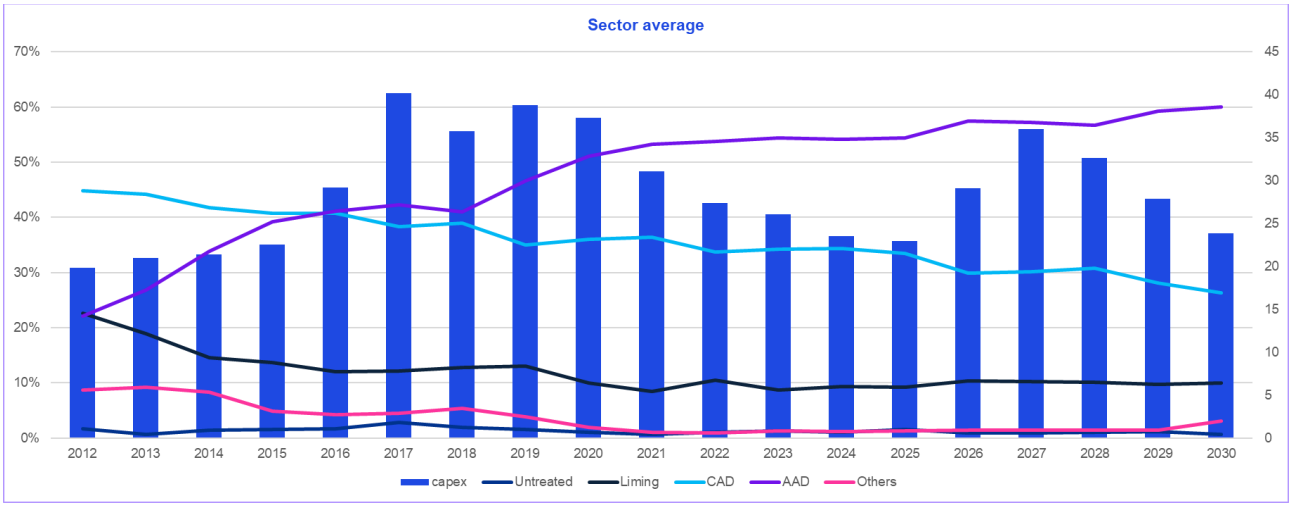


Figure 8: Sector CapEx and technology type utilisation over the modelling period

6.3 Materiality

We have calculated the materiality threshold for the bioresources price control, based on the latest view of our AMP8 Totex (Table 16 below).

Price control	Expected AMP8 totex	Materiality threshold (%)	Materiality amount (£m)	Net value of the claim (£m)	Status
BIO	£465.1m	6%	£27.9m	£107.6m	Pass

Table 16: Materiality of claim

The claim is material. The additional costs above those provided by Ofwat's modelled base costs amount to £107.6m. Refer to Section 7 for details of our cost estimate and implicit allowance. This is 29% of the projected business plan Totex for bioresources, which and is above the 6% threshold.

6.4 Insufficient Allowance

We received a DD allowance for bioresources base expenditure which is in line with our requested costs, **excluding this investment** (Table 17 below).

	Requested (£m)	Allowance (£m)	Delta (£m)	Delta (%)
Modelled allowance + CACs (excluding the Kent AAD which was re-allocated to enhancement)	255	264	+9	+3.5%
Unmodelled costs	16	12	-4	-25%
Total	**271**	**276**	**+5**	**+1.8%**

Table 17: DD bioresource base allowances

The £112.8m originally request for the Kent AAD project under our original cost adjustment claim (SRN21) was reallocated by Ofwat to enhancement. As shown in Table 18, our DD allowance for bioresources enhancement is £96m less than our forecast cost **excluding this investment.** Including this investment in

our enhancement funding request increases the funding gap to £209m which equates to the second highest percentage reduction across the industry.

Company	Allowance (£m)	Incl. Kent AAD CAC			Excl. Kent AAD CAC		
		Requested (£m)	Delta (£m)	Delta (%)	Requested (£m)	Delta (£m)	Delta (%)
ANH	104	101	3	3%	101	3	3%
WSH	90	117	-27	-23%	117	-27	-23%
NES	38	85	-47	-55%	85	-47	-55%
SVE	334	481	-147	-31%	481	-147	-31%
SWB	59	72	-13	-18%	72	-13	-18%
SRN	**108**	**317**	**-210**	**-66%**	**204**	**96**	**-49%**
TMS	230	563	-333	-59%	563	-333	-59%
UUW	221	455	-234	-51%	455	-234	-51%
WSX	71	225	-154	-68%	225	-154	-68%
YKY	82	162	-80	-49%	162	-80	-49%
Total	1339	2466	-1127	-46%	2466	-1127	-46%

Table 18: Industry DD allowances for bioresources enhancement.

The tables above show that we have received insufficient DD allowances to deliver this investment under both enhancement and base. Without sufficient funding, we are unable to deliver the necessary step change to our bioresources operation. As evidenced in Sections 4 and 5, this would result in negative consequences for our customers, our business, and the environment.

6.5 Long Term View of Model Allowance

We have taken a long-term view of the allowance and balanced expenditure requirements between multiple regulatory periods. We do not consider Ofwat's long-term allowance provides sufficient funding for this investment for the reasons described below.

Econometric modelling has inherent weaknesses in its inability to capture all cost drivers. We remain concerned about the reliance Ofwat places on econometric models that cannot truly reflect the full suite of investment drivers in an evolving bioresources operation.

Ofwat makes use of 4 unit cost econometric models to assess companies' efficient costs in bioresources at PR24. These unit cost econometric models attempt to capture the variations in companies' bioresources costs, beyond the volume of sludge produced (scale). The fit of these models, as measured by the R-squared, have low values ranging from 0.145 to 0.256, bringing into question the statistical robustness of the models in terms of their predictive power. This is further demonstrated by the fact that all 4 bioresources models have high variation in efficiency scores. According to Ofwat, "a large range of efficiency scores could indicate the presence of issues in the underlying model." Therefore, Ofwat should recognise that the modelled output is not definitive as the model cannot comprehensively account for all cost drivers and efficient funding needs.

The evidence above demonstrates that Ofwat's model does not capture the step change investment required to implement AAD assets. Even without such a material increase, we have historically overspent our modelled base allowances for wastewater expenditure, which includes the bioresources price control. This is

evidenced by Figure 9 below which shows our cumulative spend against our wastewater Totex allowance for AMP7.

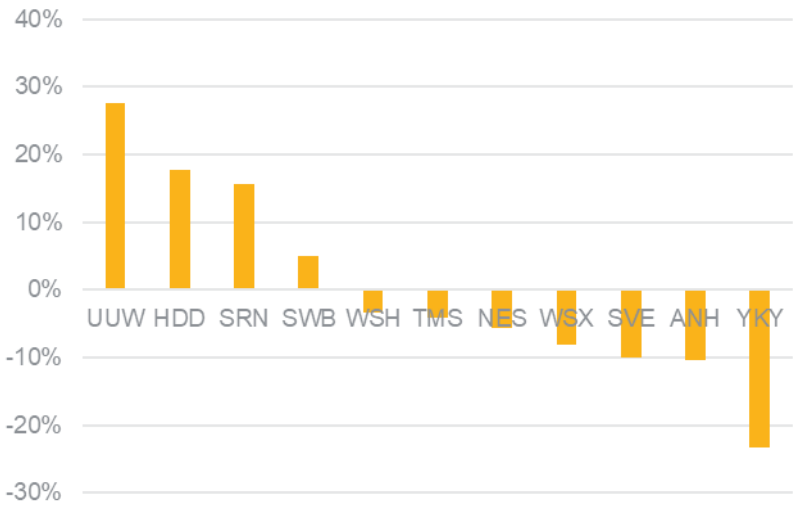


Figure 9: AMP7 cumulative spend against wastewater totex allowance (data from Ofwat Water Company Performance Report 2022-23)

Our historical outturn and forecast annual costs for bioresources base activities is presented below. This shows there is some 'lumpiness' to the base expenditure spend profile, but that peaks and troughs are generally balanced across the entire period. On average, we have historically spent £50m per year on base bioresources activities and our forecast base spend for AMP8 – excluding the Kent AAD investment – is in line with this. The Kent AAD project represents a significant step increase to our base expenditure profile. This investment is too 'lumpy' to have been included in previous funding allowances.

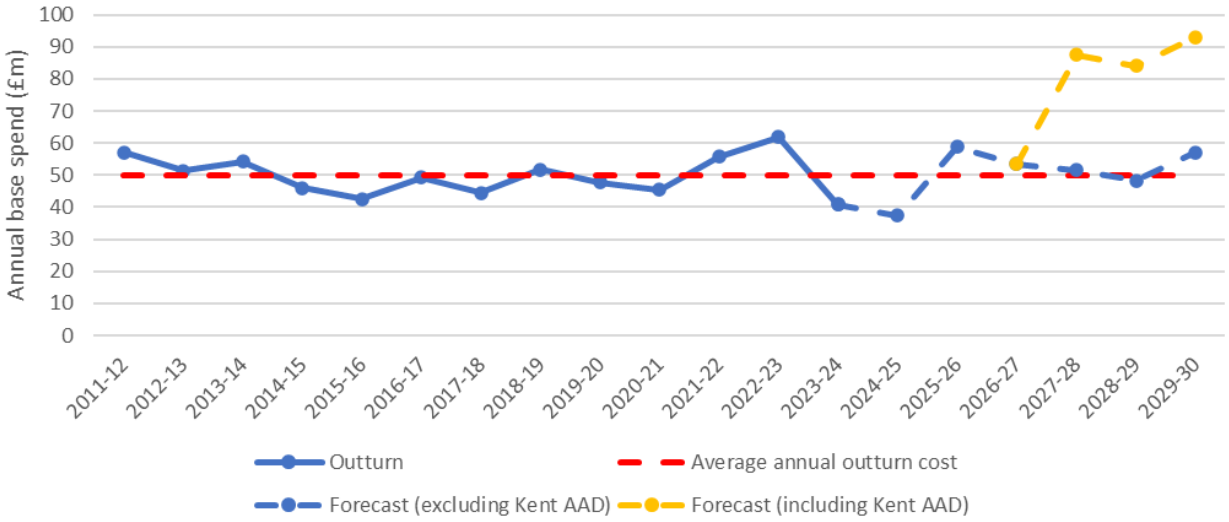


Figure 10: Historical and forecast spend for bioresources base activities.

7 Cost Efficiency

7.1 Section Overview

This section provides evidence to support our response to Ofwat's cost adjustment claim criteria relating to cost efficiency, presented in Table 19.

Ofwat criteria	Response
Is there compelling evidence that the cost estimates are efficient (for example similar scheme outturn data, industry and/or external cost benchmarking, testing a range of cost models)?	Our costs have been developed using a mixture of cost curves and unit rates. We have benchmarked our design scope against another WaSC's STC of a similar size and configuration to our intended solution at Ham Hill. Our direct cost estimates have been externally benchmarked by third party consultants Mott Macdonald. The outcomes of these activities are evidenced in Section 7.3.
Does the company clearly explain how it arrived at the cost estimate? Can the analysis be replicated? Is there supporting evidence for any key statements or assumptions?	We have provided detailed cost breakdowns for both AAD schemes and explained adjustments to these in Section 7.2. Design assumptions have been validated through scope benchmarking as described in Section 7.3. Cost assumptions have been validated through external cost benchmarking described in Section 7.2.
Does the company provide third party assurance for the robustness of the cost estimates?	Mott MacDonald conducted third party assurance and external benchmarking of our internally developed cost estimates. This is evidenced in Section 7.3.

Table 19: Response to Ofwat assessment criteria for cost efficiency.

It is important to understand the potential difference between our project cost estimate (presented here) and the required adjustment to base allowance. The necessary adjustment to our base cost allowance ultimately depends on the delivery route of this solution. We have derived an efficient cost estimate which represents the necessary adjustment to our bioresources base cost allowance to deliver the Kent project in-house. This is detailed in the following section.

We have also explored market-based delivery routes to ensure we achieve best value for customers. Our delivery options appraisal is presented in Section 9.3. This has identified that third party delivery may be possible if we can agree a market-based delivery framework with Ofwat that enables us to recover costs payable to the third party from customers at future price review. In this scenario, our requested funding adjustment is much less as we only require funding for pre-construction and contract management costs. Our estimate for these costs is presented in Section 9.3.

7.2 Cost Estimate

7.2.1 Capital Cost Estimate

Capital cost estimates for the proposed upgrades at Ashford and Ham Hill were derived by our Cost Intelligence Team (CIT), formed of professional cost estimators and data modellers, in line with our Level 1 cost estimation process detailed in our PR24 Cost and Option Methodology (SRN15).

Our Engineering Team developed a concept design for the proposed upgrades which outlined major scope items. Direct cost estimates for these items were then derived by CIT using process-level cost curves which estimate generalised allowances for key assets based on historical data. Cost data is captured from the

delivery of real projects across the industry and fed into these models to ensure they represent efficient delivery.

Mott MacDonald conducted third party assurance and external benchmarking of our direct cost estimates, which highlighted no significant difference. A comparison of our direct cost estimates to the external benchmark is provided in Table 20 below. A detailed breakdown of these costs is provided in Appendix 4.

Table 20: External benchmarking of direct cost estimates.

STC	No. of scope items benchmarked	Cost estimate	Benchmark	Delta (£m)	Delta (%)
Ashford	10/80	31.92	31.36	0.56	1.8%
Ham Hill	13/87	61.56	63.01	-1.45	-2.3%
Total	**23/116**	**93.48**	**94.37**	**-0.89**	**-0.9%**

Our direct cost estimates were then further refined based on the following activities:

- Cake storage scope for each scheme was reallocated to WINEP enhancement funding following approval by the EA.
- Before our October submission, we challenged our cost estimates for Thermal Hydrolysis Plant (THP), a potential option for AAD, by engaging a supplier to provide an indicative cost. This resulted in cost reductions in both sites. We have since benchmarked this scope further and found it to be efficient. See Section 7.3.
- We conducted further investigation into biomethane injection as an alternative to CHP and, as described in Section 4.4, excluded this from scope due to its higher cost. While we are now reconsidering this option, it remains excluded from our efficient cost estimate. If progressed, we will absorb the additional cost (estimated at £8.9m CapEx).
- We removed growth scope as we assumed this would not be covered under this cost adjustment claim. However, growth costs are not currently covered in our DD base cost allowance. We have therefore reintroduced this in our updated third-party delivery cost (see Section 9.3.3).

Risk, overhead, and indirect cost uplifts were then applied to the total direct cost to generate a total project cost. The total uplift factor applied to this investment was 2.040. Uplift values were selected based on the design maturity, complexity, and quality of cost data and have been benchmarked against industry comparators. SRN15 describes our rationale and presents benchmarking evidence for cost uplifts and efficiency factors. Our final project cost estimate is presented in Table 21 below.

Costing Adjustments	Ashford AAD (£m)	Ham Hill AAD (£m)
Direct cost estimate	31.9	61.6
Cake Covering transferred to WINEP (Approved)	-6.6	-4.7
Adjustment of design & costing for THP	-2.2	-15.5
Move from Biomethane Upgrade to CHP	-	+0.8
Growth element removed	-3.4	-6.7
Final direct cost	**19.8**	**35.6**
Total project cost (incl. indirect costs)	**40.3**	**72.5**

Table 21: Total project cost estimates after scope adjustments and uplifts.

7.2.2 Operational Cost Estimate

No operational costs have been included in this cost adjustment claim as the new facilities will not be operational until AMP9. High level OpEx was calculated using our Decisio tool to enable WLC analysis, refer to Section 4.4.4.

7.3 Benchmarking and Assurance

As detailed above, Mott MacDonald conducted third party assurance and external benchmarking of our direct cost estimates. Their benchmarking report is provided in Appendix 5.

At the time of our October submission, we had a lack of confidence in our costs estimates for THP plants as there was a large variance in costs between our bottom-up estimates and a supplier quotation obtained close to submission. This scope item was not included in our initial benchmarking exercise due to a lack of comparator cost data. We used the supplier quotation as the basis for our cost estimate in our October submission, as we perceived it to be the most reliable data source.

We have since engaged Mott Macdonald to source new external data and conduct external benchmarking for the THP scope. This benchmarking exercise is evidenced in Appendix 6 and supports our decision to use the supplier cost estimate.

To validate the scope underpinning our costs, we compared our design to a newly commissioned AAD facility with similar capacity to the intended upgrade at Ham Hill. This STC is operated by another WaSC with longstanding experience with AAD processes. We visited the newly commissioned site and found no significant issues with our design. We are therefore confident that our scope assumptions and resultant costs are reasonable and robust. An itemised scope comparison between our Ham Hill design and this STC is provided in Appendix 7.

This document, alongside our post draft determination submission, has been technically assured by Jacobs.

8 Need for Investment

Our response to Ofwat's cost adjustment claim criteria relating to investment need, is presented in Table 22. We have already provided sufficient evidence to support this response in Sections 4 and 5 of this document. Relevant sections for each criterion are signposted in the table below.

Ofwat criteria	Response
Is there compelling evidence that investment is required?	Evidence to support our need for investment is provided in Sections 4.2, 4.3, 5.2, and 5.3. Investment is being driven by our unique challenges relating to reliance on CAD and landbank availability, decreasing farmer satisfaction with our biosolids product, evolving regulations, and our aging CAD assets.
Is the scale and timing of the investment fully justified?	The scale and timing of this investment is justified in Section 5.3. The scale of this investment is being driven by external drivers (decreasing farmer satisfaction and evolving regulations), whereas the timing is being driven by internal investment drivers (aging assets). This timing has been planned as part of our long-term sludge strategy.
Does the need and/or proposed investment overlap with activities already funded at previous price reviews?	There is no overlap of this investment with activities funded at previous price reviews. We have purposely deferred investment in Kent so that we could deliver transformative change once existing assets have been fully utilised and are at the end of their economic life, as evidenced in Section 5.3. We do not consider Ofwat's base model to provide sufficient long-term allowance to cover this investment, as evidenced in Section 6.5.
Is there compelling evidence that customers support the need for investment (both scale and timing)?	We have conducted in-depth stakeholder engagement, including interviews and surveys with farmers and wholesale water and wastewater customers. There is strong support for AAD conversion in Kent, as evidenced in Section 4.4, 5.2, and 9.3.

Table 22: Response to Ofwat assessment criteria for investment need.

9 Best Option

9.1 Section Overview

Our response to Ofwat's cost adjustment claim criteria relating to best option, is presented in Table 23. We have already provided evidence for the consideration of alternative upgrade solutions to meet our investment need in Section 4.4. This section provides additional evidence relating to our exploration of market-based delivery routes.

Ofwat criteria	Response
Did the company consider an appropriate range of options to meet the need?	We have conducted an extensive technology appraisal supported by third party consultants Atkins and informed by in-depth customer engagement, as evidenced in Section 4.4. We have also explored a range of market-based delivery options based on the bioresources market opportunities identified by Jacobs in its Bioresources Market Review. This has been informed by extensive market research and engagement with more than 25 interested third parties. Our delivery options appraisal is presented in Section 9.3.
Has a cost–benefit analysis been undertaken to select proposed option? There should be compelling evidence that the proposed solution represents best value for customers, communities and the environment in the long term? Is third-party technical assurance of the analysis provided?	We have conducted a WLC and VfM analysis for our preferred option and compared this to our baseline scenario. Our assessment included quantified carbon cost estimates. We have also monetised other benefits relating to protection against future changes to customer and regulatory expectations. Our WLC assessment is presented in Section 4.4, our VfM assessment is presented in Section 9.3.4. This provides compelling evidence that our consolidated AAD solution represents best value for customers, community, and the environment. Our proposed market based delivery approach further improves this value.
Has the impact of the investment on performance commitments been quantified?	This investment may result in reduced GHG emissions. However, this won't be realised until AMP9 when the sites are operational. In AMP8, there will be no quantifiable impact on performance commitments relating to bioresources.
Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where utilisation will be low?	We have fully explored uncertainties relating to cost and benefit delivery through our investigation of alternative technology and delivery solutions. Our proposed consolidation and AAD conversion is a flexible, low risk and modular solution for our long-term Bioresources Strategy. This investment represents the first of our two stage Bioresources Strategy which ultimately moves towards thermal destruction technologies.
Has the company secured appropriate third-party funding (proportionate to the third party benefits) to deliver the project?	Third-party funding is not relevant to this investment, which is our sole responsibility.
Has the company appropriately presented the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable?	The proposed investment does not quality for DPC, but we are proposing another alternative delivery mechanism to generate better value for customers. This is presented in Section 9.3.
Where appropriate, have customer views informed the selection of the proposed solution, and have customers been	We have conducted extensive customer and market engagement to inform the selection of our preferred technology and delivery solutions. This is presented in Sections 4.4 and 9.3.

provided sufficient information (including alternatives and its contribution to addressing the need) to have informed views?	

Table 23: Response to Ofwat assessment criteria for best option for customers.

9.2 Sludge Treatment Options

Refer to Section 4.4.

9.3 Delivery Options

9.3.1 Market Opportunities

In its Bioresources Market Review[18], Jacobs identified six bioresources market opportunities and assessed their potential for future implementation and possible risks. We have assessed these options based on our unique circumstances and identified our own potential for future implementation and risks. Section 6 of our Bioresources Strategy (SRN36) provides a detailed analysis of this assessment, the outcomes of which are summarised in Table 24 below.

The outcome of this activity was the identification of three possible delivery options for the Kent AAD project:

1) Delivery in-house
2) Outsourcing our operations for a service gate fee
3) Delivery by a third party

Bioresources Market Options	Jacobs		Southern Water	
	Implementation potential	Rationale and possible risks	Implementation potential	Rationale and possible risks
Headroom trades	Low	Generally short-term solution limited by the need to transport the sludge	Low	Limited potential, focused on cross-border trading, usually to support other WaSCs with major site maintenance. Landbank risk is likely to reduce/stop this practice (refer to SRN36 Section 6.1)
Join capacity	High	Opportunities limited due to asset lifecycles and synchronisation of replacements. Expect not to reach full potential for decades.	Low	Multi-WaSCs modelling work shows limited benefit from this option. Landbank risk is likely to make this option much more complex and discourage potential interested parties. Could be an option in the context of needing to build incineration/ATC plants. (Refer to SNR36 Section 6.2).

[18] Jacobs. (2021, May). *Bioresources Market Review.*

Co-treatment	High	This option could give access to a large amount of potentially high-value feedstock for energy generation (e.g., liquid waste).	Low	Limited opportunities because of current regulatory regimes. Biosolids would currently not be allowed to be applied to agricultural land. A potential option if biosolids was directed to incineration/ATC. (Refer to SNR36 Section 6.3).
Co-location	Medium	This option could drive down the cost of treatment to drive competition. No significant constraints identified.	Low	Limited opportunities because of current regulatory regimes (adverse impact of our waste on the operator's End of Waste status). Low energy potential from our biogas likely to make our feedstock less attractive. (Refer to SNR36 Section 6.4).
Project finance	Medium	Third parties could bring efficiencies or benefits which incumbents have difficulty obtaining.	High	High potential. Landbank risk to be clearly defined in the contract and managed by the most relevant party to protect customers. (Refer to SNR36 Section 6.5).
Outsourcing	Medium	No transformational benefits to the sector (example marginal gains introduced through outsourcing of logistics). May be more significant where large efficiencies can be brought (e.g., lower costs of construction). Third parties may be more incentivised to be efficient.	High	High potential in the long-term. Landbank risk is likely to make this option much more complex and discourage potential interested parties at this stage. (Refer to SNR36 Section 6.5).

Table 24: Jacobs and Southern Water assessments of bioresources market options

We agree with Jacobs that the potential for headroom trades is low. However, we also consider the potential for joint capacity, co-treatment, and co-allocation options low, whereas Jacobs considers these options to have high or medium potential. We also have higher potential ratings for project finance and outsourcing than Jacobs. Our rationale for our different ratings is provided below.

Joint capacity

In 2022, we took part in the Ofwat Water Innovation Breakthrough project lead by Anglian Water and Business Modelling Applications (BMA). This project involved a modelling exercise which looked at unlocking bioresources market growth with participation from multiple companies across a large region of the UK.

The benefit sought by joint capacity (i.e., combining needs and building larger capacity assets) is to drive greater efficiencies by rationalising sites at a regional level and developing economies of scale. The outputs from the model concluded that significant benefits would be achieved only in specific conditions (e.g., if the industry requires significant increased treatment capacity or treatments such as incineration or ATC are required). The results of this model exercise are presented in Section 6.2 of our Bioresources Strategy (SRN36).

Our current bioresources strategy for Kent includes the rationalisation of 7 sludge treatment centres into 2 larger ones to drive cost efficiency through economy of scale in Kent. The consolidation of our sites is also at a time when replacement is timely (see Section 5.3). No additional company is needed to realise these efficiency gains.

Co-treatment

There are limited opportunities for co-treatment with other organic wastes (e.g., food waste) because co-treated wastes cannot be applied to agricultural land under our current regulatory regime. If the regulatory regime on co-treated biosolids were to change (for example as part of the new EA's Sludge Strategy), there is still a risk that sufficient landbank will not be available to accept these waste streams.

Additionally, sludge is usually a less attractive material as it offers limited benefits in comparison to other organic materials (lower solids content leading to lower biogas potential and lower nutrient value for farmers). This means it may be challenging to find third parties who are willing to potentially degrade their product through co-treatment with our sludge.

As such, we don't believe co-treatment to be a viable option for our current Kent strategy. However, this option is likely to become more attractive in the future if ATC processes are adopted. Co-treatment with ATC processes would benefit us as incorporating other organic waste streams into our process would increase our energy generation, and we would no longer have the issue of disposal to land.

Co-location

Co-location has similar issues to co-treatment relating to potentially degrading the product of a third party. While not treating waste streams together, co-locating assets typically involves sharing energy and service flows. This can impact the End of Waste status[19] of co-located products. We have considered co-location options in the past, such as for our Horsham WwTW dewatering facility. However, this option was discounted due to the risk of adversely impacting the End of Waste status of the co-located partner's product, which would increase their disposal costs significantly. No co-location opportunities have been highlighted as part of our market engagement presented in Section 9.3.2.

Project finance:

Ofwat has recognised the potential for third party delivery to provide significant benefits for customers through promoting innovation and enabling capital, operational, and financing cost savings. It's Direct Procurement for Customers (DPC) process enables companies to competitively tender for a third party to design, build, finance, operate and maintain infrastructure. While DPC does not currently apply to bioresources projects[20], we have identified the potential for significant cost savings through a similar third-party delivery mechanism.

For PR24, DPC applies by default for all discrete projects above a size threshold of £200m WLC. In our October business plan submission, we proposed a lighter touch alternative to DPC (DPC-lite) for projects below this WLC threshold which included the Kent AAD project. This was rejected by Ofwat, who stated:

"We believe the existing regulatory framework allows Southern Water to go ahead with the proposed schemes without further regulatory adaptations but will continue to discuss the approaches and whether alternative models are likely to deliver greater benefits for customers."

We have further investigated third party delivery of the Kent AAD project and the evidence strongly indicates there is high potential for success. This is detailed in the further subsections of this section 9.

[19] Regulatory designation allowing certain types of waste to be reclassified as non-waste materials.
[20] Ofwat. (2021, May). *Review of the bioresources market – consultation.* Review-of-the-Bioresources-Market-–-Draft-Findings-consultation.pdf (ofwat.gov.uk)

Outsourcing:
We are also considering the potential to outsource our bioresources operation through engaging a third party to invest, build and operate our STCs in return for an agreed gate fee and lease duration. This shifts design and operation responsibility to the third party but requires careful contract development to ensure our legal obligations are met. We also need to consider how to effectively manage biosolids if landbank challenges arrive.

We recognise our experience with an outsourcing delivery mechanism is limited and are actively building our commercial, legal, and procurement capabilities to support this. The timescales associated with this mechanism are different traditional delivery methods as a commercial model and contract needs to be agreed ahead of delivery.

9.3.2 Market Engagement

We conducted extensive market engagement to determine the true potential of the possible market delivery options identified above.

To gauge market interest and feedback for the Kent AAD project, we issued a Prior Information Notice (PIN) and a Request for Information (RFI) between February and March 2024. We also held an online market engagement event on the 5th of March 2024 that was attended by 25 companies. Overall, we received expressions of interest from 19 companies through RFI responses and bilateral meetings.

The key findings from our market engagement relating to the Kent AAD project are summarised below. Additional detail can be found in Appendix 8.

- **Contract model:** All interested parties preferred Design-Build-Finance-Operate-Maintain (DBFOM) or Design-Build-Finance (DBF) models, rejecting service agreements with gate fees.
- **Certainty of payment:** The main concern raised by interested third parties was that, unlike Ofwat's DPC model, an alternative delivery mechanism may not include a mechanism providing certainty of payment. This would place additional risk on investors and debt providers which could lead to higher bid prices and reduced project interest.
- **Energy generation:** Further discussions and assessments are needed to determine the best approach for energy generation (e.g., CHP or biomethane) and associated incentives. The feedback from companies varied depending on their risk appetite for energy price fluctuation, incentive uncertainty, and regulation complexities.
- **Risk allocation:** Some investors highlighted the need to consider risk allocation as a key driver of creating interest and value for our customers. In particular:
    - **Landbank:** Landbank risk was a major concern for investors, who were unwilling to bear the risk of reduced disposal rights and sought guarantees for final biosolids management.
    - **Combined capacities:** Combining capacities from multiple WaSCs into a single site raised concerns about landbank risk, liability, and acceptance of mixed biosolids.
    - **Planning permission:** Investors emphasized the need for certainty over planning approvals before entering the tender process.

Based on the feedback obtained through this market engagement, we discounted alternative delivery Option 2 as all interested parties rejected the idea of a service agreement with gate fees. There is clear market interest for Option 3 as evidenced by 25 companies attending our on-line town hall event, 17 replies to our RFI, and 15 bilateral meetings. However, certainty of payment is a key concern for third parties. We have therefore assessed the value of Option 3 dependent on whether we can agree a market-based delivery

framework with Ofwat that enables us to recover costs payable to the third party from customers at future price reviews.

- **3a. Without agreed alternative delivery framework**

  At DD, Ofwat said existing regulatory frameworks allow us to go ahead with the proposed schemes without further adaptations. We understand this to mean that we can competitively tender the project, but without the assurance of long-term cost recovery from customers.

  Market feedback suggests that this approach would reduce market interest and therefore price competition. It is also likely to increase the tender prices as without payment certainty, interested parties noted they would have to uplift their risk allowance. We consider therefore consider this approach to be counterproductive. The primary purpose of third-party delivery is to generate better value for customers, and, without an agreed payment mechanism, this is less likely to be achieved.

- **3b. With agreed alternative delivery framework**

  Ofwat has offered to continue discussing alternative models that will deliver greater benefits to customers. In our Market-based Delivery DD response document (SRN-DDR-039), we have proposed a market-based delivery framework for the Kent AAD project which, like DPC, includes a mechanism similar to the Allowed Revenue Direction (ARD), enabling us to recover costs payable to the third party from customers outside price reviews. Market feedback suggest this option will offer better value for money as it reduces risk for the third party.

9.3.3 Updated Third Party Delivery Costs

All investors we have spoken to are interested primarily in a DBFOM type of contract. Under a DBFOM contract, we would incur costs associated with running the procurement process and overseeing the appointed provider. Our market engagement has also highlighted the need for the following scope changes if delivered by a third party:

- **Exclude IED compliance scope for Ashford and Ham Hill sites.** Added complexity and timescales associated third party delivery may risk delivery of IED scope elements in time for the compliance deadline. For this reason, as described in query OFW-OBQ-SRN-247, we have moved Ashford and Ham Hill IED scope items back into IED enhancement funding to ensure compliance irrespective of AAD upgrades.
- **Include WINEP bioresources cake storage scope at Ashford and Ham Hill sites.** This can be delivered in line with AAD upgrades to leverage cost efficiencies associated with simultaneous delivery whilst still meeting statutory timeframes.

Updated capital cost:

The updated scope of the work included in this project (and included in SUP12) is now focused on:

- Conversion of current operation at Ashford and Ham Hill to AAD (incl. increased capacity at these sites to enable treatment of all sludge produced in our Kent) - £107.6m including implicit allowance (refer to Section 5.4.3, Section 7. and CWW18)
- Additional Cake Storage facilities at both Ashford and Ham Hill, as required under the WINEP SUiAR_IMP driver - £19.5m (refer to CWW3)
- Growth element of both AAD and Cake storage schemes - £23.2m (which are currently not part of base allowance, but included in SUP12)

The updated cost for the delivery of both scope items detailed above is £150.3m. Refer to Section 7 above and SRN43 WINEP Bioresources Cake Storage Enhancement Business case for more detailed costing of these scope items. We have included the IED costs separately in the CWW3 data table.

It is important to note that £150.3m represents the capital value of the combined AAD and cake storage works should they be delivered simultaneously by a third party. This has been used to estimate the pre-construction costs incurred by us during AMP8 for which we require additional funding. If our proposed third-party delivery approach is rejected by Ofwat, we will return to our baseline delivery scenario whereby AAD scope is delivered in-house and separate to cake storage scope. Under this scenario, our funding request reverts to £112.8m to cover in-house delivery of AAD scope in AMP8.

Pre-construction costs:

As recognised by Ofwat, pre-construction development plays a vital role in shaping the level and profile of project delivery risk. It is important that we commit the appropriate time and resources to the development of this project to minimise risks to customers and the environment.

Ofwat has set allowances for pre-construction development at PR24 which cover both project development costs (e.g., design, planning, land acquisition, enabling works, etc.) and the cost of developing the project for competitive delivery (e.g., procurement and third-party management). For the Kent AAD project, we estimate these costs at £19.49m, as detailed below:

- £9.02m of project development costs – based on 6% of total project delivery cost, as per Ofwat's proposed allowance for "good development of schemes" prior to the delivery stage[21].
- £10.47m of market-based delivery costs – Ofwat has determined that a minimum allowance of £9m is needed to fund DPC related activities, and will provide a further 0.55% of the project's WLC to reflect those areas where costs will vary according to size and complexity[22]. We have assumed a similar approach under our market-based delivery framework.

Additional information is available in our SUP12 Data Table and SRN-DDR-039 Market-based Delivery document.

Post-construction costs:

As the assets are not planned for commission until 2030, post-construction costs will not be incurred until AMP9. While they do not form part of our PR24 funding request, it is important that we have an indicative understanding of these costs to understand the actual cost of the investment that will need to be recovered from customers beyond AMP8.

Our estimated renewal capex over the lifetime of the asset is £14.8m. The operating costs for the project are estimated at £5.1m per year. These include the use of energy generated from the bioresources assets for its operation. The potential income generated from energy sold to the grid or to WWN+ has not been included.

The nature of energy costs, and the value a third party would expect to benefit from, featured clearly in our discussions with investors. We need to carefully consider the ownership of the revenues available from energy generation, and how we can provide a good balance between the incentives on bidders in competing to own the assets, and the interests of our customers in benefitting from potential gains from improved generation of energy that raises revenues.

Discussions during market engagement also highlighted the need for us to manage the biosolids once treated, as investors have clearly indicated they would not take the risk related to use of landbanks to dispose of the final solids, given the uncertainty over whether discharge to land will continue given the possibility of changes to environmental obligations on the disposal of final solids to land.

[21] Ofwat. (2024, July). *Expenditure Allowances.* https://www.ofwat.gov.uk/wp-content/uploads/2024/07/PR24-draft-determinations-Major-projects-development-and-delivery-1.pdf
[22] Ofwat. (2024, July), *Major projects development and delivery.* https://www.ofwat.gov.uk/wp-content/uploads/2024/07/PR24-draft-determinations-Major-projects-development-and-delivery-1.pdf

9.3.4 Value for Money (VfM)

Under its DPC process, Ofwat requires companies to assess the VfM of third-party delivery prior to putting the project out to tender. It's PR24 guidance sets out an assessment framework for DPC VfM that we have followed to assess the VfM of delivering the Kent AAD project through a third party. Our VfM methodology is detailed in our Market-Based Delivery DD response document (SRN-DDR-039).

VfM assessment for the Kent AAD project has been conducted as part of a wider VfM assessment for all projects considered for market-based delivery framework. We recognise that most of these projects are at early stages where market derived VfM analysis is not practicable. Instead, we have completed both quantitative and qualitative VfM assessments in line with Ofwat and literature guidance:

- **Quantitative VfM:** using Ofwat's VfM input assumptions, our quantitative VfM approach focuses on CapEx and OpEx efficiency, financing costs (including debt, equity, and gearing), and macroeconomic assumptions. Refer to Section 3.1 of SRN-DDR-039.
- **Qualitative VfM:** we have used well-established literature processes to inform our qualitative VfM approach[23], whereby projects are assessed against 12 'dimensions' that influence VfM outcomes. Refer to Section 3.2 of SRN-DDR-039.

Our quantitative and qualitative VfM assessments for the Kent AAD project are provided in Section 10.3 of SRN-DDR-039. Each of these assessments results in an aggregate score between -14 and +14. Our scoring system is presented in Table 25. The results of our VfM analysis for the Kent AAD project is presented in Table 26.

Aggregate score	Outcome
-14 to -5	Unlikely to deliver VfM
-4 to +4	Neither likely nor unlikely to deliver VfM
+4 to +14	Likely to deliver VfM

Table 25: VfM scoring system.

Assessment	Detail on value/ score	Outcome
Quantitative VfM	NPV saving £11.8m Aggregate score of +13	Likely to deliver VfM
Qualitative VfM	Aggregate score of +6	Likely to deliver VfM

Table 26: Kent AAD VfM assessment, refer to our Market-based Delivery DD response document (SRN-DDR-039)

Third party delivery of the proposed Ashford and Ham Hill upgrades allows for a single focused entity to deliver the design, construction, finance and the operations and maintenance of the two facilities for the long term. It also enables the innovation and efficiencies of a process facility to be developed by an experienced single provider that has the expertise to design, construct and then operate and maintain these facilities. Our assessment shows that third party delivery of the Kent AAD project is likely to deliver better VfM than in house, as indicated by the possible NPV saving of £11.8m an high qualitative score. It is important to note

[23] For example: the Green Book, the Department for Transport's VfM framework, and the World Bank's VfM analysis. Refer to Section 3.2 of our Market-based Delivery DD response document (SRN-DDR-039) for references.

that our current forecasts do not include any income generated from energy sold to the grid (as this remains very uncertain). With these included, the potential savings and VfM could be higher.

9.3.5 Summary

We assessed six bioresources market opportunities identified by Jacobs (Section 9.1), which identified three possible delivery options for the Kent AAD project (inhouse, fully outsourced or delivery by a third party via a market-based delivery). We have conducted extensive market engagement and VfM assessments to identify the preferred option. A summary of our assessment is provided below in Table 27.

Option	Delivery mechanism	Assessment			PR24 funding required
		Market Engagement	VfM	Result	
Option 1	In-house	N/A	Lowest VfM	Not preferred	£112.8m total project cost incurred in AMP8
Option 2	Outsourcing (gate fee)	Rejected by all interested parties	N/A	Discounted	N/A
Option 3a	Third party delivery without agreed alternative delivery framework	Low market interest due to lack of payment certainty. Likely to driver higher price due to reduced competition and increased risk.	VfM has not been assessed for this option but is perceived to be lower based on market engagement.	Possible but perceived lower VfM.	TBC
Option 3b	Third party delivery with agreed alternative delivery framework	High market interest with strong indication of VfM.	Highest VfM	Preferred	£19.49m pre-construction development costs incurred in AMP8

Table 27: Alternative delivery options assessment summary.

Third party delivery benefits customers both now and in the long term. To deliver the Kent AAD project efficiently in house would require £107.6m funding at PR24 (now including Implicit Allowance). Using a market-based delivery framework reduces this to £19.49m. Third party delivery provides better value for customers as it reduces the total project cost and allows this to be spread over multiple price reviews. The WLC of this project is likely to reduce by £11.8m if delivered by a specialised third party, due to cost efficiencies gained through streamlined delivery and operation, in line with their specific capabilities and expertise. Operational costs are estimated at £5.07m per year, to be recovered from customers at the time that they are incurred to avoid bill spikes.

Both delivery options require an adjustment to our bioresources base cost allowance. Step-change AAD investments are not currently captured by Ofwat's model allowance. This change is necessary to address our unique challenges and meet external investment needs outside of our control. There is regulatory precedent for funding this type of investment through adjustments to base, as Ofwat has allowed sludge strategy changes as 'exceptional' base expenditure items at previous price reviews. As identified by Ofwat in its DD,

this project does not meet the criteria for enhancement funding which is why we submit it as a cost adjustment claim.

The value of this cost adjustment claim depends on Ofwat's acceptance of our market-based delivery mechanism. If Ofwat accepts our proposed mechanism, we request an adjustment of £19.49m to our bioresources base allowance to enable the delivery of the Kent AAD project through a third party. If Ofwat rejects our proposed mechanism, we request an adjustment of £107.6m to our base allowance to deliver this project in house.

10 Customer Protection

10.1 Section Overview

This section provides evidence to support our response to Ofwat's cost adjustment claim criteria relating to customer protection, presented in Table 28.

Ofwat criteria	Response
Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?	We have proposed a PCD for in house delivery, refer to Section 10.2. If Ofwat accepts our proposed market-based delivery mechanism, we hope to work together to determine the best approach to customer protection under this delivery arrangement. Refer to Section 10.3.
Does the protection cover all the benefits proposed to be delivered and funded (e.g., primary and wider benefits)?	Our proposed PCD covers the complete delivery of this investment and therefore all associated benefits. If we do not deliver this investment, we will be required to give money back to the customers and left to mitigate increased biosolids disposal risks (landbank availability, famer acceptance) through our base cost allowance. This is not considered tenable under our base cost allowance, with further incentivises us to deliver this investment.
Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including the mechanism for securing sufficient third-party funding?	We provide explanation for specific third-party funding and delivery arrangements through our market-based delivery approach in Section 9.3 with further details being available in our Market-based Delivery DD response document (SRN-DDR-039). If Ofwat accepts our proposed market-based delivery mechanism, we hope to work together to determine the best approach to customer protection under this delivery arrangement.

Table 28: Response to Ofwat assessment criteria for customer protection.

10.2 In-House Delivery

The selection of this option and the technology chosen has a long-proven record of operation (including positive impacts on biosolids quality, efficiency, and reliability), the wider industry has experience in delivering the type of chosen technology across the world and this therefore protects customers from the risk of abortive spend.

Furthermore, this technology allows future bolt-on processes (for example, advanced thermal conversion technologies could be included after the AAD process) to mitigate against further landbank restrictions. This spend also aligns with our long-term adaptive strategy which aims at delivering sustainable and cost-effective solutions.

To protect our customers in case of non or late delivery, we are proposing a scheme specific price control deliverable (PCD) based on the capacity of the processes which will be built. Where the schemes do not progress or do not manage to build agreed capacity, the costs will be returned to our customers.

The expected timescales for implementation of both AAD schemes are described in Table 29 below:

Scheme	Value	Output	2025/26	2026/27	2027/28	2028/29	2029/30
Ham Hill AAD*	£72.5m	Built Capacity (TDS/y)					30,700
Ashford AAD*	£40.3m	Built Capacity (TDS/y)					15,400
*AAD site selections in Kent are assumed to be Ham Hill and Ashford, however this could be subject to change, but the overall capacity would still apply.							

Table 29: Delivery targets

For clarity:

- The conversion of Ham Hill AAD plant is expected to be completed by 31st March 2030. This CAC will allow building of a 30,700TDS/y capacity plant by the end of financial year 2029/2030
- The following conversion of Ashford AAD is expected to be completed by 31st of March 2030. This CAC will allow building of a 15,400TDS/y capacity plant by the end of financial year 2029/2030

Any non-delivery of capacity across both sites will be returned to customers at the rate of £1.36k per unit TDS capacity below the 46,100 level. An assurance exercise will be completed ahead of AMP9 to assess the completion dates of both schemes.

The details of the PCD are set out in Table 30 below:

Component	Output based on Capacity
Description	Delivery of advanced anaerobic digestion (AAD) at our Ham Hill and Ashford sludge treatment centres.
Output	46,100 TDS capacity by 2029/2030
Total cost	£107.6m (net of implicit allowance)
Unit cost	£2.34k per TDS capacity (total cost / tds capacity)
Penalty rate	£2.34k per unit (no cost sharing is assumed)
Scheme Delivery Date	31st of March 2030 (Ham Hill) 31st of March 2030 (Ashford)
Materiality of future scope changes	£1.076m
Output delivery date with current scope	31/03/2030
Conditions on allowance	Should we receive confirmation from a regulator of a necessary change to the timing or scope of a scheme, or in fact the change of scheme design to address the core issue being it, either change in the benefit delivered or the solution being more expensive, the implication of this change would be reflected in the PCD. Where this change leads to a material variance greater than 1% of the original enhancement investment, then the PCD would symmetrically account for this change in a reconciliation at the end of the AMP.
Assessment of PCD	In the event of not delivering the output by the end of AMP8 (i.e., by 31 March 2030), but the need is still required, this PCD remains in place until the end of AMP9 (i.e., 31 March 2035). Ofwat will assess the completion of this PCD by 31 March 2035 as part of the PR34 process.
Late penalty	No late penalty is applicable.
Measurement	TDS capacity reported in APR
ODIs to be netted off in the event of non-delivery	n/a
Assurance	Third party assurer will assure conditions have been met

Table 30: PCD Summary

10.3 Market Based Delivery

If given the opportunity to deliver the project via alternative market-based delivery, we need to consider how to best protect customers. Based on our assessment of alternatives we are confident we have chosen the best technology and delivery option. We hope to work with Ofwat to agree on an approach that will allow potential interested parties to bid and commit to the investment.

We understand Ofwat's concerns to ensure that customers are protected and won't pay twice for the service. We will need to carefully consider the contract terms as they are being developed. This includes not only the considerations regarding protection from failure of the technology or whole project, but also the best utilisation of any potential income streams including for energy and potential nutrients recovery.

Bioresources allows for several income streams that may fluctuate depending on the value of energy, potential nutrients recovered, and potential additional costs brought about from changes in regulations. We therefore need to consider the impact of these potential changes and the contractual terms required with a third-party provider. We also need to consider the flexibility needed to allow for potential additional investments that may be required during the lifetime of the assets.

As we are seeking for investors to commit to the investment, investors are seeking for Ofwat to agree and commit or enable an assurance that they will receive the payment payable under the contract. Although the project is in the early development phase, we propose to continue to develop the project for delivery via market-based delivery to offer the best possible outcome for customers.

11 Conclusion

This document serves as our response to Ofwat's DD assessment and restates our request for £107.6m adjustment to bioresources base allowance to deliver the Kent AAD project. It presents a compelling case for the adjustment of Southern Water's bioresources base allowance to enable the delivery of the transformative Kent AAD project. This project offers significant benefits for customers and the environment, including improved operational efficiency, resilience, and environmental performance.

As summarised below, we have demonstrated that the proposed investment has a clear need, aligns with our long-term Bioresources Strategy, and has high potential for third party delivery to achieve best value for customers. There is regulatory precedent for funding such transformative changes through adjustments to base allowances, and we urge Ofwat to take this approach for the Kent AAD project.

- **Need for investment:** Our current reliance on CAD and limited landbank availability drive higher sludge treatment and disposal costs. This project addresses these challenges by upgrading our biosolids treatment process to meet evolving environmental regulations and customer expectations. Additionally, it leverages innovative AAD technology to improve efficiency, reduce environmental impact, and increase resource recovery.
- **Alignment with long-term strategy:** This investment aligns with our long-term Bioresources Strategy, which prioritises sustainable and cost-effective solutions. As communicated to Ofwat at PR19, we have purposely deferred investment in Kent to achieve full utilisation of existing CAD assets and implement AAD at time when replacement is timely. AAD positions us well for possible future ATC implementation and is therefore considered a "no-regret" solution.
- **Value for money:** Third-party delivery offers better value for customers through potentially reduced project costs and the ability to spread this cost over multiple price reviews. Our initial analysis indicates material NPV savings if delivered by a specialised third party, due to cost efficiencies gained through streamlined delivery and operation.
- **Market based delivery:** We propose a market-based delivery framework for the Kent AAD project, which includes a mechanism like an ARD, enabling us to recover costs payable to the third party from customers outside price reviews. This framework ensures long-term cost recovery and incentivizes interested parties to bid and commit to the investment.

If Ofwat agrees to our proposed market-based delivery framework for the Kent AAD project, the necessary adjustment to our base cost allowance will decrease from £107.6m to £19.49m for AMP8. This reflects the cost that would be incurred by us for pre-construction activities. This is a significant funding reduction and therefore to customer bills in AMP8. We hope to work with Ofwat to agree on an approach that will best protect customers whilst also encouraging interested parties to bid and commit to the investment.

This project supports our commitment to providing best value for money, aligns with our environmental and long-term sustainability goals, and strengthens our resilience and adaptability to anticipated changes in customer and regulatory expectations. We urge Ofwat to allow our funding request so that we can deliver this essential investment and achieve the best possible outcomes for our customers and the environment.

12 Business Plan Dependencies

This document is supported by our SRN21 Bioresources Cost Adjustment Claim case submitted in October 2023.

Data Tables impacted by the representation:

Table/s Impacted	Data Lines Impacted
CWW18	21 to 30 Advanced Anaerobic digestion at Ashford and Ham Hill
SUP12	

All documents and tables referenced above can be found on our website here: Business Plan 2025-30 - Southern Water

Appendix 1: Customer Engagement

SOUTHERN WATER

The future of Southern Water's sludge

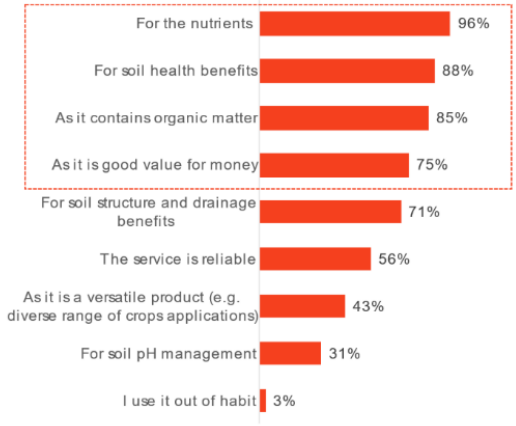
.YONDER

Qualitative & Quantitative research debrief

a. *Biosolids seen as a value material*

The main advantages of biosolids are the nutritional benefits to soil health, alongside being good value

REASONS TO USE BIOSOLIDS - PROMPTED



REASONS TO USE BIOSOLIDS – SPONTANEOUS COMMENTS

Improves soil health/ organic benefits

"Good source of organic fertiliser/improves soil health, greater than its technical nutrient value"

Phosphate and nitrogen:

"Biosolids supply important key nutrients including phosphate and nitrogen. It also is very important as a soil conditioner and enhancer to maintain and improve my soil organic matter"

Good value

"Because it's cheap organic/nutritional content. Also, a belief that a society ought to be returning its waste to the soil"

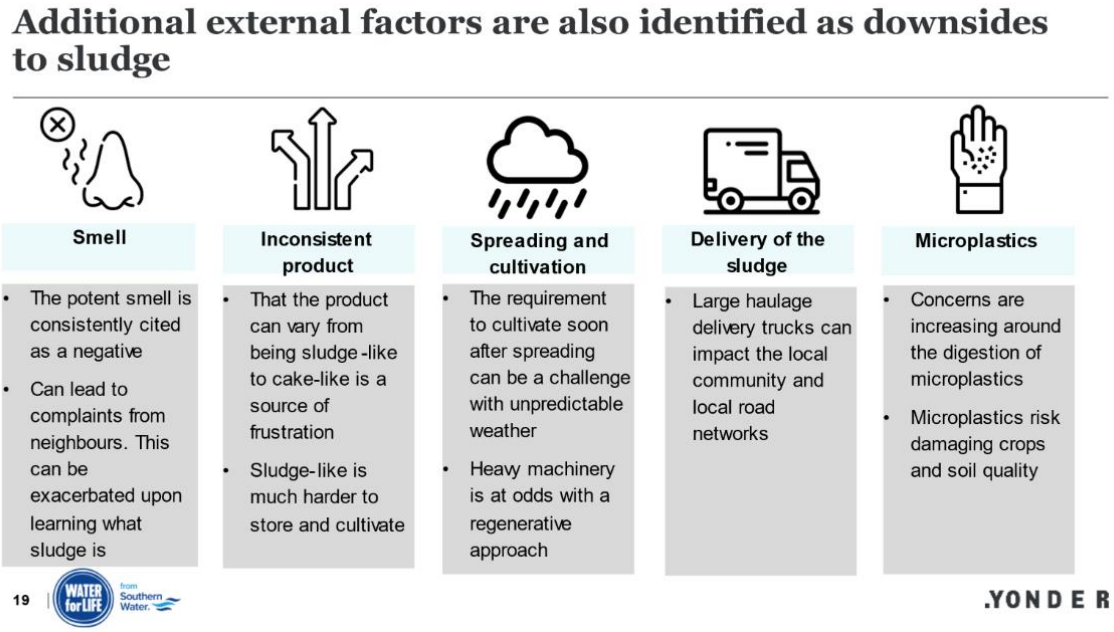
11 | WATER for LIFE from Southern Water

Q7. Why do you use biosolids ("treated sludge / treated cake") on your land? / Q8. Below are some reasons others have provide d for using biosolids ("treated sludge / treated cake") on their land. Which of the following are reasons that you use biosolids? All respondents (68)

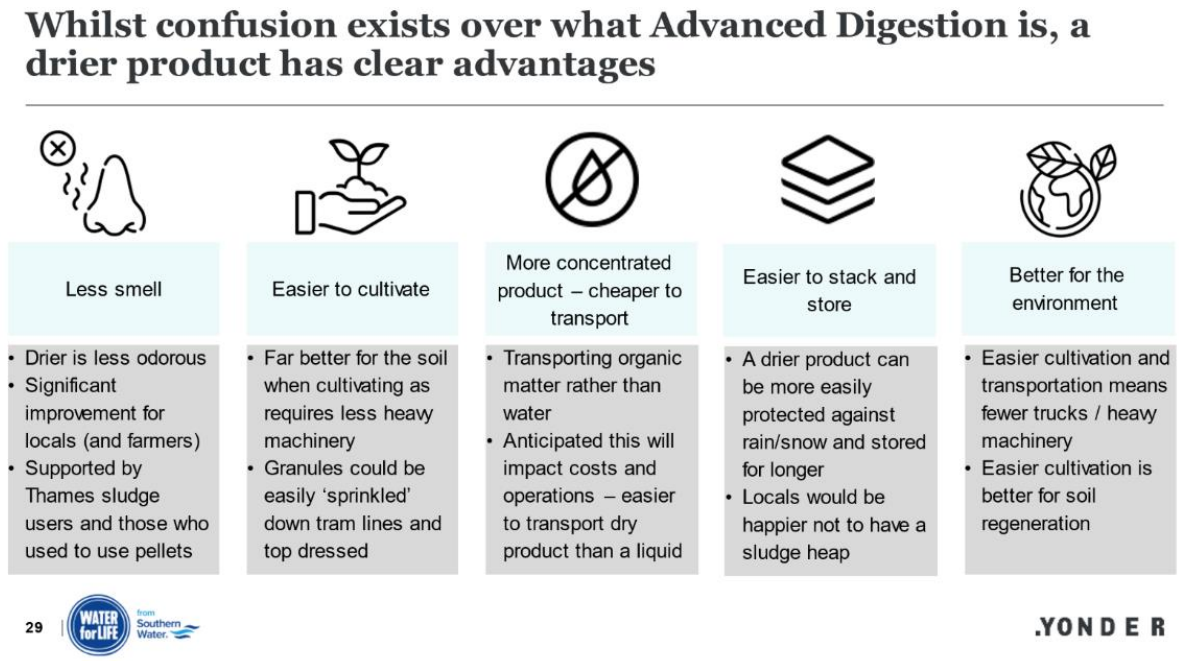
.YONDER

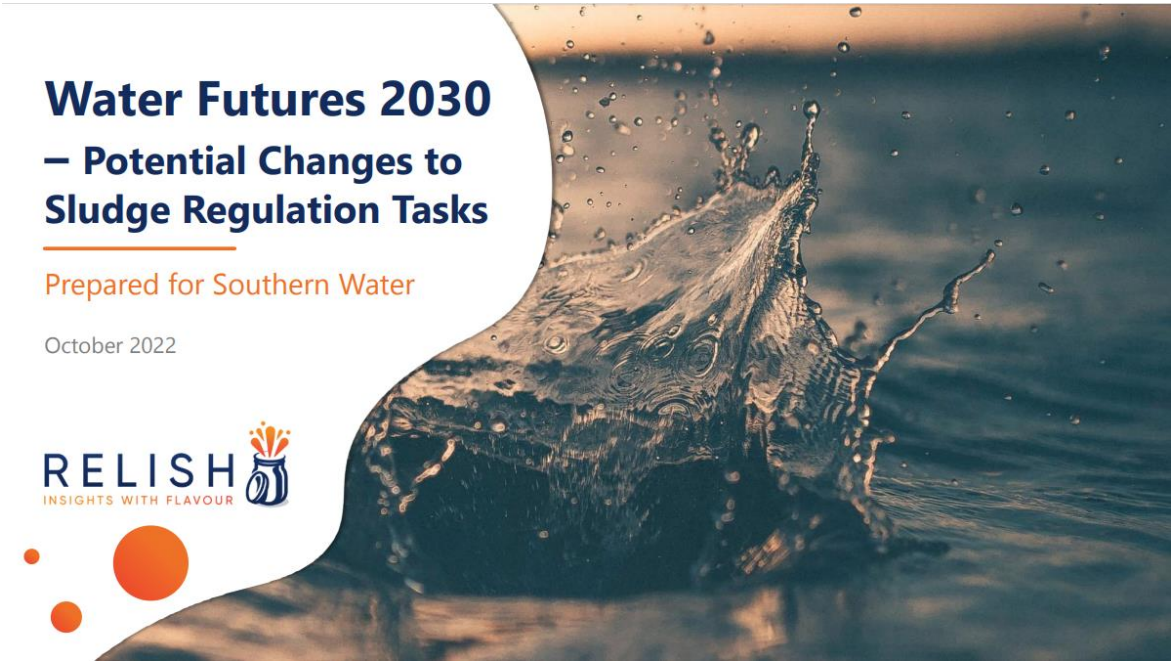
WATER for LIFE from Southern Water

b. *Limitations of current Biosolids from SWS*

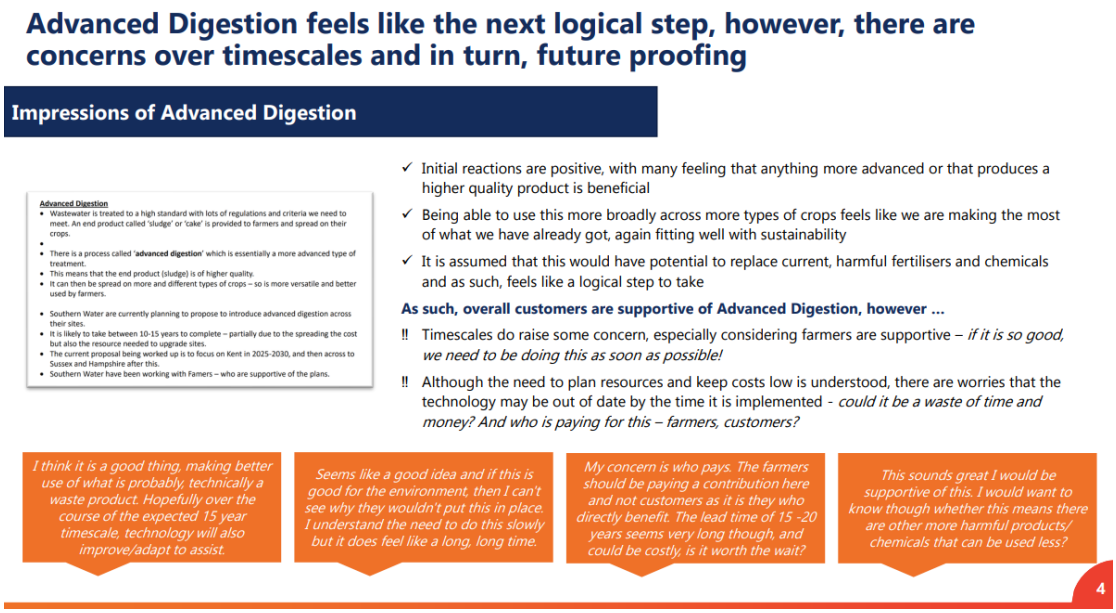


c. *Benefits expected from Advanced Digested cake*





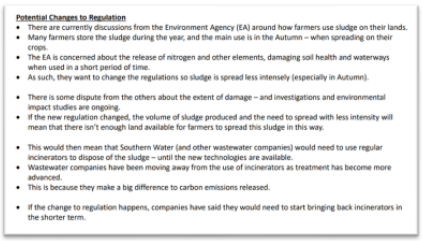
a. *Positive feedback on AAD from customers (bill payers)*



b. *Customers views on Incineration as a potential answer to mitigate impact of FRfW in the short-term*

Customers initially feel that changes in regulations are a positive step, however, the need for incinerators brings this into doubt

Reaction to Potential Changes to Regulation



Potential Changes to Regulation

- There are currently discussions from the Environment Agency (EA) around how farmers use sludge on their lands.
- Many farmers store the sludge during the year, and the main use is in the Autumn – when spreading on their crops.
- The EA is concerned about the release of nitrogen and other elements, damaging soil health and waterways when used in a short period of time.
- As such, they want to change the regulations so sludge is spread less intensely (especially in Autumn).
- There is some dispute from the others about the extent of damage – and investigations and environmental impact studies are ongoing.
- If the new regulation changed, the volume of sludge produced and the need to spread with less intensity will mean that there isn't enough land available for farmers to spread this sludge in this way.
- This would then mean that Southern Water (and other wastewater companies) would need to use regular incinerators to dispose of the sludge – until the new technologies are available.
- Wastewater companies have been moving away from the use of incinerators as treatment has become more advanced.
- This is because they make a big difference to carbon emissions released.
- If the change to regulation happens, companies have said they would need to start bringing back incinerators in the shorter term.

✓ Initially the situation makes sense, it feels positive that if there are concerns over damage then this should be investigated and other plans put on hold ….

‼ … However, the need to bring back incinerators makes customers question this

‼ It feels like a huge backwards step especially in an era of climate change and looking for more sustainable solutions. Almost a knee jerk / over reaction, surely the current damage cannot be that significant?

‼ Customers want to see proof of the damage currently being caused and how this compares to the damage that would be caused by bringing back incinerators, to understand if this step is justified

‼ There is disbelief that the damage from nitrates can be as bad as the damage to the environment from incinerators

My initial reaction to this is that it sounds counter-productive and leads to a backwards step which feels unnecessary. Bringing back incinerators seems like a big backwards step.

The regulations shouldn't be brought in until the new technologies are widely available, but I suppose it would depend on how much of an impact on soil the sludge has at the moment. I'm not sure it would be worth bringing back incinerator usage until the new technologies are available.

This feels frustrating because to protect soil health and waterways, water companies will incinerate waste thereby polluting the air, which I would imagine is another area of responsibility of the EA. I guess the question is which is the lesser of the two evils?

I would want to see definitive proof from the EA that additional nitrates are an issue in the autumn before going back to incinerators. There needs to be a balance of risks: how bad is the release of nitrogen compared to bringing back incinerators and damaging the atmosphere?

5

Appendix 2: Assessment of Biomethane Upgrade vs Combined Heat & Power engine options

"Ofwat Operational greenhouse gas emissions performance commitment."

Proposed amendment to definition to ensure greater GHG benefit of choosing Biomethane over CHP is recognised and rewarded.

Neil Liddell-Young

19/05/2023

Exec. Summary

- SWS Bioresources PR24 plan includes 2 large projects that will replace 7 existing "Conventional" AD plants with 2 new much la rger "THP" AD plants
- The existing plants are equipped with CHP and the new plants will be of sufficient size to be equipped with biomethane upgrad ing and injection or CHP
- We have modelled the GHG savings and net revenue impact for both options considering Ofwat's "Operational greenhouse gas emis sions performance commitment" v3 published in March 2023 and the further changes outlined in the April 2023 consultation response.
- Choosing Biomethane injection over CHP will delivers 100kTCO2 reduction over the 20 year M&E asset life of the Ham Hill proje ct because electricity grid decarbonises quicker than the gas grid.
- BUT choosing biomethane results in an additional £1.4m annual revenue cost compared to CHP due to the impact of the GHG PC. I t cannot therefore be chosen.
- The GHG PC allows WASC's to forgo the value of biomethane RGGO's for their exported biomethane and claim the GHG PC incentive associated with reduction in emissions.
- BUT this cannot be achieved because there is currently no method of retiring RGGO's associated with new biomethane plants in AMP 8 without losing the subsidy.
- Slide 4 explains in detail why there is no method of retiring today and that the future is uncertain. In summary:
  - RHI scheme which allows retirement of RGGO's is closed to new applicants.
  - GGSS scheme only supports new build AD and most WASC AD assets are not life expired.
  - RTFC Market is open but RGGO cannot be separated from RTFC's.
  - Looking forward to AMP 8, Government recognise in its recently published "Independent Review of Net Zero", that biomethane wi ll continue to play an important role in achieving the government's Net Zero obligation. DESNZ are working to develop a future policy framework to follow the GGSS and have requested views as part of the GGSS mid scheme review consultation which closed on 18th May 2023.
- We proposed that performance commitment is amended to create a system that can work independently of the biomethane subsidy s cheme.
- We propose an option to purchase RGGO's from the market up to the value of biomethane exported. Currently RGGO's can only be retired from own production.
- The minor amendment balances the net revenue for Biomethane and CHP and will result in the GHG PC objective being achieved.

PR24 operational greenhouse gas emissions performance commitment (wastewater) | Ofwat

We have modelled the GHG emissions and "Energy" net revenue impact of CHP against Biomethane on our Ham Hill THP project

- Changing from "Conventional" to "THP" AD creates a net increase in heat demand for the same quantity of sludge but It also pr ovides a net increase in biogas production.
- One large site has sufficient biogas to fall within biomethane upgrading plant design range.
- Net GHG and Revenue are calculated using the new Operational GHG Performance commitment definition assuming £200/tCO2e tariff .
- Net revenue is dependent on the biomethane financial support option that it is accredited to.
- Options 2 and 4 show CHP and best GHG saving fuel configuration for biomethane respectively

	Option	Biogas Utilisation	Natural Gas Utilisation	CHP Electrical Output	CHP Heat Recovery
Transfer Sludge from 4 AD sites to Ham Hill and Build New THP AD Plant	2	100% CHP	Steam Boiler to supplement heat demand	Embedded demand and surplus exported.	Hot water and steam to satisfy THP demand
	4	Steam Boiler then Biomethane Export	n/a	n/a	n/a

Proposed Amendment to Operational GHG PC

- Biomethane delivers 100 kTCO2e more GHG savings than CHP
- BUT CHP is the compelling choice whilst only the RTFC scheme is available to biomethane making the PC counter productive.
- Government recognise in its recently published "Independent Review of Net Zero", that biomethane will continue to play an imp ortant role in achieving the government's Net Zero obligation.
- DESNZ are working to develop a future policy framework to follow the GGSS from 2025 and have requested views as part of the G GSS mid scheme review consultation which closed on 18 th May 2023.
- In view of the uncertainty that retirement of RGGO's will be available in a future framework it is proposed that the performa nce commitment is amended.
- Currently only RGGO's derived from their own production may be retired.
- We propose an amendment to allow purchasing and retiring RGGO's from the **market** up to the value of biomethane that we export.
- This minor amendment ensures the PC support for biomethane over CHP is identical regardless of the rules of the subsidy schem e.

Appendix 3: Implicit Allowance Data

Table 31: Historic unit costs used in the implicit allowance calculations

	ANH	NES	NWT	SRN	SVH	SWB	TMS	WSH	WSX	YKY	UQ
Historic capital maintenance costs with sludge treatment[1] (£m, 2022-23 prices) (a)											
2011-12	30.10	16.46	2.78	13.14	25.18	2.56	24.77	19.74	6.07	40.82	
2012-13	39.81	16.93	3.79	12.67	30.14	2.15	35.26	6.71	11.65	39.73	
2013-14	20.15	10.25	6.77	19.33	59.29	2.46	38.29	3.72	15.44	32.32	
2014-15	16.70	11.20	28.36	12.23	43.23	3.83	56.77	8.29	16.07	22.26	
2015-16	15.56	4.44	33.37	14.22	32.48	6.58	122.61	8.87	17.36	17.72	
2016-17	28.36	3.08	25.78	21.07	53.19	6.76	141.46	20.35	12.05	69.72	
2017-18	13.91	6.19	22.23	16.07	57.59	2.83	92.36	40.10	14.62	57.47	
2018-19	16.45	7.99	39.19	19.58	61.90	5.85	68.00	59.69	15.61	64.96	
2019-20	13.16	13.82	25.38	16.57	72.77	7.03	48.69	45.82	13.26	89.71	
2020-21	13.14	3.06	30.99	14.18	93.48	5.26	67.51	23.96	9.28	32.11	
2021-22	17.98	2.24	25.40	26.10	49.32	8.88	87.73	13.87	10.64	14.41	
Historic sludge produced[2] (ttds/year) (b)											
2011-12	143.6	76.5	187.3	101.5	246.5	47.7	380.7	70.7	67.8	154.0	
2012-13	141.1	74.8	188.7	99.8	248.4	45.2	375.2	62.3	69.2	158.2	
2013-14	144.1	75.5	189.9	112.3	239.0	42.4	360.0	64.2	69.1	136.1	
2014-15	147.7	70.0	191.5	115.6	242.5	41.4	361.3	64.3	74.0	140.5	
2015-16	150.8	68.2	192.9	121.6	242.6	37.9	392.0	67.4	67.6	123.9	
2016-17	147.2	67.7	194.3	119.3	241.2	40.1	382.6	69.4	68.2	142.3	
2017-18	142.4	70.3	195.7	119.0	239.8	39.3	366.2	72.0	74.9	146.6	
2018-19	151.0	70.2	197.3	116.8	239.3	38.3	373.8	75.2	70.1	146.9	
2019-20	149.1	68.4	198.8	116.2	241.9	39.9	371.6	77.0	69.2	148.7	
2020-21	147.0	70.0	200.4	112.3	251.8	42.8	345.3	70.7	62.2	147.5	
2021-22	151.4	73.5	201.4	116.6	261.2	42.5	371.7	79.4	61.3	143.1	
Historic capital maintenance unit cost (£/tds, 2022-23 prices) (c) = (a) / (b)											
2011-12	209.6	215.2	14.9	129.5	102.2	53.6	65.1	279.2	89.5	265.1	
2012-13	282.1	226.3	20.1	126.9	121.3	47.5	94.0	107.7	168.4	251.2	
2013-14	139.8	135.7	35.7	172.2	248.1	58.0	106.4	57.9	223.5	237.5	
2014-15	113.1	160.0	148.1	105.8	178.3	92.6	157.1	128.9	217.2	158.5	
2015-16	103.2	65.1	173.0	117.0	133.9	173.7	312.8	131.6	256.8	143.0	
2016-17	192.7	45.5	132.6	176.6	220.5	168.4	369.8	293.3	176.7	489.9	
2017-18	97.7	88.1	113.6	135.0	240.1	72.1	252.2	557.0	195.3	392.0	
2018-19	108.9	113.8	198.6	167.6	258.6	152.7	181.9	793.7	222.8	442.2	
2019-20	88.2	202.1	127.7	142.6	300.8	176.2	131.0	595.0	191.7	603.3	
2020-21	89.4	43.7	154.7	126.2	371.2	122.9	195.5	338.9	149.3	217.7	
2021-22	118.7	30.4	126.1	223.8	188.8	209.0	236.0	174.6	173.5	100.7	
Average	140.3	120.5	113.2	147.6	214.9	120.6	191.1	314.3	187.7	300.1	125.5
Percentage of capital maintenance costs related to digestion/biogas assets[3] (d)											60%
Historic STC capital maintenance unit cost (£/ tds, 2022-23 prices) (e) = (c) x (d)											**75.3**

Source: Own calculations based on companies' data reported in Annual Performance Reports.
Notes:
(1) Capital maintenance costs are the sum of the following two costs reported by companies in their Annual Performance Reports: 'Sludge treatment - Maintaining the long-term capability of the assets – infra' and 'Sludge treatment - Maintaining the long term capability of the assets - non-infra.'
(2) Sludge produced is reported by companies in their Annual Performance Reports as 'Total sewage sludge produced.'
(3) Percentage based on our own internal records, in the absence of industry level information publicly available.

Table 32: AMP8 unit costs used in the implicit allowance calculations

	ANH	NES	NWT	SRN	SVH	SWB	TMS	WSH	WSX	YKY	UQ
AMP8 capital maintenance costs with sludge treatment[1] (£m, 2022-23 prices) (a)											
2025-2026	12.61	18.71	8.38	24.51	4.50	103.40	83.79	9.48	1.55	19.35	
2026-2027	14.56	18.82	5.66	29.13	4.50	125.67	74.93	8.58	57.27	22.25	
2027-2028	11.14	18.93	3.25	29.70	4.50	108.55	63.17	8.71	1.56	22.10	
2028-2029	11.14	19.07	3.28	22.71	4.50	69.20	56.70	8.71	1.57	18.94	
2029-2030	11.14	19.14	3.31	27.83	4.50	56.83	44.46	8.82	1.59	12.89	
AMP8 sludge produced[2] (ttds/year) (b)											
2025-2026	162.4	70.9	117.5	268.9	47.4	367.8	212.8	76.2	65.8	158.9	
2026-2027	163.5	71.3	118.3	269.7	48.6	370.2	214.2	76.8	66.1	159.9	
2027-2028	164.1	71.7	119.3	271.6	50.2	372.8	215.4	77.5	66.5	160.8	
2028-2029	168.2	72.3	120.0	272.5	51.4	375.3	216.4	78.1	67.6	161.8	
2029-2030	173.1	72.6	122.9	275.8	53.1	377.9	182.3	78.7	69.1	162.8	
AMP8 capital maintenance unit cost (£/tds, 2022-23 prices) (c) = (a) / (b)											
2025-2026	77.6	263.9	71.3	91.1	94.9	281.1	393.8	124.3	23.6	121.8	
2026-2027	89.1	264.0	47.8	108.0	92.6	339.5	349.8	111.7	866.1	139.2	
2027-2028	67.9	264.0	27.2	109.4	89.6	291.2	293.3	112.4	23.5	137.4	
2028-2029	66.2	263.7	27.3	83.3	87.5	184.4	262.1	111.6	23.2	117.1	
2029-2030	64.4	263.7	26.9	100.9	84.7	150.4	243.9	112.0	22.9	79.2	
Average	73.0	263.8	40.1	98.5	89.9	249.3	308.6	114.4	191.9	118.9	92.0
Percentage of capital maintenance costs related to digestion/biogas assets[3] (d)											60%
Historic STC capital maintenance unit cost (£/ tds, 2022-23 prices) (e) = (c) x (d)											**55.2**

Source: Own calculations based on companies' data reported in PR24 Business Plans submitted to Ofwat in October 2023.
Notes:
(1) Capital maintenance costs are the sum of the following two costs reported by companies in their Oct-23 business plans: 'Sludge treatment - Maintaining the long-term capability of the assets – infra' and 'Sludge treatment - Maintaining the long term capability of the assets - non-infra'.
(2) Sludge produced is reported by companies in in their Oct-23 business plans as 'Total sewage sludge produced'.
(3) Percentage based on our own internal records, in the absence of industry level information publicly available.

Appendix 4: Detailed Capital Cost Breakdown

Ashford

	SW Scope Information - Ashford Option 1 v5						Benchmarking				
CIT Ref	Description	Description 2	Qty	Yardstick	UoM	Base Cost	Description	Qty	Yardstick	UoM	Base Cost (2022/23)
2	SITE CLEARANCE	Site area approx. 190m x 110m = 20900m2, but yardstick max. is 4000m2.	5	4000	m2		Clearance Site Clearance: All Sites EQU-ESITE-PROV-7-099	1	20900	m2	
3	ROAD (EQSET)	Access road length approx. 620m, assumed 6m wide, hence total area is 3720, but yardstick max. is 1870m2	2	1870	m2		Roads : Tarmacadam EQU-EROADS-PROV-7-449	1	3720	m2	
4	DEMOLITION OF SLUDGE DRYING BEDS	1 no. bigger bed 40m x 28m	1	1120	m2		DEMOLITION OF SLUDGE DRYING BEDS	1	1120	m2	
5	DEMOLITION OF SLUDGE DRYING BEDS	5 no. smaller bed, each 28m x 28m	5	784	m2		DEMOLITION OF SLUDGE DRYING BEDS	5	784	m2	
6	NEW CONCRETE TANK BUND including Concrete slab	Bund plan area 50m x 50m, wall height 1.5m.	1	165	m2		Concrete : Bunded Storage Area EQU-ECONCRETE-PROV-7-103	1	3750	m3	
7	PLINTH/BASE SLAB	Plinth for 2 unscreened blended sludge tanks, assumed 8m x 16m, 800mm thick	1	102	m3		Concrete Base: Treatment Works Site EQU-ECONCRETE-PROV-7-126	1	102	m3	
9	PLINTH/BASE SLAB	Plinth for 2 no. sludge screens, assumed 15m x 10m, 800mm thick	1	120	m3		Concrete Base: Treatment Works Site EQU-ECONCRETE-PROV-7-126	1	120	m3	
10	PLINTH/BASE SLAB	Plinth for 2 blending tanks, assumed 9m x 18m, 800mm thick	1	130	m3		Concrete Base: Treatment Works Site EQU-ECONCRETE-PROV-7-126	1	130	m3	
11	PLINTH/BASE SLAB	Plinth for THP system (incl. feed silo and cambi units), assumed 30m x 20m, 800mm thick	1	270	m3		Concrete Base: Treatment Works Site EQU-ECONCRETE-PROV-7-126	1	270	m3	
12	PLINTH/BASE SLAB	Plinth for 2 no. post-digestion tanks, assumed 14m x 30m, 800mm thick	1	270	m3		Concrete Base: Treatment Works Site EQU-ECONCRETE-PROV-7-126	1	270	m3	
13	PLINTH/BASE SLAB	Plinth for liquors treatment plant, assumed 20m x 25m, 800mm thick	1	270	m3		Concrete Base: Treatment Works Site EQU-ECONCRETE-PROV-7-126	1	270	m3	
15	PLINTH/BASE SLAB	Plinth for gas holder, assumed 20m x 40m, 600mm thick	1	270	m3		Concrete Base: Treatment Works Site EQU-ECONCRETE-PROV-7-126	1	270	m3	
16	PLINTH/BASE SLAB	Plinth for 2 CHP engine, assumed 12m x 6m, 600mm thick	1	43	m3		Concrete Base: Treatment Works Site EQU-ECONCRETE-PROV-7-126	1	43	m3	
17	PILING (CFA)	Piles for 2 unsceened blended sludge tanks	1	128	m2		Piling GEN-PILN-0000	16	16	mtr	
18	PILING (CFA)	Piles for 2 blending tanks	1	200	m2		Piling GEN-PILN-0000	25	16	mtr	
19	PILING (CFA)	Piles for THP system	1	600	m2		Piling GEN-PILN-0000	75	16	mtr	
20	PILING (CFA)	Piles for 2 post-digestion tanks	1	512	m2		Piling GEN-PILN-0000	64	16	mtr	
21	PILING (CFA)	Piles for liquors treatment plant	1	500	m2		Piling GEN-PILN-0000	62	16	mtr	
22	PILING (CFA)	Piles for centrifuge building	1	500	m2		Piling GEN-PILN-0000	62	16	mtr	
23	STORAGE AREA	44 no. cake storage barn, each 6m x 30m, can be configured as a building with muitiple bays.	44	180	m2		Building Superstructure Steel: Treatment Works Site EQU-EBUILDING-PROV-7-028	44	180	m2	
24	BUILDING - PROCESS	Building for centrifuges, steam boiler, plan area 20m x 25m, single storey, heavy duty.	1	500	m2		Buildings GEN-BLDG-0000	1	500	m2	
25	WASTEWATER TANK SET	Concrete bunker for cake import silo, assumed internal dimension 13m x 7.5m x 5m(D) underground, assumed as an underground tank, w/o cover.	1	488	m3		Tanks : In-Situ Concrete EQU-ETANK1-PROV-7-471	1	488	m3	
26	ACCESS STRUCTURE (Stairs)	Accesss structure to the bunker, assumed length.	1	16	Mtr		Metalwork stairs - Process EQU-EMETALWORKS-PROV-7-348	1	30	m	
27	Excavation	Excavation for the bunker, which has wall and slab thickness 500mm.	1	655	m3						
	BALANCING TANK	Import liquid sludge reception tank, assumed 6m x 8m x 2.5m D (with freeboard), buried tank with concrete cover.	1	100	m3		Tanks : In-Situ Concrete EQU-ETANK1-PROV-7-471	1	100	m3	
28	Excavation	Excavation for the import liquid sludge reception tank, which has wall and slab thickness 500mm.	1	189	m3						

30	SLUDGE HOLDING TANK	2 unscreened blending storage tanks	2	66	m3	[redacted]	Tanks: GFS (Glass Fused To Steel) EQU-ETANK-PROV-8-606	2	66	m3
31	CHAMBER	2 cake reception bunkers 40m3 each, complete with sliding floor or transfer screws, hydraulicly operated lid, control panel below ground concree chamber	2	38.86	m2		Use SW costs for BuE	1	38	m2
32	FINE SCREEN (Inlet)	Provision of 2no. Sludge screens (huber strainpress type) D/S. Capacity of each screen 44.3 m3/h. 6mm screens. Magflow in the sludge feed	2	1063.2	m3/day		Screen: Band/Belt EQU-ESCREEN-PROV-8-250	2	45	m3/hr
33	SLUDGE HOLDING TANK	2 post-screening blending tanks	2	99	m3		Tanks: GFS (Glass Fused To Steel) EQU-ETANK-PROV-8-606	2	99	m3
34	CENTRIFUGE (EQSET)	2 thickening centrifuges	2	44.3	m3/hr		Centrifuge EQU-EMIXER-LOND-8-022	2	40	Kw
35	THP SILO	1no. THP silo, min working volume 450 m3					Use UU costs as per SW	1	450	m3
36	THP	1no. B4-4 Camb unit Feed to THP system 354m3/day @ 16.5%DS					Use UU costs as per SW	1	354	m3/day
37	BOILER(EQSET)	Provision of 1no. Steam boiler capable of supplying 4tn steam/h, converted to 3610kW	1	1280	Kw/hr		Use SW costs	1	3610	Kw
38	SECONDARY DIGESTOR	Provision of 4no. Digesters with a capacity of 3245 m3 each. Diameter 16m, Height 16m (+1.5m freeboard included)	4	3245	m3		Use SW costs	4	3245	m3
39	SLUDGE HOLDING TANK	2 Post-digestion tanks	2	730	m3		Tanks: GFS (Glass Fused To Steel) EQU-ETANK-PROV-8-606	2	730	m3
40	CENTRIFUGE (EQSET)	2 dewatering centrifuges	2	36	m3/hr		Centrifuge EQU-EMIXER-LOND-8-022	2	35	Kw
41	ANNOX LIQUORS	Provision of an anammox liquors treatment plant (tbc) Flow: 1,150 m3/day (centrifuges)					Use SW costs	1	1150	m3/day
42	GAS STORAGE FACILITY-BIOGAS	2 gas holders	2	1700	m3		Use SW costs	2	1700	m3
43	F: POLYELECTROLYTE DOSING	For thickening centrifuges, approx daily polymer peak consumption 59.6tn @ 0.2%.	1	5	MLD		Primary Treatment - Chemical Dosing (Poly-Electrolyte) WTW-TPN-0000	1	5	MLD
44	BIOGASS CHP Units with automatic PpTek siloxane filtration system	Provision of 2no. CHP engines. Min capacity of each engine 1210kW. 40% electrical efficiency	2	1100	kW		CHP: Engine EQU-ECHP-PROV-8-024	2	1210	Kw
45	F: GAS FLARING	Over yardstick max.	2	760	m3/hr		Flare/Exhaust Stack (Incineration) EQU-EODOUR-LOND-8-072	1	1520	m3/hr
46	F: POLYELECTROLYTE DOSING	For dewatering centrifuges, approx daily polymer peak consumption 219tn @ 0.2%.	1	5	MLD		Primary Treatment - Chemical Dosing (Poly-Electrolyte) WTW-TPN-0000	1	5	MLD
47	ODOUR COVER(EQSET)	Cover for unscreened blending storage tanks, assumed dia. 4.8m.	2	18	m2		Covers : GRP EQU-ECOVER-PROV-7-202	2	18	m2
48	ODOUR COVER(EQSET)	Cover for cake import silo, assumed dia. 4m.	1	13	m2		Covers : GRP EQU-ECOVER-PROV-7-202	1	13	m2
49	ODOUR COVER(EQSET)	Cover for post-screening blending tanks, assumed dia. 6.8m.	2	36	m2		Covers : GRP EQU-ECOVER-PROV-7-202	2	36	m2
50	ODOUR COVER(EQSET)	Cover for post-digestion tanks, assumed dia. 12m.	2	113	m2		Covers : GRP EQU-ECOVER-PROV-7-202	2	113	m2
51	SLUDGE BLENDING PUMP SET	Mixing pumps for item 30	2	11	kw		Pump (Progressive Cavity) : Treatment Works Assets EQU-EPUMP-PROV-8-214	2	11	kw
52	SLUDGE BLENDING PUMP SET	mixing pumps for item 33	2	15	kw		Pump (Progressive Cavity) : Treatment Works Assets EQU-EPUMP-PROV-8-214	2	15	kw
53	SLUDGE BLENDING PUMP SET	mixing pumps for item 38	8	22	kw		Pump (Progressive Cavity) : Treatment Works Assets EQU-EPUMP-PROV-8-214	8	22	kw
54	GATE VALVE	isolation valves for items 51 and 52	8	150	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	8	150	mm
55	GATE VALVE	isolation valves for item 53	16	200	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	16	200	mm
56	CHAMBER	cake reception bunker 40m3, complete with sliding floor or transfer screws, hydraulicly operated lid, control panel below ground concree chamber	1	38.86	m2		Use SW costs for BuE	1	38.86	m2
57	SLUDGE FEED PUMP SET	import cake transfer pump from reception bunker to THP feed silo	2	22.5	kw		Pump (Progressive Cavity) : Treatment Works Assets EQU-EPUMP-PROV-8-214	2	22.5	kw
58	ACTUATED GATE VALVE	isolation for cake transfer pumps,	4	200	mm		Actuators : Treatment Works Assets EQU-EACTUATORS-PROV-8-341	4	200	mm
59	GATE VALVE	isolation for cake transfer pumps,	4	200	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	4	200	mm

60	ACTUATED VALVE	v notch ball valve for dilution water control	2	80	mm	[redacted]	Actuators : Treatment Works Assets EQU-EACTUATORS-PROV-8-341	2	80	mm
62	SLUDGE FEED PUMP SET	sludge screen feed pumps	2	11	kw		Pump (Progressive Cavity) : Treatment Works Assets EQU-EPUMP-PROV-8-214	2	11	kw
63	GATE VALVE	isolation valves for item 62	4	150	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	4	150	mm
64	NRV	NRV for item 62	2	150	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	2	150	mm
65	SLUDGE FEED PUMP SET	centrifuge feed pump	2	22	kw		Pump (Progressive Cavity) : Treatment Works Assets EQU-EPUMP-PROV-8-214	2	22	kw
66	GATE VALVE	isolation valves for item 65	4	150	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	4	150	mm
67	NRV	NRV for item 65	2	150	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	2	150	mm
68	CONVEYOR	screw conveyors from centrifuges to THP feed silo	4	25	Mtr		Conveyor : Screw EQU-ECONVEYOR-PROV-8-031	2	50	mtr
69	SLUDGE FEED PUMP SET	THP feed pumps	2	2	kw		Pump (Progressive Cavity) : Treatment Works Assets EQU-EPUMP-PROV-8-214	2	2	kw
70	ACTUATED GATE VALVE	actuated valve to act as NRV for THP feed pumps	2	200	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	2	200	mm
71	GATE VALVE	isolation valve	2	200	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	2	200	mm
72	ACTUATED VALVE	dilution control valve - v notch ball vale	2	200	mm		Actuators : Treatment Works Assets EQU-EACTUATORS-PROV-8-341	2	200	mm
73	SLUDGE FEED PUMP SET	digested sludge centrifuge feed pumps	2	15	kw		Pump (Progressive Cavity) : Treatment Works Assets EQU-EPUMP-PROV-8-214	2	15	kw
74	CONVEYOR	digested sludge conveyor	2	30	Mtr		Conveyor : Belt EQU-ECONVEYOR-PROV-8-030	2	30	Mtr
75	DRAINAGE PUMP SET	return liquors PS	2	7.5	kW		Pump (Waste Submersible) : Treatment Works Assets EQU-EPUMP-PROV-8-227	2	7.5	kW
76	GATE VALVE	return liquors PS	2	150	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	2	150	mm
77	NRV	return liquors PS	2	150	mm		Valves & Fittings : Treatment Works Assets EQU-EVALVE1-PROV-8-313	2	150	mm
78	PIPEWORK(MEICA)	return liquors PS	15	150	mm		PIPEWORK(MEICA)	15	150	mm
79	PIPEWORK(MEICA)	Assumed length of pipework for transfering wet sludge from one unit to another, sized assumed 350mm dia.	100	300	mm		PIPEWORK(MEICA)	100	300	mm
80	CONVEYOR	Assumed length for conveyor from centrifudge building to the cake barns.	6	25	Mtr		Conveyor : Belt EQU-ECONVEYOR-PROV-8-030	6	25	Mtr
81	SCRUBBER (EQSET)	Capacity assumed as the existing OCU on site.	1	47000	m3/hr		Stage 3: Wet Chemical Scrubbers STW-ODC3-0000	1	47000	m3/hr
82	PIPEWORK(MEICA)	100m GRP ducts dia. 500mm for connection to OCU. Ducts to be installed above ground with steel supports.	100	500	mm		PIPEWORK(MEICA)	100	500	mm
83	F: POWER GENERATION	Generators	1	1875	kW		Standby Generator SPS-ME3-0000	1	1875	kW
84	FLOW MEASUREMENT	Additional Item Added by KPMG/Motts?	2	12.31	Ltr/sec		Flowmeter: Magnetic EQU-EFLOW-PROV-8-077	2	12.31	Ltr/sec
		Additional Project Related Costs					Additional Project Related Costs			

Total NDW £ 31,916,851.24 | **Total NDW £ 31,357,738.92**

Ham Hill

CIT Ref	SW Scope Information - Ham Hill Option 4 v2						Benchmarking				
	Description	Description 2	Qty	Yardstick	UoM	Base Cost	Description	Qty	Yardstick	UoM	Base Cost (2022/23)
2	SITE CLEARANCE	Clearace of site other than area for flood defence bund.	1	4000	m2	[redacted]	SITE CLEARANCE	3	2116	m2	[redacted]
3	ROAD (EQSET)	Access road length approx. 360m, assumed 6m wide, hence total area is 2160m2	1	1870	m2		ROAD (EQSET)	1	2160	m2	
5	DEMOLITION OF SLUDGE DRYING BEDS	6 no. smaller bed, each 110m x 12m	6	1320	m2		DEMOLITION OF SLUDGE DRYING BEDS	6	1320	m2	
6	NEW CONCRETE TANK BUND including Concrete slab	Bund for digesters, plan area 4467m2, wall height 1.3m.	1	165	m2		NEW CONCRETE TANK BUND including Concrete slab	1	5807	m3	
7	PLINTH/BASE SLAB	Plinth for 2 unscreened blended sludge tanks, assumed 6m x 14m, 800mm thick	1	67	m3		PLINTH/BASE SLAB	1	67	m3	
9	PLINTH/BASE SLAB	Plinth for 2 no. sludge screens, assumed 15m x 10m, 800mm thick	1	120	m3		PLINTH/BASE SLAB	1	120	m3	
10	PLINTH/BASE SLAB	Plinth for 2 blending tanks, assumed 8m x 16m, 800mm thick	1	102	m3		PLINTH/BASE SLAB	1	102	m3	
11	PLINTH/BASE SLAB	Plinth for THP system (incl. feed silo and cambi units), assumed 30m x 20m, 800mm thick	1	270	m3		PLINTH/BASE SLAB	1	270	m3	
12	PLINTH/BASE SLAB	Plinth for 2 no. post-digestion tanks, assumed 18m x 36m, 800mm thick	1	270	m3		PLINTH/BASE SLAB	1	270	m3	
13	PLINTH/BASE SLAB	Plinth for liquors treatment plant, assumed 20m x 25m, 800mm thick	1	270	m3		PLINTH/BASE SLAB	1	270	m3	
15	PLINTH/BASE SLAB	Plinth for gas holder, assumed 24m x 48m, 600mm thick	1	270	m3		PLINTH/BASE SLAB	1	270	m3	
17	PILING (CFA)	Piles for 2 unsceened blended sludge tanks	1	84	m2		PILING (CFA)	1	16	Mtr	
18	PILING (CFA)	Piles for 2 blending tanks	1	128	m2		PILING (CFA)	1	16	Mtr	
19	PILING (CFA)	Piles for THP system	1	600	m2		PILING (CFA)	1	16	Mtr	
20	PILING (CFA)	Piles for 2 post-digestion tanks	1	648	m2		PILING (CFA)	1	16	Mtr	
21	PILING (CFA)	Piles for liquors treatment plant	1	500	m2		PILING (CFA)	1	16	Mtr	
22	PILING (CFA)	Piles for centrifuge building	1	500	m2		PILING (CFA)	1	16	Mtr	
XX	PILING (CFA)	Plies (tension) for underground bunker	1	80	m2		PILING (CFA)	1	16	Mtr	
23	STORAGE AREA	Cake storage barn with total area 230m x 65m, can be configured as a building with muitiple bays.	1	14950	m2		STORAGE AREA	1	14950	m2	
24	BUILDING - PROCESS	Building for centrifuges, steam boiler, plan area 20m x 25m, single storey, heavy duty.	1	500	m2		BUILDING - PROCESS	1	500	m2	
25	WASTEWATER TANK SET	Concrete bunker for cake import silo, assumed internal dimension 8m x 10m x 5m(D) underground, assumed as an underground tank, w/o cover.	1	400	m3		WASTEWATER TANK SET	1	400	m3	
26	ACCESS STRUCTURE (Stairs)	Accesss structure to the bunker, assumed length.	1	16	Mtr		ACCESS STRUCTURE (Stairs)	1	16	Mtr	
27	Excavation	Excavation for the bunker, which has wall and slab thickness 500mm.	1	545	m3		Excavation				
28	Demolition of concrete tanks	Demolition of the decommissioned Water Reclamation Works at southern side of the site. Plan area is 26m x 38m, assumed depth is 4m. Old structures are to be removed to facilitate piling works for the new facilities.	1	2000	m3		Demolition of concrete tanks	1	2000	m3	
	SITE CLEARANCE	Clearance of site for flood defence earth bund.	1	4000	m2		SITE CLEARANCE	3	2333	m2	
	BUND	Construction of trapezoidial earth bund along the site boundary, length 1000m. Total earth volume 6000m3. Please see image at the right side of this sheet (Col. AN).						1			
30	SLUDGE HOLDING TANK	2 unscreened blending storage tanks	2	48	m3		SLUDGE HOLDING TANK	2	48	m3	
31	CHAMBER	40m3 cake reception bunker, cimplete with feeder screer or sliding frame to feed cake to transfer pumps	1	38.86	m2		CHAMBER	1	38	m2	
32	FINE SCREEN (Inlet)	Provision of 2no. Sludge screens (huber strainpress type) D/S. Capacity of each screen 36.7 m3/h. 6mm screens. Magflow in the sludge feed	2	880.8	m3/day		FINE SCREEN (Inlet)	2	880.8	m3/day	
33	SLUDGE HOLDING TANK	2 post-screening blending tanks	2	72	m3		SLUDGE HOLDING TANK	2	72	m3	
34	CENTRIFUGE (EQSET)	2 thickening centrifuges	2	36.7	m3/hr		CENTRIFUGE (EQSET)	2	36.7	m3/hr	
35	THP SILO	2no. THP feed silo, each with 347 m3 capacity									

						[redacted]
81	PIPEWORK(MEICA)	return liquors PS	15	150	mm	

						[redacted]
82	PIPEWORK(MEICA)	Assumed length of pipework for transfering wet sludge from one unit to another, sized assumed 350mm dia.	100	300	mm	
83	CONVEYOR	Assumed length for conveyor from centrifudge building to the cake barns.	10	30	Mtr	
84	SCRUBBER (EQSET)	Capacity assumed as the same as Ashford's existing OCU.	1	47000	m3/hr	
85	PIPEWORK(MEICA)	100m GRP ducts dia. 500mm for connection to OCU. Ducts to be installed above ground with steel supports.	100	500	mm	
86	F: POWER GENERATION		2	1875	kW	
88	SITE CLEARANCE	Assumed a footprint off 60m x 60m.	1	3600	m2	
89	PLINTH/BASE SLAB	Assumed a concrete hardstanding of 60m x 60m, thickness 300mm.	1	270	m3	
90	ROAD (EQSET)	Assumed a 4m-wide access road along primeter of the site	1	960	m2	
91	PILING (CFA)	Assumed piling is required for a quarter of the site.	1	900	m2	
92	Mains Laying - Open Cut HPPE - Field / Verge	Internal transfer pipeline, from east to west of the site, assumed dia. 350mm HDPE pipe (yardstick max).	400	350	mm	
94	Biomethane Plant	Biomethane plant with peak gas production of 28831 Nm3/d, cost based on cost curve provided by Bioresource Team. [CAPEX ONLY, excl Civils, 2022/23 base]	1	28831	Nm3/d	
		Additional Project Related Costs				

Total NDW	£	61,559,492.14

						[redacted]
	PIPEWORK(MEICA)		15	150	mm	

					[redacted]
PIPEWORK(MEICA)	100	300	mm		
CONVEYOR	10	30	Mtr		
SCRUBBER (EQSET)	1	47000	m3/hr		
PIPEWORK(MEICA)	100	500	mm		
F: POWER GENERATION	2	1875	kW		
SITE CLEARANCE	2	1800	m2		
PLINTH/BASE SLAB	1	270	m3		
ROAD (EQSET)	1	960	m2		
PILING (CFA)	113	16	Mtr		
Mains Laying - Open Cut HPPE - Field / Verge	400	350	mm		
Biomethane Plant					
Additional Project Related Costs					

Total NDW	£	63,014,446.47

Appendix 5: Direct Capital Costs Benchmarking

MOTT MACDONALD

PR24 Bioresource Estimate Benchmarking

January 2023

WATER for LIFE from Southern Water

Executive summary

An exercise was carried out to benchmark two bioresource estimates the following report outlines are the method employed and the observations made.

It is concluded that the total project variance found at less than 2.5% for NDW would be acceptable for this level of design maturity for a Class 5 estimate.

1.1 Conclusion

It is concluded that the total average project variance found at less than 2.5% for NDW would be acceptable for this level 2 estimate at a design maturity for a Class 5 estimate.

When non function cost items are removed from the comparisons Ashford has a variance of 2.9% of value of function curve items and Ham Hill a 12.1% variance.

2 Method

SWS Cost Intelligence Team (CIT) had previously developed Level 2 estimates for two projects:

- Ashford Benchmarking
- Ham Hill Benchmarking

These estimates were developed from scopes supplied by SWS Engineering Services Team (ETS). In estimating Level 2 estimates CIT apply Southern Water cost data (cost curves) to the scope to produce a Net Direct Works cost (NDW). To this NDW, CIT apply a single multiplying factor that adds allowance for the indirect cost associated with the delivery of the project. The multiplier was pre-agreed with Southern Water for all PR24 estimates

Benchmarking was requested so a comparison of the cost could be made against the wider water industry, and thus provide the Southern Water with more confidence of the costs

The benchmarking exercise was carried out by applying cost data for alternative water sector sources held anonymously by Mott MacDonald, by Mott MacDonald to the same scope. This gave an industry comparative view of the Net Direct Works (NDW)

The Indirect costs (design, Overheads etc) are difficult to compare against other WASC's as they may cover different allowances, so this exercise only compares the Net Direct Costs

3 Ashford

3.1 Benchmarking commentary on NDW for Ashford Option 1v5

SWS CIT Estimate	NDW	£31,916,815
Benchmarked Estimate	NDW	£31,357,739
Total Variance	**1.75% higher than comparison (£599,112)**	

A total number of 80 Items priced within the comparison, of those items 10 had no direct comparative rates to compare (£12,468,626) in this case the SWS costs were inputted.

3.2 Other observations

Areas where SWS costed items are noticeable higher than comparative:

[redacted]

Areas where SWS costed items are noticeably less than comparative:

[redacted]

4 Ham Hill

4.1 Benchmarking commentary on NDW for Ham Hill Option 4 v2

SWS CIT Estimate	NDW	£61,599,492
Benchmarked Estimate	NDW	£63,014,446
Total Variance	**2.4% less than comparison (£1,454,954)**	

A total number of 87 Items priced within the comparison, of those items 13 had no direct comparative rates to compare (£49,064,905) in this case the SWS costs were inputted.

4.2 Other observations

Areas where SWS costed items are noticeable higher than comparative:

[redacted]

Areas where SWS costed items are noticeably less than comparative:

[redacted]

Appendix 6: THP Benchmarking

MOTT MACDONALD

PR24 Enhancement Case Review
Bio-Resources

Project:	Bio-Resources		
Our reference:	NA	**Your reference:**	NA
Prepared by:	[redacted]	**Date:**	15/12//23
Approved by:	[redacted]	**Checked by:**	[redacted]
Subject:	Bio-Resources		

Executive Summary

As part of the PR24 Enhancement case reviews, Mott Macdonald (MM) were engaged to provide cost confidence on the costs submitted for the Bio-resource Advance Anaerobic Digestion (AAD) – External benchmarking of THP plants.

The Bio-resources costs had previously been taken to level 2 scoping / costing with a mixture of cost curves, bottom-up estimates, and supplier quotations. External benchmarking was limited at PR24, and new industry comparators were sourced, assured and aligned as part of the review. Results:

At PR24 there was lack of confidence in the estimates for THP plants as there was a large variance in costs between the bottom-up estimates produced and a supplier quotation that was obtained close to submission. The supplier quotation was used in the submission as a basis for the 2 projects, as it was seen to be the most reliable data source. The external benchmarking (of a cost model and actual project cost data) supported the decision to use the quotation. The supplier costs are 7.4% lower than the benchmark for Ashford and 6.9% above the benchmark for Ham Hill. Whereas the bottom-up estimates are 33.7% higher for Ashford and 36.0% higher for Ham Hill. The benchmarking results are well within acceptable tolerance levels and increase confidence in the PR24 costs.

AAD

1 Benchmarking – Custom Assets (THP)

CIT were asked to benchmark the cost of the THP units included in the 2 projects of the AAD sub-programme of Bioresources. These items were initially estimated at £25.45m for 2 units at Ham Hill and £7.2m for 1 unit at Ashford. A supplier quote of £5m per unit was then received and used in place of the initial estimate in the business plan submission. Due to the large discrepancy between the two costs, a benchmark was required to provide assurance.

Initial benchmarking was not completed due to lack of comparator data. For the purpose of this review, new external data from a peer company has been sourced which included new cost curves and project data from three similar projects using Cambi THP units.

A high-level benchmark of the item cost lines was undertaken by calculating a rate per output (TTDS/Yr) for each source. The sources were aligned to the Southern Water estimate base date. A newly soured external curve was also used to provide a benchmark figure for the capacities at Ashford and Ham Hill.

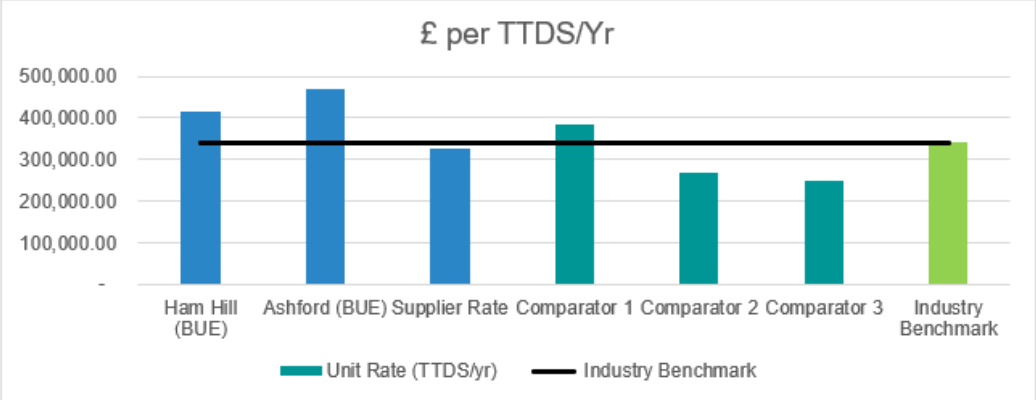


Chart 1 - Comparison of cost per TTDS/yr for THP

Chart 4 shows the results of the unit rate benchmarking.

	Unit Rate (TTDS/yr)	Against Benchmark
Ham Hill (BUE)	414,535.79	-22%
Ashford (BUE)	468,889.93	-37.6%
Supplier Rate	324,675.32	4.7%
Industry Benchmark	340,837.87	

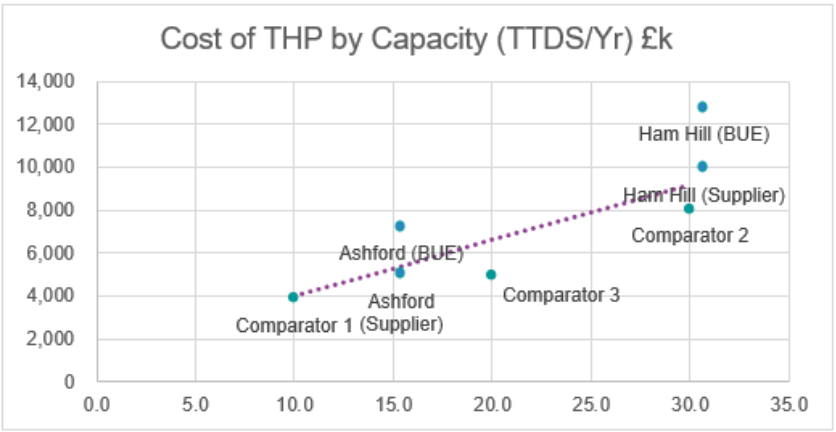
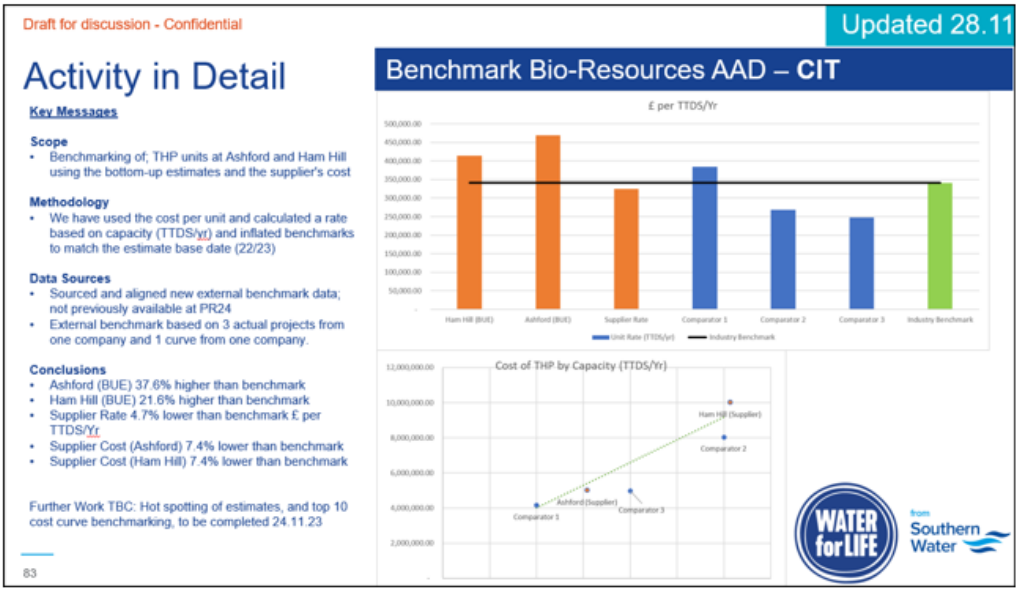


Chart 2 - Comparison of THP costs by plant capacity

Chart 5 shows how the total unit costs compare to the benchmark and comparator data by capacity (TTDS/yr). The bottom-up estimates are 33.7% higher than the benchmark for Ashford and 36.0% above the benchmark for Ham Hill. The supplier costs are 7.4% lower than the benchmark for Ashford and 6.9% above the benchmark for Ham Hill.

It can be concluded from this analysis that there is reasonable evidence to support the decision to include the supplier rate in the PR24 submission over the bottom-up estimates.

CIT Output Slides



Appendix 7: Scope Benchmarking

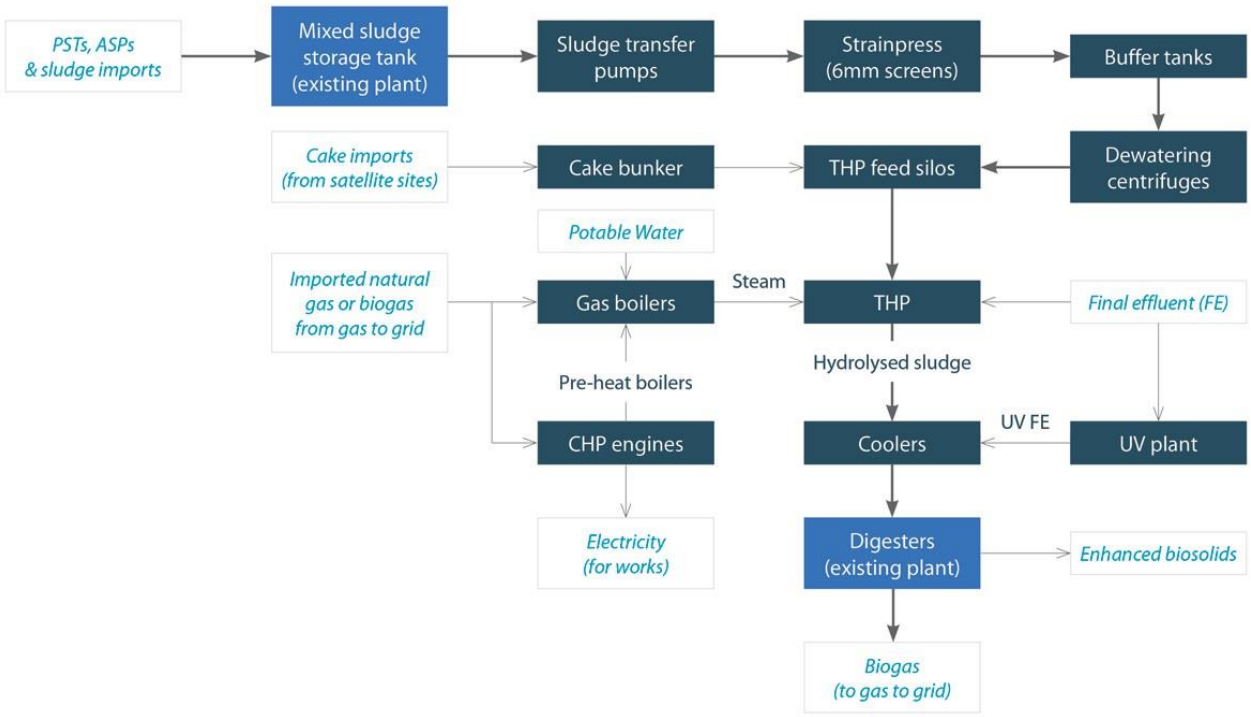
In April 2023, a small team from Southern Water visited Site A operated by another WaSC. Site A is a newly commissioned AAD site with similar capacity as SWS' Ham Hill expected AAD plant.

The WaSC operating Site A has a longstanding experience with these types of processes, so the purpose of the visit was to compare scope and capacity of key assets to ensure SWS' design was aligned with the rest of the industry.

No reliable costing could be obtained from conversation with Site A personnel hence no benchmarking of costing could be conducted.

a. *Process diagram Site A*

The diagram below is a typical flow sheet for the type of processes operated and aligns with design for Ham Hill.



b. *Scope benchmarking*

The table below compares Site A scope as per visit notes from SWS design team. This was then cross referenced with SWS' design for Ham Hill site. Items in Green are of similar scope and size as items seen at Site A. Items in Amber are for processes included in designs for both sites, but scope is slightly different, which could be attributed to specific sites requirements (e.g., Odour Control Unit). Items in red have been highlighted as not currently being part of Ham Hill scope but are considered as small items.

Item #	Site A scope from Site Visit Notes	SWS ref items
1	THP plant was built on disused trickling filters (may have been some issues with disposal of excavated material) at the existing site.	Ref 2, 11, 19, 36, 68,70, 71, 72, 73, 74, 75, 76, 82
2	2No. 800m3 balancing tanks were existing. The scheme starts from the outlet of these tanks with new transfer pumps/pipework to new THP area.	Existing asset (Site A)
3	45 Tonne cake reception plant. Basic hopper lid open to atmosphere. No building for cake vehicles to reverse into (which is clearly different to many of our sites where this is required). No odour issues recorded.	Ref XX, 25, 26, 27, 31, 65, 66, 67
4	2No. cake silos for imported cake (Stortec)	Ham Hill design includes cake bunker and pump up to blending tank
5	2 No. THP feed sludge balancing tanks 1290m3 each. Compressors for air mixing to de-stratify	Ref 35, 54 (but SWS' is smaller at 347m3 each), 69
6	3No. Hydro Strainpresses on elevated steelwork platform	Ref 9,32, 59
7	3No. Alfa-Laval centrifuges on elevated steelwork platform. Achieving around 20% DS (dilution downstream)	Ref 34 (but SWS' includes 2 no, total capacity similar), 78-81
8	Polymer storage (30 Ton Silo) and make-up system rated for 4m3/hr. 3No. dosing pump sets for each centrifuge. Provided by Richard Alan.	Ref 43
9	1No. Small Odour Control Unit (Fans rated for 4815m3/hr)	Odour plant included for Ham Hill expected to be larger than the one at Site A
10	2No. CHP Engines (Clarke energy) were existing but moved to location near to steam boiler house.	Existing asset (Site A)
11	2No. steam raising boilers (Cannon Bono Energia)	Ref 22, 24 37
12	No real treatment for boiler feed water. Some softening and chemicals added. Operator mentioned RO plant for feed water.	Considered as not needed for Ham Hill
13	1No. centralised main MCC kiosk for all MCC's for plant (including Cambi provided panels).	Assumed included in scope of other items
14	1No. gas holder	Ref 15, 42 (but SWS' include 2 no, total capacity similar)
15	1No. flare stack for unused biogas	Ref 45

16	Separate kiosk provided for gas to grid plant control etc	Ref 88-94
17	Gas conditioning system (for Gas to Grid) with propane storage vessels.	Ref 88-94 – Subsequently replaced with CHP engine
18	Anti-foam dosing for plant (IBC's in small kiosk and dosing pumps/pipework)	Considered as not needed for Ham Hill
19	Final dewatering centrifuges were existing but some upgrades to the conveying system to the open cake bays	Existing asset (Site A)
20	Cake bays were existing and used for storing raw sludge cake in addition to hydrolysed sludge	Existing asset (Site A)
21	FE usage includes 2No. boll filters (160l)	Could be included in Ham Hill scope (TBC)
22	2No. UV reactors (Trojan) 4.9kVA	Could be included in Ham Hill scope (TBC)
23	4No. booster pumps (Grundfos) 37kW	Could be included in Ham Hill scope (TBC)

The table below lists items which are part of Ham Hill's current design but were not listed as part of Site A's scope. These items are quite specific to Ham Hill's current design, layout & capacity and are therefore required in addition to the above.

Scope specific to Ham Hill	
Access road (360m)	Demolition of existing Water Reclamation Works
DEMOLITION OF SLUDGE DRYING BEDS	6 no. digesters (3333 m3 each)
Bunding for 6no. Digesters	5no. Bucher press, model HPS 12007.
2 unscreened blended sludge tanks	Gas Flare
2 blending tanks	Poly dosing (post-digestion)
Cover for unscreened blending storage tanks, assumed dia. 4.4m.	Digested cake conveyance
Cover for cake import silo, assumed dia. 4m.	Generator
Cover for post-screening blending tanks, assumed dia. 6m.	M&E associated with above items
Post digestion storage tanks	
Anammox Liquor treatment plant	

Appendix 8: Market Engagement

Context

Southern Water (SWS)'s long-term strategy for Bioresources as described in SRN36 Bioresources Strategy document as part of SWS PR24 submission focuses on the consolidation of sites and conversion of the current Bioresources operation to Advanced Anaerobic Digestion (AAD) in the first instance with the potential for further treatment. These changes will allow SWS to reduce the impact the landbank pressure (currently the only outlet available for the treated Biosolids), increase the potential for resources recovery from Bioresources, restore resilience and improve sustainability. The AMP8 focus – as described in SRN21 Advanced Digestion document – will be in our Kent region where operation is the most challenged.

Periodic Information Notice

On the 8th February 2024, SWS released a Periodic Information Notice (PIN) under Kent Bioresources Project, along with information about our long-term strategy and AMP8 focus and a Request For Information (RFI). The aim of the PIN and RFI was to understand if the project would generate any interest in the Market as well as gather feedback on current thinking. The PIN was released on both Jaggaer and FindATender websites, with the RFI data being collated on the Jaggaer portal by SWS Procurement Team between the 8th of February and 12th of March 2024. Overall, 16 companies expressed interest directly through RFI responses, among 44 companies who reviewed the PIN on our portal alone.

Subsequent Market Engagement

Whilst the PIN was open, a Market Engagement event was held on-line on the 5th of March 2024 and was attended by 25 companies (4 investors, 6 consultancies and 15 suppliers). The event was an opportunity for SWS to elaborate further on the project including drivers, strategy and timeline develop and for participants to ask for any clarifications.

Subsequently, individual 1-2-1 sessions were offered to all potential interested parties. As of mid-May 2024, SWS has met with 15 individual companies to discuss the project further.

Market Feedback Summary

The feedback SWS has received either through RFI answers or through 1-2-1 sessions is very positive and encouraging. The Market is very eager to discuss the potential of the project further as all the companies we met through 121 sessions were interested in participating in future market engagement.

All investors SWS spoke to expect to lead a consortium/SPV into the bidding process, with some already in early discussion. All other companies (e.g., suppliers and manufacturers) would want to be part of a consortium to deliver the project.

Contract & Delivery

Most interested parties have experience with either financing, delivering or supporting large infrastructure projects such as SWS' *Kent Bioresources Project* and some have experience with DPC/PFI type of contracting option.

DBFOM/ DBF/ service contract
Whist our RFI suggested 3 types of contracts (Service Agreement, Design/Build/Finance (DBF) or Design/Build/Finance/Operate/Maintain (DBFOM), most of the companies SWS has spoken to are in favour

of the DBFOM option (88%), with most of them looking at long-term partnership (i.e., 20-30 year contracts). None were interested in the Service Agreement option.

Several investors raised some concern that to ensure continued interest and keep bid prices competitive, certainty over payments to the SPV would need to be assured, as it has been for DPC. If the payments were only part of the general pool of SW's overall payments, with no priority given to pay the SPV, the associated risks would result in a likely higher price with more weight and consideration given by the SPV's debt provider on SWS' overall credit rating and assumed ability to pay for the lifetime of the contract.

SWS Strategy & Current Project Proposal

Sludge treatment technology
The majority (93%) of the participants that expressed an opinion supports SWS's current strategy for sludge treatment (either Advanced Digestion or Advanced Thermal Conversion or both).

Location of site
As a large of majority (79%) of the participants were all in favour of a DBF or DBFOM models (, the preferred option was for the new assets to be implemented onto SWS' existing sites.

Biogas use
Responses are more divided on the use of the produced biogas, with participants being interested in both electricity production and injection of biomethane into the grid.

With the uncertainty surrounding gas and electricity prices in the recent past, we would expect further discussions about the biogas production to be required in future.

Other opportunities
74% of the companies at this stage have expressed interest in investigating additional resources recovery opportunities or the potential to treat other types of wastes (e.g., food wastes). However, we expect further discussions will be required due to several uncertainties (e.g., EA's National Strategy and uncertainty surrounding co-digestion of wastes).

When discussing the potential for trading with other WaSCs (i.e. one new installation to treat sludge from 2 – or more - neighbouring WaSCs), one interested party highlighted the need - and added risk and complexity in the contract - to specify the parameters related to the incoming and treated sludge quality, especially in relation to the landbank issue (see below). Depending on the quality of the incoming sludges from the companies involved, the efficiency of the assets and quality of the resulting treated sludge would be impacted. Potentially complex mechanisms would need to be put in place to account for this.

Risks

A few potential risks were highlighted by interested parties, either through their answers to our RFI or in conversations during the 121 sessions:

Landbank
The ability to recycle SWS' treated sludge through agricultural land ("landbank") has been highlighted as a risk in the near future in various published documentation (incl. PIN supporting information and Market Engagement event presentation). All investors made clear they were not keen for the SPV to retain the sludge once treated and would prefer it is managed by SWS. Key reason given is that the risks could not be controlled by an investor and therefore could be subject to significant increased bid prices.

Outline Planning Permissions
Several participants have made clear they would not be prepared to enter the bidding process without certainty over key risks. Uncertainties remaining over the approval of the project from planning authorities could be a reason for not entering the bid. Outline planning permission- if provided ahead of the bidding process - would also allow bidders to understand and cost the requirements better which would improve the outcomes of the bid. It is therefore critical for SWS to secure a general agreement and receive planning permission early in the project.

SWS/3rd party site interface
In a DBFOM scenario - during the build phase and once in commission - a large number of interfaces are expected to need to be managed between SWS and the 3rd party. During the operational phase, particular care should be taken when drawing up the contract to ensure acceptable criteria and limits are agreed upon for the various streams and products (e.g., sludge, biogas, liquors, treated sludge…). Adequate measurement methods (online or offline sampling & analysis) should also be agreed at planning and design stage to avoid any unforeseen circumstances.

Energy generation
Further discussions and internal assessment are required to understand where the benefits of energy generation (either through production of electricity, heat or biomethane) and associated incentives would best sit. The feedback from companies varies depending on the risk appetite from all parties on energy price fluctuation, uncertainties surrounding incentives and complexity of regulations.

Bioresources Market Engagement Presentation

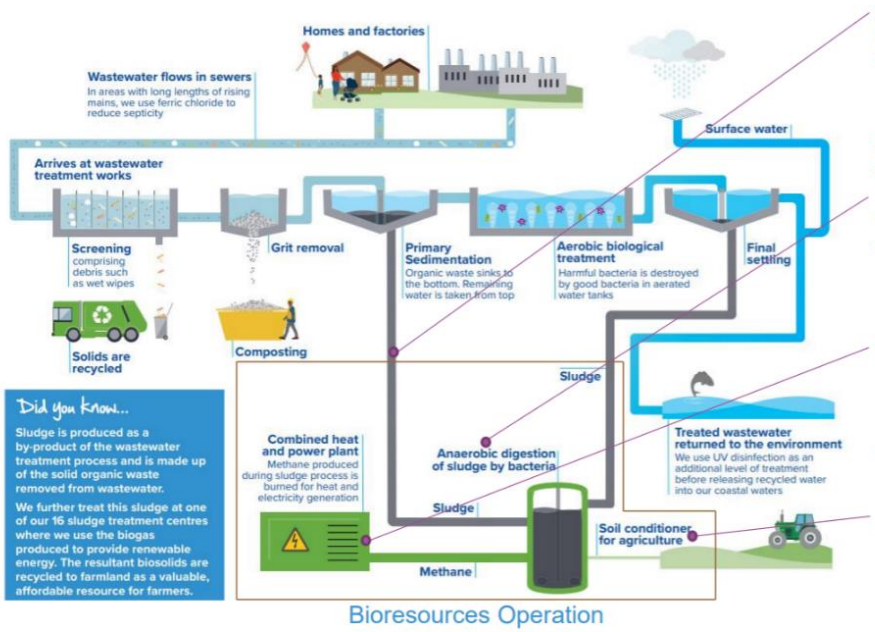
Vision and objectives for our bioresources operations

Our vision
To create a resilient & sustainable bioresources operation that maximises value for the environment and our customers using efficient and adaptive solutions

Strategic Objectives

1. Treat sludge efficiently and cost effectively to produce materials that benefit downstream supply chains
2. Eliminating our reliance on secondary treatments such as liming to produce compliant biosolids
3. Create sustainable outlets for biosolids and other waste materials
4. Maximise the recovery of resources from sludge
5. Deliver sustainable and lasting operational resilience
6. Contribute to the company's pledge to reduce its operational zero carbon by 2030 and the UK Net Zero target of 2050

Our bioresources business has 4 main asset groups



Bioresources Operation

Sludge Transport
(Liquid & Cake)
- 365 small sites
- 14 medium sites with dewatering
- 42 tankers moving 600,000 miles per year

Sludge Treatment
- 16 treatment centres at our largest works
- All conventional Anaerobic Digestion (AD) (43 digesters)
- (1x THP plant commissioning 2024)
- Many have lime plants as secondary treatment, before going to land

Energy Generation
- 18 CHP engines generating 65GWh of electricity with ROC accreditations

Sludge Recycling (to land)
- Sludge has to meet quality standards under Biosolids Assurance Scheme (BAS) to be allowed to go to land
- 447 local farmers accept the sludge over 12,000 ha

We are facing legislative and permitting changes that requires our asset base to adapt

Material regulatory changes could impact our ability to process and recycle our sludge to agricultural land

Agricultural Diffuse Pollution Regs (FRfW)

- Farming Rules for Water (FRfW) could restrict application of treated sludge to soils, impacting 75% of our production
- Under FRfW, 65% of the Biosolids produced in the UK would require alternative disposal (eg landfill or incineration) within 5 to 10 years

Contaminants in soils

- Emerging concerns over microplastics and other contaminants (eg PFAS) may result in legislation closing the recycling of sludge to agricultural land by 2040-2050

Industrial Emissions Directive

- We need to upgrade our assets to be compliant with the Industrial Emissions Directive (IED)

We explored various options as part of our strategy development

Advanced Digestion (AAD) could be the technology to adopt now, with the possibility of incorporating thermal conversion later once the technology has matured.

Technology option	Relative opex*	Relative capex	Energy recovery	Technology readiness	Relative Carbon footprint	Comment
Conventional Digestion *(Current)*	M	L	M	9	M	▪ Whilst requiring low capital investment, our current operation is not sustainable, subject to complaints and does not yield the full potential of our sludge
Drying	M	M	L	7-9	H	▪ The energy intensity of current technology makes drying only suitable for niche applications (eg Isle of Wight)
Advanced Digestion (AAD)	M	M	H	8-9	L	▪ Advanced Digestion is the current best technology to ensure Biosolids is consistently produced to highest standards and additional energy potential is recovered from our sludge
Thermal Conversion is the only concept capable of fully mitigating the landbank risk by converting the sludge to inert material						
Incineration	H	H	L	9	H	▪ Local planning for incineration is known to be a challenge and our customers feel this would be a step back for SWS. It is a well understood process, but it is also expensive and carbon intensive, partly due to the low resource recovery potential
Advanced Thermal Conversion (Pyrolysis / gasification / ...)	H?	H	M	5-8	L	▪ The overall potential of pyrolysis/gasification is higher than incineration, but some uncertainties remain as the Technology Readiness level of the process is still low. There is a good synergy between this concept and Advanced Digestion making AAD a stepping stone technology

**excl energy*

Our strategy is to consolidate the asset base and convert to advanced technologies over next 10-15 years

Overall Strategy

- Conversion from 16 conventional AD sites to 7 Advanced AD sites
- Followed by further addition of Advanced Thermal Conversion process (locations TBC)
- Electricity generation (CHPs) is currently our best option for biogas. Biomethane upgrade could be a good alternative if incentives & carbon mechanism change in our favour
- Because of the scale of the change whilst still operating, logistics are likely to be a challenge, hence the multi-AMP transformation

AMP8 focus

- Consolidation of 7 of our operational Sludge Treatment Centres in Kent to 2 "super-sites" and conversion to Advanced AD (AAD)
- Due to sites location, access and space, our super-sites of choice would be Ham Hill in North-Kent and Ashford in South-Kent
- All other 5 sludge treatment centres (STCs) would be converted to raw sludge export (liquid or dewatering) – To be delivered by SWS

Additional information on our Long-term Strategy

- SRN36 – Bioresources Strategy
- SRN21 – Advanced Digestion

Our customers are supportive of a move to advanced processes

1. Sludge is seen as a valuable product within farming, cheaper and more sustainable than manufactured fertilisers (e.g. inorganic fertiliser)

"Sludge is a cost-effective way of getting phosphate-based fertiliser onto farms. Phosphate is required for good crop production. Where I've worked South Downs is predominantly deficient in phosphate, so sewage sludge has provided a pretty good product to old fashioned fertilizer." Agronomist

"The product can be rancid. I've had residents complaining about the smell and we had environmental health involved a couple of time." Farmer

"You get good cake and bad cake. Sometimes it'll stack nicely and sometimes it'll run out." Farmer

2. However, the quality of SWS' cake can be variable. These issues should be mitigated through the use of more advanced processes

3. Farmers and customers are also mindful of potential contaminations

"I think microplastic contamination is a concern because we don't know the full impact of that on the plants or on people." Farmer

My initial impressions are what is this - is it a form of human waste similar to spreading manure? How does this work in terms of immunity to disease? Customer

4. Our customers are generally supportive of our strategy to move to more advanced processes and recover more resources from our waste…

I think it is a good thing, making better use of what is probably, technically a waste product. Hopefully over the course of the expected 15 year timescale, technology will also improve/adapt to assist.

Seems like a good idea and if this is good for the environment, then I can't see why they wouldn't put this in place. I understand the need to do this slowly but it does feel like a long, long time.

This feels frustrating because to protect soil health and waterways, water companies will incinerate waste thereby polluting the air, which I would imagine is another area of responsibility of the EA. I guess the question is which is the lesser of the two evils?

My initial reaction to this is that it sounds counter-productive and leads to a backwards step which feels unnecessary. Bringing back incinerators seems like a big backwards step.

5. … but as expected, aren't thrilled at the idea of the industry building incinerators.

Our overall Kent Bioresources project

- Whilst we are keen to explore suggestions and develop the project in conjunction with the market, our working hypothesis is:
  - Consolidate seven of our operational Sludge Treatment Centres in Kent to two "super-sites"
  - Conversion of operation to Advanced AD (AAD)
  - Combined Heat & Power engines for Biogas, but potential for Biomethane upgrade if more attractive
  - Recovery of nutrients (e.g. Ammonia)
- One option under consideration is to award a contract to finance, design and build, with the option to operate and maintain the resulting two super-sites for the contract term, delivered by a single organisation, which could be a joint venture or SPV.
- We are open to proposals for alternative locations, but considering access and space constraints, our existing sites at Ashford and Ham Hill in Kent are likely to be the most suitable.
- The other five sludge treatment centres (STCs) will be converted to raw sludge export (liquid or dewatering). These works are not considered part of this project and will be delivered separately.
- Given the age, performance, and design limitations of the assets at Ashford and Ham Hill, we expect total replacement will be necessary (incl. sludge reception, advanced digestion, dewatering, biogas use).
- The expected commissioning of the two super-sites would take place in 2030.

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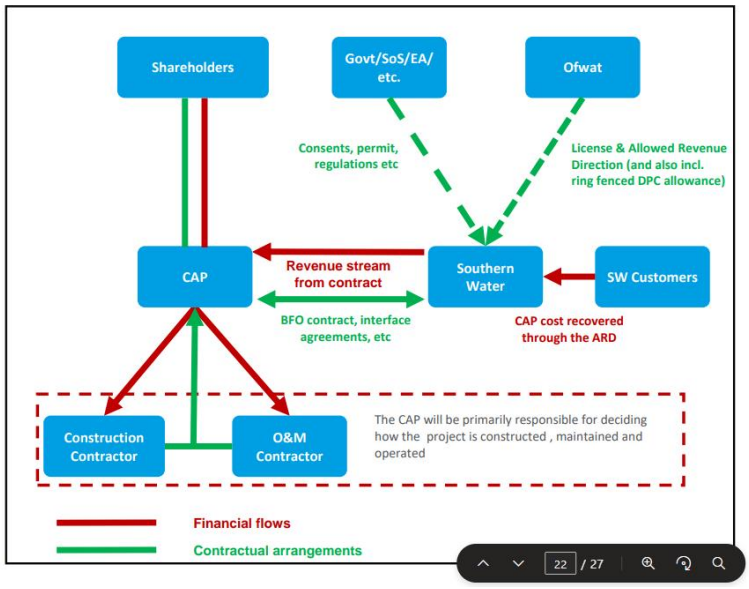
DPC model



Key characteristics of the DPC model:

- Similar structure to project finance model
- Long-term contract between Southern Water and a Competitively Appointed Provider (CAP), similar to PPP/PFI
- No separate licence for the CAP
- Revenues of the CAP are agreed through the Allowed Revenue Direction and recovered through customer bills by Southern Water.

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Possible contracting models

- We are considering different contract options for this project.
- In our PR24 submissions we have proposed for the project to be delivered as a DPC-lite delivery model. It is similar in its delivery of a DPC model where we would competitively tender for a third party to design, build, finance, operate and maintain assets.
- With Ofwat's agreement the payments would be passed through from our customers to you, in a similar way to Thames Tideway.
- Option 1: DBOFM model similar to other DPC projects.
- Option 2: Third party designs, builds and maintains, Southern Water operates and maintains.
- Option 3: Full service model: under a service contract the third-party contracts to take our sludge and dispose of it legally as required under UK legislation. The assets would be built and owned by the third party. This may allow greater freedoms to consider the capacity you would want to build and other sources you may want to provide for.

Appendix 9: Biosolids Notified Item

Context

In our October 2023 business plan submission (SRN58 Uncertainty mechanisms) we proposed an uncertainty mechanism to manage the uncertainty surrounding the application of rule 1 of the Farming Rules for Water (FRfW) legislation.

Since our business plan submission additional work has been carried out to further assess the landbank challenge (in particular, impact of FRfW and EA's National Strategy) as well as potential solutions, particularly in the shorter-term. In addition, in-line with Ofwat's recognition of uncertainty around landbank availability from 2025 onwards, the industry is now proposing a combined uncertainty mechanism for landbank, which we detail in Appendix 9-A.

Our proposal

Overall, we are supportive of the industry's proposed uncertainty mechanism and urge Ofwat to include it as a notified item. Our thoughts on this industry-led mechanism are further detailed in section 4 below.

Southern Water - alongside the rest of the industry - also disagrees with the wording used by Ofwat to qualify the trigger point for this Notified Item to be used, which restrict it to only "new or changed legal requirements" "in relation to the application to agricultural land of fertiliser derived from sludge". A non-exhaustive list of trigger points (complied in collaboration with other WaSCs) which may reduce the industry's ability to recycle biosolids to agriculture is provided in Appendix 9-B. Not all of these potential trigger points would occur by reason only of new and/or changed legal requirements, but any one of these would require substantial changes to biosolids operations and the use of biosolids as organic fertiliser. Ofwat's Notified Item proposal does not address this convergence of multiple investment drivers industrywide (or those unique to Southern Water), driving the need for investment. We understand discussions between the industry and regulators are still on-going and will go beyond Draft Determination responses.

1. Landbank current issues & risks

Current issues

As described in detail in our Cost Adjustment Claim for Advanced Digestion (SRN21) submitted in October 2023 and in earlier in this SRN-DDR-016 Bioresources AAD Cost Adjustment Claim, we are already experiencing issues related to the landbank in the relation to:

- **Geography and farming area**: Adjusted for population, the South-East of England (including London) has the smallest farmed area and approximately one-third of the cereal/wheat (the preferred type of crops for Biosolids) area compared to Eastern England which results in disproportionate pressure on the local landbank.
- **P indexes**: Within our region, Kent has the highest percentage of land with high phosphorus (P) levels (P Index 4 = 22%). We expect a complete restriction of biosolids application to Index 4 soils, as part of the Biosolids Assurance Schemes proposed 20-measures (which are now in effect). Kent also has the lowest percentage of land with lower phosphorus levels (P Index 0-2 = 37%), which may be more acceptable for P addition under stricter rules.
- **Quality of our sludge and feedback from the farmers receiving it**: Section 5.2.1 of this SRN-DDR-016 Bioresources AAD Cost Adjustment Claim and Section 1.2 and Appendix 2 of SRN21 (October 2023 submission) note that although farmers recognise the benefits and the value of our biosolids (in comparison to inorganic fertilisers), they have highlighted significant issues with consistency and odour. They have expressed their interest in Southern Water producing a Biosolids with enhanced quality (greater dryness to improve stockpile stability, more consistent nutrient

content, and ability to apply to great variety of crops outside ploughing periods) which will solidify their acceptance of our product in the short-term.

Future risk – Triggers and updated collaborative National Landbank Modelling

In addition to the risks mentioned in Appendix 9-A, a number of "triggers" were discussed and presented collaboratively by the industry (Appendix 9-B). This list is non-exhaustive and is provided here to show the variety of risks that may impact the industry's ability to recycle its biosolids to agriculture. This is particularly relevant in the context of the current wording used by Ofwat at Draft Determination which is very much focused on *"new or changed legal requirements in relation to the application to agricultural land of fertiliser derived from sludge"*, which is currently quite prescriptive.

As per item 21 of Appendix 9-B, we very much see landbank modelling as the universal approach that would enable the industry and regulators to take account of any changes in legal and non-legal requirements for biosolids use in agriculture and assess the resulting impact(s).

To this extent, the collaborative National Landbank modelling work undertaken by the industry in 2022 – as presented in detail in our WINEP Biosolids Cake Storage document SRN43 and summarised in Appendix 9-A, was updated in 2024 (Appendix 9-C). Additional scenarios were assessed, including a deeper dive into the EA's interpretation of Nitrogen and Phosphorous management which could be enforced either as part of the Farming Rules for Water or the EA's future sludge strategy. These scenarios could be linked to triggers 1 to 5 in Appendix 9-B, for example.

Table A below summarises and compares some of the additional scenarios modelled to the updated baseline (Scenario 6 – our current operation).

Scenarios 7, 8 and 9 show respectively the impact of the EA's interpretation of Nitrogen (7), Phosphorous (8) and both Nitrogen and Phosphorous (9) management on landbank availability. Data indicates that a change in both Nitrogen and Phosphorous management will result in a situation where the agricultural land available in Great Britain will not suffice, in comparison to the land required by the industry. Whilst this is mainly driven by Phosphorous management, the impact of Nitrogen is also significant.

Table A: Summary of updated National Landbank Modelling (Grieve Strategic - 2024)

Scenario (2024 update)	Land available (GB – ha)	Land required by Southern Water (ha)	Land required by industry (ha)	% of farmland needed (industry)
6 – Updated baseline	2,958,000	59,000	925,800	31%
7 – EA's interpretation of Nitrogen management (only)	2,958,000	136,500	2,274,800	77%
8 – EA's interpretation of Phosphorous management (only)	2,958,000	197,300	3,126,200	106%
9 – EA's interpretation of Nitrogen and Phosphorous management	2,958,000	240,200	3,799,000	128%
19 – Scenario 9 with 100% farmers acceptance	2,958,000	151,100	2,544,400	86%

Should these scenarios materialise, the industry will require to find alternative outlets for a large proportion of the biosolids being treated in Great Britain.

2. Reducing the issue through our AMP8 plans and alignment with long-term strategy

As developed in detail in our Bioresources Long-term Strategy document (SRN36, October 2023 submission), our plan is to first convert our operation to Advanced Anaerobic Digestion (AAD) - including consolidation of sites starting in Kent in AMP8 - followed with the implementation of Advanced Thermal Conversion (ATC) concept.

From an operation perspective, AAD will enable us to mitigate the current issues with the quality of our biosolids and the impact this will have on our ability to recycle biosolids to land through:

- increase farmer acceptance of biosolids product by an expected 50% (from current 40% to 60% as presented in Appendix 1 of SRN21 Advanced Digestion document, October 2023 submision);
- ensure compliance with BAS pathogen (currently not achievable without secondary remediation) and updated BAS dried solids standards;
- increase product dryness (better stackability in fields resulting in reduced slumping, smaller field footprints and reduced risk of run-off to surface water);
- enhance pathogen destruction allowing farmers to apply enhanced product (safe sludge matrix) to a wider range of land (e.g., grassland which covers one-third of agricultural land in the South-East of England); and
- reduce odour.

In addition to the above benefits, the implementation of AAD in AMP8 aligns completely with the second phase of our strategy (e.g., implementation of ATC) - or its adaptive pathway (e.g. implementation of dedicated incineration, where possible) - from an end product quality and energy balance – as discussed in our Long-term strategy document SRN36 (October 2023 submission).

3. Southern Water's AMP8 plans and uncertainty mechanism

As described above, whilst our AMP8 plans – especially the implementation of AAD in Kent – will improve our operation and mitigate current issues related to landbank. However, it will not fully mitigate the potential risk detailed in section 1, especially the conclusions from the updated national landbank assessment presented in Appendix 9-C.

Sustainable solutions are not currently in place to fully mitigate the risk and should these scenarios materialise in AMP8, it is likely the industry will have to put in place expensive solutions in the short to-medium term such as diverting sludge to landfill sites or co-incinerate sludge with other wastes at existing facilities, whilst preparing for longer-term solutions (e.g. dedicated incineration plants). To achieve this, an uncertainty mechanism is therefore required.

The additional evidence below confirms our AMP8 plans (particularly implementation of AAD) are "no-regret" solutions as they would support any of the scenarios described below and complete any additional solutions implemented as part of the uncertainty mechanism. To this extent, the implementation of our strategy could:

- Help manage the trigger point for the uncertainty mechanism; and,
- potentially reduce the cost of the solutions needed.

AAD impact on nitrogen removal and Farmers Acceptance

Another piece of work commissioned by the industry in May-24 was the assessment of the impact of various solutions which could be implemented across the industry on the amount of Nitrogen released to soils, compared against the current baseline (e.g., current operation across the UK). This is available in Appendix 9-D (Atkins' Dry Solids Scenario Assessment). The study also looks at how many sites each solution could be implemented with estimation of other useful parameters such as CapEx, OpEx and Carbon (see Table B).

The solutions assessed are as follows:

- Operational interventions (e.g., operational improvements. like for like replacement of dewatering assets) – 68 sites selected across the industry;
- implementation of AAD at eligible sites – 43 sites selected across the industry;
- enhanced dewatering (e.g. Bucher Press) at eligible sites – 129 sites selected across the industry; and
- implementation of thermal drying at eligible sites – 133 sites selected across the industry.

A like for like comparison of each process is not possible from this report as the number of sites where each solution could be implemented varies depending on the solution. However, from a holistic perspective, the report concludes that implementation of AAD is highly beneficial and cost-effective solution (based on normalised TOTEX) to reduce Nitrogen in biosolids sent to agricultural land, compared to enhanced dewatering and thermal drying. It also provides the greatest carbon reduction. The report also confirms our view on least-regret solution as it states*: "Scenario B [AAD Scenario] is a least regrets pathway as it acts as an enable for bolt on additional processes such as drying or other alternatives such as advanced thermal conversion if an alternative to agricultural land application for all or some of the biosolids was required in the future"*.

Table B: Impact summary of a range of processes (Atkins' Dry Solids Scenario Assessment May-24)

	Unit	Scenario				
		Baseline	A	B	C	D
			Targeted interventions	AAD upgrade / AAD new build	Dewatering upgrade	Drying upgrade
Impacted Sites	-	N/A	68	43	129	133
Impacted Raw Sludge Capacity	dry tonnes/year	N/A	569,000	370,000	1,360,000	1,370,000
Biosolids Summary						
Total Biosolids	wet tonnes/year	3,307,900	-138,000	-348,000	-882,000	-2,290,000
Total Biosolids	dry tonnes/year	856,400	-2,000	-77,800	Negligible impact	Negligible impact
Available N in Biosolids	tonnes/year	3,700	-110	-565	-370	-1,200
Cost Summary						
Direct CAPEX	million GBP	N/A	+30 to 45	+310 to 490	+240	+750
Project CAPEX[a]	million GBP	N/A	+75 to 110	+770 to 1,230	+590	+1,870
OPEX	million GBP/year	N/A	0	-3	-12	+82 to 180
TOTEX[b]	million GBP	N/A	+70 to 105	+680 to 1,100	+430	+2,540 to 3,490
Carbon Summary						
Embodied Carbon	kt_{CO2e}	N/A	Not evaluated	+320 to 510	+180	+450
Operational Carbon	kt_{CO2e}/year	N/A	Not evaluated	-170	-20	+60 to 130

[a] Estimated 2.5-factor uplift from direct CAPEX to project CAPEX; [b] TOTEX was estimated based upon 20-years, 8% discount rate and project CAPEX

The assessment is also helpful to benchmark the CapEx figures presented in this Cost Adjustment Claim (SRN21 – Advanced Digestion) and Draft Determination response (SRN-DDR-016). The Lower and Upper range presented in Table B above suggest an AAD unit cost of between 2.08 and 3.32 £k/TDS. The project cost within our Cost Adjustment Claim (£107.6m for capacity of 46,100 TDS pa) fits well within this range at 2.33 £k/TDS pa which demonstrates our proposal has been costed efficiently.

As mentioned in Section 2 above, by converting our operation to AAD, we also expect farmers acceptance for our treated biosolids to increase. This could have a significant beneficial impact on land availability for Biosolids, as demonstrated in Scenario 19 in Table A (Section 1). Whilst we do not expect to reach levels of acceptance comparable to the one tested in Scenario 19, the combined benefit of producing a more widely accepted product containing reduced levels of Nitrogen will reduce the impact of the landbank challenge locally and the associated level of solutions needed.

The assessment does not currently include a scenario where a combination of solutions are implemented. AAD for instance could be integrated with enhanced dewatering and/or thermal drying technology to minimise the amount of Nitrogen available in the biosolids applied to agricultural land, as suggested in the conclusions of the report. Our business plan focuses on AAD as a no-regrets strategy because it is well-established, minimising risk, while delivering value to our customers. However, if this uncertainty mechanism is realised, a combination of other technologies (e.g., drying, advanced dewatering, ATC) would be considered - as bolted on technologies post-AAD - to enhance the overall mitigation of landbank risks.

Short-term solutions developed as part of the Uncertain Mechanism

In May-24, an assessment was commissioned by the industry (Atkins' National Plan B – Appendix 9-E) to understand the availability of specific outlets (Plan B) for the biosolids produced across the UK should Farming Rules for Water be fully implemented. These options are:

- Landfilling at non-hazardous landfill sites,
- Land restoration (e.g., of historic open-cast coal mines),
- Co-combustion with other waste feedstocks at existing Energy from Waste (EfW) plants, and
- Co-combustion at existing cement kilns.

These options are expected to be used in the short-term, in parallel of the development of more sustainable and future-proof solutions (e.g., ATC or new build incineration plants).

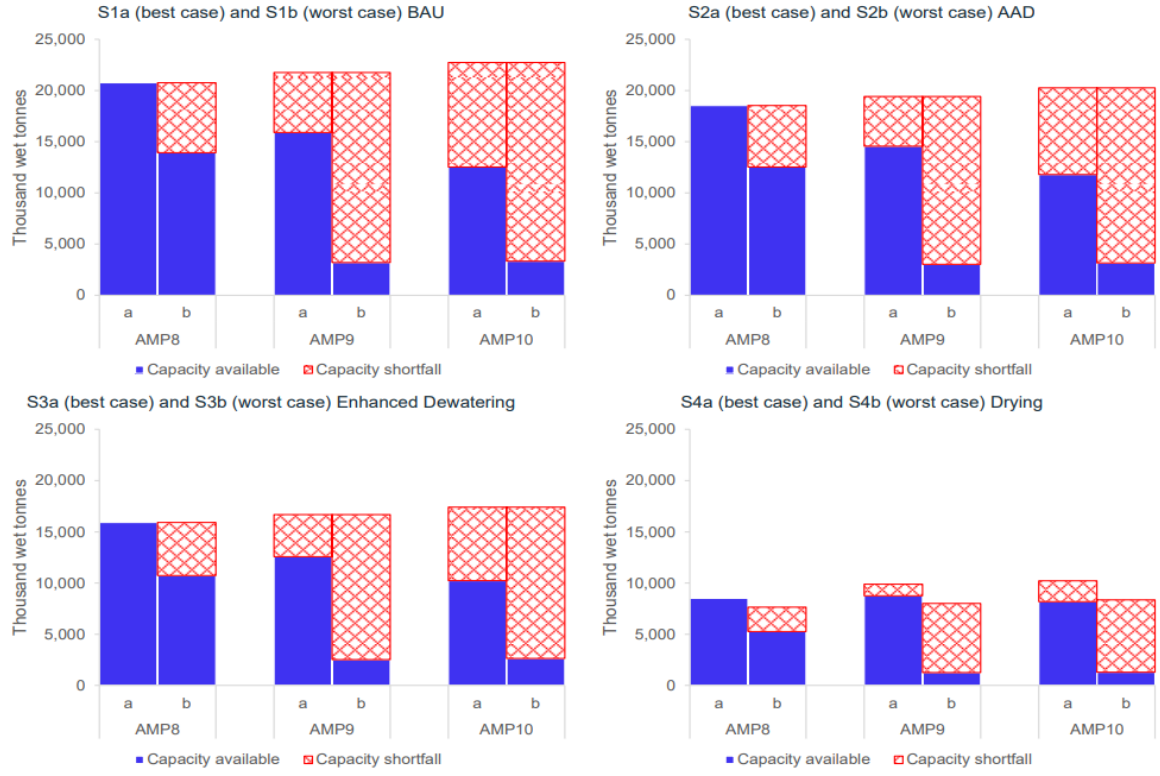
The assessment was also cross compared against different scenarios developed in Atkins' Dry Solids Scenario Assessment discussed above:

- S1 – Baseline
- S2 - Implementation of AAD
- S3 - Implementation of enhanced dewatering
- S4 - Implementation of thermal drying

At first glance, the results summarised in Figure A show that regardless of the additional process solutions developed and implemented by the industry, the capacity of the short-term outlets available in the UK is going to run out in AMP9 (best-case scenario) or AMP8 (worst-case scenario), depending on how stringent a ban on landbank use is implemented and other factors driving management of landfill and combustion sites.

The best option appears to be the use of thermal drying technology. Although a capacity shortfall is still an issue in this scenario, the volume of biosolids needing alternative solution is much smaller than it is for the other scenarios.

Figure A: Cumulative available capacity (any outlet) and capacity shortfalls at national level by AMP for best (a) and worst-case (b) scenarios (Atkins' National Plan B May-24)



In our case, thermal drying technology could be bolted on to our AAD plants at later stage. Thermal drying is also likely to be included into the flowsheet for ATC, the second stage of the implementation of our long-term strategy.

4. Southern Water's support of industry uncertainty mechanism for bioresources

Whilst Southern Water recognises and supports the proposal for a common uncertainty mechanism related to the landbank uncertainty across the industry (Appendix A), we perceive the main risks to be related to:

- The full implementation of the Farming Rules for Water (FRfW), specifically the uncertainty surrounding the potential revision of DEFRA's statutory guidance currently preventing the Environment Agency (EA) from enforcing FRfW (point number 1 in Section 1 above) and especially if no compromises can be agreed between the EA and the industry (e.g. industry's proposed BAS 20 Measures).
- The EA sludge strategy (publication date unknown) is also perceived as being a significant risk. Whilst its publication is still unknown, the transition for biosolids from the Sludge (Use in Agriculture) Regulations (SUiAR) to the Environmental Permitting Regulations (EPR) will provide the EA with enhanced controls that would allow it to enforce its interpretation of nitrogen and phosphorus management directly on Water Companies (rather than on farmers, as it would be with FRfW) – as described in point number 2 in Section 1 above. Furthermore, moving to an EPR regime could reduce the base of farmers willing to take the product, due to the added complexity.

Industry conversations with the regulators about both of these also give the perception that the impact of either of these would be immediate, with very little room for an intermediate point or transition phase. Better clarity on the regulators long-term strategy would allow the industry to plan for more sustainable solutions. We are also supportive of the non-exhaustive list of triggers presented by the industry as per Appendix 9-B. On the point related to farmers acceptance, the evidence presented in our documents shows we are already experiencing this issue with the farmers receiving our sludge (Section 5.2.1 this SRN-DDR-016 Bioresources AAD CAC and Section 1.2 and Appendix 2 of SRN21, October 2023 submission). We believe the impact could be reduced through the implementation of our AMP8 plans.

5. Conclusions

- Challenges surrounding our access to local landbank is already an issue at times because of the location of our operation, the nature of the soil in our area and the quality of our product given advancements in treatment technology
- These issues will be exacerbated much further if significant change in current practices arise, driven for example by regulatory changes (e.g. FRfW and EA's Sludge Strategy).
- Nationally, these changes would push the industry to need to find alternative and expensive solutions and outlets for the biosolids produced.
- An uncertainty mechanism is required to enable implementation of suitable solutions. A common uncertainty mechanism has been put forward by the industry.
- Our AMP8 plans provide for a step-change in the direction towards further technological solutions, will partially reduce the impact of the current landbank issues but will not suffice to fully mitigate the risk posed by national landbank shortage.
- Our AMP8 plans are "no-regret" solutions, meaning they fully align with solutions being developed as part of our long-term strategy but also with examples of solutions which will likely be deployed, should this Notified Item be triggered.

- Southern Water supports the common industry proposal, especially in relation to the FRfW and EA's National Strategy risks.

- We disagree with Ofwat's wording used to qualify the trigger point for this Notified Item to be used as it solely focuses on legal (i.e., statutory and directly enforceable regulatory) changes "in relation to the application to agricultural land of fertiliser derived from sludge" and does not account for other potential triggers (please see Appendix 9-B).

- Given the significant hurdle that the interim determination mechanism threshold represents, we are proposing that only the Bioresources price control revenue should be the base revenue to be tested against.

Appendix 9-A: Industry bioresources uncertainty proposal A PR24 notified item for bioresources uncertainty in AMP8

Summary

The risk to biosolids disposal at AMP8 is a risk that has been identified by all companies in the sector and in their business plans most companies sought some form of regulatory certainty to address the ambiguity they are facing at AMP8.

The predicted loss of landbank demonstrated by National Landbank modelling project undertaken by ADAS and Grieve Strategic indicates a national shortfall for available land bank. Given that companies will use whatever land is available (and not just the land within their service area), the impact on companies will not be individualistic – it will be highly co-dependent. The precise investment needs will depend on the extent of the landbank restrictions and how any response can best be co-ordinated across the industry. Therefore, it is important that the uncertainty is recognised by Ofwat and that a co-ordinated approach is adopted to ensure that investment requirements across the sector are both sufficient and efficient – i.e. there is enough investment to manage the risk but avoiding inefficient duplication of investment needs between companies. The IDoK process is best placed to allow consideration of the specific investment needs identified at the most appropriate time and Ofwat should make changes in landbank a Notified Item. We propose also that the materiality threshold should be amended to reflect the changes in water regulation which have occurred since the IDoK regulations were drafted in 1989.

In the event of a significant change in landbank availability or requirement triggering the need for an IDoK the landbank modelling carried out by ADAS & Grieve Strategic would need to be updated, to identify the proportion of national biosolids production which would need to be recycled via an alternative route.

Proposed Notified Item at final determination
The additional costs for the disposal of sludge arising from a change in the availability of land bank (due to either/both a reduction in available land bank, or an increase in the required landbank).

Section 1: Context

In the PR24 final methodology, Ofwat recognised that an Uncertainty Mechanism (UM) could form part of an efficient package of risk and return in the case that costs are uncertain at the time of the final determination and therefore have not been allowed for in the final determination. This note describes the uncertainty the industry is facing nationally regarding biosolids disposal to land during AMP8 and the Notified Item we are proposing for PR24.

The uncertainty facing the sector is because of both the timing and nature of the expected change which could require significant levels of investment and a coordinated industry response. This uncertainty is unlikely to be clarified prior to the PR24 final determination. It is also unclear which (if any) of the numerous potential triggers (described below) will be activated between now and 2030 and what the compounding effects of potentially multiple changes could be. These factors point to the importance of a more flexible regulatory regime during AMP8.

The uncertainty facing the sector

The bioresources sector is currently faced with significant uncertainty regarding biosolids recycling to agricultural land during AMP8. There are a number of drivers for this uncertainty and we have listed some of these below. These include potential legislative changes and possible shifting public perceptions which, for example, may impact farmer acceptance of biosolids on their land. It is important to note that the following is not an exhaustive list and it is likely to evolve as more information is known:

1) Farming Rules for Water (FRfW): Within the current guidelines, there is uncertainty regarding the long-term impact of FRfW on the spreading of treated sewage sludge on farmland, due to DEFRA's statutory guidance curtailing EA enforcement. A Post Implementation Review of FRfW is expected in late 2024 and the DEFRA statutory guidance for FRfW, which (effectively) allows autumn spreading to continue, is due to be reviewed by September 2025. The outcome and exact timing of these reviews cannot be known at present and could be subject to delays. However, these reviews could be the trigger for a significant change to the agricultural outlet for biosolids recycling early in AMP8, resulting in lower land bank availability (see discussion below).

2) EA sludge strategy: The industry has been engaging with the EA on the development of the EA sludge strategy since 2020. This includes the EA's planned transition for biosolids from the Sludge (Use in Agriculture) Regulations (SUiAR) to the Environmental Permitting Regulations (EPR). The change from SUiAR to EPR provides the EA with enhanced controls that would allow it to enforce its interpretation of nitrogen and phosphorus management directly on Water Companies (rather than on farmers). This would lead to a significant reduction in landbank availability and place additional pressure on alternative disposal outlets, which already have limited capacity. The consultant AtkinsRealis is expected to provide water companies with further information in June 2024, substantiating the national limitations of alternative outlets and we will make this information available to Ofwat. The conclusion of the EA sludge strategy is not expected before the Final Determination and the published EA sludge strategy has recently been updated specifically to remove a date of implementation. Therefore, given the potential impact on companies' ability to recycle biosolids to agricultural land, there is a risk that companies will not have funding for additional requirements in the Final Determination to meet all the requirements of the EA sludge strategy.

3) Bioresources Water industry national environment programme (WINEP) for PR24: The EA's WINEP focus is on short-term resilience in the supply chain and not the impact of a loss of landbank as a disposal route for biosolids in the medium term. The priorities for the EA for the Bioresources WINEP therefore are current issues, such as fuel and HGV driver shortages. Whilst as an industry we welcome the sludge driver and the investment this will provide to improve short-term resilience into our storage strategy, the intended effect of the Bioresources WINEP for PR24 does not address the medium-term risks to Bioresources operations caused by a loss of agricultural land. The EA has currently ruled out endorsing industry proposals relating to landbank availability, except those specifically related to storage. It is important to recognise that this rejection by the EA is not a rejection of the potential investment need, but a rejection of its classification under that WINEP driver.

4) Change in public/farmer acceptance: There has been a huge increase in interest in biosolids recycling to land. This is particularly notable in the USA and has even resulted in bans on biosolids use in some counties and states. Although the situation is not currently so stark in the UK, there has been a significant increase in media articles and even a Judicial Review launched against the EA/Defra. Such interest has the potential to have an impact on public and farmer acceptance or even make biosolids recycling not viable with little or no warning.

Landbank availability and landbank requirement

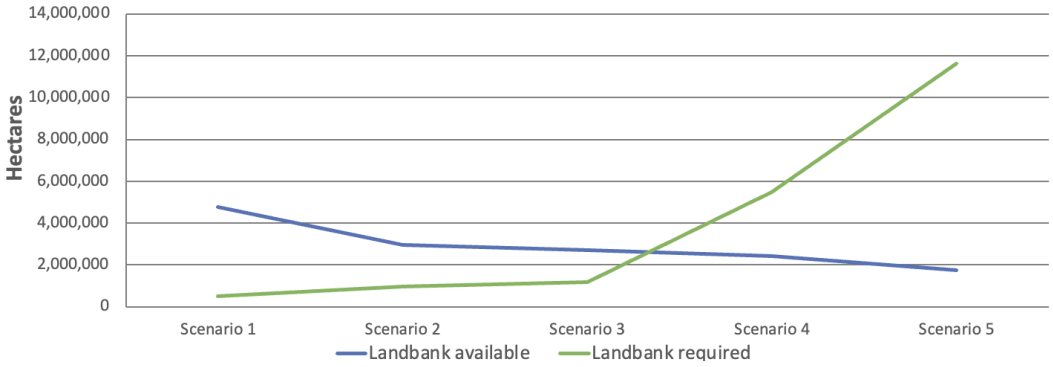
Whilst many of the restrictions above may be considered as primarily affecting the behaviour of farmers (the end users), this matters to water companies because the ability for end users to accept biosolids affects the ability of companies to discharge their obligation of safely utilising biosolids. The EA sludge strategy on the other hand has a direct impact on water companies.

Recycling biosolids to farmland is the principal outlet for the recycling of sewage sludge (circa 87% of biosolids are recycled to land), and there is no other available equivalent outlet. Therefore, if nothing else, a material change to the availability of land bank for recycling of biosolids would have a very significant impact on bioresources operations, likely requiring substantial investment in alternative treatment and disposal methods such as drying and incineration. The pre-emptive switch to these alternative methods would not be efficient given the high cost and resultant impact on customer bills.

Grieve Strategic analysed the impact of five different scenarios on the agricultural landbank. According to their report, the most likely scenario – scenario 4 - will result in a reduction of available land of around 20%

and an increase in land required by around 500% by the end of AMP9 compared to the baseline scenario. (Scenario 2 is the baseline scenario and reflects the situation as of today, scenario 1 reflects the situation at the beginning of AMP7). In other words, there would be insufficient land to recycle all the industry's biosolids.

Figure B – Land bank availability scenarios from the Grieve Strategic report



The graph above illustrates that the extent of the problem is greater than this because of the landbank requirement. Scenario 4 most closely models the phosphate restrictions which the EA has stated is their interpretation. These restrictions will increase the return frequencies to land and consequently dramatically increase the landbank required as well as reducing the available land, meaning there is insufficient agricultural land available for companies to recycle biosolids.

Furthermore, scenario 5 considers the impact of additional changes in perception, whereby landbank availability would be further impacted, down by 40% compared to the baseline scenario, and an increase in land required by around 1,000%, with the difference between landbank available and landbank required being even more pronounced than in scenario 4. Although scenario 5 is not currently considered most likely, the uncertainty and speed at which public/farmer perception could change would require an urgent industry-wide response, suggesting a flexible regulatory approach is essential.

The scale of the problem

The lack of clear and consistent planning assumptions on landbank availability and landbank required has resulted in inconsistent and varying company business plan submissions, prioritising no/low regrets investment and relying on an uncertainty mechanism, to a greater or lesser extent. The industry has not consistently planned for Scenario 4 "most likely", as that would require 66% of biosolids to be directed to an alternative outlet away from agriculture, and proposals to deliver that extent of change have not been included.

An industry shift to alternative routes of disposal for biosolids that may be required to commence in AMP8 to address the insufficiency in landbank is expected to cost several billions of pounds across the sector – both in short term mitigating actions, and long-term investment to move to the new model of sludge disposal that would be required. The cost to each company and the profile of investment required however, depends on:

- The amount of available landbank/landbank required – this depends on the extent to which legislation, regulations, interpretations of regulations or guidance over enforcement of regulation or public perceptions change, influencing the market for biosolids to agriculture.
- How much investment companies need to make to fulfil their obligations; and
- How investment should be distributed between companies - the projected landbank shortage is a national issue, and companies recycle to whatever land is available (not just the available land within the company boundary). Therefore, it seems likely to be more efficient to assess investment needs on a national basis. It may be more efficient for the industry collectively to build a smaller number of new treatment centres to service the needs of the whole sector rather than the current pattern of assets where each company is more or less self-sufficient in its treatment assets. In this scenario, some companies' additional costs could be capital ones whereas others would incur greater opex.

The current alternative routes to disposal include landfill, land restoration or sending sludge for third-party treatment and disposal. The latter, however, provides limited scope for disposal as all water companies are facing a similar challenge regarding land availability.

Companies are committed to delivering their biosolids strategies and aim to deliver a no regrets plan for AMP8. However, the uncertain nature of upcoming legislative, regulatory and public perception changes and the resultant cost impact makes it essential that a flexible regulatory approach for AMP8 is established.

New information that was not available for inclusions in October 2023 business plans

The industry has worked with the EA and held two technical meetings (Sept-Nov 2023) seeking to clarify and confirm the requirements of Farming Rules for Water for incorporation into the Biosolids Assurance Scheme. While progress was made on the majority of industry proposed improvements to biosolids recycling to agriculture, the key requirements for nutrient management (N and P) were not resolved.

The industry has commissioned additional national landbank modelling by Grieve Strategic to reflect the impact of key requirements for nutrient management (N and P) on landbank availability and landbank required, as discussed at the technical meetings. This activity was shared and discussed with the EA, Defra and Ofwat at a collaborative meeting on 12th April 2024. The output of this work was presented to Defra, the EA and Ofwat at Collaborative meetings 4 & 5 in June and July 2024. The work clearly illustrates the scale of the resulting landbank risk associated with the individual issues, with the EA's interpretation of FRfW being the most significant, reinforcing the essential need for an uncertainty mechanism.

Section 2: Interim Determinations (IDoKs) and Notified Items

Under licence condition B of companies' instrument of appointment, companies can request an interim determination for a **Relevant Change in Circumstance** or a **Notified Item** under the following conditions:

1) **Materiality**: the Net Present Value (NPV) of the decrease in revenue or, additional costs the company is expected to incur (5 years of capex, and 15 years of opex or revenue), resulting from some change, must be at least 10% of the appointed company's annual turnover in the year prior to the IDoK submission.
2) **Triviality**: where a number of costs have been combined, these individually must be 2% of the appointed company's turnover in the relevant service.

In view of the risks, we consider the agricultural outlet risk should be recognised as a **Notified Item**, as defined under condition B of our instrument of appointment, which would ensure that the consequences of any of the changes set out in section 1 would enable companies to request an IDoK reference (subject to materiality and triviality thresholds). As set out above, it is clear that it is the material increase in costs resulting from a loss in available landbank relative to the landbank required that is the trigger, not the specific route (legislative or otherwise) by which that occurs.

A change to the basis for calculating the materiality threshold

The IDoK provisions which remain in companies' licences were written in 1989. At this time each company's regulated business was regarded as a single entity. For example, price controls were expressed as a single company-wide K factor and there was very little differentiation of separate components of the water and wastewater value chains. The concept of wholesale and retail services was unheard of and there was very little consideration of the potential of competition to enable a reduction in the role of the regulator. Given this focus on the overall business, the definition of the IDoK materiality and triviality thresholds in terms of the appointed business turnover was logical and appropriate.

Since then, Ofwat has substantially changed the basis of company regulation. It now treats the business as six separate business units and sets separate price controls for each. The regulatory rules pertaining to each – for example, on the form of the price control, and the sharing of expenditure variances - are not the same. In some cases, most notably bioresources, Ofwat expects the business units to participate in their relevant

market, where possible, reducing the need for regulation. Appointees are not even obliged to continue trading in every business unit; most have left the non-household retail market.

All of these changes have reinforced the concept that appointees should manage each business unit according to its own particular regulatory circumstances rather than as mere components of a bigger entity. In view of this the 1989 IDoK provisions have long since ceased to be appropriate. If business units are to be managed in accordance with their particular circumstances, they should be treated as such when it comes to assessing the impact on their costs of major changes. Accordingly , we e propose that the materiality and triviality conditions (as set out above) should therefore be assessed at the level of the relevant price control rather than Appointee turnover.

The case for business unit level assessment of thresholds is particularly true of those business units, such as bioresources, where Ofwat expects companies to operate within wider markets. True exposure to contestable markets requires that all participants are able to adjust their prices in response to changes in their costs brought about by changes in their operating environment. A regulatory arrangement that prevents a participant from doing so condemns that participant to the risk of failure. In our view it cannot be reasonable for a water companies' bioresources revenues to be fixed at a level that were efficient in a previous market regime while its competitors adjust their revenues to deal with the costs of the new regime.

Our proposal, therefore, is that the basis for calculating the materiality threshold should be updated to match the regulatory developments since 1989. There is precedent for a change of this nature. At PR19 Ofwat introduced Condition U into the licences of five companies whose price settlements included provision for schemes to be built under Direct Procurement for Customers (DPC), which was another innovation brought into water regulation since 1989. Condition U provided for the scenario where projects needed to come out of DPC and back into in-house provision. The materiality threshold for the IDoKs enabled under this new condition differed from the standard threshold, being set at 2% of appointed business turnover.

In the same way that Ofwat developed the interim determination regime to deal with the innovation of DPC, we consider it must now do the same to match the other innovations it has introduced to water regulation.

We are proposing that the Bioresources price control revenue should be the based revenue to be tested against.

Section 3: Bioresources compliance costs Notified Item

The features of the Notified Item we propose are set out in the table below:

AMP8 Biosolids to Land Notified Item	
Mechanism type	Notified Item as an input into IDoK claim
Application Window	April – September 2025 April – September 2026 April – September 2027 April – September 2028 April – September 2029
Scope	The additional costs for the disposal of sludge arising from a change in the availability of landbank (due to either/both a reduction in available landbank, or an increase in the required landbank).
Materiality threshold	NPV of costs (5 years of capex and 15 years of opex / revenue) are > 10% of prior year Bioresources revenue.
Triviality Threshold	NPV of costs (5 years of capex and 15 years of opex / revenue) are > 2% of prior year Bioresources revenue.
Licence condition	Condition B (amended)

Appendix 9-B – Notified Item – Event Table

Background

Ofwat has stated the following in draft determinations:

"We are also proposing a notified item in all wastewater companies draft determinations in respect of potential increases to bioresources costs over the 2025-26 to 2029-30 period. This notified item applies to any increase in costs reasonably attributable to any new or changed legal requirements in relation to the application to agricultural land of fertiliser derived from sludge. This would allow price controls to be changed in-period through an interim determination if the impact on costs, alone or in combination with other eligible items, met the materiality threshold in licence condition B. We consider that a notified item is appropriate because spreading treated sewage sludge is the main outlet for bioresources operations, the impact of changes could be material and new or changed to legal requirements would not necessarily otherwise qualify for an interim determination because they might not apply directly to companies. In addition, we acknowledge that bioresources activities might be affected by the Environmental Permitting Regulations (EPR) replacing the Sludge (Use in Agriculture) Regulations (SUiAR). These requirements are due to be defined within the Environment Agency's Sludge Strategy and its implementation date is yet to be confirmed."

Companies welcome that Ofwat has recognised this risk and proposed a notified item.

The notified item should be drafted in such a way to manage the uncertainty around significant restrictions in the availability of the agricultural outlet for biosolids recycling, leading to significant levels of additional investment in bioresources assets and operations. There are concerns that the scope of Ofwat's proposed notified item fails to provide an effective uncertainty mechanism and needs updating in the final determination.

The eligibility requirement proposed by Ofwat maybe considered to be inappropriately restrictive. This is because it will only allow for any new or changed legal requirements in relation to the application to agricultural land of fertiliser derived from sludge. Even with the legal definition provided by Ofwat for this notified item, there are concerns over key events that may or may not be recognised by Ofwat as a legal change and therefore fall outside the scope of the notified item. It would be helpful for the scope to be reviewed and any ambiguity resolved in the final determination.

The following table provides a list of plausible events identified by WaSCs that may have an impact on the ability of the water industry to recycle biosolids to an agricultural outlet. The purpose of the table is to help support discussions related to the scope and wording of Ofwat's proposed notified item. This list is illustrative only, it is not intended to be exhaustive and nor can it be, as the risks may materialise through multiple other routes.

	Event Name	Description	Impact	Probability
	Leading indicators	**We consider that leading indicators should be used to identify an event or trigger has occurred, and to enable as much time as possible to prepare for a reduction in the available agricultural outlet for biosolids.**	-	-
1	Defra FRfW post implementation review	The output of this review is anticipated by the end of 2024. A Defra decision, confirmation, or change, in the management of nutrients or use of organic materials to agriculture could set different expectations for biosolids recycling than has been allowed for in the WINEP or in final determinations. This may or may not be set out through a legal change, but the outcome should be recognised as a trigger for the landbank notified item.	High	High

	Event Name	Description	Impact	Probability
2	Defra FRFW Statutory Guidance change (or expiration)	The output of a review of the Defra Statutory Guidance, which provides protection for water companies from the full ramifications of FRfW, is anticipated by September 2025. This guidance may be changed, rescinded or simply expire (which may or may not be judged to be a legal change). The loss of this guidance would lead to a significant change in the management of nutrients or use of organic materials to agriculture could set different expectations for biosolids recycling than has been allowed for in the WINEP or in final determinations. Given that this may or may not be judged to result from a legal change, the outcome should be recognised as a trigger for the landbank notified item.	High	High
3	EA Regulatory Position Statement	The EA may issue a Regulatory Position Statement with respect to the use of biosolids in agriculture. This regulatory tool is used to modify enforcement approach and is time limited. It may or may not be set out through a legal change, but the outcome should be recognised as a trigger for the landbank notified item.	High	Medium
4	EA changes in land spreading guidance impacting/relating to the biosolids supply chain to agriculture (England)	The EA may issue changes in land spreading guidance impacting biosolids recycled under EPR (now or in the future) to agriculture (England). This may or may not be set out through a legal change, but the outcome should be recognised as a trigger for the landbank notified item.	Low	Low
5	National position statement relating to the biosolids supply chain to agriculture (Wales / Scotland)	The relevant regulatory authority may issue a Regulatory Position Statement with respect to the use of biosolids in agriculture. This regulatory tool is used to modify enforcement approach and is time limited. It may or may not be set out through a legal change, but the outcome should be recognised as a trigger for the landbank notified item. (Note: Impact scored as “medium” on the basis that land availability in just one of Wales or Scotland is less significant the loss of availability in England)	Medium	Medium
6	Policy statement by food chain actors relating to changes in requirements for the biosolids supply chain to agriculture (e.g. British Retail Consortium, supermarkets)	Food chain stakeholders have a significant influence over the market for biosolids product as in input into agriculture. This was evidenced in 2000-01 with a concern over pathogens in biosolids. This threatened the loss of the agricultural outlet and led to the introduction of the Safe Sludge Matrix and its “layers of protection” to restore stakeholder confidence. This risk would not be set out through a legal change, but the outcome should be recognised as a trigger for the landbank notified item.	High	Medium
7	Policy statement by Farming quality assurance organisations relating to changes in requirements for the biosolids supply chain to agriculture (e.g. Red Tractor Assurance, Quality Meat Scotland)	Farming quality assurance organisations are stakeholders that have a significant influence over the market for biosolids product as in input into agriculture. For example, Red Tractor membership includes c90% of agricultural land. Their policy currently mandates the use of Biosolids Assurance Scheme certified biosolids as the requirement for biosolids to be accepted as a farm input. The requirement could change and support for biosolids withdrawn, driven by scientific and/ or perceived risks leading to a significant fall in demand for biosolids product. This risk would not be set out through a legal change, but the outcome should be recognised as a trigger for the landbank notified item.	High	Medium
8	Outcome of a legal action eg a judicial review, (e.g. Fighting Dirty /River Action, other etc)	The outcome of a court case may or may not be considered a legal change. To avoid any doubt over whether changes in requirements brought about though judgements made in courts are considered a legal change for the purpose of the notified item, it would be appropriate to set out clearly in the notified item that any such outcome should be recognised as a trigger for the landbank notified item.	Don’t know	High
9	Welsh government review launched into the land spreading of organic materials including AAD digestate	The output of a review into the land spreading of organic materials including AAD digestate has been announced. A Welsh Government decision, confirmation, or change, in the management of nutrients or use of organic materials to agriculture could set different expectations for biosolids recycling than has been allowed for in final determinations. This may or may not be set out through a legal change but the outcome should be recognised as a trigger for the landbank notified item.	High	High

	Event Name	Description	Impact	Probability
10	Politian/political figure statement that creates doubt over the safe and sustainable use of biosolids to agriculture	There is a risk that a statement from a political or influencing role could have an unintentional negative consequence on the market demand for biosolids. In 1988 Edwina Curry (Health minister) provoked outrage by saying most of Britain's egg production is infected with the salmonella bacteria. These claims led to a 60 percent decline in egg sales over the next few weeks. A statement that creates doubt over the safe and sustainable use of biosolids to agriculture could generate a significant and long-lasting fall in demand for biosolids to agriculture. This risk would not be set out through a legal change, but the outcome should be recognised as a trigger for the landbank notified item.	High	Low
11	Change in guidance (e.g. AHDB's Nutrient Management Guide – RB209)	Changes to good practice guidance or nutrient management guidance (e.g. RB209) could change the requirements and further restrict the available agricultural outlet. This risk would not be set out through a legal change, but the outcome should be recognised as a trigger for the landbank notified item.	High	High
12	Farm product exclusion clauses by food user groups	The whisky distilling industry has a rotation exclusion clause in farmer supply contracts that stipulates that biosolids must not be applied within crop rotations including malting barley. This restriction is in the baseline as it already exists. Further restrictions from other end users could reduce the available remaining landbank. This risk would not be set out through a legal change, but the outcome should be recognised as a trigger for the landbank notified item.	Don't know	Don't know
13	Landowner and farmers decide not to accept biosolids	There are instances in other countries where community groups are putting pressure on individual farmers and landowners not to accept biosolids deliveries over fears of health risks and environmental harm. These are currently low in number and impact, but the prevalence of these events could escalate. Should the number of landowners or farmers rejecting biosolids increase significantly, this would lead to a significant fall in demand for biosolids. The cumulative decisions of landowners or farmers should be recognised as a non-legal trigger for the landbank notified item.	Don't know	Don't know
14	Legislation changes to adopt 'full' EPR requirements for Biosolids disposal as delivered by the EA sludge strategy	This seems likely to be implemented as a legal change and may be eligible for classification as a relevant change of circumstance (RCC). For the avoidance of doubt, it would be helpful to retain the reference to the EA sludge strategy as a trigger for the notified item.	High	Medium
15	Outcome based regulation	An outcomes-based approach to regulation is one which stipulates a final outcome but does not prescribe how the outcome is reached. This approach can enable changes and introduce new requirements to deliver the outcome which does not require new legislation. This risk may or may not be set out through a legal change, but the outcome should be recognised as a trigger for the landbank notified item.	High	High
16	Devolved Government objections	The movement of waste between devolved nations may be an issue that leads to pressure on companies not to send waste between nations. Given that this may or may not be judged to result from a legal change, the outcome should be recognised as a trigger for the landbank notified item.	Med	Med
17	Farm incentive and payment schemes	Farmers may be incentivised to change practices or land use based on economic incentives or payments. Such schemes may already exist, but incentive rates may be modified, to influence further the participation rate of farmers. Given that this may or may not be judged to result from a legal change, the outcome should be recognised as a trigger for the landbank notified item.	Med	Med

	Event Name	Description	Impact	Probability
	Lagging indicators	**We consider that lagging indicators could be used as a backstop indicator to evidence that an event or trigger has occurred, leading to an observable reduction in the available agricultural outlet for biosolids.**	-	-
18	Existing reported data on “disposal outlets”	Ofwat collects bioresources data from WASCs each year. There are specific reporting requirements for sludge outlets set out in Bio4 lines 18- 22. This information would show a change in the proportion of outlets used for biosolids, with a reduction in the agricultural outlet and an increase in other outlets such as restoration, landfill, Energy from Waste and incineration. The reporting will be for the previous year so this could act as a lagging indicator that a change in the agricultural outlet for biosolids has occurred. This could be used to set a threshold above base use of alternative outlets which if surpassed would be the trigger for the notified item. This risk would not be set out through a legal change, but the outcome could be recognised as a trigger for the landbank notified item.	Don't know	High
19	Actual haulage distance vs modelled haulage distance	Ofwat collects bioresources data from WASCs each year. There are specific reporting requirements for the transport of biosolids to outlets set out in Bio1 lines 26 -29. It may be possible to monitor the difference between the baseline haulage distances generated as an output of the landbank modelling and compare that to the actual haulage distances of WASCs. The reporting will be for the previous year so this could act as a lagging indicator that a change in the agricultural outlet for biosolids has occurred. This could be used to set a threshold above a base level which if surpassed would be the trigger for the notified item. This risk would not be set out through a legal change, but the outcome could be recognised as a trigger for the landbank notified item.	Don't know	High
20	Collate feedback from farm customers to identify any changes in sentiment towards the acceptance of biosolids as an input to farms.	WASCs could collect customer feedback from the farming customers they work with and allocate an area of agricultural land where the farmer or landowner has decided that they do not want any biosolids. Evidence would need to include the farmers reason and the area of land that has been excluded from receiving biosolids products. A methodology for data collection needs to be established to ensure consistency and a baseline is required to understand current sentiment, above which the change can be measured against. This risk would not be set out through a legal change, but the outcome could be recognised as a trigger for the landbank notified item.	Medium	High
	Landbank Modelling Trigger	**We consider that it is the change or loss of the available agricultural outlet for biosolids that is the trigger for investment and therefore should be the trigger for the Notified Item, irrespective of which of the legal or non-legal event or events lead to the change or loss of the available agricultural outlet for biosolids.**	-	-
21	Modelled Landbank Risk Ratio threshold	There could be many individual or multiple compounding events that lead to a loss in the agricultural outlet for biosolids that are not related to a legal change. The changes in requirements could be beyond the extent to which costs have been allowed for at the final determination. There is a risk that in seeking to identify each and every event, one or more could be overlooked and that omission lead incorrectly to a failure to recognise a change in the available agricultural outlet for biosolids. The universal approach that would take account of any changes in legal and non-legal requirements for biosolids use in agriculture would be to use a landbank model. The approach could use an agreed governance and methodology to establish and agree the baseline requirements that reflect the cost allowed for at final determination.	Universal assessment	Universal applicability

	Event Name	Description	Impact	Probability
		It could also set out an agreed threshold, which if passed regardless of the specific event or events would act as the trigger for the landbank notified item. It is the loss of the agricultural outlet for biosolids that is the trigger for increased scope and investment costs. The modelling activity would incorporate and evidence all the changes that have occurred and the inputs into the model. The governance and modelling process would involve EA/Defra and Ofwat as well as companies / water industry. A governance and process proposal and method to calculate the baseline and threshold for the trigger is set out in a separate document.		

Appendix 9-C – Updated National Landbank Modelling (Grieve Strategic - June-24)

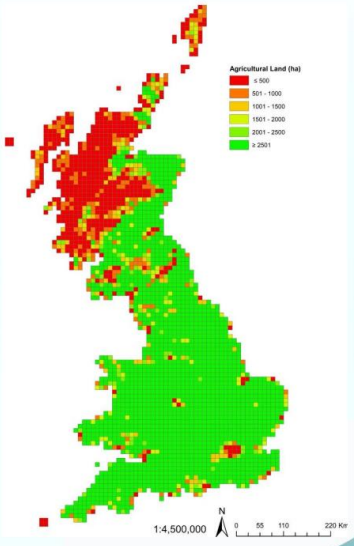
National Landbank Study – Draft Phase III results

To inform Draft Determination and regulatory/policy maker discussions

04/06/2024

Outline methodology

- Mapping and associated statistics showing change in available land between the scenarios (i.e. colour coded maps showing available land across GB)
- In addition to the restrictions posed by the different scenarios, the mapping includes:
  - Physical legislative restrictions
  - Livestock manures
  - Competing non-farm organic manures
- Landbank required calculated based on three STC locations per company using bespoke company data
- Radial rings merge within companies, but overlap between companies



Proposed scenarios

- All scenarios will use updated STC information (treatment process, biosolids quantity and biosolids quality) based on business plan submissions with previous Scenario 2 environmental restrictions (end AMP7 baseline)
- Previous scenarios considered multiple variables including assumptions around uncertain factors e.g. reduced farmer acceptance. This modelling exercise will "isolate" the key singular factor in each scenario to provide clarity and certainty over the impact of each specific change
- The different scenarios will then focus on the key factors identified previously and/or any new factors that have come to light after business plans were submitted, specifically:
  - Different approaches to N and P management
  - Rationalisation and changes in sludge treatment
  - Reduction in available land from land management policy (i.e. Sustainable Farming Incentive Sustainable Farming Scheme, Nutrient Neutrality and Biodiversity Net Gains)
  - Applying N&P approaches to all organic manures (not only biosolids)
  - Effect of different product forms (i.e. pellets and compost)
  - Effect of increased farmer acceptance (to demonstrate this is not a dominating factor)
- The details of the combinations that make up the 14 proposed scenarios are shown next

Revised landbank required figures (ha)

WaSC	S6 Updated STC	S7 EA N	S8 EA P	S9 EA N&P	S10 EA N&P All manures	S11 WI N	S12 WI P	S13 WI N&P	S14 WI N&P All manures
Anglian Water	169,600	414,500	530,800	635,100	635,100	185,000	184,100	200,400	200,400
DCWW	24,500	37,300	115,900	125,800	125,800	24,600	31,300	32,100	32,100
Northumbrian Water	13,400	42,700	54,100	78,300	78,300	13,500	16,600	17,200	17,200
Severn Trent Water	193,900	572,900	619,200	817,300	817,300	202,100	205,300	225,600	225,600
Scottish Water	68,100	109,400	188,200	203,800	203,800	68,300	70,600	72,500	72,500
Southern Water	59,000	136,500	197,300	240,200	240,200	69,100	64,900	77,400	77,400
South West Water	37,700	61,700	168,300	185,200	185,200	37,700	46,900	47,800	47,800
Thames Water	138,400	369,000	468,100	564,800	564,800	158,200	151,700	166,400	166,400
United Utilities	74,100	162,100	257,500	302,900	302,900	75,100	81,900	85,700	85,700
Wessex Water	69,200	144,300	261,600	302,000	302,00	80,700	76,300	85,200	85,200
Yorkshire Water	77,900	224,400	265,100	343,400	343,400	84,100	85,500	94,600	94,600
Total required	**925,800**	**2,274,800**	**3,126,200**	**3,799,000**	**3,799,000**	**998,400**	**1,015,000**	**1,104,900**	**1,104,900**
Landbank available	**2,958,000**	**2,958,000**	**2,958,000**	**2,958,000**	**1,340,500**	**2,958,000**	**2,958,000**	**2,958,000**	**2,158,700**

Revised landbank required figures (ha)

WaSC	S6 Updated STC	S15 Site rationalisation	S16 Reduction in available land	S9 EA N&P	S10 EA N&P All manures	S17 EA N&P All composted	S18 EA N&P All pellets	S19 EA N&P 100% farmer acceptance
Anglian Water	169,600	169,600	169,600	635,100	635,100	867,500	486,500	428,800
DCWW	24,500	24,500	24,500	125,800	125,800	327,000	113,900	76,400
Northumbrian Water	13,400	13,400	13,400	78,300	78,300	157,200	68,000	55,300
Severn Trent Water	193,900	140,800	193,900	817,300	817,300	1,199,700	662,500	580,400
Scottish Water	68,100	66,600	68,100	203,800	203,800	426,600	187,700	143,800
Southern Water	59,000	59,000	59,000	240,200	240,200	394,300	183,600	151,100
South West Water	37,700	37,800	37,700	185,200	185,200	359,300	132,500	79,000
Thames Water	138,400	138,400	138,400	564,800	564,800	1,161,700	548,200	435,500
United Utilities	74,100	66,900	74,100	302,900	302,900	691,200	293,800	209,300
Wessex Water	69,200	73,300	69,200	302,000	302,00	434,600	184,700	149,600
Yorkshire Water	77,900	77,900	77,900	343,400	343,400	533,500	277,300	235,200
Total required	**925,800**	**868,200**	**925,800**	**3,799,000**	**3,799,000**	**6,552,600**	**3,138,800**	**2,544,400**
Landbank available	**2,958,000**	**2,958,000**	**2,780,600**	**2,958,000**	**1,340,500**	**2,958,000**	**2,958,000**	**2,958,000**

Appendix 9-D – Dry Solids Scenario Assessment (AtkinsRealis - May-24)

TECHNICAL NOTE

Dry Solids Scenario Assessment

SUBJECT	PROJECT NO.	DATE
Dry Solids Scenario Assessment	5228752	3 July 2024

AUTHORS	DISTRIBUTION	REPRESENTING
[redacted]		Assured Biosolids Limited

Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	First Draft for Client	GP, BL	AS	SR	GS	26/04/2024
2.0	Draft incorporating comments	BL	AS	SR	GS	10/05/2024
3.0	Incorporating Scottish Water Data and further client comments	BL	AM	SR	GS	03/07/2024

Client signoff

Client	Assured Biosolids Limited (ABL)		
Project	Dry Solids Scenario Assessment	**Project No.**	5228752
Client signature / date	[redacted] 03/07/2024		

TECHNICAL NOTE

1. Overview

1.1 Scope & Drivers

This project aims to support Assured Biosolids Limited (ABL) and its member WaSCs (Water and Sewage Companies) in their ongoing discussions with the Department for the Environment, Food & Rural Affairs, the Environment Agency, Natural Resources Wales (NRW) and the Scottish Environmental Protection Agency regarding options to reduce the diffuse pollution potential of biosolids applied to land. The outputs are required to assist WaSCs in any response to the PR24 draft determination from Ofwat in July 2024.

The scope of this project is to explore high-level options to "go beyond" the standards within the existing agreed 'twenty measures' in relation to the Farming Rules for Water (FRfW). The project will focus on viable technical interventions for biosolids processing that could reduce biosolids generation (dry tonnes and wet tonnes) and available nitrogen content. These are key determinants in the diffuse pollution potential of biosolids applied to land. It should be noted and acknowledged that total phosphorus (P) will remain a constant regardless of the treatment, dewatering or drying process interventions, the scope of the project also does not address microplastic or chemical contaminants. The total expenditure (TOTEX) and carbon impact of different solutions has been evaluated to support strategic decision making. Assessment of other operational interventions for the storage and land application is not included in this work and will be covered by other projects. These outputs will feed into the conclusions for a wider package of work conducted in this area.

1.2 Methodology

The project commenced with a review of 2022/2023 published Bioresources Market Information (BMI) data for WaSCs in England and Wales to establish the baseline position. The main body of this report refers to England and Wales only. Site data was provided by Scottish Water separately, and so a further analysis which aggregates outcomes for England, Wales and Scotland has been provided in **Appendix D.**

The methodology included a review of current performance for each treatment type which include Advanced Anaerobic Digestion (AAD), conventional AD and lime stabilisation. Based on this data set and AtkinsRéalis technical knowledge and assumptions (see **Appendix A**), the following scenarios were explored:

Scenario A: Targeted interventions to stabilise dewatering performance for sites which identified as underperforming (e.g., operational optimisation, replacement dewatering assets, complete overhaul of sludge treatment process).

Scenario B: Upgrade to AAD at conventional AD and lime stabilisation sites to reduce total wet and dry solids for recycling (employing conventional dewatering processes).

Scenario C: Upgrade to enhanced dewatering (e.g., Bucher Press technology or equivalent) at AAD, conventional AD and lime stabilisation sites to increase final output up to 35%DS.

Scenario D: Upgrade to thermal drying at AAD, conventional AD and lime stabilisation sites to increase final output up to 85% dry solids.

For each scenario, AtkinsRéalis identified qualifying sites based upon broad thresholds for minimum sludge throughput. These thresholds were due to practical engineering limitations and economic viability and informed

TECHNICAL NOTE

4. Scenario Comparison & Summary

The impact of each scenario on the generation of biosolids and its readily available nitrogen content across England and Wales is outlined in **Figure 4** below. This is accompanied by an evaluation of 20-year TOTEX for the deployment of each scenario to support strategic-level comparison (**Figure 5**). A tabulated outcome summary is also available in **Appendix C**.

The full assessment including the data provided for sites in Scotland is included in **Appendix D.** Our brief for the project was primarily to support in discussions in relation to the PR24 process for sites in England and Wales, for clarity we have structured the main body of the report to focus on the England and Wales data. **Appendix D** provides the full UK position which shows there is no significant difference in the option comparison and summary findings when viewed at a national level.

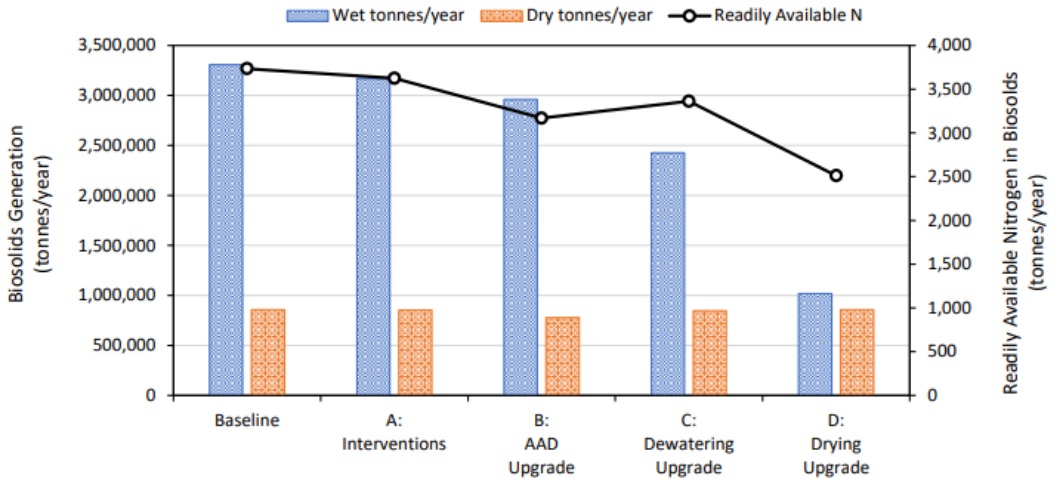


Figure 1 – Impact Summary for Scenario A-D

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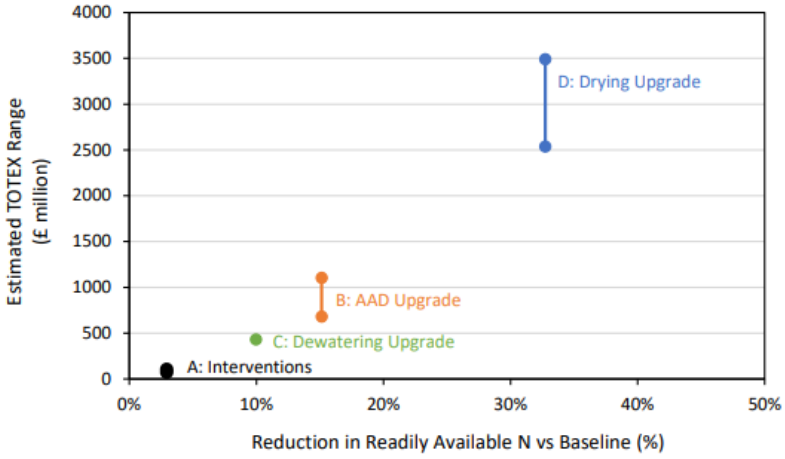

Figure 2 – TOTEX Estimation for Scenario A-D

Based on this evaluation, the following insights can be drawn out:

- Addressing the underperforming sites (Scenario A) can result in a 4% reduction in the total volume of material and a 3% reduction in RAN of products applied to agriculture. Whilst a limited impact it does demonstrate there are benefits to optimisation and making improvements to the existing asset base. The interventions to realise these calculated benefits will be site specific and an individual site assessment to determine the appropriate action.

- Upgrading remaining sludge treatment (Scenario B) to advanced anaerobic digestion (AAD) has a significant impact, reducing volume of material applied to land by 11% and a 15% reduction in RAN. There are also additional benefits as the additional conversion of organic matter through the AAD process increased production of biogas that can be used to produce renewable energy such as electricity through CHP (15GWh) or biomethane for grid injection (39GWh).

- Improving dewatering by deployment of enhanced dewatering technology (Scenario C) provides a significant reduction in volume of material applied to land, 27% compared to the base position, however the reduction in RAN is less significant compared with scenario B.

- Drying of the biosolids cake offers the biggest volume and RAN reductions, a 69% reduction in material volume applied to agriculture and a 32% reduction in RAN when compared to the base case. However, there are significant capital and operational costs involved in delivery of a drying strategy at a £2.5-3.5Bn if applied across the entire existing asset base. There are also added complexities to consider with a thermal drying strategy in terms of integration with the existing assets, this is a contributing factor in the wide range of TOTEX. For example, site and company specific complexities need to be considered to determine the most appropriate method for providing heat for the drying process, this is particularly the case for existing sites with AD or AAD that use biogas to fuel CHP or upgrade to biomethane.

Importantly, this project has focussed on high level opportunities for the deployment of each scenario independently, building from the base, i.e. Base to A, Base to B, Base to C and Base to D.

Scenarios B, C and D all offer positive benefits in reducing RAN. To illustrate this If we assume that nitrogen is the limiting factor for land application then these scenarios could result in an increase in application rates of between 1.98% and 4.26% which would contribute to a small reduction in land requirement for the application of the treated biosolids products.

TECHNICAL NOTE

5. Conclusion

In conclusion, it is ultimately likely, a blend of solutions will be the most effective strategy to deliver the greatest environmental benefit.

Optimisation options as set out in scenario A should be considered, its likely most sites will benefit from an optimisation programme that would lead to a small improvement in dry solids.

A strategy where WaSCs continue to move sites from lime stabilisation or AD to AAD is highly beneficial as this reduces the total tonnes dry solids of biosolids product and through improved digestion performance reduces the RAN in the product. Scenario B is also a least regrets pathway as it acts as an enable for bolt on additional processes such as drying or other alternatives such as advanced thermal conversion if an alternative to agricultural land application for all or some of the biosolids was required in the future.

It should be recognised that AAD is better suited to larger centralised STC's as the technology is not considered to be available or economically viable at the smaller sites. A detailed assessment of bioresources networks would be required to develop a plan for centralised facilities and satellite dewatering facilities, the viability and optimisation of this type of plan will be heavily influenced by local factors such as transport logistics, permitting and planning.

A combined strategy of optimising existing sites whilst replacing smaller facilities with centralised AAD sites and employing enhanced dewatering systems may present a cost-effective solution to generate a smaller quantity of enhanced biosolids with lower available nitrogen. Pursuing synergistic and site-specific solutions may therefore provide the greatest benefit at the lowest cost, and support ABL and member WaSCs to reduce the diffuse pollution whilst maximising the positive environmental impacts of spreading biosolids to land.

Thermal drying whilst providing potential significant environmental benefit in terms of material volume reduction and RAN this needs to be balanced against the very high TOTEX cost and operational carbon impacts for heating the drying processes.

Appendix 9-E – National Plan B - A Review of the Resilience of Biosolids Outlets (AtkinsRealis - May-24)

1. EXECUTIVE SUMMARY

The aim of this project is to obtain a high-level understanding of the capacities of identified alternative biosolids outlets at the regional and national level through modelling the sector's biosolids production, destinations, and projection across several possible future scenarios. The alternative outlets considered were:

- Landfilling at non-hazardous landfill sites;
- Land restoration (e.g., of historic open-cast coal mines);
- Co-combustion with other waste feedstocks at existing Energy from Waste (EfW) plants; and
- Co-combustion at existing cement kilns.

Four scenarios characterising possible Water and Sewerage Company (WaSC) interventions around biosolids treatment were developed (in alignment with other concurrent work on biosolids % dry solids (DS):

- S1 – Business as Usual (BAU): Assumes biosolids production via current treatments and % DS, as per the most recent data available (England and Wales – 2022/23, PR24 data tables; Scotland 2022 WICS E Tables) [1].
- S2 – Advanced Anaerobic Digestion (AAD): Assumes all biosolids currently produced through treatment via conventional AD or liming will be produced via AAD treatment. This will reduce biosolids volumes compared to BAU through greater volatile solids reduction and improved % DS.
- S3 – Enhanced Dewatering: Assumes BAU in terms of treatment type producing biosolids but also assumes significantly improved dewatering to produce cake at 35% DS (e.g., by using a Bucher press, or similar).
- S4 – Drying: Assumes BAU in terms of treatment type producing biosolids but also assumes biosolids will be subsequently thermally dried to produce dried granules or pellets at 85% DS.

To manage future uncertainty, projections of these scenarios were broken down into best-case (a) and worst-case sub-scenarios (b) (Figure *1-1*). The available capacity of biosolids outlets for best and worst-cases are defined in Table 5-1)

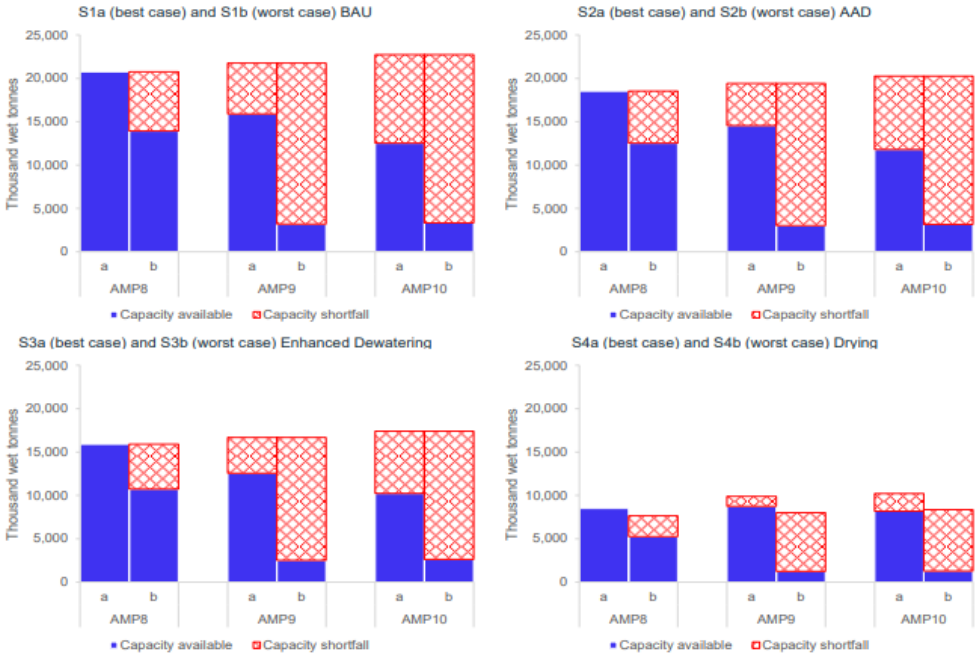

Figure 1-1: Cumulative available capacity (any outlet) and capacity shortfalls at the national level by AMP for best (a) and worst-case scenarios (b)

Upon constraint of the agricultural landbank, landfill is expected to become a primary alternative biosolids outlet (assuming not more combustion capacity can be developed). As a result, modelled capacity shortfalls are principally linked to the closure of that landfill capacity. In the best-case this is expected to occur in 2032. This is based on our interviews with UK landfill operators, which indicated that only a fraction of the remaining landfill void capacity is likely to be developed into cells for acceptance of waste. One interviewee estimated that only c.60% of their remaining capacity would be used. Using this as a best-case assumption, and at the current rate of landfill capacity consumption, we modelled closure of the last of the UK's landfill capacity by 2032.

In the worst-case, a proposed ban on the landfilling of biodegradable waste will come into effect in England, effectively closing-off landfill capacity to biosolids, from 2028.

In the best-case, a shortfall in the capacity of biosolids outlets develops from AMP9 for all scenarios. However, in the worst-cases this shortfall begins to develop in AMP8 and comprises a significantly greater volume of biosolids (up to c.85%). Our analysis suggests that no Water and Sewage Company (WaSC) intervention in any scenario will likely be able to fully mitigate this shortfall, although they will reduce the absolute biosolids volume impacted by the shortfall. This pattern was shared at the national level and all regional levels.

We recommend the following **next steps** are undertaken by UK WaSCs either individually or collectively, as applicable:

1. As a priority, the water sector should engage the Environment Agency and any other relevant stakeholders on the subject of proposed banning of biodegradable materials from landfill in England (noting that the formal consultation period closed on the 14th of July 2023). In particular, the sector must gain an understanding of the technical thresholds for the definition of biodegradability and whether digested and advanced digested biosolids are likely to be exempt from the ban or would be included.

2. WaSCs should use this high-level analysis as a starting point to further support their collective and individual rationales for conditional investments submitted as part of PR24 proposals to Ofwat, noting that Ofwat will now submit their draft determinations to WaSCs on July 11th 2024. Further work should include the development of methodologies to allow WaSCs to agree defined trigger points that when met will initiate conditional investments necessary to attempt to head-off the eventualities depicted in this report.

3. This analysis provides a high-level best and worst-case picture at the national level but does not provide sufficient resolution of detail to guide individual WaSC strategies to cover-off the risk depicted in the scenarios. WaSCs will need to develop individual strategies to manage the shortfall in capacity for biosolids characterised in this work. This must include impacts from competition for capacity (biosolids from other WaSCs but also other wastes) and costs associated with the implementation of mitigation methods.

SR