Advanced Anaerobic Digestion at Ashford and Ham Hill

Cost Adjustment Claim

09/06/2023

June 2023

from Southern Water

Glossary

Abbreviation	
AD	Anaerobic Digestion
AAD	Advanced Anaerobic Digestion
AMP	Asset Management Plan
ATC	Advanced Thermal Conversion
BAS	Biosolids Assurance Scheme
BAT	Best Available Technique
CHP	Combined Heat and Power plant
DPC	Direct Procurement for Customers
EA	Environment Agency
EPR	Environmental Permitting Regulations
FRfW	Farming Rules for Water
IoW	Isle of Wight
SE	South-East
STC	Sludge Treatment Centre
TDS	Tons of Dry Solids
WaSCs	Water and Sewerage Companies

Executive Summary

This document provides details of the cost adjustment claim for advanced anaerobic digestion (AAD) at two of our sludge treatment centres (STC), Ashford and Ham Hill. Given our current total reliance on agricultural land for recycling of the final biosolids output, our bioresources operation is at risk to any restriction of this outlet. The conversion to AAD at these sites provides:

- Greater resilience of the supply chain to agriculture as the product is of greater demand and utilisation by our farming customers. AAD Biosolids can be used for a wider range of crop applications (safe sludge matrix) and are drier (compliance with 20% DS threshold in BAS standards)
- Reduces the overall dry mass (~18.5% reduction) and volume (~32% reduction) of biosolids produced compared to conventional treatment thus lowering the quantity of material requiring access to agricultural land.

Table 1: Summary table

Name of claim	Advanced anaerobic digestion at Ashford and Ham Hill
Business Plan Tables where botex claim is reported	CWW18
Price control the claim relates to	Bioresources
Total gross value of claim for AMP8	£125.6m
Total implicit value of claim for AMP8	£2.3m
Total net value of claim for AMP8	£123.3m
Materiality for relevant price controls	£18m
DPC?	No, but see text in section 2

What is the claim for?

Investment is required to convert Ashford and Ham Hill STCs in Kent from Conventional Anaerobic Digestion (CAD) to Advanced Anaerobic Digestion (AAD), including improved dewatering of digested sludge to increase the supply chain resilience of biosolids recycling by:

- Increasing farmer acceptance of product by an expected 50% (Appendix 1 - National Landbank Study Clarification on scenarios and modelling (*ADAS & Grieve Strategic - 2022*)-a)
- Ensuring compliance with BAS pathogen (currently not achievable without secondary remediation) and updated BAS dried solids standards.
- Increased product dryness (better stackability in fields resulting in reduced slumping, smaller field footprints and reduced risk of run-off to surface water).
- Enhanced pathogen destruction allowing farmers to apply enhanced product (safe sludge matrix) to a wider range of land (e.g. grassland - one-third of agricultural land in the South-East of England[1])
- Reduced odour

In addition, the tightening of spreading windows and stricter criteria of applications (i.e. Farming Rules for Water[2]) will reduce the amount of agricultural land (landbank) available to recycle our Biosolids.

Beneficial use of the additional biogas produced (Combined Heat & Power) also supports our customers view that we should be recovering and producing more renewable energy and reducing our carbon footprint.

Ofwat uses benchmarking models to determine the efficient bioresources base cost allowances. According to Ofwat's April 2023 cost model consultation[3], such models rely on the relationship between historical costs (for operating and maintaining existing assets plus enhancement expenditure to accommodate sludge growth) from 2011-12 to 2021-22 and exogenous cost drivers. The econometric models provide insufficient allowance to accommodate the lumpy investment needed to change the technology from CAD to AAD for two reasons. Because the econometric models cover only 11 years of historical data, they do not include long-run capital maintenance costs longer than the asset life of CAD assets, they provide insufficient allowance to fund the type of lumpy investment that Southern Water needs at this point in time to change the technology from CAD to AAD. This is compounded by the fact that the econometric models do not include enhancement expenditure to accommodate sludge quality improvement, such as transitioning from CAD to AAD, that other companies have incurred in the past meaning that the modelled allowances do not reflect such historical lumpy costs.

Without a resilient landbank, Southern Water may be unable to beneficially recycle biosolids to agricultural land instead relying on landfill or incineration in the short term. This outcome does not align with the UKs net-zero carbon commitments nor Southern Waters environmental aims. Our view is that delivery of AAD in this area will help mitigate landbank risks and that this warrants a separate cost adjustment to accommodate Southern Water's specific circumstances (outlined in Section 2). We also recognise the transition to AAD and the drier product it produces is part of the adaptive pathway leading to the development of advanced thermal conversion technologies which could be utilised if biosolids recycling became unviable in the future.

Table 2: Summary evidence table

Test	Brief summary of evidence to support claim
Need for cost adjustment	Atypical investment is required to upgrade the technology of our digestion facilities from AD to AAD in order to satisfy future capacity and quality requirements for the disposal of our bioresources. Because the econometric models cover only 11 years of historical data, they do not include long-run capital maintenance costs longer than the asset life of AD assets and hence they do not fund lumpy investment that Southern Water needs at this point in time to change the technology from CAD to AAD. This is compounded by the fact that the econometric models do not include enhancement expenditure to accommodate sludge quality improvement, such as transitioning from CAD to AAD, that other companies have incurred in the past meaning that such historical lumpy costs are not reflected into the in the modelled allowances.
Uniqueness	We have the largest proportion of conventional digestion in the industry and our treated sludge is mostly limited to applications on cereal crops and to a lesser extent oil-seed rape (due to current regulatory requirements). This limits the farms that we can recycle to. Biosolids are recycled to agricultural land, however the South-East of England has the lowest farmed area and the second lowest area of cereals (biosolids typical outlet) when adjusted for population. Advanced Anaerobic Digestion demonstrates Best Available Technique (BAT)[4] for sludge treatment and can mitigate landbank pressure, however, we currently have the lowest adoption of AAD in the industry.
Management Control	This investment has been driven by an increasing number of factors outside of management control including the threat of resilience on the supply chain through the Farming Rules for Water (FRfW)[2] requirements, the Environment Agency's (EA) Policy Paper 'Strategy for safe and sustainable sludge use'[5] and adherence to BAT requirements for biological treatment of waste. In addition, we have a relatively low proportion of farmed area, wheat area and cereal area when adjusted for population[6].
Materiality	The claim is material at £123.3m of the forecast AMP8 Bioresources business plan totex, compared to the Ofwat materiality threshold of 6% of totex (£18m).
Adjustment to allowances	This is additional expenditure required from an atypical investment that the bioresources econometric models do not account for. We've calculated implicit allowance to be £2.3m
Cost Efficient	We have benchmarked our scope and construction costs for the two sites and have addressed the discrepancies where required. These included removal of Growth element (included in the totex allowance) and adjustment of design/costing of a specific asset (THP).
Need for Investment	The threat to resilience of the supply chain through the FRfW requirements in terms of nutrient management and the EA's Strategy for safe and sustainable sludge use.
Best option for customers	The optioneering has demonstrated that AAD is the best options available and are supported by customers.
Customer Protection	We have set out a price control deliverable to ensure customers are protected if we do not deliver.

1. Need for Adjustment

1.1. Why is Southern Water Unique?

The South-East (SE) of England is the most populous region of the UK with a population over 18 million. Significant quantities of biosolids are produced treating the wastewater produced in the SE and are typically recycled to cereal crops, particularly wheat. Adjusted for population, the SE has the smallest farmed area and the second lowest area of farmed cereals and wheat among English regions[6] as demonstrated in Figure 1.

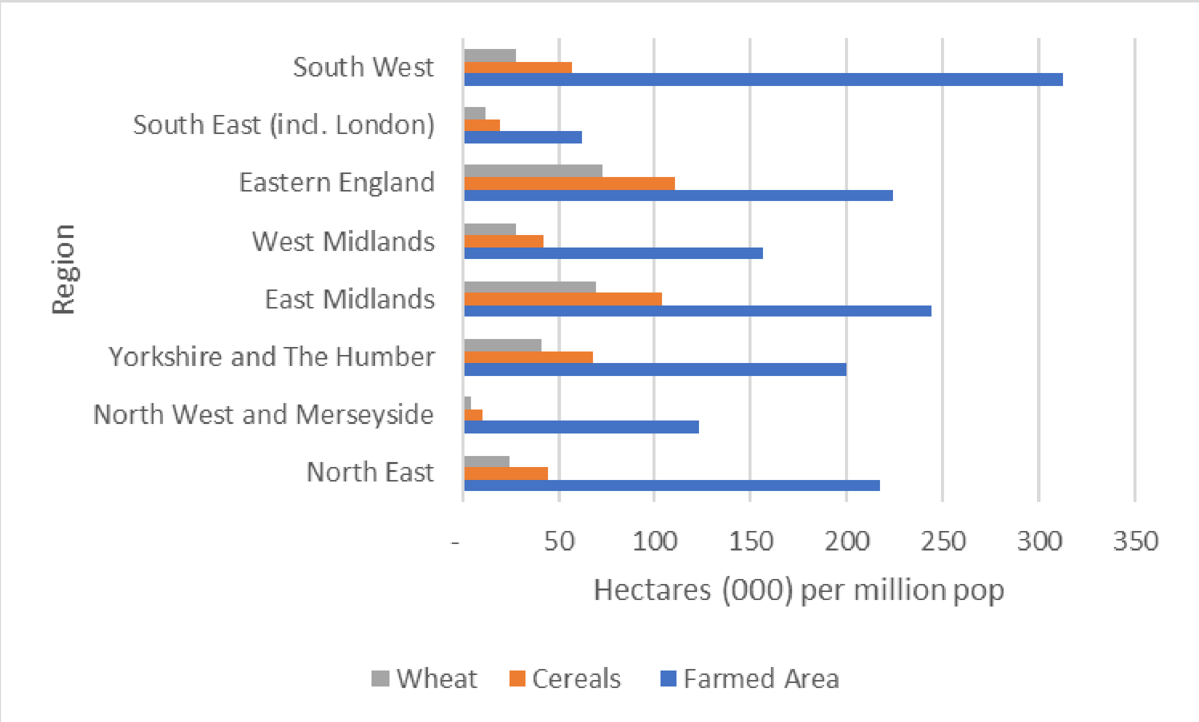

Figure 1: Farmed Areas by Region[6]

SWs region has significant coastal populations including South Hampshire, Brighton & Hove and Medway. Within these regions biosolids produced cannot easily be transported radially (because of the coast), limiting disposal to inland locations. Pressure on these locations is compounded by our proximity to Greater London, which produces vast quantities of biosolids with limited available landbank. London's biosolids are largely exported to surrounding landbank in Eastern and Southern England. Adjusted for population, our counties of Hampshire & Isle of Wight (IOW), Sussex and Kent have approximately one-third of the cereal/wheat area compared to Eastern England which results in disproportionate pressure on the local landbank. Compounding this challenge is more varied topography and smaller field sizes (46% <20 Ha, 20.9% >100 Ha) compared to Eastern England (35.3% < 20 Ha, 33.6% >100 Ha) further increasing recycling cost and complexity. Southern Water have considered transporting biosolids further to areas with higher quantities of landbank, however this was not deemed viable because of increased requirement for on-site storage and increased transport costs.

In addition, competition for the outlet from other organic wastes and the tightening of spreading windows / criteria of applications[2] risk a diminishing landbank. Whilst this is also true for other WaSCs, we have unique circumstances in our region and Kent in particular is a 'hotspot' of limited landbank availability. The Kent region is currently the most stressed area for our Bioresources operation from a resilience perspective and North Kent especially is one of the most stressed areas country-wide and therefore faces higher costs in the round compared with its peers (Figure 2).

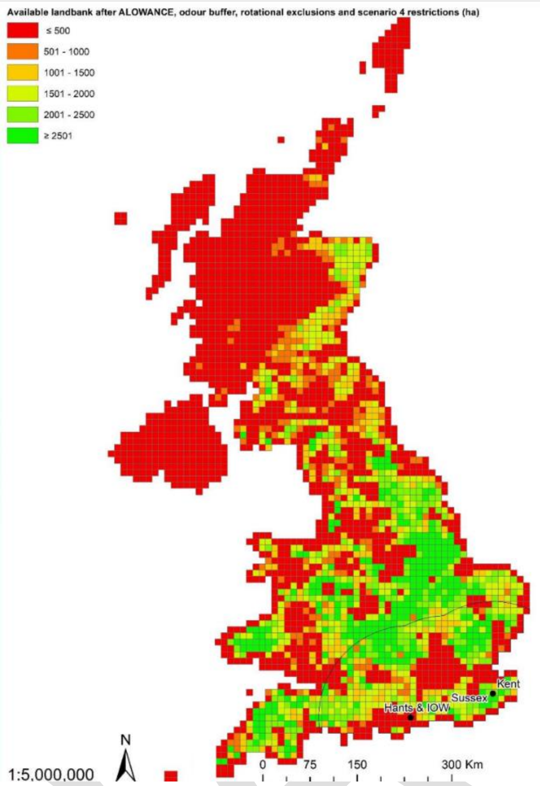

Figure 2: Agricultural land available to Southern Water with current operation (incl. impact of Farming Rules for Water)

At present, we treat 100% of our sludge through conventional anaerobic digestion (CAD). Whilst we ensure 100% of our treated Biosolids recycled to agriculture is compliant, the current performance of our STCs, in terms of pathogen reduction, is varied and double handling of the material (additional maturation, chemical use, transport) is required to ensure compliance to the microbiological standards in BAS is achieved. Implementing AAD will help ensure our product is 100% compliant and can be recycled to agriculture immediately.

The main attractiveness of companies investing in AAD in the past, is the increased biogas production (and associated incentives - e.g. Renewable Obligation Credits, Renewable Heat Incentives, Green Gas Support Schemes), this in turn maximises efficiency and profitability of the bioresources business. At Southern Water, our focus was instead to ensure we kept our customers' bills low, therefore we endeavoured to maximise the use of our existing assets and chose a lower CapEx strategy. This is demonstrated from Figure 3 below which shows our total enhancement capex spent over the last 10 years per TDS comparative to the industry.

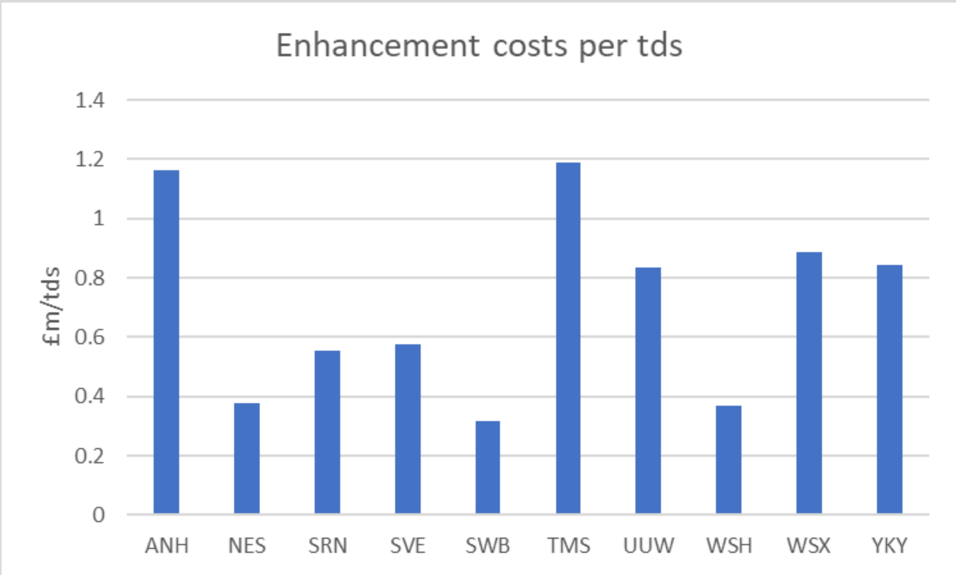

Figure 3: Enhancement CapEx - Industry comparison (APR 2013-2022)

The incentive schemes for biogas are either no longer available or being phased out and the outlet security for our treated sludge (landbank) is now at much higher risk (as described in section 2). These alongside the relatively mature and proven status of advanced digestion are the reasons why we recognise we now need to invest in such technology.

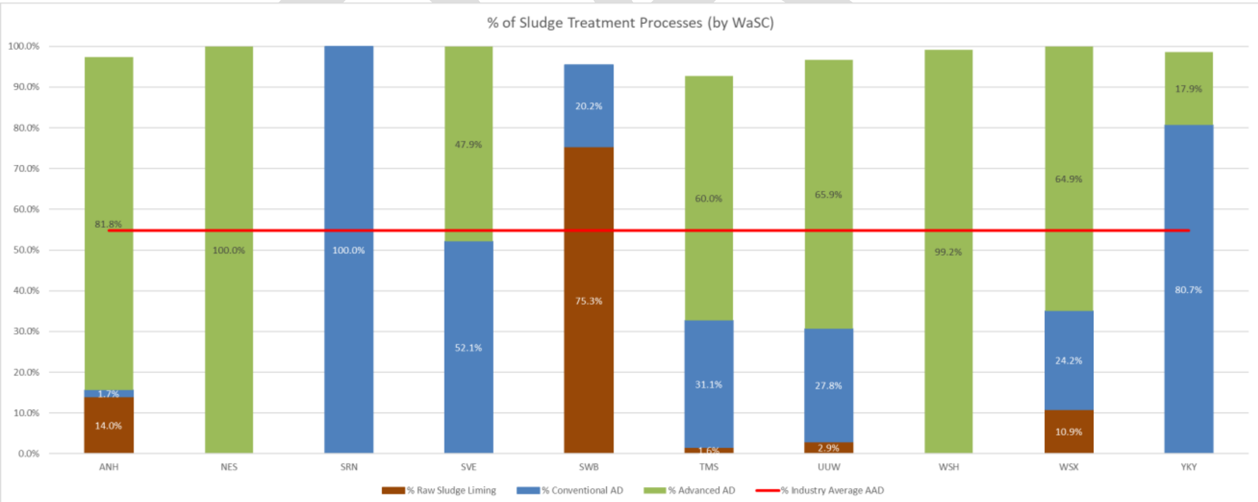

Figure 4: Sludge Treatment Processes (by percentage – *APR Industry Datashare 2022*)

In comparison, as shown on Figure 4, only an average of 33% of the industry's raw sludge is treated through conventional AD, with AAD being the most common type of treatment (55% on average). Pressure on regional landbank can be mitigated through the adoption of advanced digestion (AAD) which significantly reduces the volume of biosolids produced and increases its quality resulting in an enhanced biosolid output. Enhanced (sometimes called Class A) biosolids benefit from increased dryness, improved farmer acceptance and can be applied to a wider range of agricultural soils. WaSCs in the South-East, including Thames Water and Anglian Water, already operate AAD processes with 60% and 84% of sludge treated this way respectively. Following the implementation of AAD in our Kent area, c. 30% of our sludge will be treated through this process.

Delivery of AAD in this area will mitigate these risks and that this warrants a separate cost adjustment to accommodate Southern Water's specific circumstances which the econometric models used to determine efficient cost allowances for bioresources do not account for (see section 1.4).

1.2. Management Control?

This investment has been driven by an increasing number of factors outside of management control that threaten the access to the agricultural landbank outlet. For example, exceptional weather events caused by global warming is leading to more frequent intense rainfall impacting access to fields which can increase the pressure on other available land.

There is also the cumulative impact of changes to the regulatory environment governing biosolids treatment and its management including, for example:

- Nutrient restrictions and the ongoing Farming Rules for Water (FRfW)[2] implementation
- The Environment Agency's (EA) Policy Paper 'Strategy for safe and sustainable sludge use'[5] highlights their intention to move biosolids recycling to land activities from the Sludge (Use in Agriculture) Regulations to the Environmental Permitting Regulations (EPR) based framework.

These changes, as described further in section 2, will make recycling of our treated sludge to agriculture more challenging. This will have a greater impact on our operation as access to farmland areas in the South-East is already limited (Figure 1).

In addition, farmers are demanding enhanced product quality (greater dryness to improve stockpile stability, more consistent nutrient content, and ability to apply to great variety of crops outside ploughing periods) and to this extent, the resilience of the supply chain to agriculture is dependent on Southern Water investing in improved treatment technologies. Our customer engagement survey (discussed further in Section 2) has shown that it is primarily external factors that would prevent the future use of biosolids by farmers – this includes regulatory constraints, phosphorus levels in the soil or restrictions on certain soil types. Without further investment to improve the product quality to make it more consistent, less odorous and drier (to make spreading easier), these stakeholder concerns have the potential to impact the longevity of this option. We gathered from the farmers surveyed that they would prefer to use a product which is drier, would smell less, be better value for money and be easier to store, spread and cultivate (Appendix 2 – The future of Southern Water's sludge – farmer survey (*Yonder for SWS - 2022*)).

1.3. Materiality of Claim?

We have calculated the materiality threshold for the Bioresources price control, based on an early view of our AMP8 Totex.

Table 3: Materiality Thresholds

Price control	Expected AMP8 totex	Materiality threshold (%)	Materiality amount (£m)
WWN+	£300m	6%	£18m

The claim is material. The additional costs above those provided by Ofwat's modelled base costs amount to £123.3m. This is 41% of the projected business plan Totex for Bioresources (and is above the 6% threshold). This is comprised of upgrading our 2 Bioresources sites:

- Ham Hill - £78.4m (post Implicit Allowance adjustment)
- Ashford - £44.9m

Table 4: Materiality of Claim

Price control	Threshold (£m)	Net value of the claim (£m)	Status
BIO	£18m	£123.3m	Pass

Section 1.4 below explains how we derived the cost of the claim gross and net of implicit allowances.

1.4. What are the adjustments to the allowances?

The cost claim is not included in our modelled cost allowances, which do not make allowances for lumpy investments that take place at discrete points in time. Indeed, according to Ofwat's April 2023 cost model consultation, the PR24 bioresources econometric benchmarking models will rely on the relationship between historical costs (which include cost for operating and maintaining existing assets plus enhancement expenditure to accommodate sludge growth) from 2011-12 to 2021-22 and exogenous cost drivers accounting for scale, economies of scale in sludge treatment and location of sewage treatment works relative to sludge treatment centres. The econometric models provide insufficient allowance to accommodate the lumpy investment needed to change the technology from Conventional AD to Advanced AD for two reasons. First, because the econometric models include only 11 years of historical data, they do not include long-run capital maintenance costs longer than the asset life of AD assets. As such, the models do not fund lumpy investment needed at discrete points in time to change the technology, which is the case of the investments proposed in this claim. Second, the econometric models do not include enhancement expenditure to accommodate sludge quality improvement, such as transitioning from Conventional AD to Advanced AD, meaning that other companies' enhancement expenditure in transitioning to Advanced AD is not factored into the modelled allowances.

Whilst we are planning to deliver a significant technology upgrade to these sites, the existing assets will need to be retained until commissioning is complete.

The modelled bioresources efficient totex allowance will then continue beyond AMP8 as we will need to maintain the new assets. As these assets will provide additional benefit in terms of biogas and renewable energy potential, it may be deemed that the totex cost needed to operate these new assets will reduce to allow for this. However, this is already partially reflected in the efficient modelled allowance because the historical cost data used in the econometric models reflect the fact that 55% of sludge in the industry is already treated through AAD technology of which was funded through additional cost allowances not base expenditure.

For this claim, any implicit allowances would be related to accommodating Growth at sludge treatment centres which OFWAT is likely to provide an allowance for as part of its base econometric models. Although, given we are intending to change a number of our sites to dewatering only towards the end of the AMP and we are likely to generate more electricity overall which will improve OpEx. We have calculated an implicit allowance for AMP8 based on these assumptions (Table 5):

Table 5: Implicit allowance summary

	Implicit allowance (£m)	Assumptions
Reduction of Capital Maintenance on specific sites	0.3	The last 6 months of AMP8, we will be operating Motney Hill, Aylesford, Gravesend & Queenborough as raw sludge dewatering & export to Ham Hill AAD only.
Reduction of Opex in Kent region in AMP8	2..0	Improved OpEx, based predominantly on increased electricity generation.
Total	**2.3**	

This implicit allowance has been removed from our total claim.

2. Need for Investment

There is a need to ensure our biosolids is consistently acceptable by our customers (farmers) in terms of regulatory compliance, price and product quality, so that demand stays above the supply, especially in a highly competitive market from other WaSCs already producing enhanced quality biosolids and low-cost manures and slurries. Whilst we ensure 100% of our treated Biosolids recycled to agriculture is compliant, the current performance of our STCs sometimes requires us to extend treatment through additional maturation or chemical use to ensure compliance to the microbiological standards in BAS is achieved. Improving our sludge management practices by utilising advanced sludge treatment technology increases our resilience in managing the impacts of climate change (such as wet weather limiting access to outlets) and periods of supply chain disruption (e.g. during closed spreading periods as a consequence of FRfW) by reducing the volume of treated sludge produced and improving the way it can be stored (e.g. dryer product, easier to stack). This will better serve the continuous production of biosolids that are beneficially supplied to our farming customers for spreading onto their agricultural land.

The full impact of the application of the Farming Rules for Water especially could increase the cost of Biosolids disposal 5 fold as 2/3 of the Biosolids produced in the UK would require alternative outlets (Appendix 1 - National Landbank Study Clarification on scenarios and modelling (*ADAS & Grieve Strategic - 2022*)) (likely landfilling and incineration, assuming space is not a constraint), increasing our current OpEx from c. £21.5m pa to £46.4m pa.

Pre-empting this challenge as early as possible by ensuring we produce Biosolids widely accepted by farmers whilst trying to reduce volumes through implementation of a cost-effective strategy should be our focus in the coming years.

When we consulted with our customers - both farmers (see Appendix 2 – The future of Southern Water's sludge – farmer survey (*Yonder for SWS - 2022*)) and bill payers (see Appendix 3 – Water Future 2030 – Potential Changes to Sludge Regulations (*Relish for SWS - 2022*)a) - about AAD, their initial reactions were positive, with many feeling that the use of advanced processes and the production of higher quality material (e.g. consistent, easier to handle) was beneficial and a step forward. The farmers survey suggested that getting access to biosolids that can be used more broadly across more types of crops is a way of maximising the beneficial use of a product which would be otherwise disposed/destroyed, which also aligns with our sustainability objectives.

There is also evidence that our customers support the need for investment in that they want to see pollution stopped and in making these improvements to our product quality and complying with Farming Rules for Water[2], we are achieving a higher level of environmental protection:

- We reduce the volumes of biosolids that need to be moved to agricultural land, thereby reducing fuel consumed in haulage,
- AAD has lower fugitive emissions that conventional digestion due to greater containment within the process
- The biosolids products are more stable, reducing the risk of diffuse pollution due to run-off once stockpiled in fields.

The focus on Kent, compared to any other area is because our operation in this region is the most challenging with assets being on average older and capacity being more constrained. Kent is also the area where consolidation would be the most valuable, as discussed in Section 3.

In addition, regulatory compliance and future wastewater infrastructure is one of the 21 top priorities areas that are important to our customers. This need has been clearly defined as part of our long-term Bioresources Strategy and the scale and timing of the investment is justified.

These schemes were initially included as part of our WINEP submission for Bioresources in November 2022 but were subsequently marked as "Removed" by the Environment Agency which means they accepted the benefits of the schemes being proposed but considered they were not part of the scope of the WINEP Sludge Drivers. We now believe a Cost Adjustment Claim is now our best option moving forward.

3. Best Option for Customers

There is a need to ensure wider stakeholder confidence in the biosolids to land route, including continued accreditation to the industry Biosolids Assurance Scheme (BAS).

In order to ensure we have taken the best possible option for our customers we have considered a range of treatment options to meet our requirements as outlined in Table 6 below:

Table 6: Options summary

#	Option	Decision	Overview
1	Do Nothing	Discounted	The existing system of conventional digestion retains less solids destruction and therefore greater haulage to farms. The need for further processing (a mixture of liming and maturation) lowers farmer acceptance due to lower biosolids dryness; creates numerous compliance failures in terms of pathogen reduction; and does not mitigate the risk of diffuse pollution in fields due to risk of slumping stockpiles
2	Incineration	Discounted	Incineration is undeliverable for at least 10 years and does not align with our carbon strategy
3	Advanced Thermal Conversion	Discounted	The technology readiness level is not high enough yet for the industry to adopt this at the current time. ATC can be bolted onto AAD as a future further mitigation to landbank issues, should more prominent risks materialise.
4	Develop Lime stabilisation further	Discounted	Discounted due to the process increasing volumes of Biosolids post-treatment and can be highly odorous due to the release of ammonia during the treatment stage. Requires chemicals that are energy and carbon intensive in their production
5	Conventional Anaerobic Digestion (incl. secondary digestion)	**Considered**	Similar to current method employed but would require the addition of secondary digestion on all STCs. It doesn't provide the same level of solids reduction and stabilisation as AAD and therefore results in lower farmer acceptance and therefore greater field requirements. Higher level of fugitive emissions according to the Carbon Accounting Workbook, compared to AAD.
6	Conversion to Advanced Anaerobic Digestion of all 7 sites in Kent	**Considered**	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. AAD to be implemented at all sites in Kent (7 No.)
7	Conversion to Advanced Anaerobic Digestion & Consolidation of sites	**Adopted**	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. AAD to be implemented and consolidation of all sites to both Ashford and Ham Hill

Continuing our current operation ("Do Nothing" option) would impact our ability to recycle our Biosolids to agriculture more significantly. Our analysis shows that the impact of the application of the Farming Rules for Water would increase our recycling costs 5-fold, with a resulting average overall OpEx for Kent increasing 2-fold from £168/TDS to £367/TDS (from £7.4m pa to £16.0m pa – not including Carbon).

On this basis, we have carried out a Whole Life Cost analysis for the options considered as feasible, as described in Table 7 below. Using our Decision Support tool (from Business Model Associates) and for our Kent region only:

- CapEx was calculated over 25 years of operation using bottom-up cost curves for each option. The benefit of doing this over a longer period of time is that the model contains information related to remaining life of current assets and is able to give the analysis a more representative picture
- OpEx was averaged over 25 years of operation (including energy, transport, disposal) using typical process assumptions (including availability, capacity, performance)
- Carbon was averaged over 20 years of operation, using emissions factors from the latest version available of the Carbon Accounting Book. As this metric is difficult to segregate per region (e.g. Kent) on our model, the numbers below are for the Bioresource operation across all regions. Only changes were applied to Kent therefore the relative difference is only due to changes in Kent
- Whole Life Cost calculation was carried out over 30 years using the WLC analysis tool embedded in SWS' PR24 Option Scorecard

Table 7: Whole Life Cost Analysis

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 30 years £m)
5 – Conventional Anaerobic Digestion (incl. Secondary Digesters)	259.7	16.0	44,862	827.1
6 - Conversion to Advanced Anaerobic Digestion of all 7 sites in Kent	473.3	13.6	34,672	916.2
7 - Conversion to Advanced Anaerobic Digestion & Consolidation of sites	324.3	15.4	33,257	802.7

The preferred option (Advanced Anaerobic Digestion and consolidation of sites) will meet the need to provide modern sludge treatment quality for Kent area, in a cost-effective way and to a standard which will help mitigate coming legislative requirements (e.g. Farming Rules for Water) and reduce landbank risks. The biosolids produced at the end of the process can be used on a wider range of crops (e.g., grassland) and will be more widely accepted by farmers because of its attractive properties (easier to stack, less odorous and more versatile). This coupled with the volume reduction (increased solids destruction and improved dewaterability) will enable us to reduce the risks associated with supply chain disruption.

Significant uncertainty continues to surround the future of Bioresources operations as the continued use of biosolids as a phosphate-based fertiliser for farming is in doubt due to the anticipated DEFRA and EA regulations review in 2025.

The Bioresources core pathway in the long-term delivery strategy plans for a phased reduction in the use of landbank as a disposal mechanism by 2040-2050. To this effect, the development of our long-term Bioresources strategy includes the assessment and potential implementation of Advanced Thermal Conversion (ATC) type of technologies (e.g. Pyrolysis, Gasification) in order to fully mitigate the risks related to the landbank. The conversion of Advanced AD is seen as a “no-regret” solution as such ATC processes could be easily installed post-AAD given the beneficial interdependencies between the two concepts, from a mass & energy balance point of view[7].

However, should a partial landbank ban be introduced in 2025, an adaptive plan is in place that will accelerate our move away from landbank use. The proposed Ashford and Ham Hill Advanced Anaerobic Digestion plants will remain a key component of our plans whatever the outcome of the review. However, a partial ban on landbank use would result in a re-focussing of future enhancement spend away from additional advanced digestion sites to thermal destruction technologies. Incineration is our potentially primary disposal mechanism in the short term. However, incineration is not our preferred option and as such is not in our core pathway as we recognise the associated customer reservations and high CO_2 footprint it would lock us into for 20+ years. Incineration only becomes an option, if both pyrolysis is tested and shown not to be viable, and if DEFRA and the EA make an adverse decision in AMP8.

We undertook qualitative and quantitative approaches to our farmer engagement including in-depth interviews and surveys of our farmers to gain feedback on the quality of the product provided to them, the benefits and barriers to using it as well as their needs in order to support our proposals. The feedback is that Biosolids is an inherent part of their operation because it provides their soils with useful, cost-effective nutrients. The prospect of getting better quality product is clearly welcome (Appendix 2 – The future of Southern Water’s sludge – farmer survey (*Yonder for SWS - 2022*).

Surveys show that our customers are supportive of our strategy to enhance our current operation and the quality of our product (Appendix 2 – The future of Southern Water's sludge – farmer survey (*Yonder for SWS - 2022*)and Appendix 3 – Water Future 2030 – Potential Changes to Sludge Regulations (*Relish for SWS - 2022*)Appendix 3 – Water Future 2030 – Potential Changes to Sludge Regulations (*Relish for SWS - 2022*). However, moving to incineration in order to fully mitigate the landbank challenge is seen as taking a step backwards due to its high CO_2 emissions profile (see Appendix 3-b). We agree with our customers and are keen to explore and adopt more advanced type of technologies (such as Advanced Thermal Conversion).

We believe the option selected is appropriate to the size and complexity of the risks and issues to be addressed.

4. Cost Efficient

Cost estimates and costing stages are summarised in Table 8.

Initial costing has been derived by SWS' costing team through the use of cost curves for specific items extracted from the specific high-level design carried out by SWS' design team. These cost curves were built upon previous projects that included similar items.

An external benchmarking carried by Mott MacDonald highlighted no significant difference in the direct costs (2.5% for NDW). We provide evidence of this benchmarking exercise in Appendix 4 - Motts MacDonald Costing Benchmarking report. We have also undertaken benchmarking of our scope for Ham Hill STC site by visiting another WaSCs' plant of similar size. Once again, no significant differences in the scope were highlighted (as per Appendix 5 - Additional Internal Scope Benchmarking (Other WaSC's AAD plant) – Notes from visit of Site A).

Initial costing for both sites was therefore kept as a basis for further cost refinements as described below and summarised in Table 8:

- Firstly, following discussion with the Environment Agency about our Bioresources WINEP submission, we agreed with the Environment Agency to remove the Cake Storage element of each scheme, which we resubmitted as a WINEP enhancement scheme and was subsequently approved.
- Secondly, we adjusted the design of the THP plants for both sites which reduced costing. This is based on cost curves we received from the supplier, which we provide in Appendix 6 – Indicative cost for THP (CAMBI). We note these costs are commercially sensitive.
- Thirdly, a further assessment (Appendix 7 – Assessment of Biomethane Upgrade vs Combined Heat & Power engine options) of Biomethane Upgrade vs CHP was carried out following OFWAT's publication of the PCs for Green House Gases[8] for Ham Hill. This prompted us to move away from Biomethane upgrade and use Combined Heat & Power (CHP) engines instead. We will continue reviewing any changes in relation to Biomethane Upgrade, especially from a Carbon benefit and incentives point of view. Costing for CHP engine for Ham Hill was extrapolated based on costed item from Ashford design based on sludge throughput.
- We then removed the growth element of the schemes as we expect this to be included into the modelled bioresources efficient totex allowance.
- Finally, we added indirect costs and overheads of 2.27x of direct costs, which is based on industry benchmarks. Description of the tool used and rational is available in Appendix 8 - SWS Cost Multiplier Calculation Tool.

Table 8: Costing Adjustment Summary

Costing Adjustments	Type of costs	Cost Source	Ham Hill AAD (£m)	Ashford AAD (£m)
Initial costing	**Direct**	**SWS internal cost curves**	**61.6**	**31.9**
Cake Covering transferred to WINEP (Approved)	Direct	SWS	-4.7	-6.6
Adjustment of design & costing for THP	Direct	SWS	-15.5	-2.2
Move from Biomethane Upgrade to CHP	Direct	SWS	+0.8	-
Growth element removed	Direct	SWS	-6.7	-3.4
Final Direct Costing	**Direct**	**SWS; external benchmarks**	**35.6**	**19.8**
Total Costs (incl. Indirect)	**Total**	**SWS; external benchmarks**	**80.7**	**44.9**

As mentioned above, we are also able to drive further value by investing in AAD and consolidating our Bioresources operation in Kent at 2x key sites (Ham Hill and Ashford), allowing us to remove the need for sludge treatment at 5 other sites.

Whilst this reduces capital expenditure thanks to the economy of scale, it could also limit investment associated with achieving BAT for the biological treatment of waste – subject to EA approval - at a smaller number of sites which is more cost effective for our customers.

We are considering delivering these projects through our alternative financing route. We would identify one or more investors who would design, build, finance, operate & maintain the assets and we would buy services from this group via an arms-length long term contract. We consider this can offer additional benefits via increased scope for innovation, reduced deliverability risk and payment profiles that better match the time when the assets will be in service.

This is atypical expenditure and is not relevant for a symmetrical cost adjustment.

5. Customer Protection

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 extensive 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.

There are also secondary benefits for our customers associated with potential reduction in odour and fugitive emissions.

However, in order 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 9 below:

Table 9: Delivery targets

Scheme	Value	Output	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Ham Hill Advanced AD	£78.4m	Built Capacity (TDS/y)					30,700	
Ashford Advanced AD	£44.9m	Built Capacity (TDS/y)						15,400

For clarity:

- The conversion of Ham Hill AAD plant is expected to be completed by 31st March 2029. 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 2030/2031

If we deliver either of the schemes late, we expect to pay a penalty of £0.026k per TDS for every month the scheme is delivered late (this will be dependent on the delivery route of the scheme). This is based upon the total scheme value, the cost sharing rate and the total months in an AMP period.

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 46100 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 10 below:

Table 10: PCD Summary

Component	Output based on Capacity
Output	30,700 TDS pa capacity by 2029/2030 46,100 TDS capacity by 2030/2031
Total cost	£123.4m
Unit cost	£2.67k per TDS (pa) capacity
Penalty rate	£1.34k per unit assuming a 50/50 cost sharing rate
Scheme Delivery Date	31st March 2029 (Ham Hill) 31st of March 2030 (Ashford)
Gated dates (if required)	Assurance of the scheme will be delivered on time at 31st March 2028/29
Late penalty (if required)	£0.022k per TDS for every month late.
Measurement	Performance reported in APR

Conditions (if required)	(if applicable)
Assurance	Third party assurer will assure conditions have been met

*NOTE: The late penalty is derived from £123.3m (total net claim cost)*50%(cost sharing rate)/60(months late)/46,100(total capacity in TDS pa))*

If a higher amount of throughput is constructed, there will be no adjustment.

6. Conclusion

To summarise, the adoption of two advanced anaerobic digestion facilities at Ham Hill and Ashford STCs will enable SWS to treat sludge to a high-quality product for agricultural recycling.

The investment has been driven by an increasing number of factors outside of management control including the threat of resilience on the supply chain through the FRfW requirements, the EA's strategy for safe and sustainable sludge use and adherence to BAT requirements for the biological treatment of waste. In addition, we have a relatively low proportion of farmed area, wheat area and cereal area when adjusted for population.

Our customers want to see pollution stopped and in making these improvements to our sludge treatment centres we will be achieving a higher level of environmental protection. In addition, regulatory compliance and future wastewater infrastructure is one of the 21 top priorities areas that are important to our customers. Feedback from our customers (including our farmers, the end users of our biosolids) is supportive of recycling treated biosolids to agriculture. It is primarily external factors that would prevent the future use of biosolids by farmers – this includes regulatory constraints, phosphorus levels in the soil or restrictions on certain soil types. Without further investment, these stakeholder concerns have the potential to impact the long-term viability of this recycling option.

Consolidating our STCs into these 2 large AAD facilities at Ham Hill and Ashford will strengthen our operation and mitigate immediate threats as it reduces the amount of biosolids produced and opens up additional farmland for spreading. The Biosolids obtained is a more stable product, less likely to cause public nuisance which makes it more desirable and well received by farmers. The processes involved are highly contained systems to avoid fugitive emissions.

We believe the technology can also be efficiently integrated with additional bolt-on processes (e.g. thermal destruction technologies), this enables us to stay adaptive should the landbank risks materialise further at later stage. This need and opportunity have been clearly identified and defined as part of our long-term Bioresources Strategy.

We have set out an appropriate price control deliverable in order to fully protect our customers and ensure they will not be disadvantaged from this cost adjustment claim.

A summary of the costs included and not included in this claim is available in Table 11 below:

Table 11: Costs Summary

Costs included in this Claim (£m)		Costs not included in this Claim (£m)	
Conversion of Ham Hill STC to AAD	Total Cost = 78.4	Cake storage WINEP	Net Direct Cost = 11.3

Conversion of Ham Hill STC to AAD	Total Cost = 44.9	Growth	Net Direct Cost = 10.1
TOTAL	Total Cost = 123.6	TOTAL	Net Direct Cost = 21.4

List of References

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[2] DEFRA (2018). Farming rules for water – getting full value from fertilisers and soil. *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/695598/farming-rules-for-water-policy-paper-v2.pdf*

[3] Ofwat (April 2023). PR24 Econometric Base Cost Models Consultation. *https://www.ofwat.gov.uk/consultation/pr24-econometric-base-cost-models-consultation/*

[4] European Commission (2018). Best Available Techniques (BAT) Reference Document for Waste Treatment. *https://eippcb.jrc.ec.europa.eu/sites/default/files/2019-11/JRC113018_WT_Bref.pdf*

[5] Environment Agency (2020). Environment Agency strategy for safe and sustainable sludge use. *https://www.gov.uk/government/publications/environment-agency-strategy-for-safe-and-sustainable-sludge-use/environment-agency-strategy-for-safe-and-sustainable-sludge-use*

[6] DEFRA (2010). Structure of the agricultural industry in England and the UK at June. *https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june*

[7] Mills, N. (2015). Unlocking the full energy potential of sewage sludge. EngD. University of Surrey https://openresearch.surrey.ac.uk/esploro/outputs/doctoral/Unlocking-the-full-energy-potential-of-sewage-sludge/99515301502346

[8] OFWAT PR24 operational greenhouse gas emissions performance commitment (wastewater) https://www.ofwat.gov.uk/publication/pr24-operational-greenhouse-gas-emissions-performance-commitment-wastewater/

List of Appendix

A 1 ADAS & Grieve Strategic (2022) - National Landbank Study Clarification on scenarios and modelling
A 2 YONDER for Southern Water (2022) - The future of Southern Water's sludge – farmer survey
A 3 Relish for Southern Water (2022*)* - Water Future 2030 – Potential Changes to Sludge Regulations
A 4 Motts MacDonald - Costing Benchmarking report
A 5 Additional Internal Scope Benchmarking (Other WaSC's AAD plant)
A 6 CAMBI - Indicative cost for THP **Commercially Sensitive**
A 7 Assessment of Biomethane Upgrade vs Combined Heat & Power engine options
A 8 Southern Water Cost Multiplier Calculation Tool

Appendix 1 - National Landbank Study Clarification on scenarios and modelling (*ADAS & Grieve Strategic - 2022*)

ADAS grieve strategic

National Landbank Study

Clarification on scenarios and modelling

a. Farmers Acceptance of various quality of Biosolids

ADAS grieve strategic

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]	Scenarios 4 & 5: 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%	✗	✓

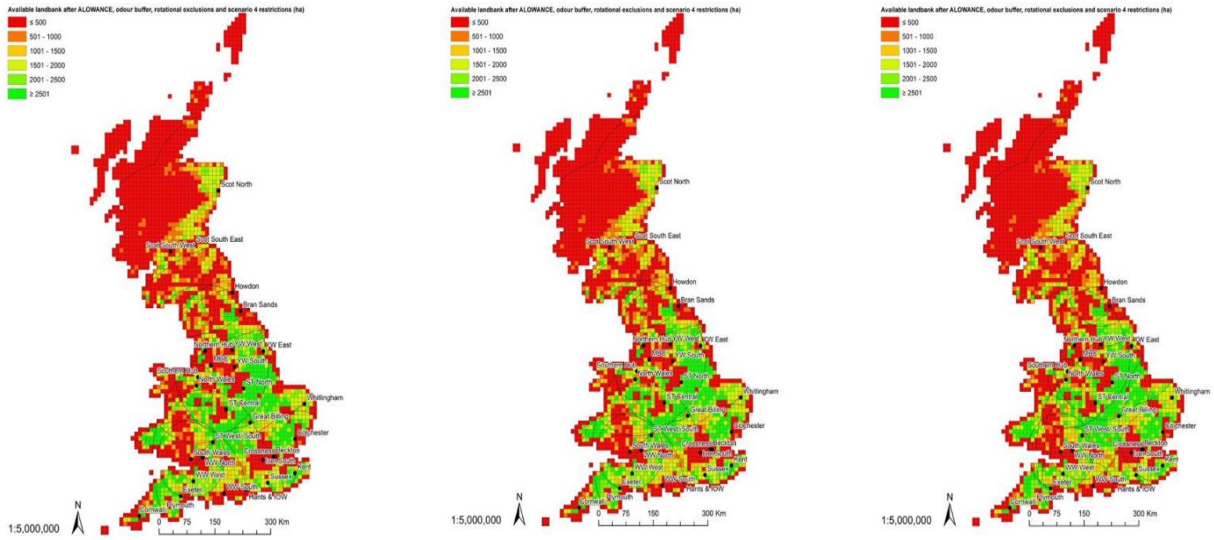
✗ = no; ✓ = yes; ✓~ = yes, depending on Safe Sludge Matrix treatment standard; kg/t fw = kilograms per tonne (or cubic metre) fresh weight; kg/ha = kilograms per hectare

[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%)

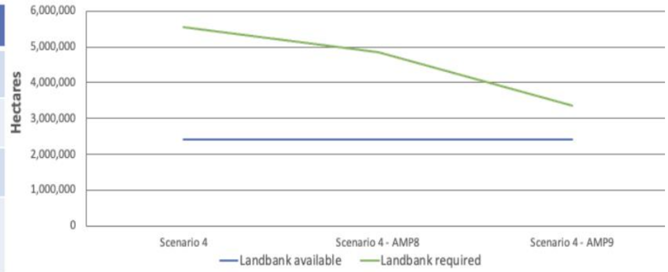
WATER for LIFE from Southern Water

b. *Impact of application of Farming Rules for Water on landbank available in the UK (Scenario 4)*

Effect of WINEP submissions



Scenario	Scenario 4	S4 – AMP8	S4 – AMP9
Quantity to land (TDS)	1,138,000	1,040,000	813,000
Required land (ha)	5,560,000	4,860,000	3,350,000
Landbank available (ha)		2,410,000	
Percentage of biosolids requiring an alternative outlet	67%	60%	35%



Appendix 2 – The future of Southern Water's sludge – farmer survey (*Yonder for SWS - 2022*)

SOUTHERN WATER

The future of Southern Water's sludge

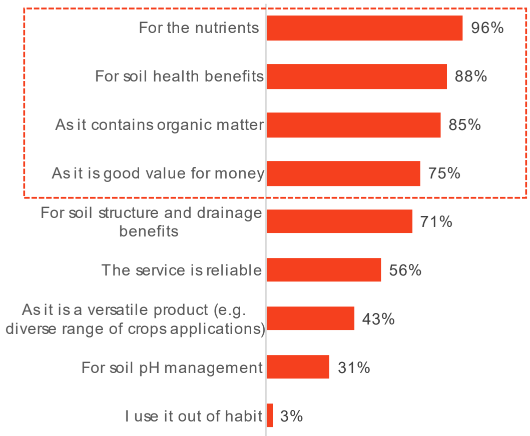
Qualitative & Quantitative research debrief

.YONDER

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"

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

.YONDER

b. Limitations of current Biosolids from SWS

Additional external factors are also identified as downsides to sludge

Smell	Inconsistent product	Spreading and cultivation	Delivery of the sludge	Microplastics
• The potent smell is consistently cited as a negative • Can lead to complaints from neighbours. This can be exacerbated upon learning what sludge is	• That the product can vary from being sludge-like to cake-like is a source of frustration • Sludge-like is much harder to store and cultivate	• The requirement to cultivate soon after spreading can be a challenge with unpredictable weather • Heavy machinery is at odds with a regenerative approach	• Large haulage delivery trucks can impact the local community and local road networks	• Concerns are increasing around the digestion of microplastics • Microplastics risk damaging crops and soil quality

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c. Benefits expected from Advanced Digested cake

Whilst confusion exists over what Advanced Digestion is, a drier product has clear advantages

Less smell	Easier to cultivate	More concentrated product – cheaper to transport	Easier to stack and store	Better for the environment
• Drier is less odorous • Significant improvement for locals (and farmers) • Supported by Thames sludge users and those who used to use pellets	• Far better for the soil when cultivating as requires less heavy machinery • Granules could be easily 'sprinkled' down tram lines and top dressed	• Transporting organic matter rather than water • Anticipated this will impact costs and operations – easier to transport dry product than a liquid	• A drier product can be more easily protected against rain/snow and stored for longer • Locals would be happier not to have a sludge heap	• Easier cultivation and transportation means fewer trucks / heavy machinery • Easier cultivation is better for soil regeneration

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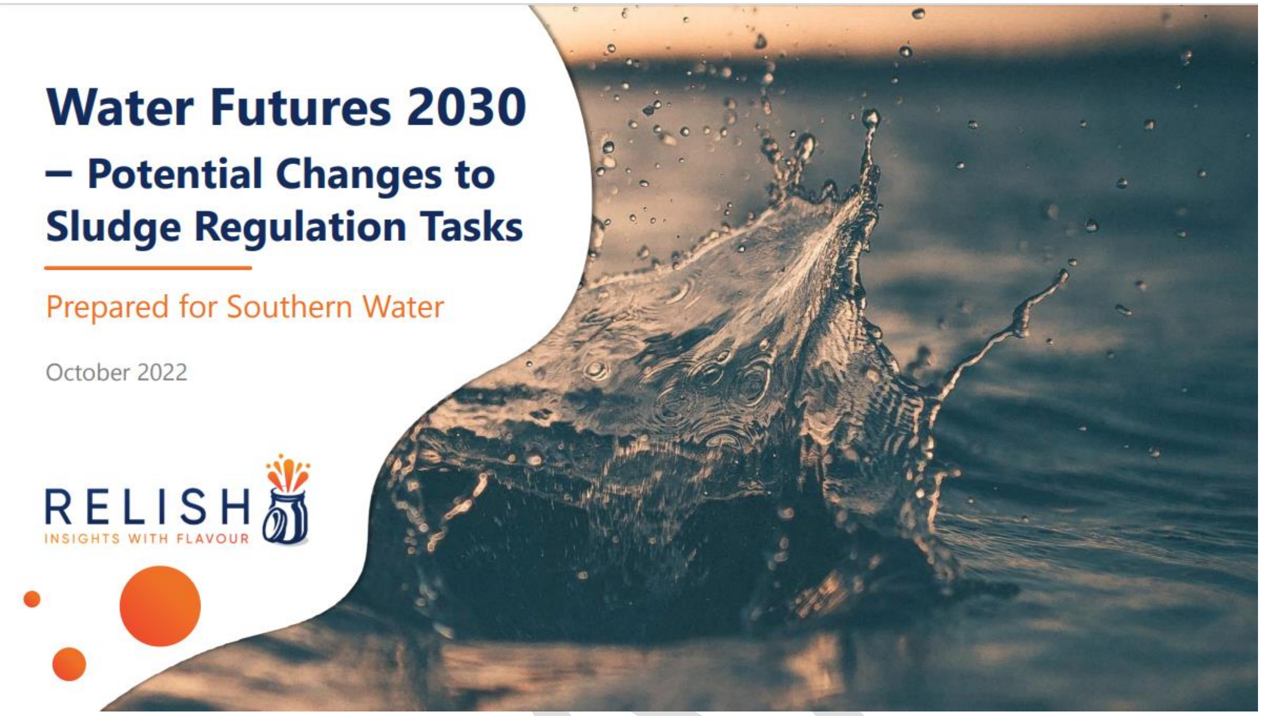
Appendix 3 – Water Future 2030 – Potential Changes to Sludge Regulations (*Relish for SWS - 2022*)



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

Advanced Digestion feels like the next logical step, however, there are concerns over timescales and in turn, future proofing

Impressions of Advanced Digestion

<u>Advanced Digestion</u>

- Wastewater is treated to a high standard with lots of regulations and criteria we need to meet. An end product called 'sludge' or 'cake' is provided to farmers and spread on their crops.
-
- There is a process called '**advanced digestion**' which is essentially a more advanced type of treatment.
- This means that the end product (sludge) is of higher quality.
- It can then be spread on more and different types of crops – so is more versatile and better used by farmers.
- Southern Water are currently planning to propose to introduce advanced digestion across their sites.
- It is likely to take between 10-15 years to complete – partially due to the spreading the cost but also the resource needed to upgrade sites.
- The current proposal being worked up is to focus on Kent in 2025-2030, and then across to Sussex and Hampshire after this.
- Southern Water have been working with Famers – who are supportive of the plans.

✓ Initial reactions are positive, with many feeling that anything more advanced or that produces a higher quality product is beneficial

✓ Being able to use this more broadly across more types of crops feels like we are making the most of what we have already got, again fitting well with sustainability

✓ It is assumed that this would have potential to replace current, harmful fertilisers and chemicals and as such, feels like a logical step to take

As such, overall customers are supportive of Advanced Digestion, however …

‼ Timescales do raise some concern, especially considering farmers are supportive – *if it is so good, we need to be doing this as soon as possible!*

‼ Although the need to plan resources and keep costs low is understood, there are worries that the technology may be out of date by the time it is implemented - *could it be a waste of time and money? And who is paying for this – farmers, customers?*

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.

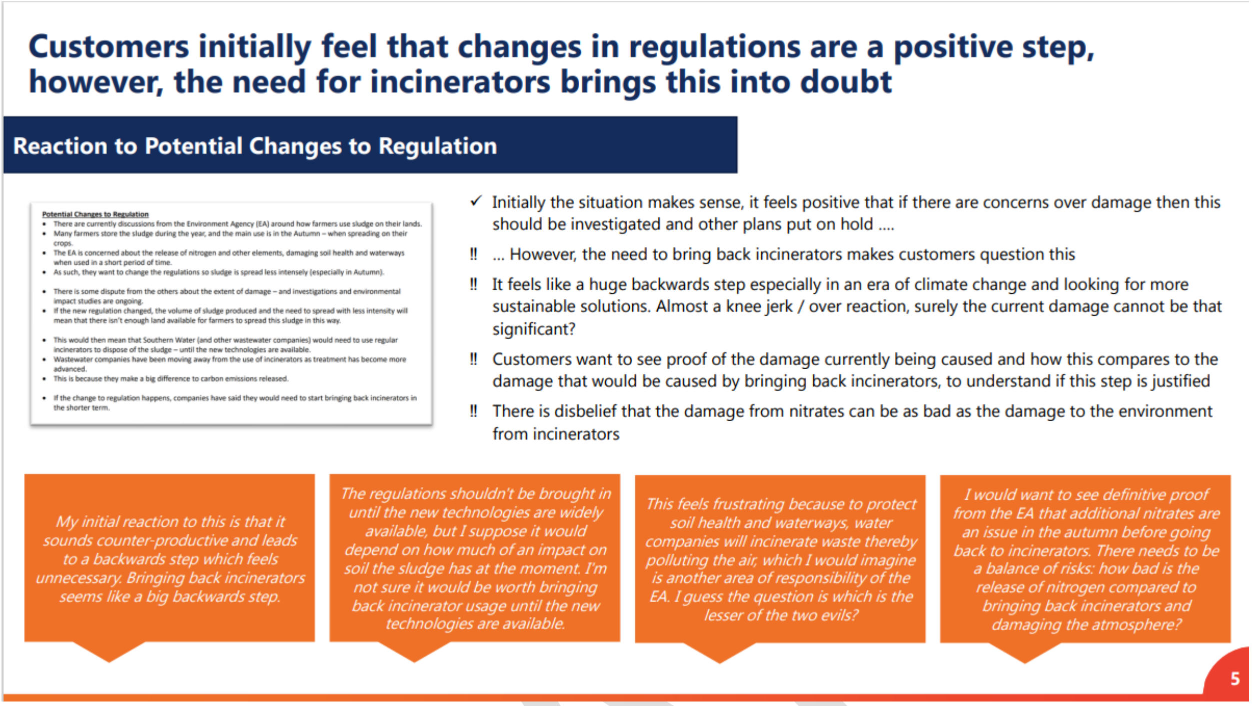
Seems like a good idea and if this is good for the environment, then I can't see why they wouldn't put this in place. I understand the need to do this slowly but it does feel like a long, long time.

My concern is who pays. The farmers should be paying a contribution here and not customers as it is they who directly benefit. The lead time of 15 -20 years seems very long though, and could be costly, is it worth the wait?

This sounds great I would be supportive of this. I would want to know though whether this means there are other more harmful products/ chemicals that can be used less?

4

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



Appendix 4 - Motts MacDonald Costing Benchmarking report

MOTT MACDONALD

PR24 Bioresource Estimate Benchmarking

January 2023

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:

- Site clearance and Road items 50% higher (£480k across two items)
- SW Piling 48% higher than benchmark – the yardsticks are different in both pricing models Piles per m2 for SW calculation verses Nr of piles on the comparative yardstick (£732k across 6 items)
- Storage Area 19% higher (£1,271k)
- Conveyor 27% higher (£51k on two items)
- Centrifuge feed pump / pump sets 31% higher (£29k on two items)
- Gas Flaring 66% higher (£216k)
- Biogas CHP 12% higher (£330k)

Areas where SWS costed items are noticeably less than comparative:

- Sludge Holding tank 94% lower (£47k)
- Odour Covers averaged 169% lower (£81k across 4 items)
- Power Generation 121% lower (£732k)
- Reinforced Concrete Items on average 26% lower (range -78% to +23%, £839k across 9 items)
- Valve rates average 244% lower (£53k across 13 items)
- Polyelectrolyte dosing 183% lower (£43k)
- Flow measurement 204% lower (5k)

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:

- Site clearance and Road items 49% higher (£199k across two items)
- SW Piling 50% higher than benchmark – the yardsticks are different in both pricing models Piles per m2 for SW calculation verses Nr of piles on the comparative yardstick (£773k across 7 items)
- Conveyors average 46% higher (£482k across 3 items)
- Gas Flaring 56% higher (£93k)

Areas where SWS costed items are noticeably less than comparative:

- SW Sludge Holding tanks average 59% lower (£54k across two items)
- SW Odour Covers averaged 163% lower (£102k across 4 tiems)
- SW Power Generation 121% lower (£1,463k)
- Valve rates averaged 370% lower (£71k across 18 items)
- Polyelectrolyte dosing 257% lower (£48k)
- New concrete tank Bund 62% less (£1,131k)
- Mains laying Open cut in the Field / Verge 176% less (£101k)

Appendix 5 - Additional Internal Scope Benchmarking (Other WaSC's AAD plant) – Notes from visit of Site A

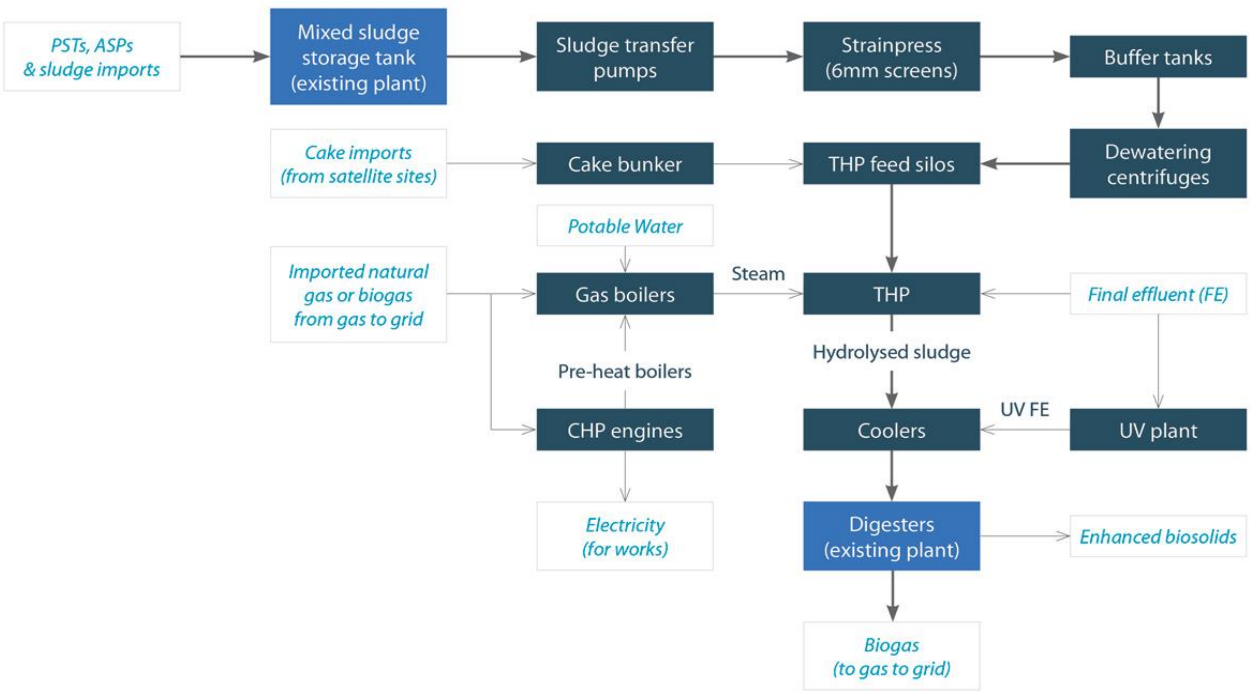
In April 2023, a small team from Southern Water visited Site A operated by another WaSC. Site A is a newly commissioned AAD site with similar capacity as SWS' Ham Hill expected AAD plant.

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 carried out.

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 – Subseqently 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 6 – Indicative cost for THP (CAMBI)

6.1. Commercially Sensitive

Fwd: UK - Southern Water - Price indication

ER
Ester Rus <ester.rus@cambi.com>
To Perrault, Aurelien; Heitmann, Marc

This sender ester.rus@cambi.com is from outside your organization.

Reply | Reply All | Forward | ...

Tue 16/05/2023 15:18

Dear Aurelien,

Cambi is pleased to submit this price indication for the Cambi THP B4-4 (equipped with 4 reactors).

The Cambi scope includes:

- 1 Train THP B4-4 (comprising: 1 pulper / 4 reactors / 1 flash tank / 2 pumps for pulper recirculation and reactor feed / 2 pumps for flask tank discharge) supplied as a modular system, including internal piping, steel structures and platforms
- 1 Process Gas unit
- Control system within THP
- Piping within the THP
- Insulation of THP
- Transport to site
- Supervision during installation and commissioning
- Training
- Manufacturing according to EN/British standards

The budget price is **5 000 000 GBP***

*Price level as May 2023 – Budget price excludes all taxes including, without limitation, VAT and sale taxes or custom duties.
Price is budget estimates, and is subject to confirmation due to raw material, labour, currency fluctuations and general inflation.

Please note that the Cambi scope excludes:

- Any other items not specifically stated above
- Interconnecting piping (outside Cambi package)
- Installation and Commissioning of Cambi package
- Building and Civils
- Utilities (water, electricity…)

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Appendix 7 – 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 larger "THP" AD plants
- The existing plants are equipped with CHP and the new plants will be of sufficient size to be equipped with biomethane upgrading and injection or CHP
- We have modelled the GHG savings and net revenue impact for both options considering Ofwat's "Operational greenhouse gas emissions 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 project 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. It 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 will 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 scheme.
- 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 provides 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 important 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 GGSS mid scheme review consultation which closed on 18th May 2023.
- In view of the uncertainty that retirement of RGGO’s will be available in a future framework it is proposed that the performance 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 scheme.

Appendix 8 - SWS Cost Multiplier Calculation Tool

Our overall Business Plan submission will include a Technical Annex which will explain in detail the approach we followed to derive the scorecard below and benchmarking against the industry.

The options available within the tool are summarised below. These are used to produce the Cost Multiplier number.

Assessment scorecard

The scorecard below should be used to assess each scheme/driver's risk level

	Indicator	Assessment of criterion indicators: Low confidence	Medium confidence	High confidence
Maturity of design	1. Maturity of design and cost	• Level 1 stage in design and cost	• Level 2 stage design and cost	• Level 3 design and cost
	2. Detail of planning to deliver design requirements	• Requirements defined, but delivery plan not yet understood		• Ready to award to design and build contractor
Complexity of scheme	1. Implementation complexity	• Scheme/driver has never/rarely been delivered before by Southern Water • Material concern on the availability of appropriate skills and resources to deliver	• *Schemes/drivers which fall between Low and High assessment should be scored as 'M'*	• Similar schemes delivered frequently before with considerable success • High confidence that range of skills and resources on hand to deliver
	2. Interdependency risk	• Success is highly dependent on that of other schemes		• Success is independent to that of other schemes
	3. External stakeholder interest	• Scheme is highly vulnerable to external stakeholder influence		• Scheme is not materially vulnerable to external stakeholder influence
Quality of cost data	1. Volume of available cost data	• Limited volume of cost data [>5 schemes]	• *Schemes/drivers which fall between Low and High assessment should be scored as 'M'*	• Large volume of relevant cost data [10+ schemes]
	2. Availability of contemporary cost data	• Lack of contemporary cost data [>5 years]		• Cost estimation data is contemporaneous [5+ examples within last 2 years]
	3. Range of cost data	• Wide range of cost data points to feed into cost estimation r2 value of less than 0.6		• Narrow range of cost data points to feed into cost estimation 0.8 and above

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For both schemes, we used the following assumptions:

- Maturity of Design: Low Confidence as the design which was put together is still high level at this stage
- Complexity of scheme: Low Confidence as Advanced AD is a new concept to SWS
- Quality of cost data: Medium Confidence as the costs have gone through a number of benchmarking exercises

Based on the above, the resulting Cost Multiplier was then calculated:

Background:
The below risk assessment calculation can be used to calculate the risk multiplier for a given scheme. This can be applied to the direct cost of a project to calculate the overall cost.

How to use:
user defined — Please select H=High, M=Medium, L=Low from the drop down menu boxes.

Note: Each element of risk must be assessed on a Low, Medium or High confidence basis. "High" corresponds to greater confidence (on design maturity, Complexity and quality of cost information). For example, a "High" for complexity means high confidence that scheme complexity is manageable within estimated cost. It does not mean high complexity.

Risk Assessment Calculation

	Element	Confidence	Output
A	Design Maturity	L	40%
B	Complexity	L	40%
C	Quality of Cost Information	M	11%
D	Combined Weighting		91%
E	Weighted Multiplier Source		11.6%

Overall Multiplier Calculation

	Element	Infra	Non-Infra
A	Overhead	9.5%	9.5%
B	Risk	11.6%	11.6%
C	Indirect Cost	33.0%	85.4%
D	**Overall Multiplier**	**1.63**	**2.27**