WSX18 - Bioresources strategy and investment

Business plan
2025-2030

Wessex Water
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WSX18 - Bioresources strategy and investment

CONTENTS

This supporting document is part of Wessex Water's business plan for 2025-2030.

Please see 'WSX00 – Navigation document' for where this document sits within our business plan submission.

More information can be found at wessexwater.co.uk

For annexes, see Supporting Document WSX19 – Annexes – Bioresources strategy and investment

Executive summary

We expect significant changes in bioresources in AMP8, with the development of the bioresources market bringing new opportunities for delivering improved bioresources services to customers, but regulatory and environmental uncertainties potentially creating new challenges in the delivery of these services.

Our strategy for delivering efficient and reliable bioresources services to our customers is to provide sufficient resilience in our entire bioresources supply chain to ensure that our sludge can be treated and recycled in a safe, reliable, and sustainable way. We also aim to maximise the potential of nutrient and energy value in sludge to minimise the cost and carbon footprint of our bioresources service. To achieve both objectives in AMP8, we aim to maximise sludge treatment through anaerobic digestion (to increase renewable energy generation and reduce sludge volumes for disposal), but also provide additional headroom capacity through lime treatment for resilience.

In reviewing market opportunities for AMP8, we identified a shared need with Severn Trent Water to invest in additional sludge treatment capacity in our Northern region and their Southern region. We therefore set up a joint market enquiry with Severn Trent Water to seek 3rd party solutions to deliver the additional capacity with greater efficiency. We received a wide range of proposals from 28 companies, and we shortlisted the best three for an interview. Unfortunately, we found that none of the companies were able to offer commercial models that will result in any step-change in price efficiency, or solutions that will enable us to operate in a different way.

We have forecast that our total sludge production will increase to 69,200 tonnes of dry solids (tds) by the end of AMP8, due to population growth and increased phosphorus removal in AMP8. Our capacity provision has been assessed against this forecast and we concluded that additional capacity would be required by the end of AMP8, approximately 10,950 tds per year, to accommodate the increase in sludge production and improve our headroom capacity for resilience management. We propose to provide this additional capacity by building two new digesters at Avonmouth and installing a larger lime treatment plant at West Huntspill.

There is uncertainty around the future availability of landbank due to expected changes in the Farming Rules for Water (FRfW) regulation, which will restrict sludge spreading on soils that are high in nutrients. Depending on the extent of the changes to FRfW, there could be insufficient landbank to allow us to continue recycling all our sludge to land. To mitigate this risk in the short term, we are proposing to increase our sludge storage capacity by providing nine new sludge storage barns.

Due to the implementation of the Industrial Emissions Directive (IED) in the water sector, our five anaerobic digestion sites will be permitted under IED and will need to comply with Best Available Techniques (BAT) and the Environment Agency's (EA) guidance on 'Biological waste treatment: appropriate measures for permitted facilities' (AM). Significant capital investment is required at all five sites to bring them up to BAT and AM standard to comply with IED. While IED compliance is an AMP7 obligation, we did not request funding for IED in PR19 due to the lack of clarity on the scope of IED. The delays in the permitting process mean that IED compliance will likely be pushed into AMP8, and we have therefore included IED investments in PR24. As there is still uncertainty with the funding mechanism for IED, we have also submitted a base cost adjustment claim for IED costs.

Due to the EA's review of the current regulatory regime for sludge treatment, storage, and use, they intend to publish their Sludge Strategy which will see sludge brought into the Environmental Permitting Regulations (EPR) and all our lime treatment centres to be permitted in AMP8 as a result. It is expected that these sites will need to comply with AM guidelines and therefore require similar investments like the IED sites to achieve compliance. Site upgrades for EPR compliance have been excluded from the scope of the PR24 Water Industry National Environment Programme (WINEP). As we believe that EPR compliance will likely be an AMP8 obligation, we have included these site upgrades as quality enhancement investments.

1. Introduction

1.1. Strategic direction statement

We are committed to delivering the most efficient and reliable bioresources services to our customers. Therefore, our long-term bioresources strategy objectives are:

1. to treat and recycle sewage sludge in a safe, reliable, and sustainable way, and
2. to maximise the potential of its nutrient and energy value to minimise costs and carbon footprint.

We aim to deliver safe, reliable, and sustainable sludge treatment by:

- effective operation and management of bioresources activities, and
- ensuring our sludge treatment assets are serviceable and in a stable condition through maintenance and planning. We describe our proposals for maintaining our bioresources services in the document WSX10 titled 'Maintaining our services'.

We aim to minimise our operating costs and reduce the carbon footprint of our sludge treatment by:

- investing in sustainable forms of sludge treatment that will result in a lower carbon footprint and increased renewable generation,
- exercising control measures over greenhouse gas emissions, and
- optimisation of sludge transportation logistics.

The continued development of the market for bioresources enables us to explore other potential opportunities to secure efficiencies in the delivery of bioresources services to our customers. Our aim is to ensure we are efficient against other operators in the market and to increase this efficiency by importing or exporting sludges, where appropriate, with neighbouring water and sewerage companies to utilise available spare capacity in the region Enhancement case criteria.

1.2. Principles of approach

Our sludge treatment strategy up to now has been to treat a greater proportion of our sludge via anaerobic digestion (AD) and reduce reliance on lime addition for treatment. The benefits of this strategy are the reduced sludge volumes for disposal and the improved carbon footprint from increased renewable energy generation and reduced chemical consumption. In pursuing this strategy, we have consolidated sludge treatment from 11 bioresources centres to seven – five AD sites (Avonmouth, Berry Hill, Poole, Taunton, and Trowbridge) and two lime treatment sites (Ratfyn and Yeovil Vale Road). Of the remaining four bioresources treatment centres (all of which were lime treatment sites), two were planned to be converted into dewatering sites (Minehead and West Huntspill), while the other two were planned for closure (Malmesbury and Wincanton).

Our sludge treatment strategy for PR24 is to continue maximising sludge digestion at the five AD sites due to the benefits mentioned above. However, we needed to keep West Huntspill and Malmesbury open in AMP7, as we lacked treatment resilience due to the 2020 Avonmouth incident and delays in the digester maintenance scheme at Poole. We acknowledged in PR19 that our capacity headroom in AMP7 would reduce as a result of our decision to not provide additional capacity to accommodate growth in sludge volumes.

Our review of treatment resilience in PR24 concluded that a capacity headroom of at least 30% is required to accommodate seasonal variations in sludge production, planned capital maintenance, and any unplanned plant failure. Our strategy to achieve this level of headroom in AMP8 is to provide additional digestion capacity at Avonmouth and additional lime treatment capacity at West Huntspill.

We have identified the need to temporarily close three of our anaerobic digestion sites to enable major maintenance and upgrade works to be safely undertaken at these sites. To facilitate their closure, we require additional short-term headroom capacity in AMP8 and therefore plan to provide temporary dewatering and lime treatment at West Huntspill and Palmersford, which will be funded through capital maintenance expenditure.

Figure 1 shows our current and forecast treatment % by AD and lime treatment. We currently digest around 80% of our sludge and lime the remaining 20%. With the planned AD site closures for maintenance in AMP8, we forecast that our treatment profile will shift to c. 70% digestion and 30% lime treatment. While this is our baseline plan for AMP8, we hope to optimise our tactical planning to recover as much sludge to our operational AD sites and minimise lime treatment, as per our bioresources strategy.

Figure 1 - Sludge treatment by treatment type in current (2023) and future (2025, 2030 and 2035) operation.

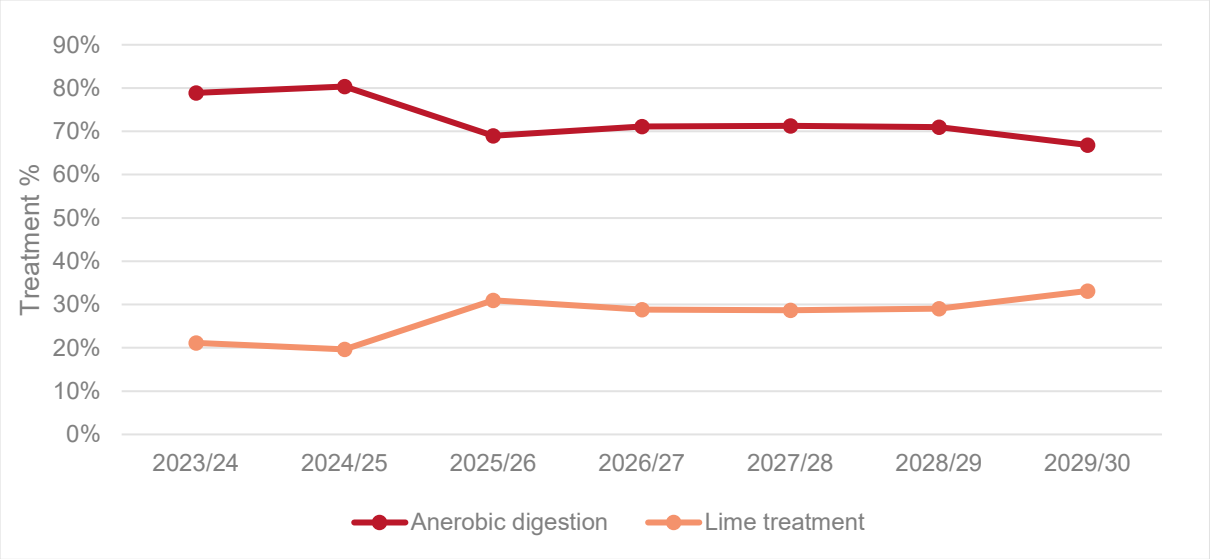


Figure 2, Figure 3 and Figure 4 show the historic regional profile of our sludge treatment from 2010 to 2020, while Figure 5 and Figure 6 show our forecast for 2025 and 2030.

Figure 2 - Sludge treatment in 2010

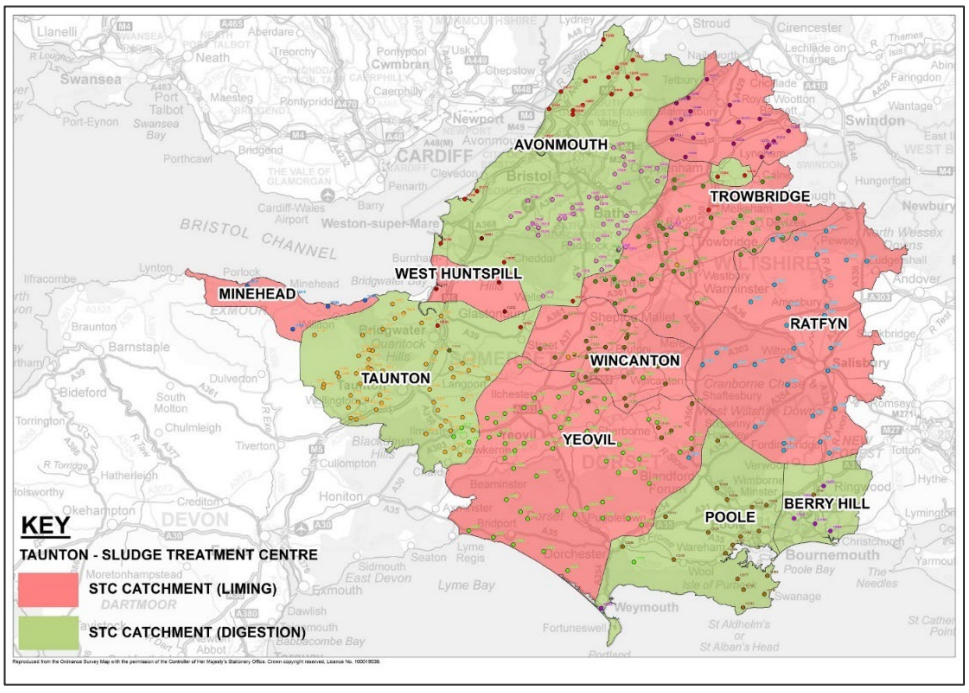


Figure 3 - Sludge treatment in 2015

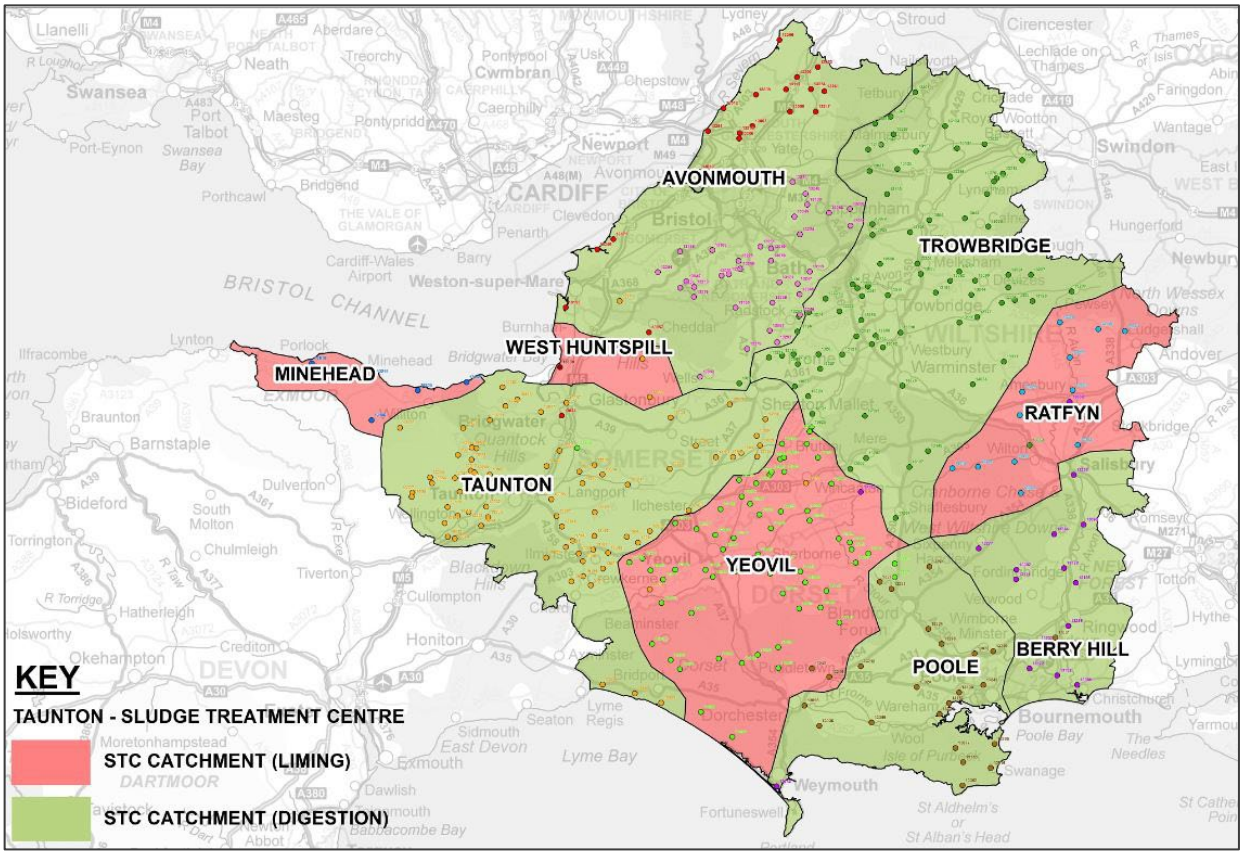


*Figure 4 - Sludge treatment in **2020***

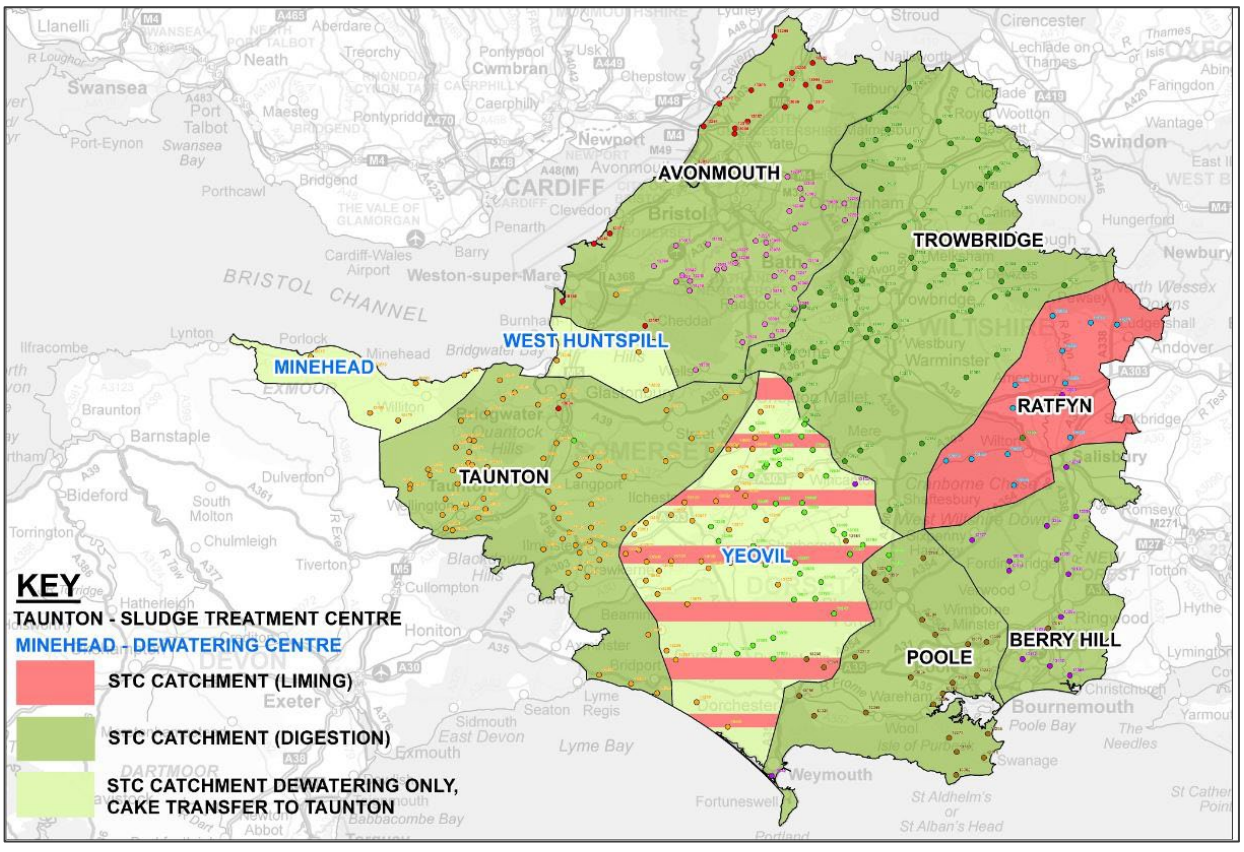


Figure 5 - Sludge treatment in 2025

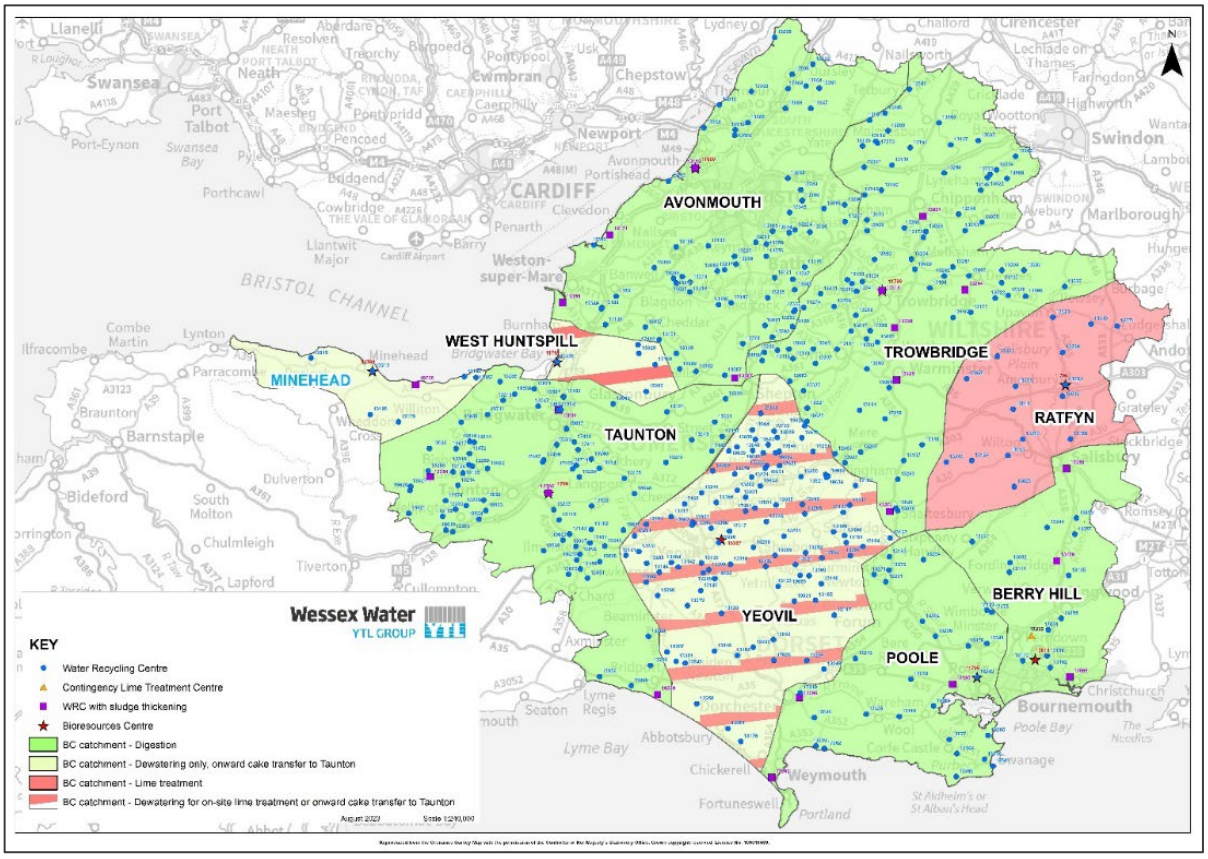
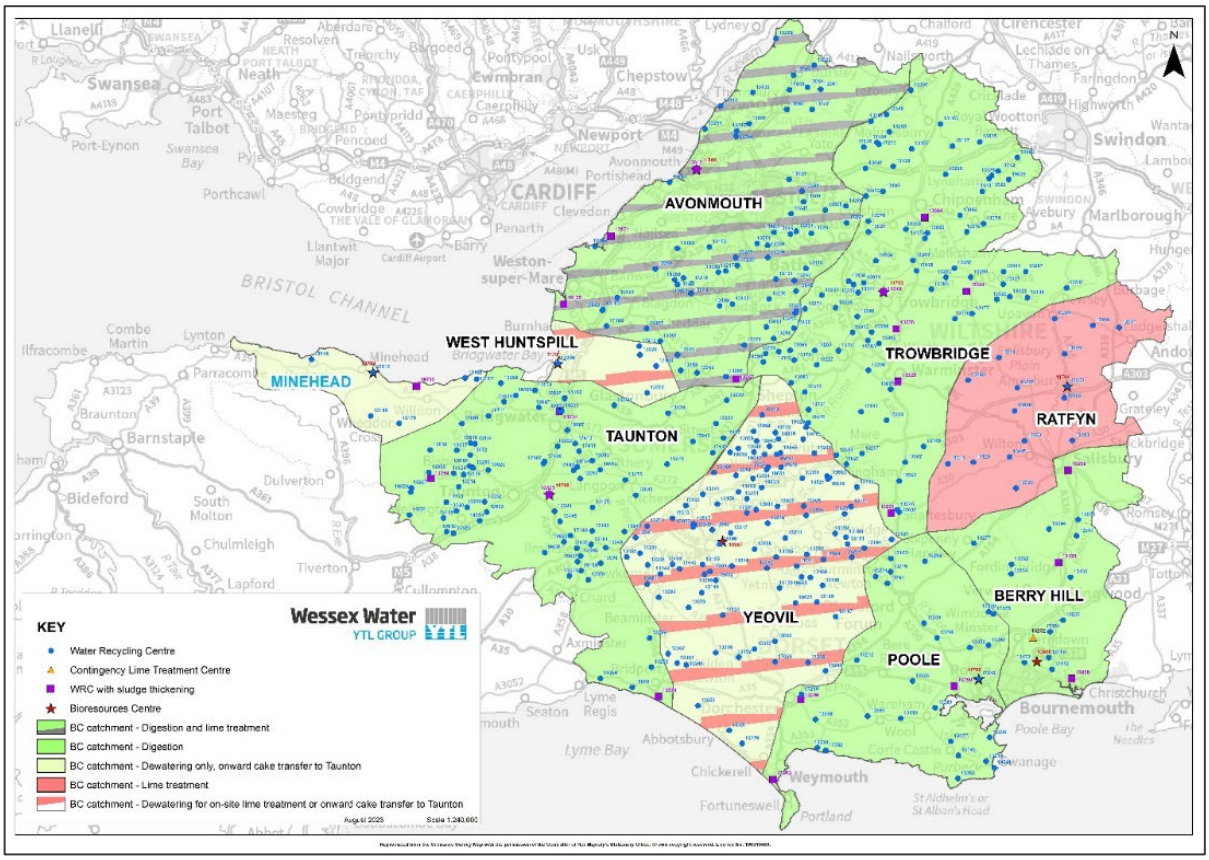


Figure 6 - Sludge treatment in 2030



1.2.1. Growth and quality enhancement investment proposals

The list of proposed growth and quality enhancement investment proposals for bioresources is summarised in Table 1; with further detail provided in subsequent sections of this document.

Table 1 - Growth and quality enhancement investment proposals for AMP8.

No.	Growth or quality	In or out of WINEP	Need or regulatory driver	Proposal
1	Growth	Out of WINEP	Our forecast total sludge production in AMP8 exceeds our current availability capacity Additional capacity required to achieve at least 30% regional headroom for resilience	Provision of two new digesters at Avonmouth and a larger lime treatment plant at West Huntspill to provide 10,950 tds per year of new capacity
2	Quality	In WINEP	Reinterpretation of Farming Rules for Water regulation impacting future landbank availability Move of biosolids to a deployment system (due to EPR implementation on sewage sludge recovery and disposal), resulting in potential delays in transport and land application of biosolids	Provision of additional 46,900m^3 biosolids storage capacity, which will allow all our biosolids to be stored for 3-4 months. The additional storage capacity will be delivered through nine Dutch barns – one at Avonmouth, two at Trowbridge, and six at Malmesbury.
3	Quality	Out of WINEP	Deterioration of sludge dry solids due to increased chemical dosing for achieving tighter P consents	Provision of additional sludge screening and thickening of 5,475 tds per year at Avonmouth.
4	Quality	Out of WINEP	Industrial Emissions Directive (IED)	Delivery of various site improvements (such as secondary containment and covering open sludge tanks) at Avonmouth, Berry Hill, Taunton, Trowbridge, and Poole to bring them up to BAT and Appropriate Measures standards
5	Quality	Out of WINEP	Environmental Permitting Regulations (EPR)	Delivery of various site improvements (such as secondary containment and covering open sludge tanks) at Palmersford, Ratfyn, Minehead, West Huntspill, and Yeovil Vale Road to bring them up to BAT and Appropriate Measures standards

We consider the enhancement cases no. 1, 2, 4, and 5 in Table 1 to be material due to their expenditure values. Our assessment of each material enhancement case is provided in Table 21, Table 22, Table 23 and Table 24 in Section 7.

As part of our internal governance process for the business plan, the outcomes developed have been tested through a series of internal risk and challenge meetings.

1.2.2. Risk management

The identification and management of risk is delivered through a tiered system of groups drawn from operational staff, management, Executive Directors, and the Board. The Board reviews and holds ultimate responsibility for the risk process, supported by the Audit and Risk Committee.

Asset and operational risks are reviewed, assessed and recorded continuously by staff, as a result of regular reviews and in response to changes. Risks are scored using an externally accredited process which assesses probability and impact on a five-by-five matrix. Risk mitigation plans are recorded and implemented where appropriate and pre and post mitigation scores are recorded.

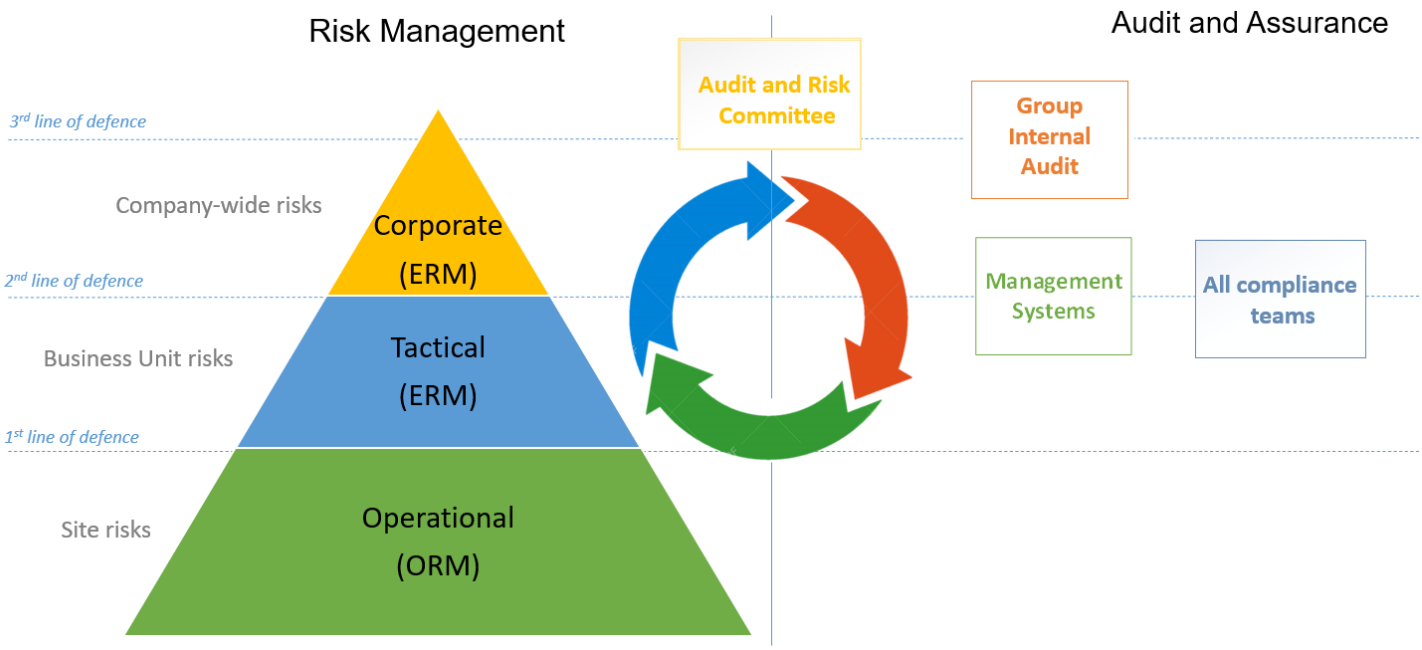
The risks identified provide a foundation for the risk hierarchy identifying more substantial tactical risks and a line of sight to the corporate risk system. The corporate risk register is maintained by senior managers from across the business who are experts in their respective fields. Oversight of this process is by our Risk Management Group (RMG) that review all business risks, including emerging and strategic risks. Where a risk is deemed out of tolerance, RMG will consider additional measures to reduce it to an acceptable level or escalate the risk as appropriate to the Executive Leadership Team (ELT) or the Board.

RMG meets through the year and submits an update on the strategic and principal risks to the ELT and the Board twice a year. Any significant new risks are reported to the monthly ELT meetings.

ELT scrutinises and challenges the risks and request additional work where necessary to better classify the risk or explore alternative mitigation methods.

In 2023 we are introducing a new corporate risk system which will integrate all of our company risk records and assurance activities, as represented in Figure 7 below.

Figure 7 - New corporate risk system



This would aim to:

- enable risks to be assessed consistently across the business with all relevant information in one place
- provide improved oversight of the company's overall risk profile and insight into detailed risk information
- produce a more succinct process for prioritising action plans for the mitigation and control of risks.

- allow us to make the better investment decisions by balancing risk, performance, and cost.
- streamline and simplify the audit process across the business and enable “Integrated Assurance” – using information about risks in the business to target our audit and assurance efforts and track trends.

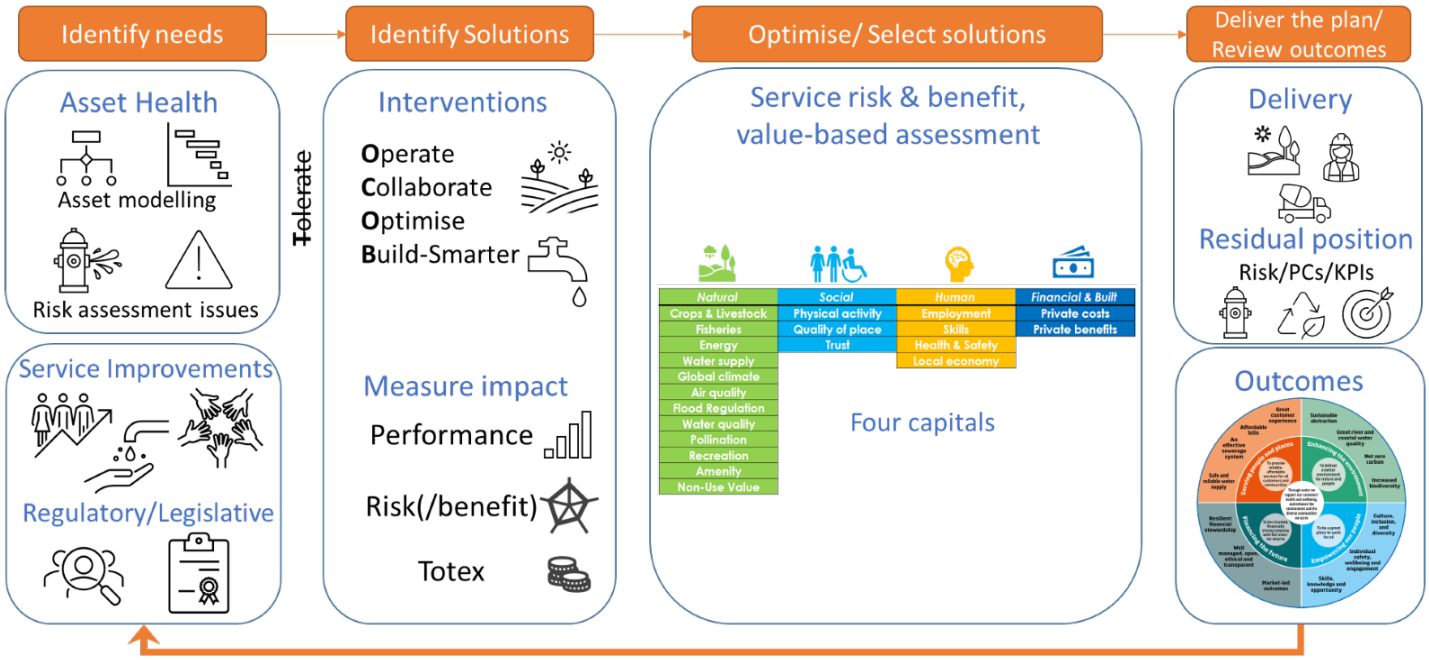
The audit module is already live and in use across the business. The risk module is expected to go live in Summer 2023. As part of this roll out, we have cleansed our existing risk data to maximise benefits of the system.

If a more substantial solution is required, involving a capital project, this will be dealt with through our investment management process. Suitable options are considered prior to an agreed solution being agreed. The capital scheme solution is then prioritised for funding based on the risk identified.

1.2.3. Investment management

Our new asset and investment management strategy is being implemented utilising the EDA (Enterprise Decision Analytics) decision support tool to enable optimal, data-driven decisions that balance complex factors for an optimal asset investment plan (Figure 8).

Figure 8 - Asset and investment management overview



This enables a consistent approach across the business for how we plan, manage and make-decisions on our investments, using service- and value-based decision making. It uses a forward-looking approach to project the change in risk, to inform when the risk should be mitigated, and uses a hierarchy of interventions to identify appropriate solutions. The risk reduction and benefits added of each solution is quantified and assigned value using the Service Measure Framework (SMF). The SMF monetises risk and benefits using four capitals, Natural, Social, Human and Financial/Built. When an optimisation is run in EDA, solutions are evaluated to determine the best-value options and associated optimal timing for implementation, that also effectively contribute to the programme-level risk reduction and performance targets required, within given financial constraints.

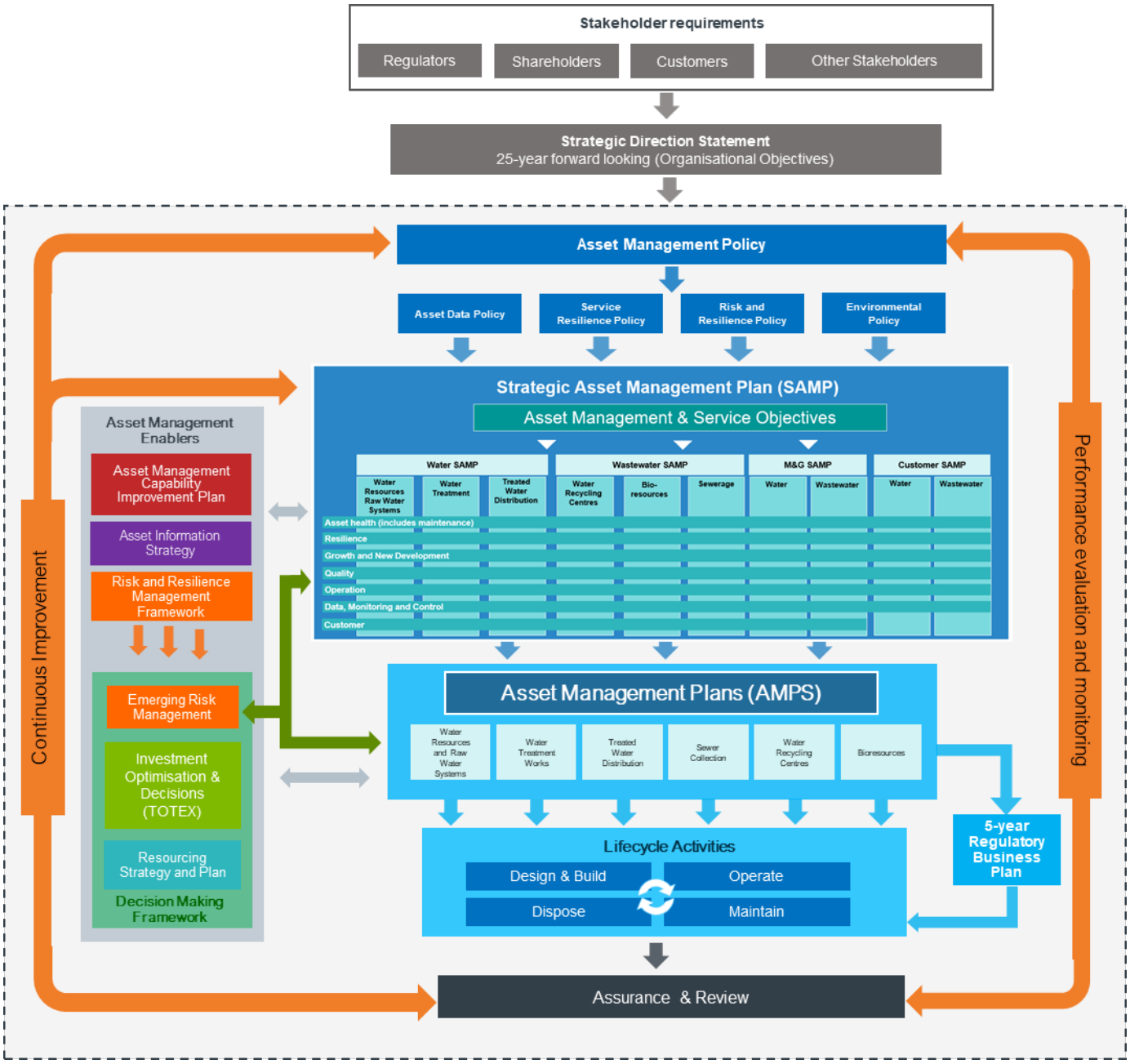
1.2.4. Asset management

Our asset management framework (Figure 9) is used to direct, coordinate, and control our asset management activities.

As a water and sewerage company (WaSC), our assets are used to deliver service to our customers and our asset management activities include all activities that allow us to:

- establish and deliver the objectives set out in our long-term strategic direction statement (including performance commitments)
- realise value from our assets for customers, communities, stakeholders, shareholders, and the environment.

Figure 9 - Asset Management Framework



Our asset management framework includes policies, strategies, plans, information management, decision-making processes and capital and operational delivery. It provides a number of important functions:

- it provides a clear line of sight so that everybody who works for or on behalf of Wessex Water understands how they contribute towards the delivery of our company objectives. The line of sight translates

organisational objectives from our strategic direction statement into asset management policy, strategy, and objectives, which cascade down into more detailed asset management plans and delivery activities.
- it ensures that our senior management decisions, strategies, and plans consider the bottom-up, fact-based realities, i.e., asset capabilities, performance, opportunities and constraints through our risk management and resilience framework and our decision-making governance processes.
- it provides our delivery staff with direct visibility of the purpose of the work they undertake – so they understand why it is needed, not just when and how to do it. This helps with identification and prioritisation of risks as well as encouraging innovation through identifying better ways of achieving objectives.

Our framework allows us to monitor our performance against all objectives through a hierarchy of KPIs and align our decision making and risk management processes to the achievement of objectives at all levels of our organisation.

Our asset management framework applies to the following types of assets:

- Nature-based assets e.g., reed bed, sustainable urban drainage
- Physical assets used for the provision of services to our customers.
- Equipment, inventory, and properties owned by Wessex Water
- Data, information and operational technology and digital assets
- Intangible assets – such as Wessex Water leases, brands, intellectual property rights, licences and software
- Wessex Water employees and third-party providers

1.2.5. Resilience

‘Resilience is the ability to cope with, and recover from, disruption and anticipate trends and variability in order to maintain services for people and protect the natural environment now and in the future’ (Resilience in the Round, Ofwat, 2017).

Resilience is at the heart of our business plan and is the fundamental driver behind how we deliver our ‘safe and reliable water supply’ strategic outcome. We recognise the responsibility we have in providing essential public services to customers and in managing the natural environment, both now and for future generations. Maintaining and strengthening our resilience is critical to ensuring we can continue to deliver reliable and trustworthy services to our customers. This is particularly true given the landscape of an increasingly frequent experience of more extreme shocks and stresses. To be truly resilient and fit for the future, we recognise we must take a long-term view in our plans and procedures, with an aim to anticipate likely changes and actively respond or adapt as they occur.

In recent years, Covid-19, the war in Ukraine and global economic challenges have highlighted the increasing frailty of our supply chain, including people resources, power, chemicals, materials, technology, information security such that we are having to be more self-reliant and provide increased resilience just to maintain existing service performance (i.e. more generators, increased cyber security, early procurement, additional on-site resilience at key locations).

We face many challenges which will potentially affect our resilience, now and in the future, and we must predict and prepare for these eventualities. We recognise these are sector or wider issues, so we cannot address them all by ourselves, so we will also seek partnerships with others to address specific improvements.

2. Market opportunities

2.1. Overview

We welcome the opening of the bioresources market this AMP and fully support the development of the market to bring new opportunities for delivering efficient bioresources services to our customers.

Our approach to the bioresources market is to explore the opportunities that will deliver existing services for lower cost or provide additional services to others where capacity exists or is created. We consider there are four main trading opportunities for bioresources:

- providing a resilience service with minimal additional assets,
- logistics optimisation across water and sewerage company boundaries,
- short to medium-term bioresources contracts to utilise a third party's temporary spare capacity,
- longer-term bioresources contracts with a third party.

We have reviewed the opportunities that might be available within our area and at the boundaries with other water and sewerage companies (WaSCs) using each company's publicly available bioresources market information. We also update our bioresources market information on our website annually in July to ensure our trading opportunities are visible to the market. This bioresources market information has formed the basis of discussions with other WaSCs in our PR24 planning, to understand the potential options for trading and investing in shared capacity for efficiency.

We have also engaged the wider market for 3rd party solutions for capacity provision in AMP8 through a joint market enquiry with Severn Trent Water. We describe this in further detail in Section 2.4.

2.2. Existing opportunities

We have been providing a longer-term bioresources service for Veolia's sewage treatment works at Tidworth since June 2011. A complete service is provided: Wessex Water collect the sludge, treat it at either Ratfyn or Trowbridge and undertake the subsequent recycling of the treated product to land.

We have exported sludge to neighbouring WaSCs for 3rd party resilience service. For example, in 2022-23 we exported 115tds of sludge from our South East region to Southern Water's Millbrook site in Southampton to cope with the delays in the digester refurbishment work at our Poole site. We also exported 75tds of sludge from our Northern region to Severn Trent Water's Netheridge and Finham sites due to the lack of contingency capacity in our Northern region as a result of the 2020 Avonmouth incident.

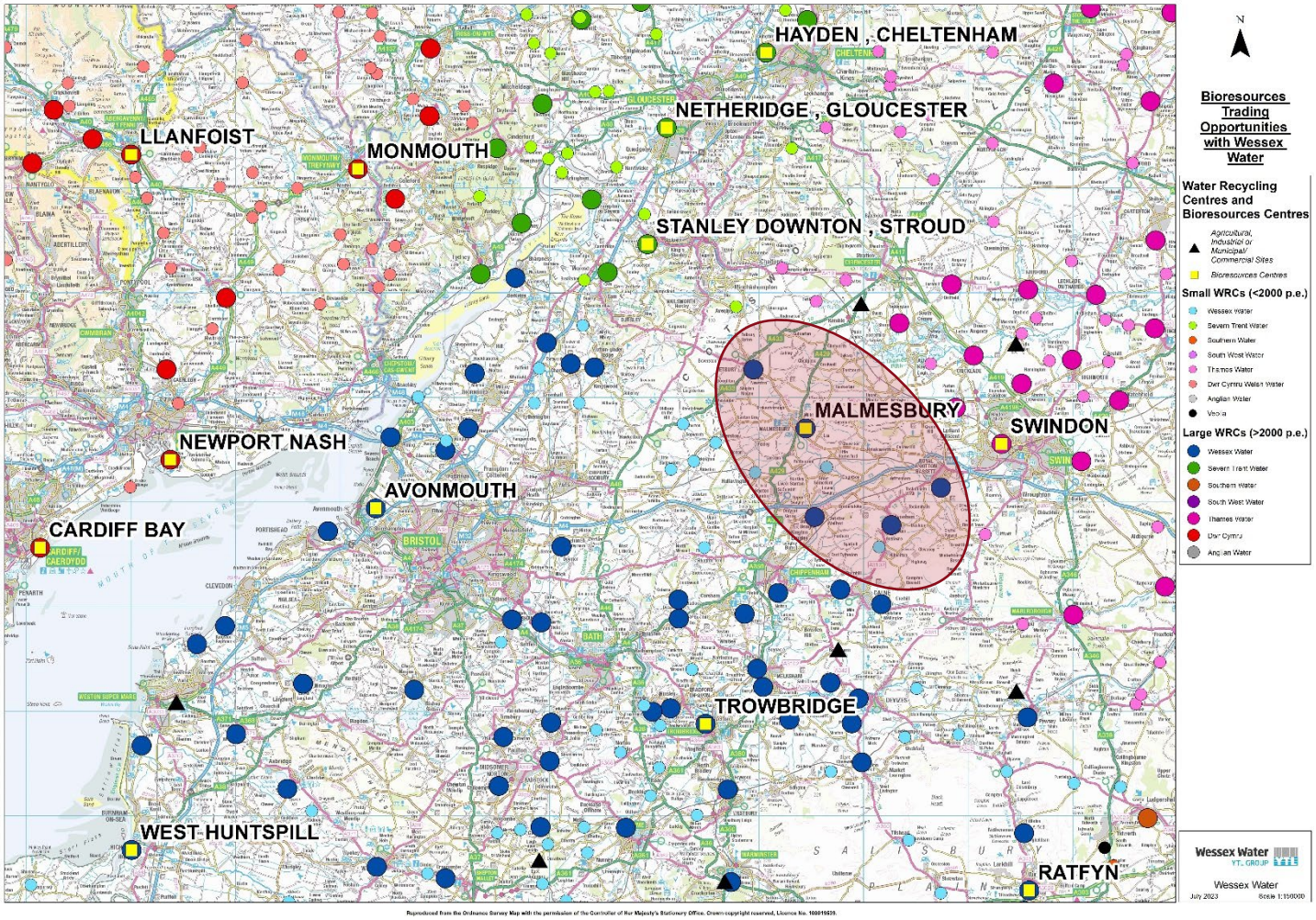
2.3. Future opportunities

We have structured our review of PR24 market opportunities by our geographical regions (Northern, South West and South East). A map of our entire region showing the location of bioresources centres and water recycling centres is provided in Annex A1.

2.3.1. Northern region

Our Northern region consists of Avonmouth, Trowbridge, and our proposed contingency lime treatment centre at Malmesbury. It is bordered by Severn Trent's Southern region (which consists of Hayden, Netheridge and Stanley Downton) and Thames Water's Swindon site. Figure 10 shows this combined geographical area.

Figure 10 - Northern region



We forecast the need for additional capacity in our Northern region in AMP8. Severn Trent Water have also identified the need for new capacity in their Southern region. We have therefore discussed options for joint capacity provision. We decided to engage the market to explore joint 3rd party solutions for potential increased efficiencies. We describe this in further detail in Section 2.4.

There is also the opportunity for short to medium term sludge trades with Severn Trent Water. The recent THP upgrade to their Finham site has resulted in available headroom, which Severn Trent Water are willing to offer on an ad hoc basis to assist with our resilience management. We therefore plan to export sludge from our Northern region to Finham until our proposed contingency lime treatment at Malmesbury and West Huntspill are available in early AMP8. We do not consider long-term sludge export to Finham to be sustainable for resilience management as the headroom capacity at Finham is contingent to Severn Trent Water's bioresources operation. We also consider the commitment to long-term trades to be a risk at the moment due to the ongoing uncertainties in the environmental regulations that affect sludge treatment and disposal, i.e., Industrial Emissions Directive (IED), Farming Rules for Water (FRfW) and the EA's Sludge Strategy. However, we will continue to monitor our trading activities with Severn Trent Water as we are both keen to develop the market in this region for the benefit of our customers.

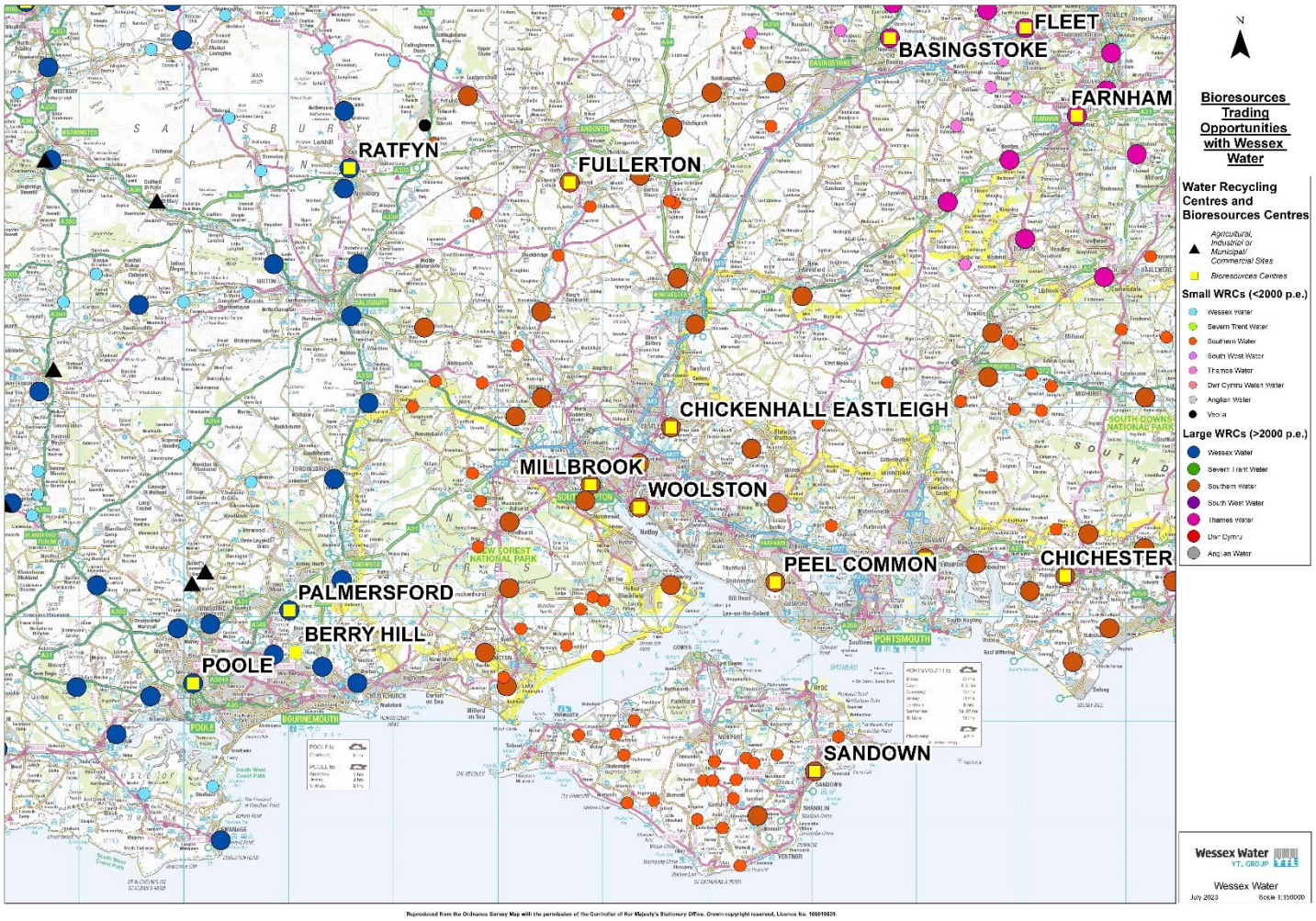
In Figure 10, the five larger water recycling centres in the red shaded area are located closer to Swindon than Trowbridge, but currently export sludge to Trowbridge (as Malmesbury was closed at the end of AMP6 and will only be reopened to operate as a contingency lime treatment centre from AMP8). Sludge from these five water recycling centres could be diverted to Swindon as part of a logistics optimisation solution. As both Swindon and Trowbridge are advanced anaerobic digestion sites, the cost of sludge treatment at both sites would be comparable. However, according to the bioresources market information published by Thames Water, there would not be any tradeable

capacity at Swindon throughout AMP8. We will continue engaging with Thames Water to review future trading opportunities should headroom capacity at Swindon becomes available.

2.3.2. South East region

Our South East region consists of Poole, Berry Hill, Ratfyn, and our proposed contingency lime treatment centre at Palmersford. It is bordered by Southern Water's Millbrook and Fullerton sites. Figure 11 shows this combined geographical area.

Figure 11 - South East region



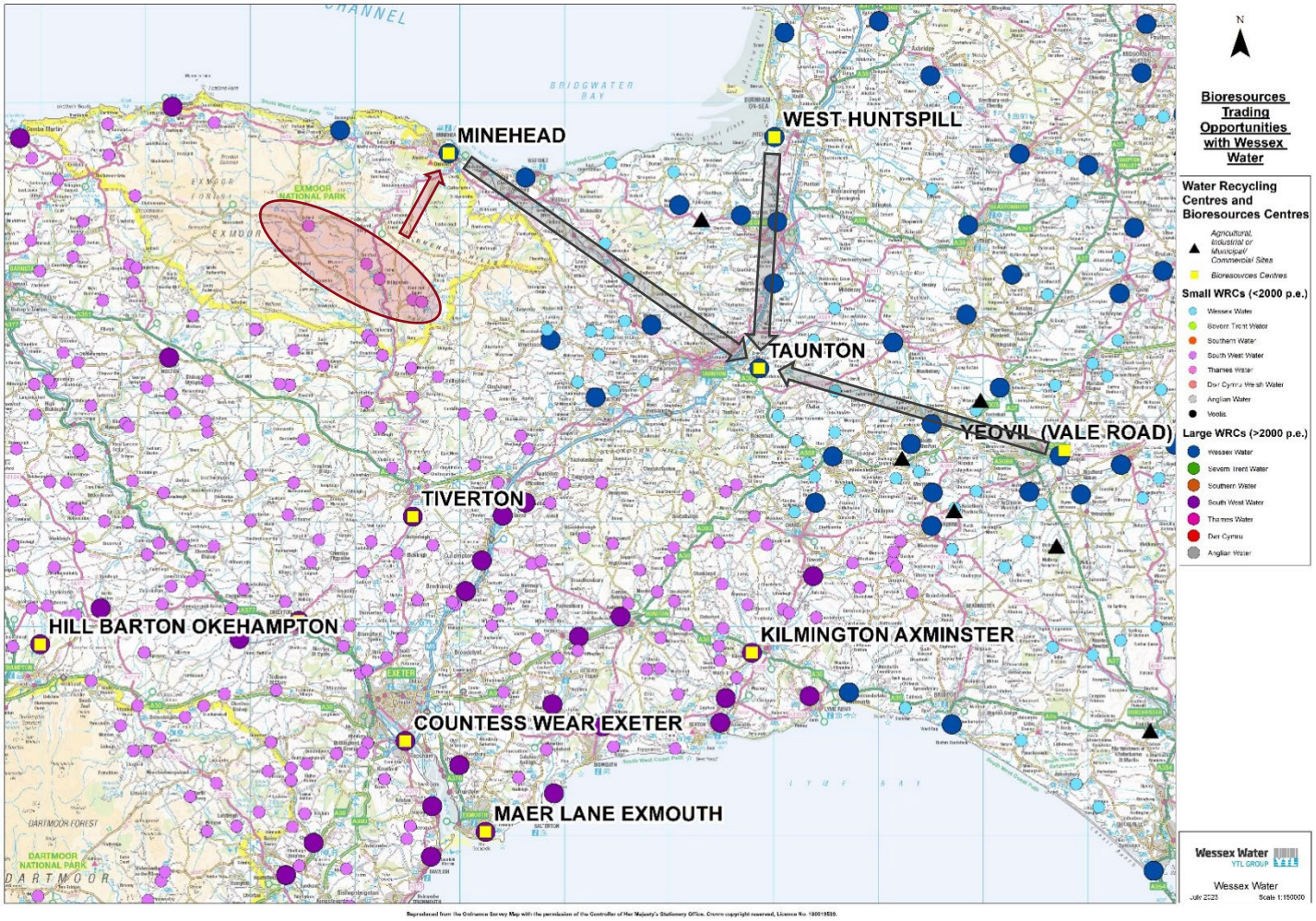
We are not forecasting the need for additional capacity in our South East region in AMP8, as additional capacity was provided in Berry Hill in AMP6 and the digesters at Poole are being refurbished so that Poole's digestion capacity can be maximised. When the digester refurbishment is complete at Poole, we forecast that Poole and Berry Hill will have a combined headroom capacity of c. 500 to 1000 tds per year in AMP8.

In our discussions with Southern Water, we understand there would not be any long-term tradeable headroom capacity at Millbrook or Fullerton. However, we are both committed to supporting each other's resilience management through mutual ad hoc sludge trading. To that end, we have set up a resilience agreement with Southern Water, which is provided in Annex A2.

2.3.3. South West region

Our South West region consists of Taunton, Minehead, West Huntspill and Vale Road (Yeovil), and borders South West Water. Figure 12 shows this combined geographical area.

Figure 12 - South West region



In AMP6, we invested in additional capacity and cake reception at Taunton to develop the site into a regional digestion hub. This allowed the bioresources operation in the region to be optimised, as dewatered sludge from Yeovil, West Huntspill and Minehead could be transferred to Taunton for digestion, instead of on-site lime treatment. The lime treatment plants at these sites would then be reserved as contingency capacity for resilience.

The onward transfer of sludge from Minehead would allow South West Water's water recycling centres in Exmoor (in the red shaded area in Figure 12) to export sludge into Minehead for onward transfer to Taunton. This was trialled in PR19. However, we identified issues with the biogas system at Taunton, which is required to be rectified before Taunton could operate at design capacity. A capital maintenance scheme is underway for upgrading the biogas system at Taunton, which we expect to complete by 2025; at which time we will review the Minehead arrangement with South West Water. However, we anticipate that the risks associated with the uncertainties of IED, FRfW and the EA's Sludge Strategy will impede long term commitment to this arrangement from both parties.

We forecast that Minehead and Yeovil will have a combined tradeable capacity of c. 1500 tds per year in AMP8. As cake transfer is possible between Minehead, Yeovil, West Huntspill and Taunton, these four sites operate as one integrated bioresources treatment system and the tradeable capacity can therefore be provided through any of the four sites.

We envisage that the cake reception facilities at Taunton and West Huntspill would make these two sites attractive for trading due to the efficiency from transporting sludge as cake. We would be able to use these two sites to offer ad hoc resilience service to South West Water to support their resilience management in this region. We maintain a good working relationship with South West Water, and we will continue to collaborate with them to develop the market in this region.

In recent discussions with South West Water, both companies recognised there is potential for further cross-border collaboration in our region. We will explore options with South West Water for the efficient delivery of capacity provision covering 25 years of sludge growth needs from both companies. We will report updates in our annual bioresources market monitoring survey submission.

2.4. Market engagement with Severn Trent Water

2.4.1. Overview

In June 2022, Severn Trent Water (STW) and Wessex Water (WSX) recognised that we were both seeing an investment need in the North of the WSX region and the South of the STW region. There were 4 sites identified that could benefit from new capacity within the next 5-10 years and so a joint Market Challenge was released.

The Market Challenge was set up as a structured approach to the wider Water industry seeking solutions and commercial models that could allow us to deliver better value for our customers. An informal route was chosen because it was unclear what would best fit the market's needs. The intent was to understand how any formal tender might be structured to get most interest and value once the challenge was concluded. It also allowed each company to maintain impartiality if one was keen to provide capacity for the other at a host site.

In the first stage we received 28 separate company responses. These responses ranged significantly from highly innovative technology to component parts of the process, to optimisation of our existing sites and several full-service provisions.

Given the requirements of the challenge and the required timeline, a lot of the technologies that were either not providing the additional capacity or did not have the established technology readiness were discounted. Some of these technologies will be followed up by the companies independently of each other to ensure the opportunities they create can be advanced where appropriate.

The best responses were shortlisted to three companies capable of providing new capacity. These companies were then interviewed by a panel from both companies to assess some of the more detailed contractual obligations and risk challenges. The companies gave a variety of responses, but many of the opportunities presented were reliant upon connection to existing assets and process.

Upon review, both STW and WSX reached the conclusion that the market is not mature enough to go to formal tender – the responses were not sufficient enough to make either company believe there is a suitable, competitive market to use. All offers were heavily reliant upon using land, access to the associated wastewater treatment plant and planning commitments of the existing sites.

All bids were reviewed for process improvement, commercial feasibility, and resilience to see how they could better the existing methods of operation. On all counts, no clear step change from how the incumbent WaSCs operate could be discerned. Many of the offers sought to replicate some of the most cost beneficial / profitable areas of our existing process whilst passing back the risk for delivery to the incumbent.

In conclusion, the market has demonstrated a well-acknowledged opportunity to optimise sites but has not shown sufficient deviation from current best practice to demonstrate that the marketplace can deliver any further efficiency. Consequently, STW and WSX are not looking to progress with a joint market solution at this time and will factor development of the capacity into our own PR24 business plans.

2.4.2. Summary of approach

Following the conclusion of the AMP7 business planning process, Severn Trent Water (STW) and Wessex Water (WSX) met to discuss the possibility of using markets to establish new treatment capacity in the Somerset / Gloucestershire area where our 2 companies share a catchment border. Both companies are high performers in the Bioresources sector and have shared interests in producing high value solutions for the next AMP.

Both companies have a need for new treatment capacity and so a market challenge was set up. The market challenge process seeks to establish outline solutions from the market for sludge services prior to building a formal tender. In this case, the aim of the process being to identify new treatment capacity for 10,000 to 25,000 tonnes of dry sludge per annum by 2027.

STW need to invest in our Southern region due to a combination of ageing assets and growing population around the Cheltenham and Gloucester area. WSX are expecting to see growth in the Avonmouth and Trowbridge catchments that would require new capacity to treat.

Both companies need to have a solution that fits in with AMP8/9 strategy and are open to options around trading across the traditional geographic boundaries to make this happen. Three options were discussed, STW treats WSX on one site, WSX treats STW on one site, or a market solution that treats both.

In order to understand the prospective options in the market a challenge was launched with very broad parameters to understand what type of solution the market would use and how they would help with the uncertainty around environmental regulation.

STW and WSX issued our joint market opportunity on the 29th of June 2022 seeking new market capacity. The launch was accompanied by a webinar for interested parties where both companies gave insight to the challenge and took questions on our needs. The challenge was also promoted at both the 2022 Utility Week and Biogas Expo exhibitions. Over 70 companies signed up to express initial interest, with c. 40 attending the launch webinar, ranging from fellow Wastewater Companies to innovative technology suppliers.

The initial request was for a short report-based response on how each service provider would tackle the challenge and work with the companies in any role to deliver the outputs. 28 companies responded with a broad range of options, with 30 options received in total. Due to the high volume of responses, it took longer than expected to review the offerings against technical viability, ability to tackle the challenge and commercial suitability of the company.

7 either did not meet the challenge needs and were discounted.

8 were found to be too innovative. Either the technology had never operated at scale required or had not operated on sewage sludge. These have been taken forward in to cross-industry discussions on future technology trials.

6 were only a part solution via integration into the existing asset base and would provide additional capacity but would be limited by geography. These may be considered further by STW and WSX individually.

3 offers were generic in that they did not produce a clear offering, only outlined the wide range of operational models they could offer. With no discernible, credible offer these companies were dismissed with a view that they may return in any formal tender.

6 proposals offered a solution that was considered credible, with 3 of these consisting solely of incineration of biosolids. Due to the uncertainty around the environmental regulation of biosolids disposal, the incineration options have not been progressed further at this stage.

Three companies were therefore shortlisted for face-to-face reviews to shape the type of commercial models needed to make this a success. The questions for the interview are supplied in Annex A3. The questions were issued to companies in advance, allowing for them to prepare in advance and gave companies an opportunity to

demonstrate how they would differentiate themselves from our existing operations and how they would setup their service offering. The following analysis shows the conclusions of these activities and questions.

2.4.3. Detailed Analysis

1. Management of capacity – contracting approach

A concern for both companies was the security of future capacity and how it could be managed commercially. There were two models proposed:

- Merchant facility. This would be a plant completely based on contracted volumes of supply, most probably on a separate site. Contracts would focus on long term capacity supply but any capacity outside of the core request would be open for trading. This posed a lot of risk for STW and WSX given the lack of certainty around future volumes due to population growth and technical demands of the waste WINEP.
- Co-sponsored facility. The site is formally obliged to take future volumes from STW and WSX as a priority. This may need to be co-located. This option was favoured as it gave the companies control over the capacity and long-term security for the service provider. However, this is conventionally how sites are built, and the inefficiency of surplus capacity remains with the Wastewater companies rather than the service provider.

Both options were proposed, and 2 of the final 3 companies offered good flexibility around the options. Step-in rights were discussed in the event of default. If the merchant model was operated then this would be a challenge, given the likelihood of external contracts forming a large part of the business.

The challenge for both STW and WSX is that a merchant model clearly offered the greatest opportunity for efficiency but gave a high level of uncertainty around long term security of capacity. In procuring the long-term capacity, both companies would be following an investment approach similar to the existing method of self-construction and so it appears to offer less efficiency.

2. Regulatory uncertainty

One of the key areas of discussion was around the security of long-term treatment and how the impact of environmental options would be managed. In all circumstances, the risk fell back to the WaSC as the licensed undertaker. In the event of loss of land bank there would be a cost to bear, and this would likely be a substantial shift to new technology that would not be deployed initially. However, different options were proposed by the 3 candidates.

- One company proposed an additional installation of a mono-incinerator. They felt that this could be deployed at the scale required but it would be testing the throughput limits of current technology. The cost would add £80-£100 per tonne wet feed to the process.
- Two companies suggested they would focus on pyrolysis technology to mitigate the loss of land bank. One company was in the process of trialling a plant in the USA, but this was being combined with MSW type waste and had not entered commissioning yet.
- In all cases, the preference was to stay with sludge to land in the first instance to keep costs down. One company did show a concerning lack of understanding around sludge / biomass to land regulations which did pose a concern for both parties.

In all 3 cases, the companies failed to show real differentiation from conventional models. One company did have a well thought out solution, but the price involved was hard to invest in and there were concerns over permitting and land availability for construction and disposal. There were groups from the earlier rounds that have developmental technology that may improve this market and should be explored. In all cases, the risk would be an additional cost under the contract and one which would be significantly harder to negotiate if a service provider were in place.

Regulatory certainty around IED and Sludge to land would help to clarify the situation for both WaSCs and the market. Without certainty, there is clearly an expectation that STW and WSX would carry the risk and could potentially be contractually tied to a very expensive ongoing solution if the environmental risks materialise.

3. Need for links to existing water recycling centre

Liquor returns are a key feature of any treatment facility. Internal costs for Tanker Waste disposal based on the Mogden formula show this to be a significant expense which is currently managed via a cost neutral transfer between price controls. When discussing with the final candidate companies, all 3 suggested this was an area which required input / innovation. One company did not offer a response with enough clarity in this space, but there were two separate suggestions.

- One company suggested the only way to cope with the liquors would be to co-locate with a sewage works either at Gloucester or Avonmouth. This means that there would be no removal of cost or risk associated with the treatment of liquors. It would also mean that the WaSCs would have to find land for the development and one WaSC would need to travel the full distance to the host site.
- One company suggested co-location with an energy recovery facility (ERF) that they were already operating. This would allow heat from the ERF to evaporate off the liquors and leave only solids for further processing. Whilst potentially effective, this did leave a lot of concerns around process emissions with the direct evaporation of ammonia to atmosphere. It also raised concerns around IED and permitting requirements.

In order to progress a 3rd party bid it became clear that a wastewater company would need to have available a significant parcel of land. The preference of proximity to a Sewage Treatment facility for the treatment of liquors implies that the host company would require a portion of land to sell and would have to have capacity for the expansion of the Sewage works to ensure the liquors could be accepted from all of the sites.

4. Cost of financing and length of contract

For the contract to proceed the companies offering the full DBFO model were seeking a form of contract that guaranteed supply for 20 years. These could take the form of 15+5 contracts or variants thereof, but no contract was offered for a shorter period. The current rules around co-mingling of waste and uncertainty around future disposal mean that any investment requires that level of long-term certainty on gate fee.

Under current regulatory process, the investment is only secure for 5 years and if it becomes inefficient then the wastewater companies would be expected to take the financial risk. This could leave both companies exposed to 15 years' worth of inefficient contracting, even if it is linked to circumstances beyond their control e.g., technology shift.

The positive is that the market is clearly interested in long term value, and as such it is possible to get more certainty around capacity availability into the future. With improved certainty around future environmental and financial regulatory requirements, this could be a more attractive proposition.

5. Unit rate efficiency

One company provided an indicative gate fee of £80 per wet tonne of sludge cake, while another company provided a range from £20-£75 per wet tonne of sludge cake. At £75 and £80 per wet tonne, these prices are much higher than our current unit costs, and these offers do not provide a step change in efficiency. The large range quoted in the 2nd offer highlights a lack of maturity in the market and therefore a lack of confidence in providing any cost certainty. In any case, without a formal tender, it would be high risk to commit to such an offer.

Other companies did not provide any costs, presumably because they do not have certainty around the cost to treat at this scale. Without a clear commercial establishment of risk and the terms of engagement, most companies were not prepared to quote a price. This is going to cause us problems as we look to compare effective treatment models with market rates to make a formal decision.

6. Structuring a tender – challenges around working together

Whilst less concerning, an interesting point to note has been the development of the relationship between Wessex and Severn Trent. The experience has been incredibly positive, but the one area we are both sure would be tricky to develop is aligning the objectives and direction of both businesses precisely enough to create a formal tender.

With most companies preferring a single entity to contract with, we would be required to form an alliance or joint venture company to effectively move the sludge. Whilst we have not taken it further at this time, this is not common practice and we have identified it may take time to align shared objectives that meet individual company ODIs as well as understanding how we would manage additional capacity rights or potentially even step in rights for either party.

To organise a collaboration of this type would take time, even though both companies appear well aligned. Before any tender exercise could be run, we would need to create a contracting entity that would be fit for purpose and meet all regulatory guidance / expectations.

2.4.4. Summary

STW and WSX are both seeking to develop new capacity in AMP8 and AMP9 in a similar region. We wanted to understand if the competitive market was there that would give us confidence to allow a 3rd party to provide some of our Bioresources services. We viewed success from the process would be the identification of a growing market with multiple companies seeking opportunities with us.

Unfortunately, the market has given no clear direction of where it can offer price efficiency or alternative methodologies for operating beyond how we do today.

Most of the companies interested in the market are selling part of the treatment solution as a build on what we do today as opposed to an end-to-end service offering. Whilst useful to us and very interesting, this is broadly how we operate today, seeking innovation at various points in the process as regulatory or environmental drivers appear.

Commercially, companies are looking for the same security as we are. Long term security on income and risk reduction through more certain regulation. Working with these companies may offer some degree of shared responsibility, but when it comes to providing customer value no company was prepared to support the wastewater businesses in our legal duties or risk by providing long term cost certainty.

In terms of an operational model, even the best responses relied very heavily on co-location to provide land, reduce cost and deliver liquor disposal. This means that our existing sites and assets are considered well positioned and with clear commercial advantages.

Financially, companies were needing to cover borrowing costs. Whilst no discussion was had on the rates involved, with the ability of STW and WSX to raise funds and balance against the RCV processes this means that a new entrant will struggle to compete in terms of funding efficiency.

There are several excellent opportunities which each company will follow up with individual suppliers. However there have been very limited numbers of applications that offer something to differentiate the market to what we do today. STW and WSX both are best positioned to manage our existing assets, the land around them and our relationship with our wastewater colleagues for liquor treatment. We both have secure financing approaches which are well supported by the current regulatory framework for PR24. We retain better control over future capacity needs and regulatory uncertainty by managing our own asset base. All companies asked would expect us to pay variations if there were substantial changes to regulation as expected.

To move to a more merchant based market moving forwards, the key drivers will be improving the certainty of environmental regulation and increasing education of the supply chain to the needs of the wastewater companies and some of the unique challenges being managed. There were not enough credible offers submitted that made us think the market can be competitive and significantly change how bioresources operates commercially at this time.

3. Future landbank availability

3.1. Background

We currently dispose 100% of our biosolids to agricultural land and have a particularly high percentage of our catchment that is classed as environmentally sensitive. The sole reliance on a single agriculture outlet for our sludge poses a significant risk for our bioresources supply chain, as future landbank availability is expected to reduce.

In terms of pressure on landbank, there are a wide range of factors that could and do affect the amount of agricultural landbank available for biosolids recycling. The regulatory environment has and continues to be subject to change, which can create uncertainty and pressure on the landbank. The regulations governing the recycling of biosolids to agricultural land are under review and there has and continues to be significant discussion concerning the Farming Rules for Water (FRfW) regulations. Although the introduction of Statutory Guidance in relation to the FRfW appears to have abated concerns, there is still uncertainty around certain requirements and what may happen in the future. Phosphate management is likely to continue to come under renewed focus probably leading to a tightening of rules beyond what is currently allowed under the Biosolids Nutrient Management Matrix and even in terms of nitrogen management (e.g., autumn applications). Moreover, the exact form of the EA Sludge Strategy is still being decided, but it is likely to have a significant impact on the process, logistics and operations associated with the recycling of biosolids to agricultural land.

Another potential threat to the recycling of biosolids to agricultural land is the presence of contaminants in sludge, such as poly- and perfluoroalkyl substances (PFAS), microplastics and antimicrobial resistance, which are not removed by the current sludge treatment methods of anaerobic digestion and lime dosing. Negative public perception on biosolids could potentially lead to public pressure to close the agricultural outlet for sludge.

The reduction of landbank availability within our catchment boundary would result in the need to pursue landbank outside our catchment boundary. As this would be the same for other companies, the industry has therefore considered landbank management to be a national issue and requires a collaborative approach across the industry. To aid this, the industry commissioned the following studies:

- National landbank assessment – completed by Grieve Strategic to model future landbank availability based on nutrient restrictions imposed by the FRfW regulation,
- Biosolids storage assessment – completed by Atkins to understand storage capacity requirements in AMP8,
- National Bioresources Strategy – completed by Atkins (for CIWEM) to identify potential strategic directions for bioresources and route map for diversification of sludge outputs.

The outcomes from these studies are discussed further in Sections 3.1.1 to 3.1.3, but the summary conclusion is that the most likely scenario is that there will be insufficient landbank by 2035 for all companies in England and Wales to recycle their biosolids. There is therefore a need for investment in reducing the volumes of biosolids requiring disposal, providing sufficient supply chain resilience through sludge storage, and planning for the diversification of sludge outputs to unlock new disposal outlets.

3.1.1. National landbank assessment

The national landbank assessment was undertaken by Grieve Strategic to review future landbank availability. A range of landbank scenarios was produced based on increasing stringency in the nutrient restrictions from the FRfW regulation.

The modelling methodology considers forecast biosolids volumes supplied by each company, and various factors, such as land restrictions, nutrient content in biosolids, soil phosphorus index, and farmer acceptance rates.

A breakdown of the landbank scenarios and associated assumptions can be found in Annex A4, with a summary of the scenarios as follows:

- Scenario 1 – Historical in 2020 (pre-FRfW reinterpretation)
- Scenario 2 – Baseline in 2025 (post-FRfW reinterpretation)
- Scenario 3 – Minimal change by 2035
- Scenario 4 – Most likely change by 2035
- Scenario 5 – Plausible maximum change by 2035

The worst-case scenario, which is not modelled, is a total closure of the landbank outlet, which could be prompted by external factors such as public perception.

A geospatial view of the outcomes for Scenarios 2 to 5 are shown in Figure 13, Figure 14, Figure 15 and Figure 16.[1]

*Figure 13 - **Scenario 2** (Baseline in 2025)*

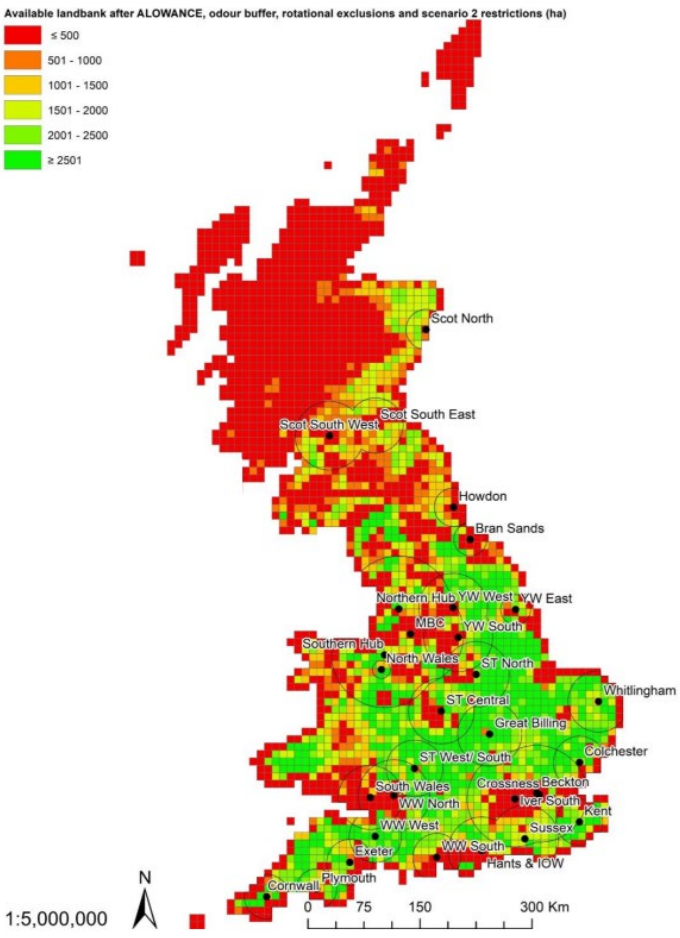
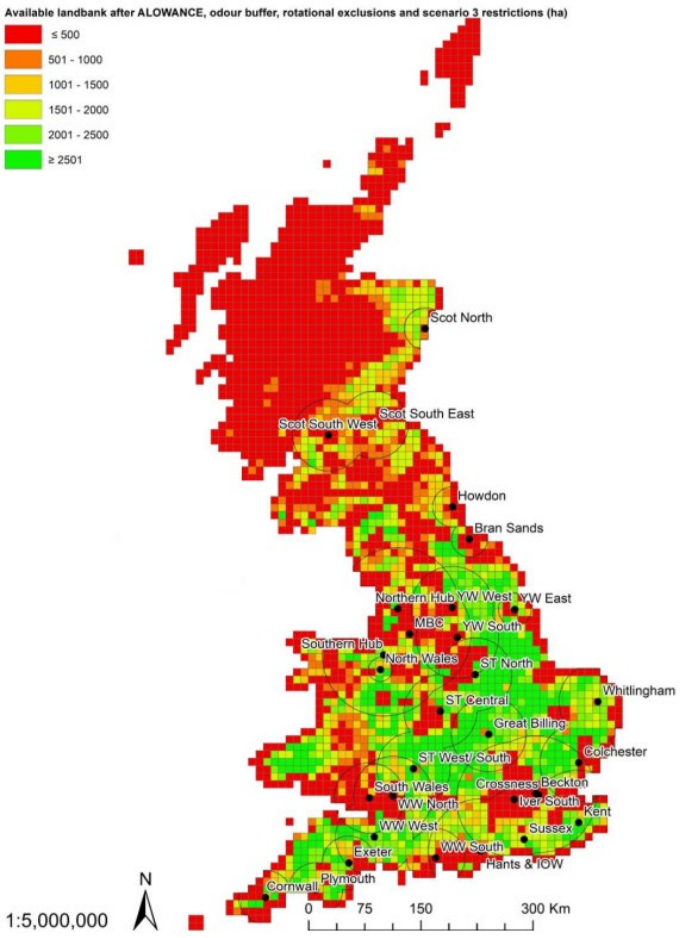


*Figure 14 - **Scenario 3** (Minimal change by 2035)*



[1] Source: Grieve Strategic, “National Landbank Assessment”, 2023.

*Figure 15 - **Scenario 4** (Most likely change by 2035)*

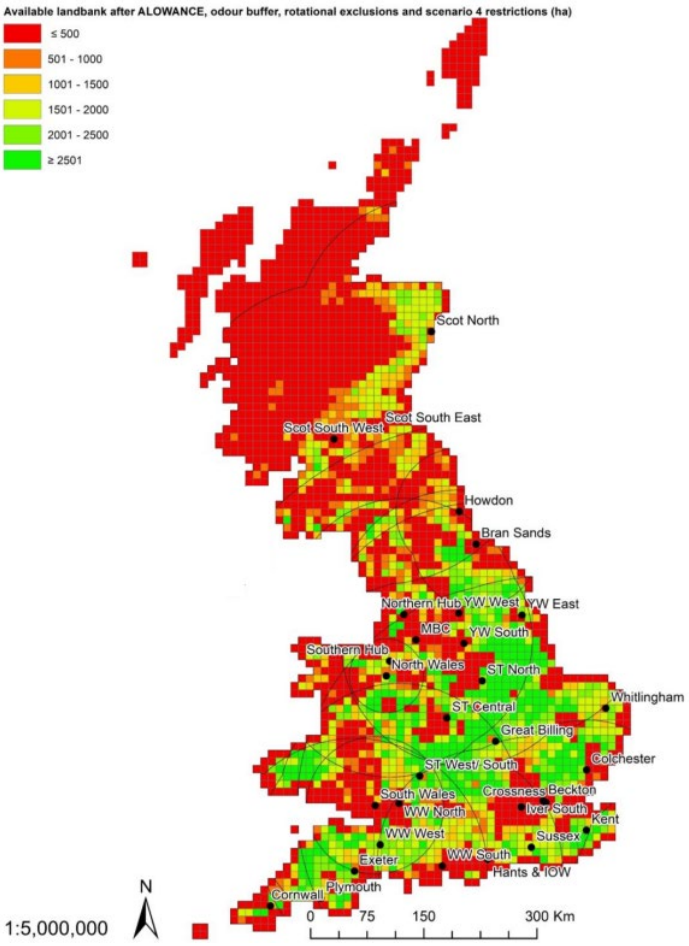
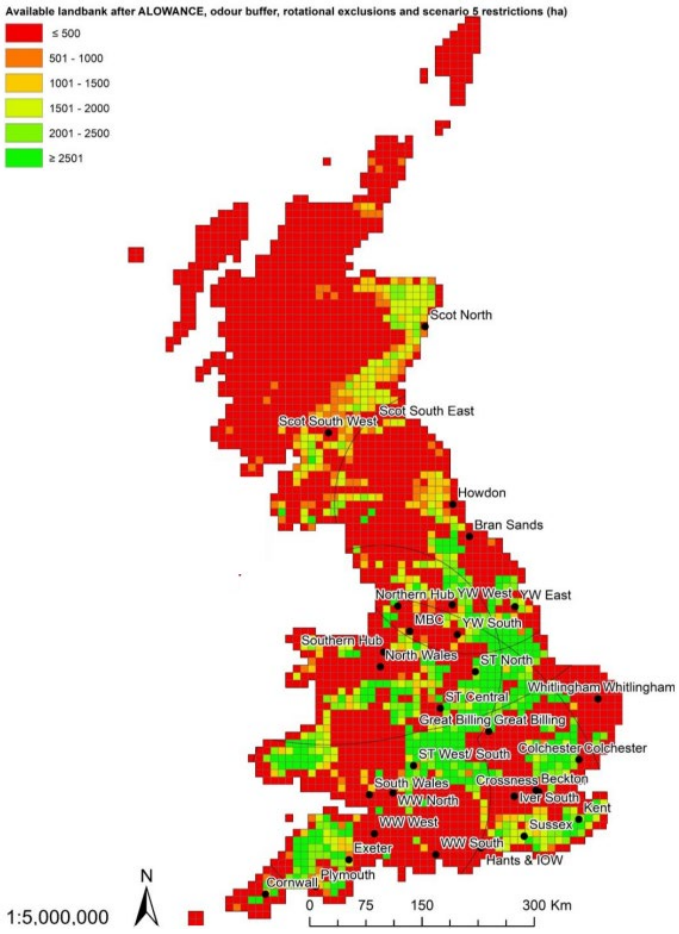


*Figure 16 - **Scenario 5** (Plausible max. change by 2035)*



The landbank requirements for the different scenarios are summarised in Table 2, while the estimated maximum distances to access suitable landbank for the different scenarios are summarised in Table 3.

Table 2 - Landbank requirements for different scenarios

Scenario:	2 (2025)	3 - Minimal 2035		4 – Most likely 2035		5 - Plausible worst 2035	
	Land required (ha)	Land required (ha)	Change from Scenario 2	Land required (ha)	Change from Scenario 2	Land required (ha)	Change from Scenario 2
Wessex Water	60,600	73,400	21%	372,600	515%	871,900	1339%
All WaSCs	1,128,900	1,446,900	28%	6,629,800	487%	13,717,600	1115%
Available land	2,958,000	2,688,500	-9%	2,407,000	-19%	1,745,000	-41%
%age utilisation	38%	54%		275%		786%	

Table 3 - Estimated maximum distances to access suitable landbank for different scenarios

Scenario:	2 (2025)	3 - Minimal 2035		4 – Most likely 2035		5 - Plausible worst 2035	
	Max. distance (km)	Max. distance (km)	Increase from Scenario 2	Max. distance (km)	increase from Scenario 2	Max. distance (km)	Increase from Scenario 2
Wessex Water	48	53	10%	159	231%	>500	942%

The conclusion of the assessment at a national level is that there is sufficient agricultural land to recycle all biosolids in Scenarios 1 to 3, but insufficient agricultural land in Scenarios 4 and 5. Companies will be competing for the same landbank in certain regions in Scenarios 4 and 5 (as indicated by the overlapping radial rings in Figure 15 and Figure 16). One of these regions is the South West/South Wales area where we will potentially be competing against South West Water, Severn Trent Water and Dŵr Cymru Welsh Water for landbank.

We would require five times more landbank in Scenario 4 and 13 times more landbank in Scenario 5 when compared to the baseline in Scenario 2. This translates to more than twice the maximum distance that we would need to travel not access suitable landbank in Scenario 4, and more than nine times the distance in Scenario 5.

The most likely scenario is Scenario 4. If this scenario materialises, there will be a deficit of c. 4,200,000 ha of available land to enable all biosolids to be recycled at a national level by 2035. This would mean a significant amount of biosolids would need to be disposed via incineration or landfill, as there are currently no other viable disposal routes for sludge. There is therefore a need to invest in the diversification of sludge outputs, such as the development of advanced thermal conversion (ATC) technologies, to open new sludge disposal routes by 2035 and avoid disposal by incineration.

3.1.2. Biosolids storage assessment

A cross-company assessment of biosolids storage requirements was undertaken by Atkins in August 2022. The assessment considered the following areas:

- Review of regulatory requirements and best practice
- Data analysis of existing storage provision
- The results from the landbank assessment detailed in the previous section
- Assessment of the various internal and external factors that could impact on the ability to recycle biosolids to land (e.g., regulatory restrictions, flooding, farming practices, farmer acceptance, public perception, emerging contaminants, etc.)

The assessment report made recommendations on the volume of storage required in each landbank scenario. The conclusions are summarised in Table 4.

Table 4 - Biosolids storage recommendations.

Landbank Scenario	Storage (months)	Notes
1	1	Minimum 1 month storage to allow logistics flexibility
2	3	Minimum 3 months storage to allow logistics flexibility and over-winter storage when farm access limited
3	3	Minimum 3 months storage to allow logistics flexibility (longer haulage runs) and over-winter storage (when farm access limited)
4	6	Minimum 6 months storage to allow logistics flexibility (longer haulage runs) and over-winter storage (when farm access limited) and inter-spreading season closed periods
5	3-6	Assuming that all biosolids can still go to agriculture: minimum 6-month storage to allow logistics flexibility (longer haulage runs) and over-winter storage (when farm access limited) and inter-spreading season closed periods; Assuming that some biosolids will be diverted to thermal outlets, reducing volumes to land: minimum 3-month storage to allow logistics flexibility (longer haulage runs) and over-winter storage (when farm access limited)

The recommended technical requirements for new storage are:

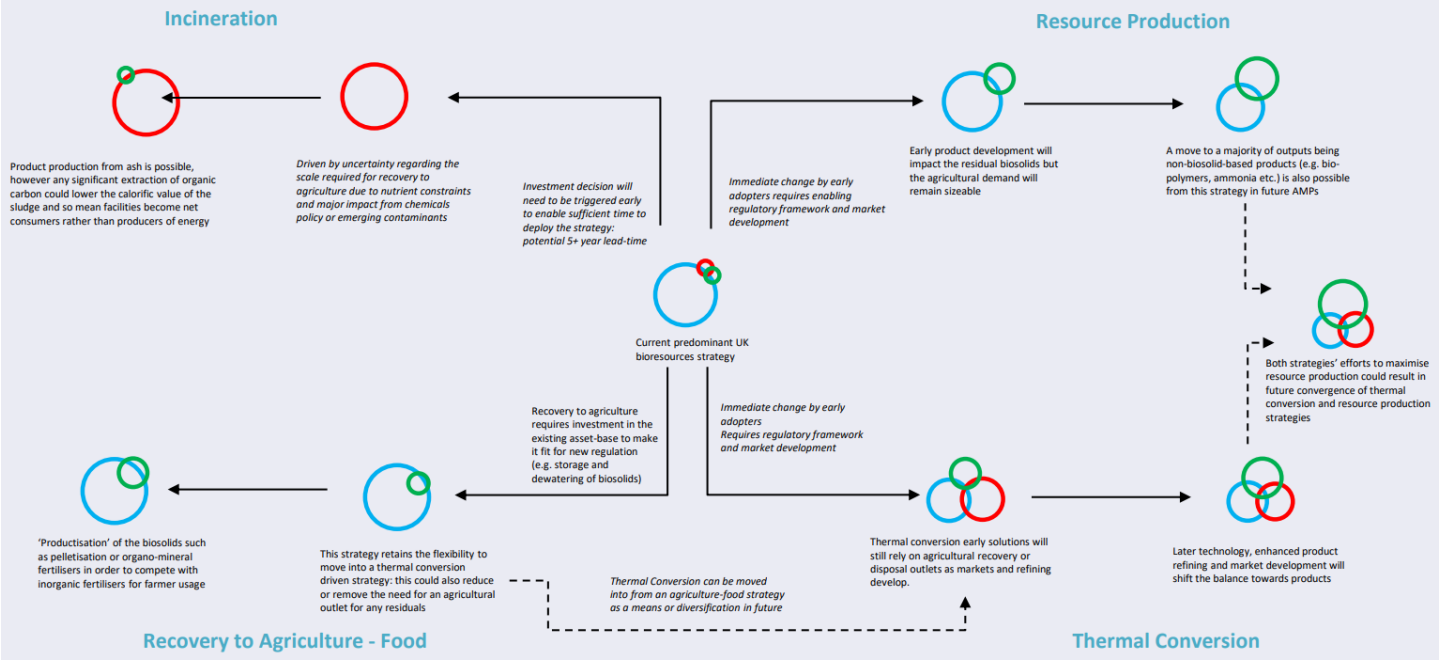
- Covered storage,
- Dutch-barn configuration, with all drainage captured in a sealed system and returned for treatment,
- Fully enclosed / odour-controlled only where required by site-specific risk assessment.

3.1.3. National Bioresources Strategy

The Chartered Institution of Water and Environmental Management (CIWEM) commissioned Atkins to develop a collaborative long-term strategy for bioresources in England and a route map to provide the sector with a view of the future direction of bioresources management.

The abbreviated route map of adaptive pathways for bioresources is illustrated in Figure 17. The starting point is depicted in the centre of the graphic, with the movements and interconnectivity between strategies illustrated. There is no scale regarding time, however the movement between each icon would take at least one AMP period. The area of each Venn diagram circle is proportionate to the volume of end-product produced (or disposed of).

Figure 17 - Abbreviated route map of adaptive pathways for bioresources[2] (The red circle represents disposal, the green circle represents resource recovery, and the blue circle represents recycling/recovery.)



The current predominant strategy is to recover sludge to agriculture. If we continue with this strategy, we will need to invest in storage, enhanced dewatering or potentially pelletisation to make it fit new regulation (e.g., changes in FRfW). If recovery to agriculture is no longer deemed viable due to landback pressures, the strategy can shift to thermal destruction of sludge, i.e. incineration. If incineration is planned for 2035, an investment decision will need to be made in PR24 due to the 5+ year lead-time for planning and building new incineration plants.

An alternative pathway to incineration is advanced thermal conversion (ATC) of sludge. As ATC technologies and outputs are still novel, enabling regulation and market development will be required to facilitate this strategy. Early ATC solutions will need to rely on agricultural recovery or disposal outlets as markets for ATC outputs develop. Further development of ATC technologies and the market for their outputs will shift the outputs to becoming products.

Resource production is also a possible strategic direction for bioresources. High value resources such as biochar, hydrogen, bio-polymers, ammonia can be produced from sludge. Maximising resource production can be incorporated into an ATC strategy when ATC outputs are established or refined.

3.2. Water Industry National Environment Programme

The PR24 Water Industry National Environment Programme (WINEP) included two new drivers related to sludge. They are:

- SUiAR_IMP – Actions to improve resilience in the sludge supply chain to agriculture and other relevant use or disposal outlets.

[2] Source: Atkins, "Developing a long-term strategy for bioresources in England", 2023.

- SUiAR_ND – Actions to meet requirements to prevent deterioration in soil quality or water quality.

According to the EA's WINEP driver guidance, the sludge drivers are aimed at delivering improvements in the resilience of the sludge management chain. This can be achieved by improved sludge management practices and the creation of suitably robust contingency measures. Companies are expected to develop and utilise new and additional sludge treatment and management technologies, along with better contingency plans to manage impacts of climate change and periods of supply chain disruption will better serve the continuous production of treated sludge (biosolids) that are beneficially supplied to farmers for spreading onto their agricultural land.

3.2.1. Need for investment

Our need for quality enhancement investments in the WINEP for bioresources is driven by changes in the environmental regulation framework which impact future landbank availability and our process, logistics and operations associated with the recycling of biosolids to agricultural land.

The main driver for the changes in future landbank availability is the EA's reinterpretation of the Farming Rules for Water (FRfW) regulation, which imposes more stringent nutrient restrictions on available agricultural land for sludge application. Assured Biosolids Ltd. (ABL) and all the WaSCs have developed a new biosolids requirements document called "20 Measures" which seeks to detail how WaSCs will transpose FRfW requirements into the existing Biosolids Assurance Scheme (BAS). The changes introduced by the FRfW reinterpretation have been modelled in the national landbank assessment. The assessment outcome shows that the FRfW changes will most likely result in insufficient landbank to accommodate the disposal of all biosolids at a national level by 2035. At a Wessex Water level, we will require five times more landbank by 2035 to recycle all our biosolids.

Another significant change in environmental regulation affecting biosolids is the move of sewage sludge recovery and disposal into the regulation of the Environmental Permitting Regulations (EPR). Under EPR, biosolids will be managed under a land spreading permit and deployment system, which has the potential to result in delays in the transport and application of biosolids, therefore requiring additional storage for resilience. This change is expected to happen when the Environment Agency's Strategy for Sustainable Sludge Use (EA Sludge Strategy), which was supposed to be in 2023, but is now delayed as the EA are reviewing the timeline for implementation. As the Sludge Strategy has not yet been published, the agreed assumption for the purposes of business planning is that companies will need to comply with the permit clauses in the current Standard Rules 2010 No. 4 & 6.

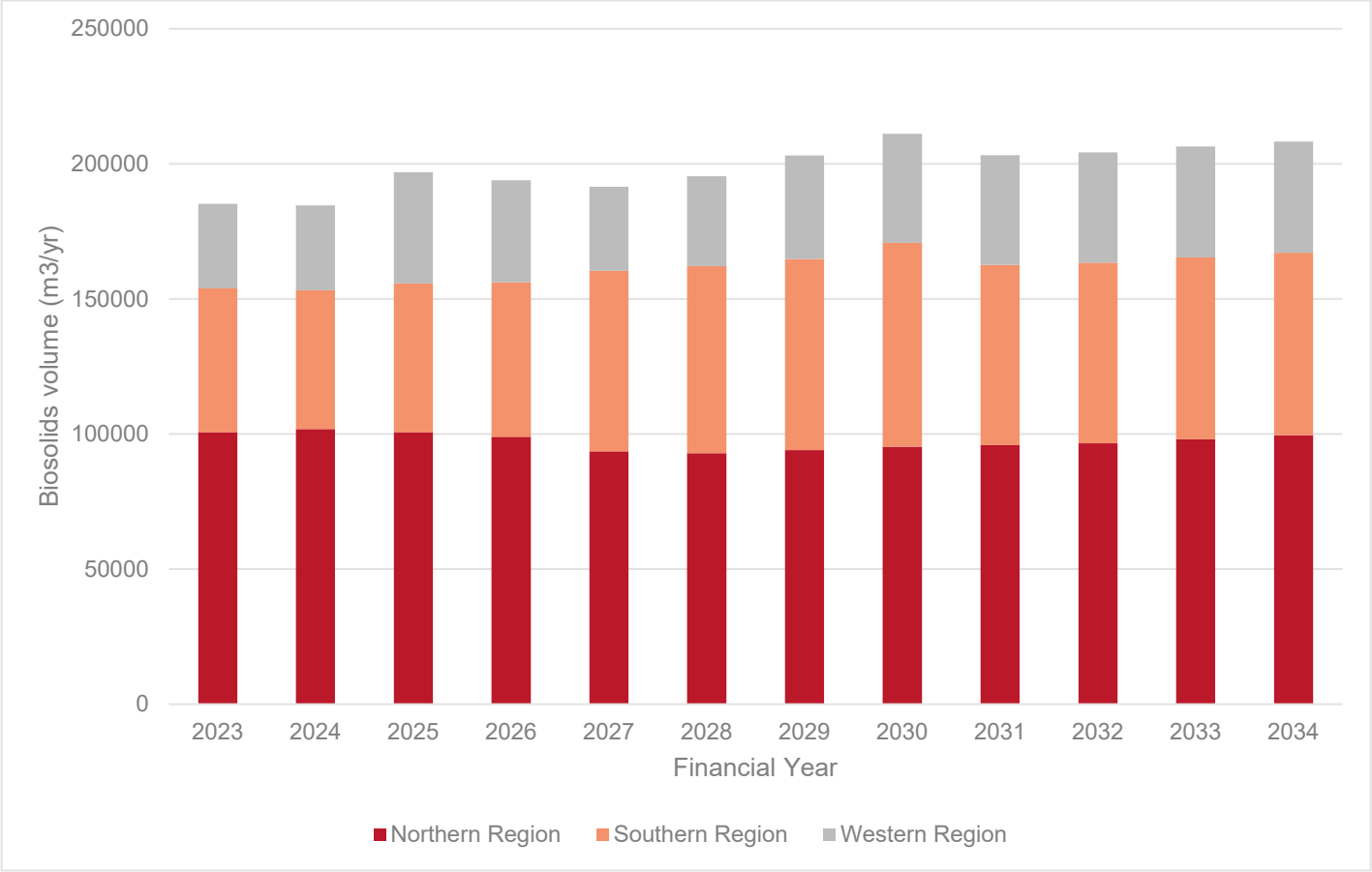
We also expect that when the EA Sludge Strategy is implemented, there is potential for the existing Biosolids Assurance Scheme (BAS) to form part of a biosolids earned recognition scheme for EPR compliance. Therefore, it is assumed that the industry needs to achieve 100% compliance with BAS moving forwards in AMP8, whilst noting that this is not currently a statutory requirement. There are ongoing discussions between the EA and Assured Biosolids Ltd (who owns the BAS scheme) to confirm the scope of BAS compliance in EPR, but it is assumed that compliance with BAS demonstrates compliance with all current regulations and codes of practices such as NVZs, P index, RB209 and spreading controls.

The move of sewage sludge into EPR regulation also means that all sludge treatment activities will need to be permitted under EPR. All bioresources centres that treat sludge volumes via anaerobic digestion above a certain threshold will be issued installation permits under the Industrial Emissions Directive. We expect that bioresources centres with lime treatment will be issued bespoke waste operation permits in AMP8 when the EA publishes their Sludge Strategy, which will provide guidance on the permitting requirements for various sludge treatment activities and the route map for the transition. Our lime treatment centres will need to comply with AM guidance. The EA have stipulated that AM covers multiple levels of environmental permitting for sludge treatment, storage, and recycling. The guidance states "there is an overlap between BAT and necessary measures for waste operations. The EA uses the term "appropriate measures" to cover both sets of requirements. The guidance sets out what we must consider and using risk assessments can assess what is appropriate, and we can propose alternative methods, but they must still attain the same level of environmental protection. As a result, these sites will need to be provided with secondary containment, improved drainage, fugitive emissions control, and other measures to mitigate the risk of environmental pollution.

3.2.2. Forecast biosolids volume, quality, and storage requirements

We forecast our total biosolids volume to be c. 202,000m^3 by 2029-30. 94,000m^3 of our biosolids would be produced in our Northern region which consists of Avonmouth and Trowbridge; 70,000m^3 in our Southern region which consists of Berry Hill, Poole, Palmersford and Ratfyn; and 38,000m^3 in our Western region which consists of Taunton, West Huntspill, Minehead and Yeovil. Figure 18 provides a summary of our forecast biosolids volumes.

Figure 18 - Biosolids volumes from 2023/24 to 2034/35



Our forecast biosolids quality (dry solids) from each bioresources centre is provided in Table 5. The expected dry solids of biosolids for BAS compliance under EPR is an average of 25%. Dry solids of a biosolids can be increased through enhanced dewatering or drying to minimise the volume of biosolids for storage or disposal.

Table 5 - Biosolids dry solids % in AMP8

Bioresources centre	Average biosolids dry solids % in AMP8
Avonmouth	25%
Berry Hill	23%
Minehead	29%
Poole	24%
Ratfyn	30%

Taunton	24%
Trowbridge	22%
Vale Road	28%
West Huntspill	30%
Palmersford	30%

We currently have two biosolids storage facilities – one at Taunton in our Western region and another at Wimborne in our Southern region. This is summarised in Table 6.

Based on the recommendation of the biosolids storage assessment undertaken by Atkins, we would require between 3-6 months' storage for all our biosolids to accommodate the potential delays in the deployment system, allow for logistics flexibility, and provide over-winter storage. We would therefore need to provide additional storage capacity in our Northern region to achieve the storage requirement above.

Table 6 - Existing biosolids storage barns

Storage Facility	Region served	Capacity (m^3)	Storage provision by 2029-30[3]
Taunton	West (Taunton, West Huntspill, Minehead and Yeovil)	10,800	3-4 months
Wimborne	South (Berry Hill & Poole, excluding Ratfyn)	6,700	1-2 months

3.2.3. Options assessment

As evidenced from both the landbank and storage assessments the critical driver that affects our WINEP option selection is the landbank scenario that is used for planning purposes. These have been presented to EA as WaSCs required guidance on which scenario should be used as the basis of the WINEP submission. The EA have not been able to confirm this, advising that it is a matter for the Department for Environment Food and Rural Affairs (Defra). Discussions were held with regulatory stakeholders (EA, Defra and Ofwat) but there was no consensus on an agreed approach. Therefore, our position was to plan for the scenario considered the most likely (i.e., Scenario 4). As detailed in the previous sections, this has a significant impact on the investment required due to the step change in land required, and the potential need to remove a large portion of our sludge from the agricultural outlet by thermal destruction, i.e., incineration.

[3] Assumes 80% capacity utilisation to account for potential stockpile slumping and maintaining access.

On the basis of planning for Scenario 4, we proposed the following options in Table 7.

Table 7 - WINEP options assessment

Option		Progressed / discounted
1	Provide additional storage only in AMP8	Discounted
2	Provide additional storage and enhanced dewatering in AMP8	Discounted
3	Provide additional storage and sludge drying in AMP8 (to enable ATC or incineration in AMP9)	Progressed to WINEP submission
4	Provide additional storage, sludge drying and incineration in AMP8	Discounted

In all options, we would need to provide additional storage capacity to ensure sufficient storage resilience is available in AMP8. The required storage capacity can be reduced if the volume of biosolids is reduced by either enhanced dewatering or sludge drying. We opted for sludge drying, as it would be a pre-requisite step to either ATC or incineration in AMP9. Installing large-scale enhanced dewatering would potentially lead to asset stranding in AMP9 if ATC or incineration is required.

We did not deem that incineration is feasible in AMP8 due to the 5+ year lead time required for planning and constructing new incineration plants. We have therefore submitted the option of providing additional storage and sludge drying in AMP8.

We have also submitted an action in the WINEP for site improvements for our lime treatment centres for EPR compliance. The proposed action includes site-specific solutions for providing secondary containment, improved drainage, and fugitive emissions control (i.e., covering open sludge tanks).

3.2.4. Options assessment outcome

The outcome of our submitted WINEP actions (proposals) is summarised in Table 8.

Table 8 - WINEP options assessment outcome

Action ID	Action Name	Action Description	Options Assessment Outcome
08WW100900a	Malmesbury BC - Sludge Storage	Provide biosolids storage at Malmesbury BC to provide resilience to our Northern region to mitigate restrictions on spreading to land.	Proceed
08WW100900b	Trowbridge BC - Sludge Storage	Provide biosolids storage at Trowbridge BC to provide resilience to our Northern region to mitigate restrictions on spreading to land.	Proceed
08WW100901a	Avonmouth BC - Sludge Drying	Provide sludge drying at Avonmouth BC to improve quality of biosolids and reduce volume for disposal	Remove

08WW100901b	Berry Hill BC - Sludge Drying	Provide sludge drying at Berry Hill BC to improve quality of biosolids and reduce volume for disposal, in addition to additional liquor treatment capacity to maintain effluent compliance	Remove
08WW100901c	Taunton BC - Sludge Drying	Provide sludge drying at Taunton BC to improve quality of biosolids and reduce volume for disposal, in addition to additional liquor treatment capacity to maintain effluent compliance	Remove
08WW100901d	Trowbridge BC - Sludge Drying	Provide sludge drying at Trowbridge BC to improve quality of biosolids and reduce volume for disposal, in addition to additional liquor treatment capacity to maintain effluent compliance	Remove
08WW100902a	Minehead BC - EPR Improvements	Upgrade Minehead BC to ensure compliance with EPR/Appropriate Measures requirements	Remove
08WW100902b	Ratfyn BC - EPR Improvements	Upgrade Ratfyn BC to ensure compliance with EPR/Appropriate Measures requirements	Remove
08WW100902c	Vale Road BC - EPR Improvements	Upgrade Vale Road BC to ensure compliance with EPR/Appropriate Measures requirements	Remove
08WW100902d	West Huntspill BC - EPR Improvements	Upgrade West Huntspill BC to ensure compliance with EPR/Appropriate Measures requirements	Remove
09WW100903	Avonmouth BC - Biomass Boiler (Incineration)	1x biomass boiler (incineration) installation at Avonmouth BC for generating heat from combusting dried sewage biosolids, with ash then disposed to landfill.	Not assessed

Only our proposal for additional storage was approved to proceed. We were asked to remove our proposals for sludge drying and site improvements for EPR, as the EA viewed that they are outside the scope of the sludge drivers. Our proposal for incineration in AMP9 was not assessed as the EA did not assess proposals that are not within AMP8.

The EA sent an Information Letter in May 2023 to clarify that the scope of the sludge drivers is limited to actions that improved the resilience of biosolids recycling to agricultural land, namely biosolids storage and actions that will improve the quality of biosolids such as enhanced dewatering or pelletisation. Actions that related to thermal destruction or conversion of sludge were deemed to be outside the scope of the sludge drivers. A copy of this Information Letter is provided in Annex A12.

In accordance with this guidance, we have removed our proposal for sludge drying and increased the amount of storage capacity we would provide at Avonmouth, Trowbridge and Malmesbury. The revised actions were approved by the EA to proceed. The list of revised actions is provided in Table 9.

Table 9 - Revised WINEP actions and their outcomes.

Action ID	Action Name	Action Description	Options Assessment Outcome
08WW100900a	Malmesbury BC - Sludge Storage	Provide biosolids storage at Malmesbury BC to provide resilience to our Northern region to mitigate restrictions on spreading to land.	Proceed
08WW100900b	Trowbridge BC - Sludge Storage	Provide biosolids storage at Trowbridge BC to provide resilience to our Northern region to mitigate restrictions on spreading to land.	Proceed
08WW100900c	Malmesbury BC - Sludge Storage	Provide additional biosolids storage at Malmesbury BC to provide resilience to our Northern region to mitigate restrictions on spreading to land.	Proceed
08WW100900d	Trowbridge BC - Sludge Storage	Provide additional biosolids storage at Trowbridge BC to provide resilience to our Northern region to mitigate restrictions on spreading to land.	Proceed
08WW100900e	Avonmouth BC - Sludge Storage	Provide additional biosolids storage at Avonmouth BC to provide resilience to our Northern region to mitigate restrictions on spreading to land.	Proceed

3.2.5. Conclusions

While the approved actions for storage would improve the resilience of our biosolids recycling activity, they would not provide sufficient long-term mitigation against the landbank risk expected in Scenario 4. We will need to diversify our sludge outputs by 2035 to unlock new sludge disposal outlets and reduce our reliance on a single agricultural outlet. To this end, we have engaged with other water companies to begin discussions on possible collaborative trials that can be undertaken as part of an innovation initiative in AMP8 to develop viable ATC solutions for PR29.

The removal of our proposed actions for EPR-related site improvements from the sludge drivers and the lack of alternative applicable drivers in the WINEP would mean that these proposals would need to be progressed as non-WINEP quality enhancement investments.

In cross-company discussions about the WINEP, most companies indicated that they would be basing their proposed actions on Scenario 4 (Insufficient landbank by 2035). We understand that due to the initial lack of guidance by the EA on the scope of the sludge drivers, companies proposed a wide range of actions that amounted to a national WINEP programme of over £1b for bioresources, raising concerns about the affordability of the programme. Grieve Strategic collated all the WINEP actions on an anonymous basis to assess the impact of these actions on future landbank availability. Their updated landbank modelling showed that there would still be a deficit of c. 950,000 ha of available landbank by 2035 under Scenario 4 – meaning that the national WINEP programme would be ineffective in resolving the landbank issue. We believe the EA would have rejected all actions that were not related to storage, as is the case for us. Therefore, the industry would potentially be exposed to the risks associated with insufficient landbank availability should Scenario 4 materialises by 2035.

4. Industrial Emissions Directive (IED) and Environmental Permitting Regulations (EPR)

4.1. Background

4.1.1. Application of IED and EPR to bioresources

In February 2013, the EU Industrial Emissions Directive (IED) was transposed into UK law under the Environmental permitting Regulations (EPR). Under IED, pollutants from industrial emissions are regulated and industrial installations are therefore required to reduce their emissions to air, land and water. The Environment Agency (EA) have decided to enact IED across all industries in England and Wales, including bioresources. The application of IED in bioresources meant that all bioresources treatment sites undertaking the biological treatment of sewage sludge (i.e., anaerobic digestion) exceeding 100 tonnes per day are required to apply for IED environmental permits under EPR.

As sewage sludge has historically been exempted as a waste by way of the Urban Waste Water Treatment Directive, there was initial uncertainty surrounding the applicability of IED to sewage sludge treatment. A legal review was undertaken to resolve this, and EA set out an interim position which delayed the need for water companies to apply for IED permits. In July 2019, water companies received an official letter from the EA confirming the requirement to apply for permits by August 2022. This has since been extended to December 2024 to account for permitting delays. This revised timescale means that design and delivery of improvement works for IED compliance will be undertaken in AMP8.

The move of sewage sludge into EPR regulation also means that all sludge treatment activities that currently operate under a T21 waste exemption, such as our lime treatment and mechanical sludge thickening sites, will need to operate under a waste operation permit in the future. This is because the EA are looking to change waste tonnage limits for the T21 to 100,000 wet tonnes imported per year to 100,000 wet tonnes indigenous plus imported volumes. There are no EPR standard rule sets for physico-chemical treatment, which lime treatment and mechanical sludge thickening are classed, and so these processes will require a bespoke waste operation permit.

The EA intended to publish their Sludge Strategy in 2023 to provide guidance on the permitting requirements for these T21 sites. However, they have indicated that this work is now delayed. Therefore, it remains unclear what the exact requirements would be for the T21 sites that will need to operate under bespoke waste operation permits, and the length of time allowed for transition changes. We anticipate that the permit requirement will likely be sometime in AMP8 and therefore, the design and delivery of improvement works required for EPR compliance will be undertaken in AMP8.

4.1.2. Implications on sludge treatment assets

All sludge treatment sites that require IED permits will need to comply with:

- The EU Waste Treatment Best Available Techniques (BAT) which are best economically and technically viable techniques in waste treatment to prevent, minimise and reduce emission to air, water and land.
- The EA's 'Biological Waste Treatment: Appropriate Measures for Permitted Facilities' guidance ('Appropriate Measures') which prescribes the measures that are required in the design, construction, operation, and maintenance of a waste operation facility.

BAT and Appropriate Measures (AM) are the key guiding principles underlying the EA's approach on IED compliance. The EA expect all sites to be risk-assessed to determine if they comply with BAT and AM. All non-compliant sites would need to be improved and upgraded to BAT and AM standards by December 2024. The EA have however indicated that as long as "best endeavours" are being made with IED site improvements, work can continue beyond the December 2024 deadline. This means that development of solutions and designs will be crucial to show the EA of our intentions to provide environmental protection.

Significant capital investment is required to bring the infrastructure at our five anaerobic digestion (AD) sites up to BAT and AM standards, so that they can comply with IED. The two areas that require significant CAPEX are the provision of impermeable surfaces and secondary containment to all digesters and sludge tanks, and the retrofit of all open sludge tanks with covers.

We also expect a significant increase in OPEX when the sites operate under IED permits, as additional operational and maintenance activities are required to maintain the performance of the AD process and condition of all sludge assets to the standard required by BAT. Examples of the additional responsibilities required under IED are the increased monitoring, sludge and liquor sampling, inspections for leaks (fugitive air emissions and potential liquid leaks to ground water) and odour, and maintenance of the new online monitoring equipment required under IED (such as flowmeters, pressure monitors and gas analysers).

The T21 sites that will be permitted under EPR will also need to comply with AM guidance. One uncertainty is there is no dedicated AM guidance for physio-chemical treatment, which would mean that the lime treatment process falls between the biological treatment AM and chemical waste AM. However, we expect all types of AM to be very similar, as they are based on BAT and the EA's necessary measures for waste operations. Therefore, we expect that the T21 sites will require significant improvements, like the IED sites, to meet AM standards.

4.1.3. Misalignment in PR19 timescales

The formal letter from the EA in July 2019 (Annex A9) requesting water companies to apply for IED permits came too late in the PR19 cycle, as business plans for AMP7 was already submitted. While the EA's position is that they have warned water companies about the future inclusion of sewage sludge into IED and EPR, this was challenged legally until 2019, which meant there was uncertainty around the applicability of IED on sewage sludge treatment throughout the PR19 planning process. Furthermore, at that time the EA were not clear on what they deemed as acceptable BAT as the AM guidance document was only consulted on in 2020 and published in 2022. Therefore, there has been a 'moving goalpost' leaving companies in a position where they have not been able to adequately estimate the level of investment required at the sludge treatment sites.

Therefore, in PR19, most companies did not include any costs associated with IED, as evidenced in Table 10 which shows the 'Allowance v. Submitted' costs in the PR19 Final Determination (based on the WWS5 table of each company's business plan data tables).

Yorkshire Water and Northumbrian Water subsequently included in their CMA submission that they will incur costs of complying with IED which were not considered at PR19. Both companies asked for an uncertainty mechanism that allowed for cost recovery through adjustments to the bioresources RCV in AMP7. CMA findings affirmed the uncertainty around the scope of IED and associated costs for compliance:

"There is a high level of uncertainty around the cost of IED compliance, arising from potential differences in needs, scope, and efficient costs for a large number of activities. This makes setting ex-ante allowances particularly problematic."

Table 10 - Allowance v. submitted cost table from PR19 FD[4]

Other costs, allowances for AMP7
Price base: £m Real, 2017/18 prices

Cost: **Industrial emissions directive**

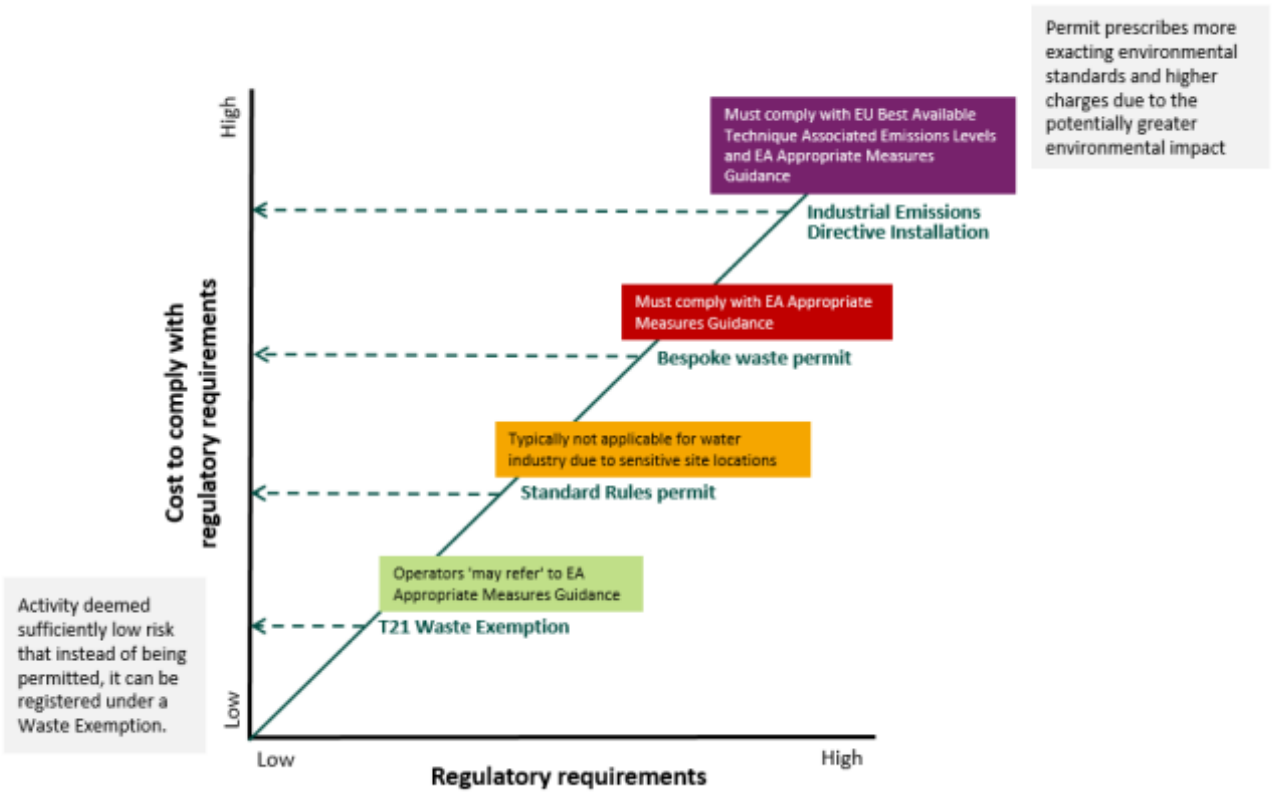
	Business plans		Ofwat allowance	
Company	Wastewater network plus	Bioresources	Wastewater network plus	Bioresources
ANH	0	0.0	0.0	0.0
HDD	0	0.0	0.0	0.0
NES	0	0.0	0.0	0.0
NWT	0.9	8.7	0.9	8.7
SRN	0	0.0	0.0	0.0
SVE	0	0.0	0.0	0.0
SWB	0	0.0	0.0	0.0
TMS	0	0.3	0.0	0.3
WSH	0	0.2	0.0	0.2
WSX	0	0.0	0.0	0.0
YKY	0	0.0	0.0	0.0
AFW				
BRL				
PRT				
SES				
SEW				
SSC				
Total	**0.9**	**9.2**	**0.9**	**9.2**

4.1.4. Further scope creep in PR24

The lack of guidance in PR19 on what the EA deemed as acceptable BAT resulted in uncertainties around the scope of site improvements required and therefore the level of investment required in AMP7. Additionally, the EA stated in a Waste and Recycling Network meeting in June 2019 that they consider the cost implications will relate to permit variation costs and limited asset improvements, as they assumed that there was not a significant step change in standards required under T21 Waste Exemptions (that companies had to comply with prior to IED) to those required under IED. However, this was not the case, as the "goalpost" for what was acceptable BAT solutions continued to move in the following years which resulted in the scope of IED improvements to grow larger than previously expected. This is also supported by Atkins in their independent technical review of IED in April 2023. A figure from their report which shows the significant step change in regulatory requirements and associated cost to comply is provided in Figure 19.

[4] Source: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.ofwat.gov.uk%2Fwp-content%2Fuploads%2F2019%2F12%2FFFM_UC_OtherCosts_FD.xlsx&wdOrigin=BROWSELINK

Figure 19 - Regulatory requirements and costs to comply[5]



The AM guidance, which the EA only formally published in September 2022 after the vast majority of permit applications were made, sets out blanket requirements for all assets in a prescriptive approach using terminology such as “you must”, whereas BAT allows for a more risk-based approach. AM effectively raises the bar in environmental protection standards and the associated costs for compliance. AM requirements significantly exceed those of BAT in the areas of covering/storage and secondary containment, which are two areas that require the most significant investment to upgrade. We have seen an instance of the EA’s strict adherence to AM requirements when they rejected our risk-assessed containment proposal of providing vehicle collision protection to a concrete tank at Poole, insisting that secondary containment is necessary for this tank despite its extremely low failure rate.

As of September 2023, the EA have provided more clarity to their “must” statements in the AM guidance document. They clarified that operators should risk-assess the requirements to determine if the prescribed appropriate measure should be applied or an alternative measure would be more applicable. However, any alternative measure must provide the same level of environmental protection.

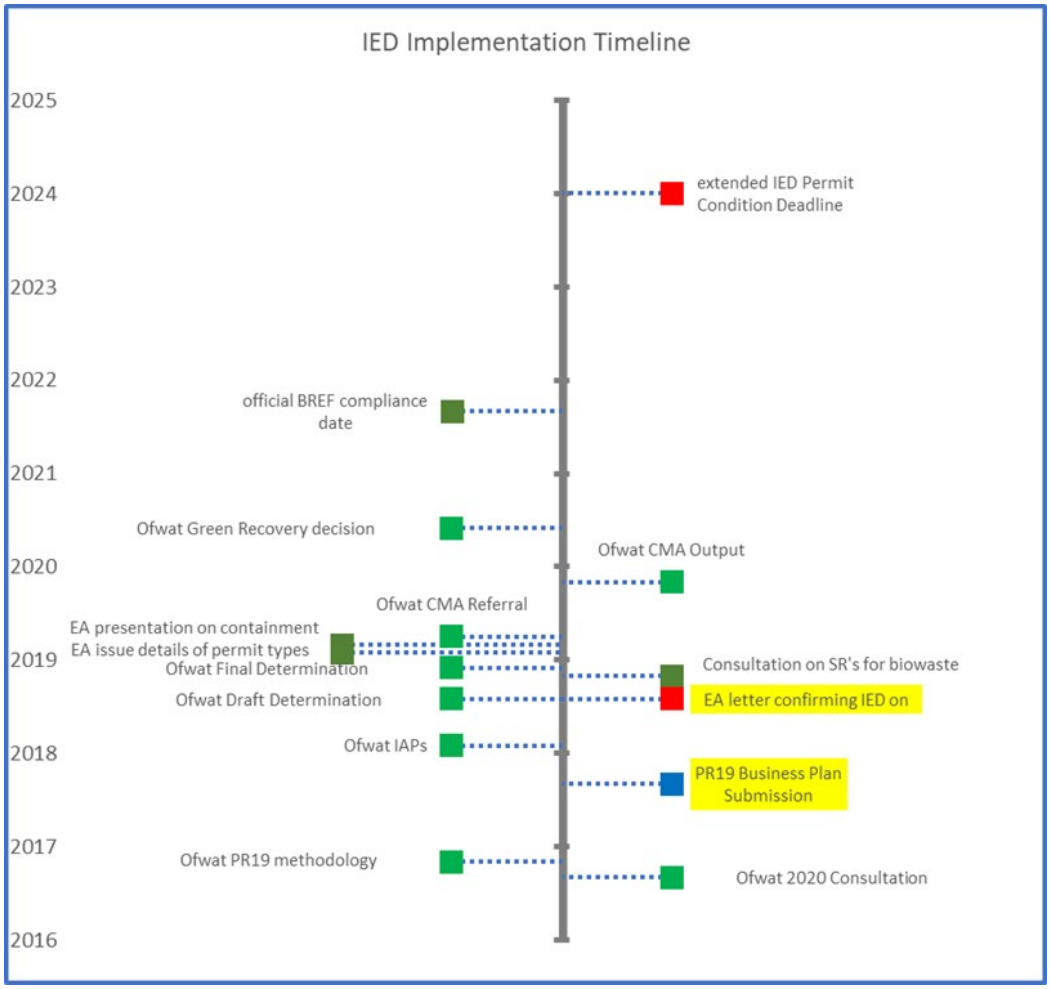
The comparison between BAT and AM has been assessed by Atkins, and their summary is provided in Annex A6.

[5] Source: Atkins, “Industrial Emissions Directive Supporting Document for Water UK,” 2023.

4.1.5. Timeline of events

Figure 20 (taken from a briefing note on IED to Water UK in May 2022) shows when significant events have taken place in the development of IED within the industry. As can be seen the industry did not have clear guidelines that permitting would be required in AMP7 and so were unable to adequately estimate the investment required. Additionally, delays in the release of the AM guidance have put further pressure on being able to clearly articulate the costs of compliance.

Figure 20 - Timeline of IED related events[6]



United Utilities submitted IED investment proposals under the Green Recovery scheme in 2020 but were rejected by Ofwat because the deadline for IED compliance was 2024, so IED investment proposals would not need to be brought into AMP8. Ofwat cited the EA's position that companies have been given sufficient time to have their sites BAT-assessed, draw up improvement plans and implement them before 2024. However, we now know that this would have not been the case, and the delivery of IED improvements were likely slip into AMP8 due to the scope

[6] Source: Thames Water, "IED Background for Water UK," 2022

creep caused by AM guidance in 2022 and the delays in the permitting process. However, Ofwat acknowledged in their Green Recovery final decision document that:

"…if any IED requirements did extend into the 2025-30 period, [they] would be open to considering an allowance under transition funding allowance for investment in 2024-25 as part of the 2024 price review. This process is available for all companies that did not appeal their PR19 final determinations to the Competition and Markets Authority."

The industry considered including IED investment proposals in the PR24 Water Industry National Environment Programme (WINEP) as the IED obligations are viewed as PR24 sludge enhancement activities. However, Ofwat and EA both disagreed with this view (as evidenced in the Ofwat WINEP feedback letter in 2022 in Annex A10, and the EA-WaSCs WINEP evidence log in Annex A11). Therefore, we did not include any IED investment proposals in our PR24 WINEP programme.

4.2. Permit details

In Table 11, the expected permit dates detailed are the latest estimation produced by our EA permitting officer in early August 2023. The expected permit dates for the physico-chemical permits at the lime treatment sites will depend on when the EA publish their Sludge Strategy and the length of time allowed for transition changes. We expect there could be similar permitting delays as experienced for the IED installation permitting process with the number of physio-chemical only permits needed in the water industry.

Please note: All Wessex Water sites will be bespoke IED installation permits because maximum acceptance will exceed 500,000 tonnes per year and the sites are close to sensitive receptors, which means no site meets the criteria stipulated by the EPR standard rules AD installation permit (SR2021 No.10).

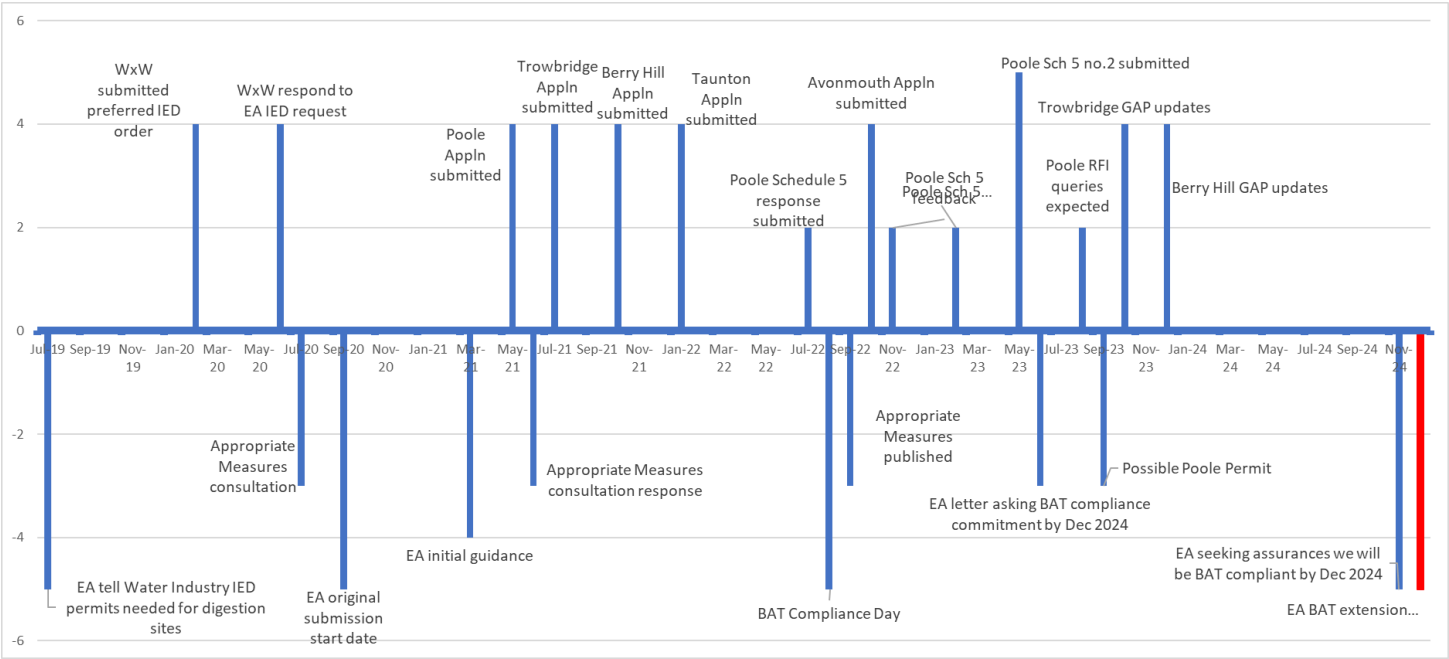
Table 11 – Summary of Wessex Water sites that require IED and EPR permits.

Site name	Sludge treatment process	Existing permit type and process covered	Expected Permit issued date (also detailed in column BM)	Will the site have physico-chemical activity as well as AD (Yes/ No)
Poole	AD	Waste operation permit for tankered sludge imports	October / November 2023	No
Trowbridge	AD	Waste operation permit for tankered sludge imports	June 2024	No
Berry Hill	AD	Waste operation for tankered sludge imports	September / October 2024	No
Taunton	AD	Waste operation permit for sludge storage in Barns	Late 2024	No
Avonmouth	AD	Waste operation permit for tankered sludge imports	Spring 2025	Yes – Avonmouth only will have a physico-chemical activity added onto its IED installation permit
Minehead	Lime	T21 exemption	AMP8	n/a
Ratfyn	Lime	T21 exemption	AMP8	n/a
Yeovil Vale Road	Lime	T21 exemption	AMP8	n/a

West Huntspill	Lime	T21 exemption	AMP8	n/a
Palmersford	Lime	T21 exemption	AMP8	n/a

IED permit timeline in Figure 21 shows key dates for Wessex Water above x-axis and EA key dates below x-axis; and used in conjunction with Table 12 shows the current permit application status of Wessex Water's sites.

Figure 21 - Permit timeline showing key Wessex Water and EA time points. (n.b. scale only used to allow entries to fit on)



Dates for Wessex Water permit applications are further detailed in Table 12; we have only received EA feedback on the Poole application via the Schedule 5 notification. The latest response we made to the EA was completed in May 2023 and are expecting some RFIs (Requests for Further Information) to finalise the information the EA holds about the site. This enables the EA to complete its determination phase. Following these replies to the RFIs, our EA permitting officer has indicated they will start to draft the Poole permit with an expected publication date later this year.

EA's requirements have become more certain over the Schedule 5 process, and we now are more aware of the standard required, so we are currently undertaking an appraisal of gaps that are still remaining in information we've provided in the applications. Trowbridge and Berry Hill are being completed this autumn.

Table 12 - Current Wessex Water permit application status

Site	Submitted Date	Schedule 5 notification no. 1 submitted	Schedule 5 notification no. 2 submitted	Estimated end to end determination time (EA estimation)	Estimated Permit Issue Date
Poole	April 2021	July 2022	May 2023	Already in determination	October/November 2023
Trowbridge	July 2021			6 – 9 months	June 2024
Berry Hill	October 2021			6 – 9 months	September / October 2024

Taunton	January 2022			6 – 9 months	Late 2024
Avonmouth	September 2022			9 – 18 months (based on complexity)	Spring 2025

4.3. Estimated costs

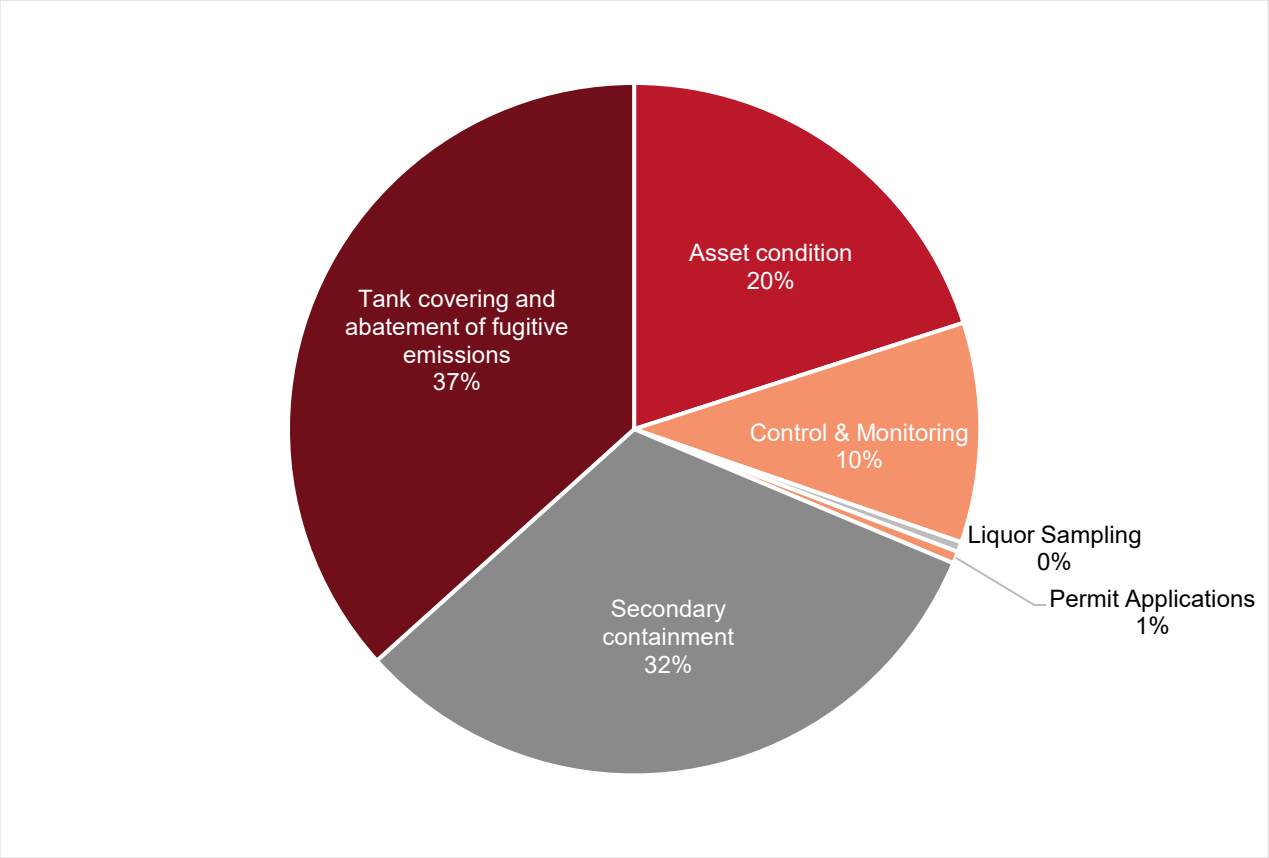
The areas of IED compliance expenditure for our 5 AD sites are summarised in Table 13.

Table 13 - Areas of IED compliance expenditure.

Area of expenditure	Funding	Description
Secondary containment	Enhancement	Providing secondary containment for all digesters and sludge holding tanks to the standard of CIRIA 736
Tank covering and abatement of fugitive emissions	Enhancement	Covering all open sludge tanks and extracting the headspace gas for either odour treatment (if methane levels are low) or recovery to the biogas system (if methane levels are high)
Control and monitoring	Enhancement	Providing additional online monitors (such as flowmeters, pressure monitors, gas analysers, etc.) to improve the control and monitoring of the AD process
Liquor sampling	Enhancement	Undertake a rigorous 12-month sampling programme to fully characterise the liquor streams that are discharged back to the sewage treatment process, followed by routine sampling to monitor the quality of the liquors
Permit application	Enhancement	The development of various management plans (such as odour, leaks, waste, raw materials, energy efficiency, etc.) and one-off surveys and risk assessments that need to be completed as part of the permit application process
Additional resources	Enhancement	Additional resources (such as plant operators, scientists, engineers, and technical specialists) would need to be recruited to undertake the additional operational and maintenance activities required by the AD sites when they operate under IED permits
Asset maintenance	Base	Additional maintenance will be required to improve the condition of a large number of bioresources assets up to BAT standard

The pie chart in Figure 22 illustrates the CAPEX profile of the expenditure for upgrading all our 5 AD sites to BAT and AM standards. The estimated total CAPEX is £158m. The two areas of most significant CAPEX expenditure are the implementation of secondary containment as per the CIRIA 736 standard, and the installation of covers on all open sludge tanks to reduce fugitive emissions.

*Figure 22 - CAPEX split by expenditure areas for upgrading all existing Wessex Water AD sites to comply with IED (**total CAPEX of £158m**)*



The CAPEX profile for upgrading all our T21 lime treatment sites to BAT and AM standards for EPR compliance is similar – with secondary containment and tank covering being the most significant areas of expenditure. The estimated total CAPEX for EPR compliance is £26m.

Table 14 shows the expenditure profile of both IED and EPR upgrades in AMP8, split by enhancement and base costs. AMP8 TOTEX is estimated to be £200.8m, with £33.4m allocated as base costs and £167.5m allocated as enhancement costs.

We believe all our IED costs will be incurred in AMP8 as the design and delivery of IED upgrades can only be undertaken in AMP8 due to the delays in the permitting process. We also believe all EPR costs will be incurred in AMP8 as the EA will likely begin the EPR permitting process in AMP8.

Table 14 – Expenditure profile of IED and EPR upgrades split by base and enhancement costs.

Expenditure	2025-26	2026-27	2027-28	2028-29	2029-30	AMP8 total
IED Base CAPEX	£6.8	£12.8	£8.2	£2.6	£0.0	£30.4
IED Base OPEX	£0.4	£0.5	£0.5	£0.8	£0.8	£3.0
IED Enhancement CAPEX	£27.9	£51.4	£38.5	£9.5	£0.0	£127.4
IED Enhancement OPEX	£1.4	£1.8	£2.2	£3.3	£3.6	£12.4
EPR Base CAPEX	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0

EPR Base OPEX	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0
EPR Enhancement CAPEX	£9.2	£9.2	£0.0	£7.5	£0.0	£25.8
EPR Enhancement OPEX	£0.3	£0.3	£0.3	£0.5	£0.5	£1.9
						£200.8

Note the above TOTEX figures for IED are marginally higher (c£5m) than the IED data submission in August 2023 due to continued refinement of scope as our permit applications are progressed, and an adjustment to the allocation of operating costs between enhancement and base.

4.4. Cost adjustment claim

We believe there will be step-change increase in the maintenance requirements for bioresources assets when our AD sites operate under IED permits. This is because there are a number of bioresources assets on our sites that do not meet BAT due to their design or condition. Assets that are in poor condition and therefore not compliant, will therefore need to be repaired or replaced. As the assets are replaced on a like-for-like basis, we have allocated these costs as base costs. In most cases, the need to repair or replace these assets would be brought forward (i.e., accelerated maintenance) due to the need to maintain asset condition to BAT standards, which removes the flexibility of risk management that would be part of our maintenance strategy for bioresources prior to IED implementation. We have submitted a base cost adjustment claim for IED to argue that the step-change increase in maintenance requirements due to IED needs to be modelled in the base cost (as this was not the case in PR19).

As we believe there is still uncertainty in the funding mechanism for IED, we have decided to include both base and enhancement costs in our claim to ensure the total cost of the IED compliance programme is clearly captured for full transparency.

Due to the similar nature of the required site upgrades for EPR compliance, we have also included all EPR enhancement costs in our cost adjustment claim. We felt that it is important to highlight the need for EPR investments to be funded in PR24, as the EA have excluded EPR upgrades from the scope of the PR24 WINEP.

For further details on our cost adjustment claim, please refer to Annex 5 of document WSX09 (‘CAC5 Industrial Emissions Directive (IED) and Environmental Permitting Regulations (EPR) costs’).

5. Sludge production forecast

5.1. Background

5.1.1. Current sludge production methodology

For provision of sludge figures within our Annual Performance Review we have determined a sludge production figure from the records of cake recycled to land. This approach has been adopted as the data available is the most reliable. Volumes exported are measured either by weighbridge or by load cells on vehicles and routine sampling is undertaken to obtain sludge cake density. To arrive at a sludge production figure allowance is then made for either the lime added or losses through digestion, depending on the process used for treatment. Lime addition is obtained from purchase records. Sludge is routinely sampled pre- and post-digestion for dry solids content which provides the data for an average destruction rate to be calculated.

5.1.2. Sludge measurement

All site-to-site sludge by tanker or truck is measured. Sludge transported from water recycling centres (WRC) to bioresources centres (BC) via tanker is measured for volume and density by loggers at the BCs. Dewatered sludge (cake) from WRCs transported by truck to BCs is measured for volume by load cells on the trucks. Sludge cake density is determined through routine sampling.

We have historically lacked sludge measurement of indigenous sludge from WRCs co-located with BCs. In 2018, we installed sludge flowmeters and density monitors at all our WRCs co-located with BCs, which will provide data on indigenous sludge at these sites. This will enable 100% direct measurement of sludge production at the boundaries of the Network+ and Bioresources and enable comparison with the current method of deriving sludge volumes from cake disposal volumes.

As the real-time accurate measurement of sludge density is technically difficult and to ensure a high level of accuracy is achieved, calibration against results from laboratory analysis of samples was undertaken. Measurement data was only available from 2020/21 onwards. Table 15 shows the comparison between the total sludge production values for the last 3 financial years calculated from direct sludge measurement and the current method of using cake disposal volumes.

Table 15 - Total sludge production obtained by direct measurement of indigenous and imported sludges vs. calculation from cake disposal volumes

Method	Units	2020/21	2021/22	2022/23
Direct measurement of indigenous and imported sludges	tds	78,637	81,752	81,684
Calculation from cake disposal volumes	tds	62,200	61,330	62,963
Difference	%	26%	33%	30%

As can be seen from Table 15, there is a significant difference in the sludge production values obtained from both methods. We believe this is due to the inaccuracy in real-time density measurement as the density monitors are optical sensors which require extensive calibration to accurately measure chemical-dosed sludges. We have therefore continued the calibration exercise on the density monitors to improve their accuracy in measuring the dry

solids of chemical-dosed sludges. In the interim, we will continue with our current method of calculating sludge production using cake disposal volumes.

5.2. Sludge production forecast model

Our sludge production forecasting methodology is based on a bottom-up approach which considers:

- the sludge produced at each WRC,
- the annual population growth at each WRC, and
- the additional sludge produced at each WRC as a result from phosphorus (P) removal.

To enable sludge production forecasting for PR19, a model of theoretical sludge production was produced using the following approach:

- Sludge production backcalculated from exported sludge was compared with sludge production derived from the sum of indigenous (calculated from PE and a theoretical production rate of 0.065g/hd/day1[7]) and the total of all logger imports.
- This exercise was undertaken with data for three financial years (2014/15, 2015/16 and 2016/17).
- This showed that the sludge loggers at some treatment centres appeared to overstate the volume (tds).
- A calibration factor for imports, specific for each logger, was determined such that:

  Produced (from exports) ≈ Indigenous (from PE) + Logged Imports x Calibration Factor

- To adjust for changes in sludge from P removal a theoretical sludge percentage increase, dependent on treatment type (activated sludge, biological filters, tertiary etc.) and the consent limit has been used.
- A theoretical sludge volume for each year in the eight-year period from 2010/11 to 2017/18 has then been derived as follows:

  Theoretical production = {Av. indigenous (2014/15,2015/16,2016/17)} x Annual Growth Factor + Calibrated logged imports

- The growth factor has been adjusted to derive a fit with reported sludge production over the period 2010/11 to 2017/18; a reasonable correlation is achieved when a growth factor of 0.4% per annum is assumed.

The theoretical sludge percentage increases due to P removal used in the model are summarised in Table 16.

Table 16 – Theoretical percentage sludge increase for different treatment types and consent limits

P Consent	<1 mg/l	=1 mg/l	<=2 mg/l	>2 mg/l
Biological filter	23%	21%	15%	11%
Activated sludge	17%	11%	10%	9%

[7] Based on Wessex Water design standards and assuming a primary sludge production of 0.04 kg/hd/day and a secondary sludge production of 0.025 kg/hd/day. The former is appropriate for WRCs without chemical dosing, as is the case for most of our co-located sites and the latter is typical for either a filter works or an activated sludge plant with a long sludge age.

To enable sludge production forecasting for PR24, we re-baselined the model to 2022/23 volumes due to the significant drop in sludge production between 2018/19 and 2021/22 (as shown in Figure 23). We believe the drop in 2018/19 and 2019/20 was due to an improvement in the measurement of cake disposal volumes, while the drop seen in 2020/21 to 2021/22 was due to the impact of COVID-19 restrictions on commercial, industrial and holiday activities in our region.

We estimated additional sludge growth for tighter P consents in AMP8 (i.e., 0.5mg/l and 0.25mg/l) using a line of best fit with the theoretical sludge percentage increases in Table 16.

5.3. Forecast volume increase from 2023/24 to 2034/35

We used the model to forecast the total sludge production from 2023/24 to 2034/35. An underlying growth factor of 0.4% per annum has been assumed, based on the analysis of historical data described above, with increases in sludge production from additional inorganic sludge calculated when a new or tighter P consent is introduced at a WRC.

Figure 23 shows the forecast sludge production from 2023/24 to 2034/35.

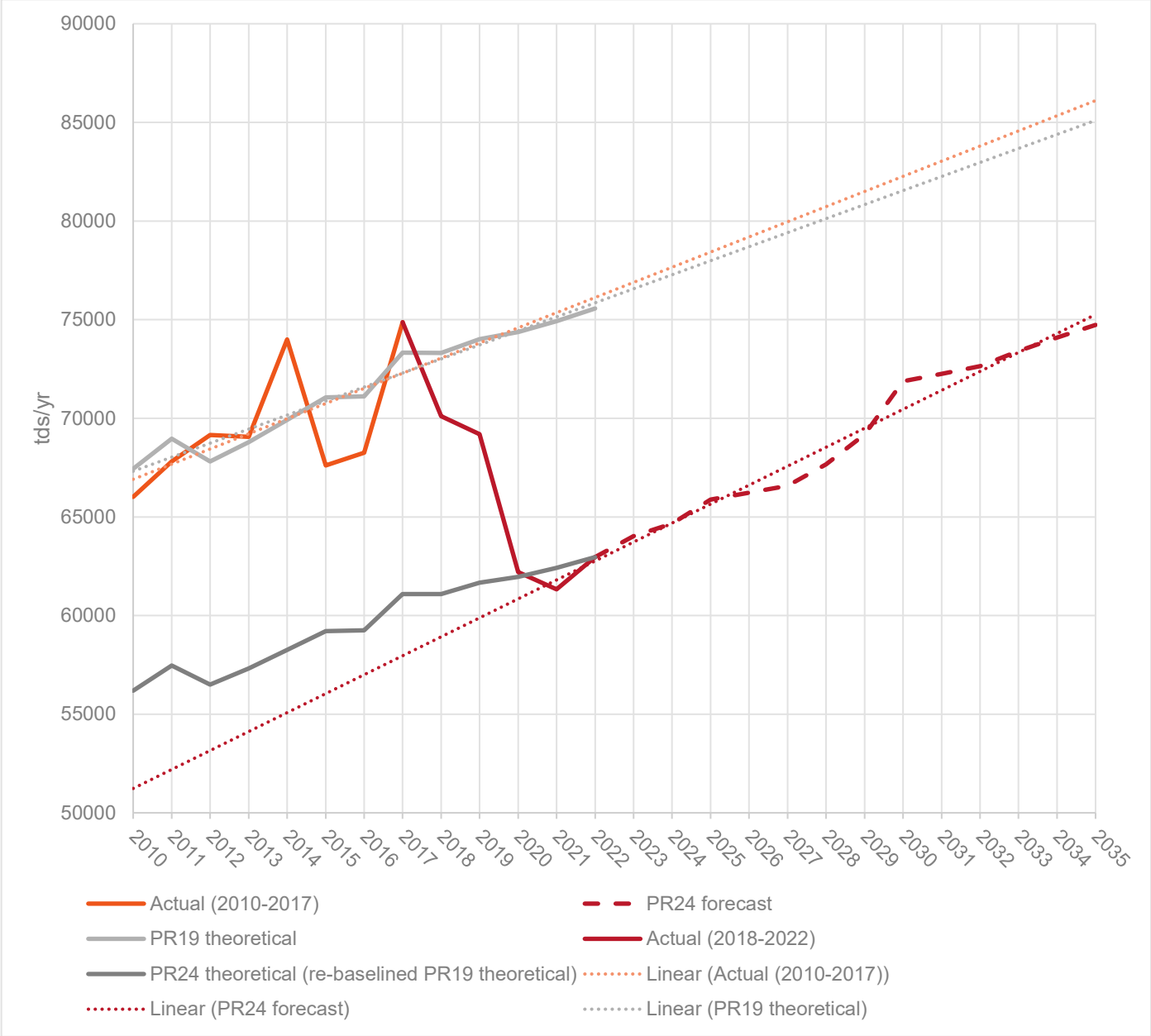
We believe the significant drop seen between 2017/18 and 2019/20 was due to an improvement in the measurement of cake disposal volumes. We therefore consider the lower volumes seen from 2020/21 to 2022/23 to be the current baseline of our forecast. However, we have only based our model on 2022/23 volumes because we believe the sludge production in 2020/21 and 2021/22 have been influenced by the impact of the Covid pandemic.

The forecast annual sludge growth from P removal in AMP8 is higher than historic increases seen in AMP6 or AMP7 due to the tightening of P consents for many sites in AMP8, with most consent limits reducing to 0.5mg/l or 0.25mg/l. This results in up to 25-30% more sludge produced from the increased chemical dosing and tertiary solids removal.

The forecast annual sludge growth from P removal is similarly high for AMP9, as even more sites will be receiving tighter P consents in AMP9.

We have forecast the annual sludge growth from P removal based on the expected completion date of each individual P removal scheme. We are expecting a large number of the AMP8 P removal schemes to be completed in 2029, which explains the step change in sludge production from 2029/30 and 2030/31.

Figure 23 – Sludge production model and forecast



5.3.1. Impact of population growth on sludge production

Local Planning Authorities publish local plans which prescribe the scale, scope, and timing of new development to meet demand for housing and employment land. Local plans generally cover a 10-to-15-year period with further information available to inform location through site allocations document and a 5-year supply of development land. For producing long-term demand projections, we use a hybrid of Local Plan information over the shorter 5- and 10-year period and introduce a trend-based projection over the longer 25-year term, aligning with data published by the Office of National Statistics (ONS). Within our projections we also take consideration of non-household growth, such as increases in commercial and industrial flows and loads.

The projected growth at each WRC is expressed as population equivalent (PE). Based on our engineering design standards, we assume that the theoretical sludge production at each site to be proportional to its PE – at a rate of 0.065g/hd/day. As described in our forecast methodology, we calibrated the theoretical sludge production against actual sludge production data and found that annual sludge growth due to population growth was approximately 0.4%.

5.3.2. Impact of PR24 P removal schemes on forecast sludge production

We derived theoretical sludge increase percentages based on the type of treatment and P consent limit (as summarised in Table 16). We applied the relevant percentages to sites planned for new or additional P removal in AMP8 (as per the WINEP programme in Annex A5) to calculate the additional sludge production due to P removal at these sites. The forecast of annual sludge growth is then produced based on the expected completion of each individual P scheme. There is uncertainty in the timing of delivery of individual P schemes, which is explained in further detail in Section 5.4.2.

The impact of our PR24 P removal schemes on our forecast total sludge production is illustrated in Figure 24. Both sets of sludge production forecasts consider sludge growth due to population growth, but the one in orange excludes sludge growth due to P removal in AMP8 and AMP9. Therefore, the difference between the sludge production values shows the amount of additional inorganic sludge that is produced due to P removal, which is 5.1% of total sludge production in 2029/30 (i.e., end of AMP8) and 8.7% of total sludge production in 2034/35 (i.e., end of AMP9). Sludge growth due to P removal is significant in AMP8 and AMP9 when compared to sludge growth due to population growth, which is only 2.7% to 2.8% of total sludge production at the end of AMP8 and AMP9. Table 17 summarises this data.

In Figure 24, the visible step-change increase in the forecast total sludge production with P removal between 2029/30 and 2030/31 is due to the concentration of P removal schemes forecast to be completed in 2029.

Figure 24 – Forecast sludge production with and without sludge growth due to P removal in AMP8 and AMP9

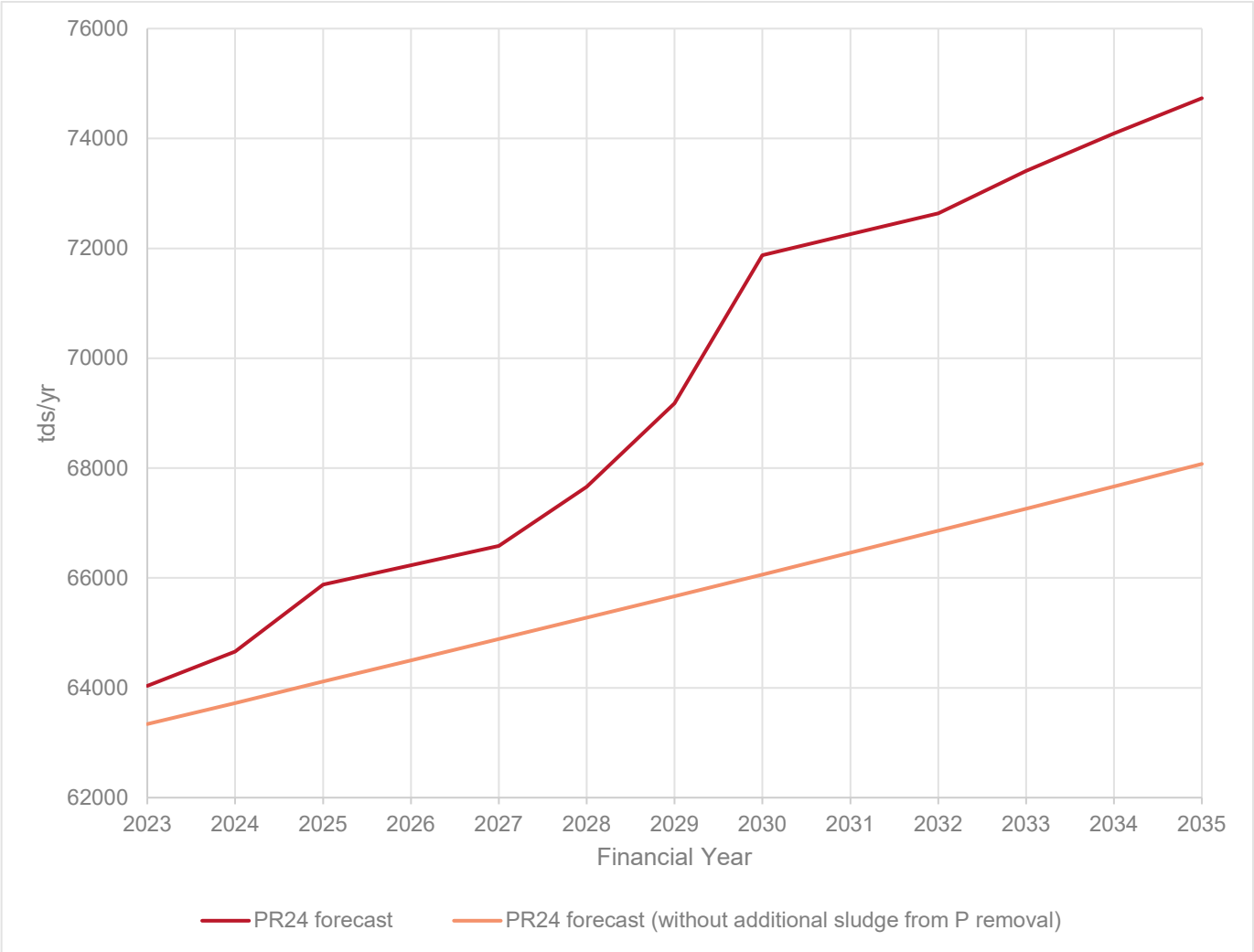


Table 17 – Total sludge growth over AMP8 and AMP9 due to population growth, P removal and both

Sludge growth due to…	AMP8		AMP9	
	% of total sludge production in 2029/30	tds	% of total sludge production of 2034/35	tds
Population growth	2.8%	1,948	2.7%	1,999
P removal	5.1%	3,512	8.7%	6,426
Population growth and P removal	7.9%	5,460	11.4%	8,426

5.3.3. Comparison of forecasts with historical sludge production growth rates

Table 18 shows the modelled sludge production growth rate compared with historical sludge production growth rates obtained from direct sludge measurement and the current method of deriving sludge production from cake disposal volumes. Figure 25Figure 25 – Forecast sludge production using modelled sludge production growth rate and historical sludge production growth rates in shows the forecast of sludge production from 2023/24 to 2034/35 using the 3 different growth rates.

Table 18 – Modelled sludge production growth rate vs. historical sludge production growth rates

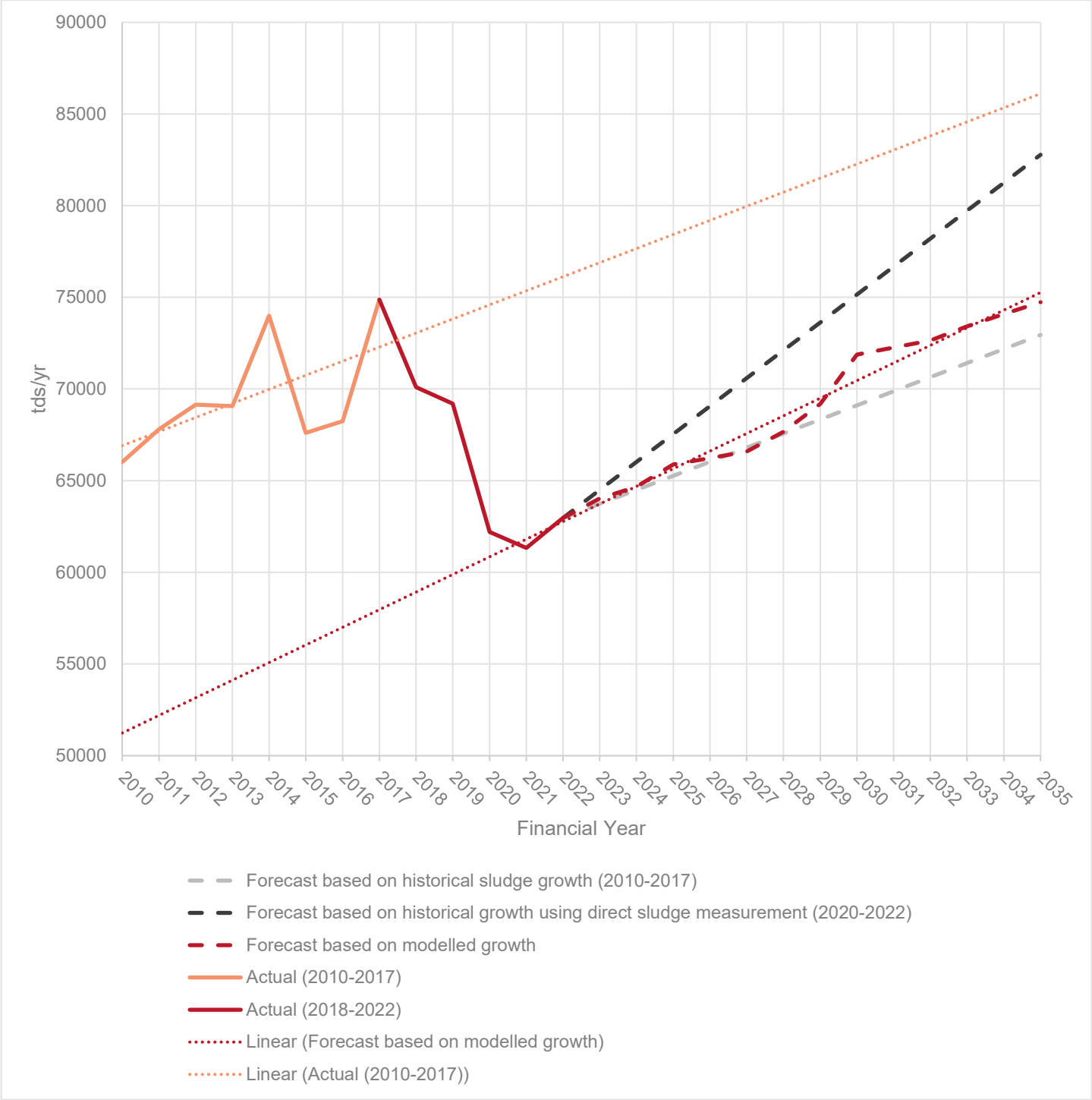
Sludge production growth rates	tds/yr	% of total sludge production in 2022/23
Modelled growth rate based on annual growth factor of 0.4% and PR24 P removal programme	961	1.5%
Historical growth rate based on 2010-2017 total sludge production (derived from cake disposal volumes, i.e., the current method used in APR reporting)	768	1.2%
Historical growth rate based on direct sludge measurement from 2020-2022	1,524	2.4%

The historical sludge production growth using obtained from the current method of deriving sludge production from cake disposal volumes excluded 2018-2022 due to the significant drop in sludge production during these years. Whereas the historical sludge production growth rate obtained from direct sludge measurement only included 2020-2022 because measurement data was not available prior to 2020.

We consider the modelled sludge production growth rate to be the most accurate as it is obtained from a bottom-up analysis of each site's sludge production, considering population growth (i.e., the annual growth factor of 0.4%) and site-specific sludge increases due to P removal. Conversely, we consider the historical sludge production growth rate obtained from direct sludge measurement to be most inaccurate due to the challenges faced in calibrating the dry solids measurement and the limited historical data available for analysis.

In Figure 25, the forecast based on modelled sludge production growth has a similar but slightly larger slope than the trendline of historical sludge production from 2010-2017. This is aligned with our expected sludge growth in AMP8 and AMP9, as this reflects larger sludge volumes from increased P removal in AMP8 and AMP9 compared to previous AMPs.

Figure 25 – Forecast sludge production using modelled sludge production growth rate and historical sludge production growth rates in Table 18



5.3.4. Relationship between sludge production and total load received

As described in Section 5.3.1, our forecast modelling shows that sludge growth due to population growth is proportional to population growth at an annual rate of 0.4%. Our projections of population growth at each site considers the forecast increase in commercial and industrial flows and loads, converted into PE As the load received at each site is dependent on the calculated PE of the site, we expect our forecast sludge production to correlate to the total load received at all sites. Any forecast increases in commercial and industrial loads would be reflected in the forecast sludge production using this methodology.

Total sludge production is influenced by non-appointed liquid waste treatment. Historically, sludge produced from non-appointed liquid waste treatment has been around 6% of our total sludge production, which is a small percentage. We do not expect our non-appointed liquid waste treatment operation to change in any significant way. The forecast of non-appointed liquid waste treatment is described in the commentary for Table BIO1.

5.4. Uncertainties in forecasting

5.4.1. Measurement improvement

Our methodology for forecasting volumes is derived from historical measurement of cake exports. We are progressing transfer to direct sludge measurement by density and volume measurement. As we have described, accurate real-time measurement of sludge volumes is technically difficult, in particular chemical-dosed sludges that can influence the measurement of dry solids. We are continuing calibration work on the density monitors to improve their accuracy, with the view of having accurate sludge measurement that can be used in forecasting sludge production in PR29.

5.4.2. P removal

At the time of writing, the final Water Industry National Environmental Programme (WINEP) on which the business plan is to be based, is yet to be finalised. Therefore, there is uncertainty in both the P consent limits (whether 0.5mg/l or 0.25mg/l) and the date of delivery for several sites. The sites subject to confirmation are typically either small sites or site that have existing P removal consents that are potentially tightening. Therefore, the uncertainty in the additional sludge increases from these sites is considered immaterial when taken in context of the overall sludge production forecast.

The PR24 P removal programme as of July 2023 in the WINEP is provided in Annex A5.

There is also uncertainty in the timing of the delivery of each individual P removal scheme planned in AMP8, as this is dependent on the optimisation of the overall investment plan in AMP8, including consideration to the River Water Quality performance commitment which incentives early delivery of P removal schemes. The impact of this on sludge production forecast is the profiling of the sludge growth due to P removal over the 5 years of AMP8. However, due to the significant number of medium to large sites requiring new or additional P removal in AMP8 and the subsequent length of the delivery programme, we expect the completion of these schemes to be concentrated at the back end of AMP8 and a step-change increase in sludge production from 2029/30 to 2030/31.

6. Investment plans

6.1. Growth and headroom capacity

As of 2023, there is 68,073 tds per year of total available capacity at our bioresources centres and 2,738 tds per year of contingency capacity provided through temporary dewatering at several water recycling centres. Our estimated total average sludge production for 2023 is 64,035 tds, which would mean a current capacity headroom of only 11%. We do not consider this level of headroom to provide sufficient resilience for managing sludge peaks or unforeseen plant failure or allow for digester maintenance. Our assessment of capacity availability concluded that 30-40% headroom capacity is required for resilience management.

We forecast total sludge production to increase to 71,876 tds by 2030. To accommodate this growth and achieve a headroom of at least 30%, an additional c. 23,000 tds per year of capacity is required by 2030. We forecast that an additional 12,191 tds per year of capacity will be available from 2025 when the lime treatment plant at Avonmouth is reinstated and the digester refurbishment at Poole is complete. The shortfall capacity of c. 11,000 tds per year will need to be provided in AMP8 through growth enhancement investment. We are therefore proposing the following investments:

- To build two new digesters at Avonmouth to provide 7,300 tds per year of new digestion capacity (of which 3,650 tds per year capacity is for headroom/contingency),
- To install a larger lime treatment plant at West Huntspill to provide 3,650 tds per year of new lime treatment capacity for contingency.

We have identified the need to take three of our AD sites offline in AMP8, one at a time, to undertake major capital maintenance and implement site-wide improvements for IED and H&S compliance. We plan to take Taunton offline in 2025 to 2026, Trowbridge in 2027 to 2028, and Berry Hill in 2029 to 2030. To enable this programme, we would require additional short-term/temporary headroom capacity to facilitate these works in AMP8. From our capacity review, we estimated that we would need to provide 16,425 tds per year of temporary headroom capacity from 2025 to 2030, which will have to be included in our capital maintenance expenditure. We plan to hire temporary dewatering and lime treatment plants at West Huntspill and Palmersford to provide the required short-term additional headroom capacity.

Table 19 summarises the treatment capacity of each bioresources in current operation (2023) and in 2030. The treatment capacity for 2030 considers the capacity reduction of 9,855 tds per year (based on Berry Hill's capacity) and the short-term contingency measures provided to make up this shortfall.

Table 19 – Treatment capacity at each bioresources centre now vs in 2030

Bioresources centre	Current operation (2023)		AMP8 operation (by 2030)	
	Treatment	Operational capacity[8] (tds/yr)	Treatment	Operational capacity[9] (tds/yr)
Avonmouth	Advanced anaerobic digestion	31,938	Advanced anaerobic digestion	35,588
			Advanced anaerobic digestion (permanent contingency)	3,650
	Raw sludge lime treatment (out of service)	0	Raw sludge lime treatment (permanent contingency)	3,650
Berry Hill	Conventional anaerobic digestion	9,855	Conventional anaerobic digestion	9,855
Malmesbury	Temporary raw sludge dewatering for onward lime treatment at Ratfyn (short-term contingency for capital maintenance in AMP7)	-	Temporary raw sludge dewatering will be removed – site becomes all Network+	-
Minehead	Raw sludge dewatering for onward digestion at Taunton or lime treatment at West Huntspill	-	Raw sludge dewatering for onward digestion at Taunton or lime treatment at West Huntspill	-
Palmersford	Temporary raw sludge dewatering for onward lime treatment at Ratfyn (short-term contingency for capital maintenance in AMP7)	-	Temporary raw sludge and cake lime treatment (short-term contingency for capital maintenance in AMP8)	9,855
Poole	Conventional anaerobic digestion (out of service)[10]	0	Conventional anaerobic digestion	8,541
Ratfyn	Raw sludge lime treatment	3,504	Raw sludge lime treatment	3,504
	Raw cake lime treatment (permanent contingency)	1,369	Raw cake lime treatment (permanent contingency)	1,369
Taunton	Conventional anaerobic digestion	8,760	Conventional anaerobic digestion	8,760

[8] The operational capacity of each site is assumed to be 90% of the maximum capacity to account for downtime for maintenance.
[9] The operational capacity of each site is assumed to be 90% of the maximum capacity to account for downtime for maintenance.
[10] Poole's AD plant is currently offline due to a major digester refurbishment programme in AMP7.

Trowbridge	Advanced anaerobic digestion	8,760	Advanced anaerobic digestion	8,760
West Huntspill	Raw sludge dewatering for onward digestion at Taunton	-	Raw sludge dewatering for onward digestion at Taunton	-
	Raw sludge and cake lime treatment (permanent contingency)	1,369	Raw sludge and cake lime treatment (permanent contingency)	3,650
			Temporary raw sludge and cake lime treatment (short-term contingency for capital maintenance in AMP8)	6,570
Weston-Super-Mare	Temporary raw sludge dewatering for onward lime treatment at West Huntspill (short-term contingency for capital maintenance in AMP7)	-	Temporary dewatering plant to be removed; site becomes all Network+	-
Wincanton	Retired – site becomes all Network+	-	Retired – site becomes all Network+	-
Yeovil Vale Road	Raw sludge dewatering for 33% in-situ lime treatment and 67% onward digestion at Taunton	5,256	Raw sludge dewatering for 33% in-situ lime treatment and 67% onward digestion at Taunton	5,256
			AD site closure for maintenance and IED upgrades in AMP8 (Taunton in 2025-26, Trowbridge in 2027-28, and Berry Hill in 2029-30)	-9,855
	Total capacity (without contingency)	68,073	Total capacity (without contingency)	70,409
	Total capacity (with contingency)	70,811	Total capacity (with contingency)	99,153
	Forecast sludge production	64,035	Forecast sludge production	71,876
	Forecast capacity headroom	11%	Forecast capacity headroom	38%

Figure 26 illustrates the profile of our capacity and headroom against our forecast sludge production from 2023-2034.

Our proposed growth enhancement investments in AMP8 will provide 10,950 tds per year of additional capacity to accommodate growth in sludge volumes and recover our headroom level to at least the required 30% level. Our planned AD site closures in AMP8 will reduce our available capacity by c. 9,000 tds per year from 2025-2030. To compensate for this reduction and ensure there is sufficient resilience to support the planned works, we will be providing 16,425 tds per year of temporary headroom from 2025-2030, which will be funded through capital maintenance (base) expenditure.

With our proposed provision of additional capacity in AMP8, it is unlikely we would require additional capacity provision in AMP9, as there would be sufficient capacity throughout AMP9 to accommodate peak sludge production and maintain the required 30% headroom level (as can be seen in Figure 26).

Figure 26 - Forecast sludge production and capacity provision from 2023-34.

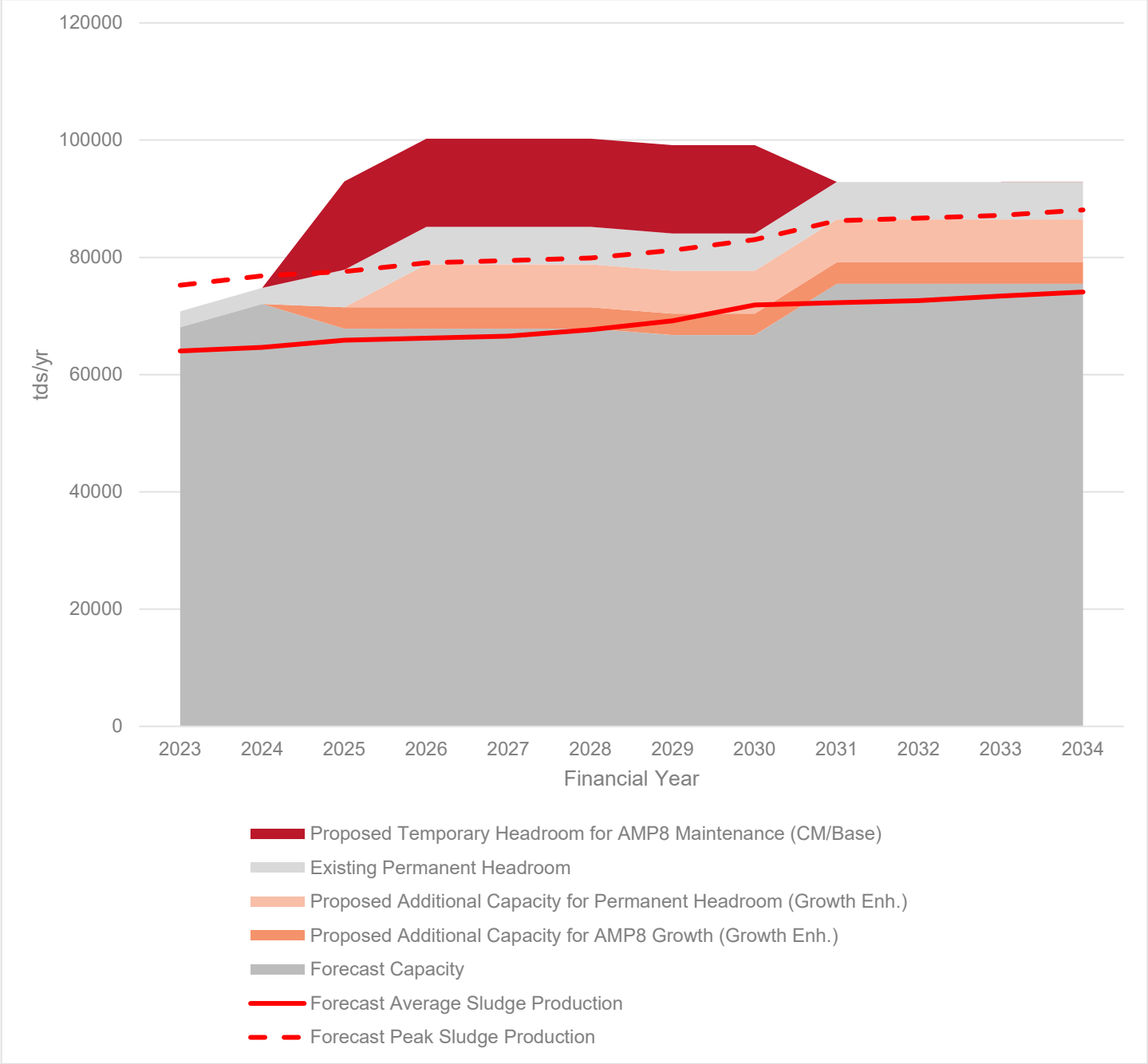


Figure 27 and Figure 28 illustrate the expected monthly profile of total sludge production for 2023 and 2030 respectively. This profile was produced based on historic sludge volumes from 2020 to 2022.

Figure 27 - Monthly total sludge production vs. capacity in 2023.

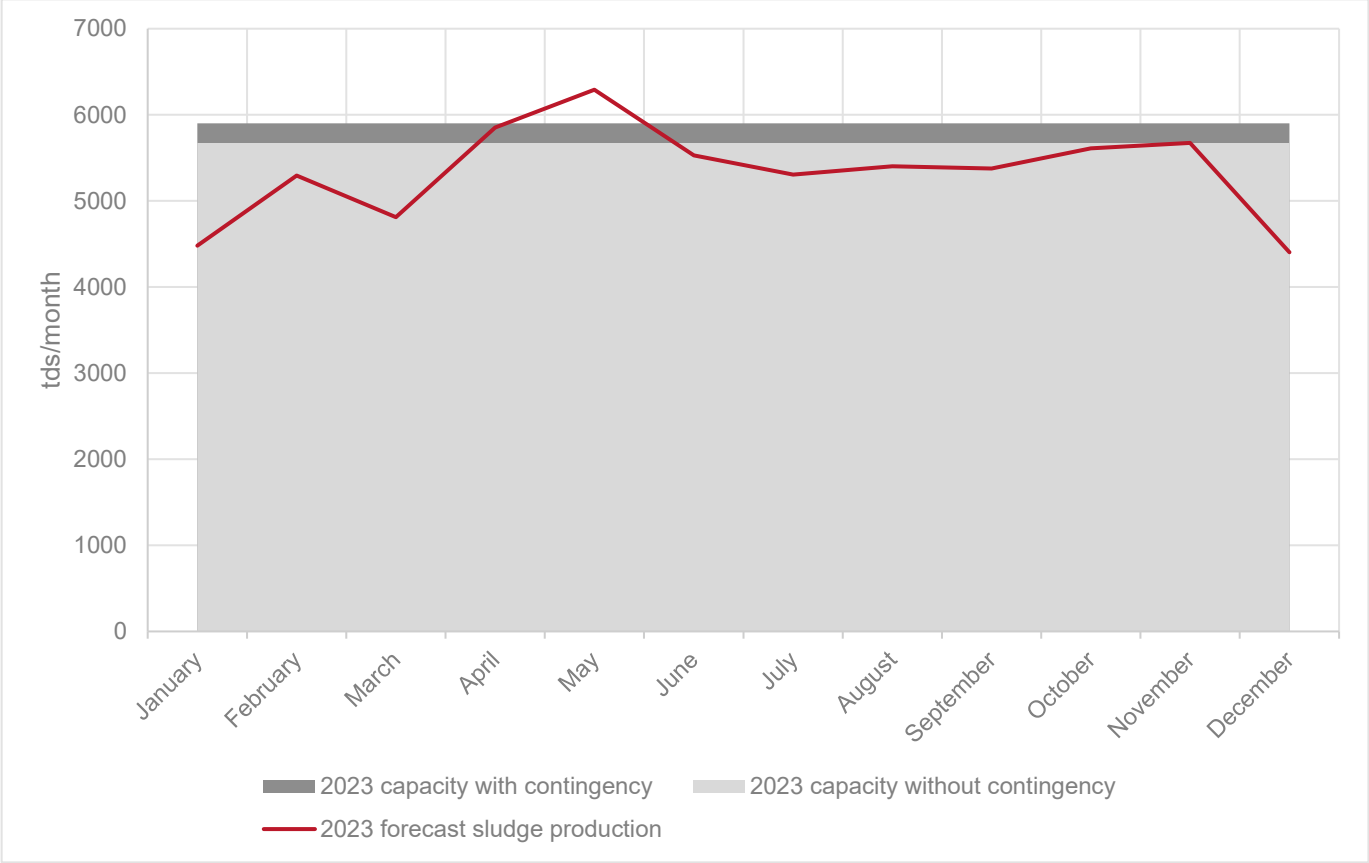
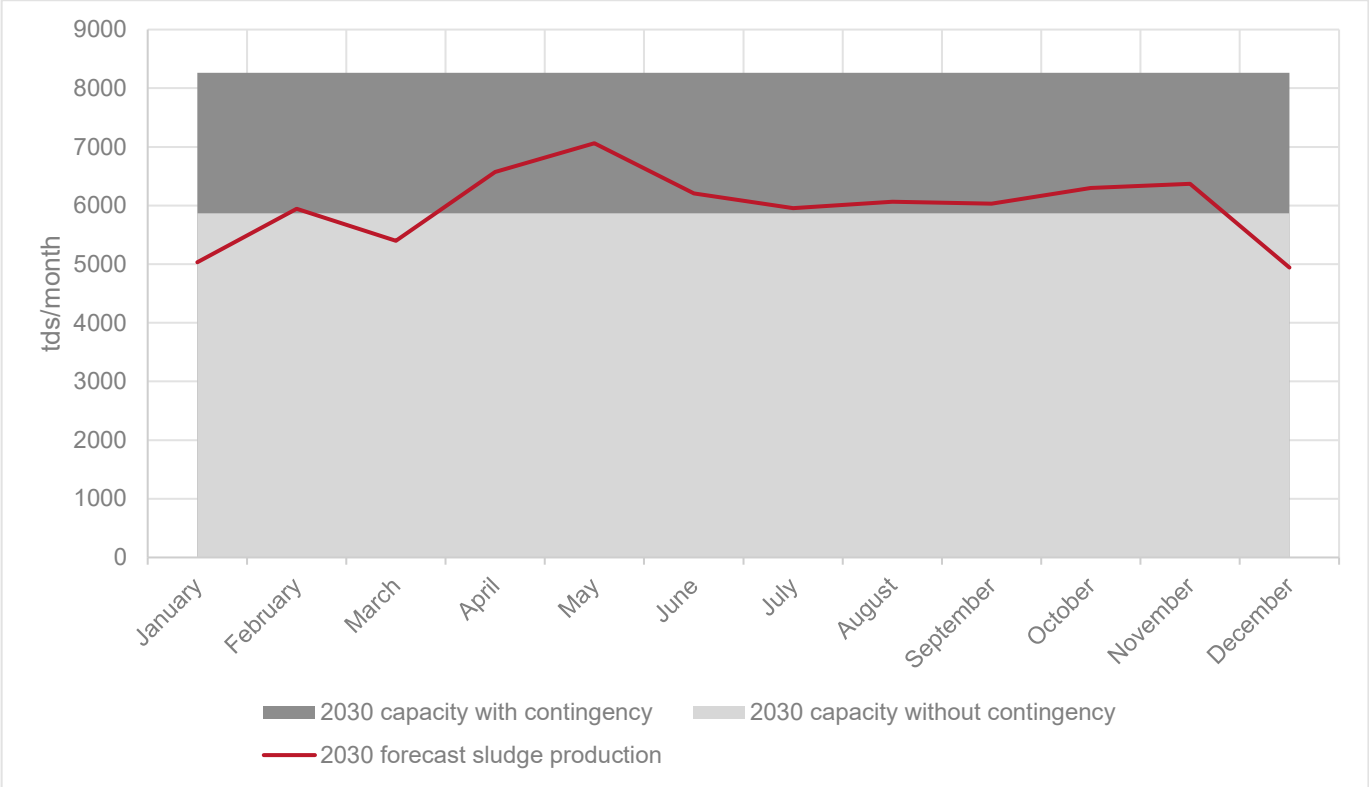


Figure 28 - Monthly total sludge production vs. capacity in 2030.



As can be seen in Figure 27 and Figure 28, we currently do not have sufficient headroom capacity to cover peak sludge production volumes during the spring months of April and May, but we will by 2030 when we increase our headroom capacity to 38%. Furthermore, the increased headroom capacity will enable planned digester maintenance and mitigate against the risk of unplanned AD plant downtime, which typically results in significant capacity reductions (between 10-15% of total capacity).

In our review of headroom capacity provision, we considered the option of cross-border trading to smooth the spring peaks in sludge production so that headroom can be reduced. While our neighbours (Severn Trent Water, Southern Water and South West Water) indicated that they would accept sludge imports to support our resilience management, they cannot guarantee availability of this resilience service as they would need to utilise their headroom to manage their spring peaks as well.

Atkins undertook a review of treatment capacity at a national level to understand the viability of cross-border sludge trading to smooth the profile of sludge production and therefore reduce the amount of additional capacity that each company would need to provide. They collated data provided by each company on forecast sludge volumes and capacity as part of their review. From the data provided, they concluded all companies experienced shared spring peaks which limit the opportunities for capacity sharing to smooth the profile of sludge production. They also concluded there will be insufficient capacity for all periods of the year on a national level by 2030 and new capacity will need to be provided then.

6.2. Quality enhancement

6.2.1. Biosolids management

The implementation of the Environmental Permitting Regulations (EPR) on sewage sludge recovery and disposal activities will move biosolids into a deployment system, which will likely result in delays in the transport and land application of the biosolids. We also expect the land application of biosolids to be restricted in the autumn period due to the EA's reinterpretation of the Farming Rules for Water regulation. We will therefore require additional biosolids storage capacity in AMP8 to mitigate the risk of these environmental regulation changes.

We are proposing to invest in the provision of additional 46,900m^3 biosolids storage capacity, which will be delivered through nine Dutch barns. We plan for one storage barn to be provided at Avonmouth in 2026, two at Trowbridge in 2028, and six at Malmesbury in 2029. Along with our existing storage barns at Taunton and Wimborne, these nine additional storage barns will provide a total of 3-4 months' storage for all our biosolids by 2030.

The provision of 3-4 months' storage for our biosolids will also allow for over-winter storage and help to mitigate the risk of wet weather restrictions on biosolids application to land.

6.2.2. Treatment resilience

We are proposing to provide additional sludge screening and thickening of 5,475 tds per year at Avonmouth due to the deterioration in the quality (dry solids) of the imported sludges from satellite sites that have increased chemical dosing for achieving tighter P consents in AMP8.

6.2.3. IED site improvements

All five of our AD sites will be regulated under IED permits and will therefore need to comply with the standards set out in BAT and Appropriate Measures guidance. Significant capital investment is required on all five sites to upgrade them in the following areas:

- Secondary containment – the area in which sludge holding tanks are located must be made impermeable and contained within bund walls as per the CIRIA 736 standard,

- Tank covering – all open sludge holding tanks must be covered to minimise fugitive emissions; the headspace gas must odour treated or returned to the biogas system if a high level of methane is present,
- Control and monitoring – more stringent measures must be implemented for odour control, bioaerosols control, leak detection (to minimise fugitive emissions), and burst protection for below-ground assets (to minimise land pollution).

There will also be a significant increase in the required operational and maintenance activities under IED which will impact the OPEX of our AD sites. One example is the sampling requirements under IED – significant costs will arise from the need to routinely sample and analyse sludge liquors for pollutants and digested sludge for residual methane levels. We also anticipate the need for additional resources (e.g., plant operators, scientists, engineers, and technical specialists) to undertake the additional operational and maintenance activities required under IED.

6.2.4. EPR site improvements

With sewage sludge classed as a regulated waste under the EPR, the EA will require all sludge treatment activities to be regulated under waste permits in the future. The EA are planning to publish their Strategy for Sustainable Sludge Use (Sludge Strategy) which will provide guidance on the permit requirements for all sludge treatment activities that are currently not permitted, e.g., mechanical sludge thickening and lime treatment. We anticipate that all our water recycling centres with mechanical sludge thickeners and bioresources centres with lime treatment will be issued with bespoke waste operation permits in the future. This would mean that these sites will need to comply with Appropriate Measures (AM) guidance. We will therefore need to invest in upgrading these sites with secondary containment, improved drainage, fugitive emissions control, etc. to meet AM standards (similar to the upgrades required for IED sites).

The timescale of the permitting requirements is still uncertain as it is dependent on when the EA will be publishing their Sludge Strategy. This was supposed to happen in 2023, but the EA have indicated that this is now delayed as they are reviewing the timeline for the implementation of the Strategy. We anticipate that the EA's Sludge Strategy to be published in the next few years, which will mean that the permitting exercise to commence in AMP8 and the site upgrades will also be required in AMP8. Therefore, the investments for the required site upgrades will need to be considered in PR24, to avoid funding issues, similar to those that occurred with IED during PR19.

There are uncertainties as to how the EA would propose to permit mechanical sludge thickening plants on a water recycling centre, so we have excluded these sites from our review for PR24. We have however included lime treatment centres in our PR24 review as we believe there is more certainty in the permitting scope as these sites currently operate under T21 waste exemptions and have similar process configuration to sludge AD sites.

Our review has shown that significant capital investment will be required on all four of lime treatment centres to upgrade them to meet BAT and AM standards. The two areas that will require the largest investment would be secondary containment and covering of open sludge tanks.

6.3. Capital maintenance

We forecast a step change in our major maintenance requirements for bioresources in AMP8. The reasons for the increased major maintenance in AMP8 are:

- The digesters at Avonmouth, Trowbridge, Taunton and Berry Hill will need to be inspected and cleaned as they reach 10 years of operation in AMP8,
- Various biogas assets such as biogas holders, flares and pressure relief valves will need to be refurbished or replaced to meet process safety standards,
- The maintenance programme of various bioresources assets will need to be accelerated to ensure that the sludge treatment process at IED-permitted AD sites meet BAT standards.

We describe our proposals for maintaining and operating our bioresources assets in document WSX10 titled 'Maintaining our services'.

Major maintenance schemes at a bioresources centre often restricts treatment capacity so we plan maintenance schemes strategically to minimise the impact on our overall treatment capacity. The delivery of large-scale site upgrades for IED and EPR compliance will also need to be factored in our maintenance planning for AMP8. Our proposed plan is illustrated in Figure 29.

Figure 29 - Investment plan for AMP8.

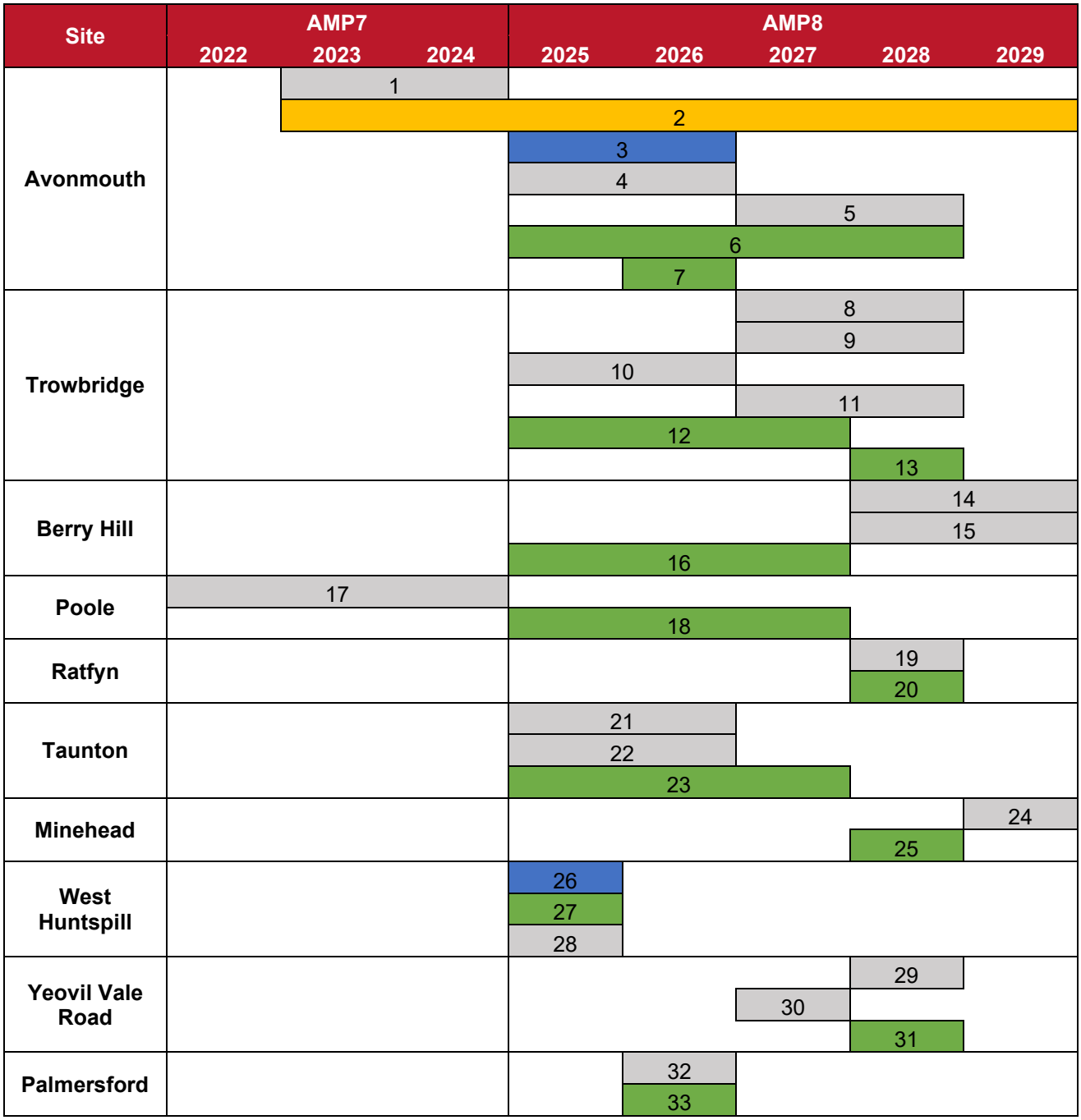


Table 20 - Details of proposed investments in Figure 29.

	Site	Investment type	Description of work
1	Avonmouth	Capital maintenance	Demolition of cake silos and reinstatement of lime treatment plant (due to 2020 Avonmouth incident)
2	Avonmouth	Capital maintenance & quality enhancement	Digester inspection, cleaning, refurbishment and IED upgrades (rolling programme for eight digesters)
3	Avonmouth	Growth enhancement	Two new digesters for growth and headroom
4	Avonmouth	Capital maintenance	H&S improvements (biogas system upgrade, relocation of gas holder, biogas flare and site control room)
5	Avonmouth	Capital maintenance	Replacement of imported sludge tank, sludge thickeners, and main sludge pumping station
6	Avonmouth	Quality enhancement	IED improvements (secondary containment, improved site drainage, fugitive emissions control, etc.)
7	Avonmouth	Quality enhancement	New sludge storage barn
8	Trowbridge	Capital maintenance	Major APD refurbishment, digester inspection, cleaning and refurbishment (two digesters)
9	Trowbridge	Capital maintenance	H&S improvements (biogas system upgrade, replacement of gas holder, relocation of tanker refuelling and sludge reception, etc.)
10	Trowbridge	Capital maintenance	Replacement of dewatering belt presses
11	Trowbridge	Capital maintenance	Replacement of pre-digestion sludge tanks, thickeners, and liquor balancing tanks
12	Trowbridge	Quality enhancement	IED site improvements (secondary containment, improved site drainage, fugitive emissions control, etc.)
13	Trowbridge	Quality enhancement	Two new sludge storage barns
14	Berry Hill	Capital maintenance	Digester inspection, cleaning and refurbishment
15	Berry Hill	Capital maintenance	H&S improvements (biogas system upgrade, replacement of digester roofs and gas holder, etc.)
16	Berry Hill	Quality enhancement	IED improvements (secondary containment, improved site drainage, fugitive emissions control, etc.)
17	Poole	Capital maintenance	Major AD plant refurbishment
18	Poole	Quality enhancement	IED improvements (secondary containment, improved site drainage, fugitive emissions control, etc.)
19	Ratfyn	Capital maintenance	Replacement of lime treatment plant

20	Ratfyn	Quality enhancement	EPR improvements (secondary containment, improved site drainage, fugitive emissions control, etc.)
21	Taunton	Capital maintenance	Digester inspection, cleaning and refurbishment
22	Taunton	Capital maintenance	H&S improvements (biogas system upgrade, replacement of gas holder, boiler and standby generator)
23	Taunton	Quality enhancement	IED improvements (secondary containment, improved site drainage, fugitive emissions control, etc.)
24	Minehead	Capital maintenance	Replacement of centrifuge and polyelectrolyte dosing plant
25	Minehead	Quality enhancement	EPR improvements (secondary containment, improved site drainage, fugitive emissions control, etc.)
26	West Huntspill	Growth enhancement	Upgrade of lime treatment plant for headroom
27	West Huntspill	Quality enhancement	EPR improvements (secondary containment, improved site drainage, fugitive emissions control, etc.)
28	West Huntspill	Capital maintenance	Temporary lime treatment plant for short-term contingency
29	Yeovil Vale Road	Capital maintenance	Replacement of dewatering belt presses and lime treatment plant
30	Yeovil Vale Road	Capital maintenance	Replacement of washwater tank
31	Yeovil Vale Road	Quality enhancement	EPR improvements (secondary containment, improved site drainage, fugitive emissions control, etc.)
32	Palmersford	Capital maintenance	Temporary lime treatment plant for short-term contingency
33	Palmersford	Quality enhancement	EPR improvements (secondary containment, improved site drainage, fugitive emissions control, etc.)

7. Enhancement case assessments

Our growth and quality enhancement investment proposals for bioresources are summarised in Table 1 in Section 1.

We have undertaken an enhancement case assessment for our proposals of:

- Site improvements for Industrial Emissions Directive (IED) compliance
- Site improvements for Environmental Permitting Regulations (EPR) compliance
- Provision of additional biosolids storage for sludge disposal resilience
- Provision of additional sludge treatment capacity to accommodate increased sludge production due to population growth and increased P removal

Each enhancement proposal has been assessed against the following criteria:

- Need for enhancement investment
- Best option for customers
- Cost efficiency
- Customer protection

7.1. Industrial Emissions Directive (IED) compliance

*Table 21 - Enhancement case assessment - **Industrial Emissions Directive (IED) compliance.***

	Requirement	See chapter	Comment
1. Need for enhancement investment			
A	Is there evidence that the proposed enhancement investment is required (i.e., there is a quantified problem requiring a step change in service levels)? This includes alignment agreed strategic planning framework or environmental programme where relevant.	Industrial Emissions Directive	IED compliance is a regulatory requirement. Our five anaerobic digestion (AD) sites will be issued IED permits. These sites will need to be upgraded to meet Best Available Techniques (BAT) and Appropriate Measures (AM) standards. The areas of improvement that require significant capital investment are the provision of secondary containment to CIRIA 736 standard and the covering of all open tanks for abatement of fugitive emissions. Failure of compliance with IED permits may impact our environmental performance assessment (EPA) score and enforcement action from the EA.
B	Is the scale and timing of the investment fully justified, and for statutory deliverables is this validated by appropriate sources (for example in an agreed strategic planning framework)?	Industrial Emissions Directive	Our proposed IED investments have been scoped using a bottom-up approach. We have undertaken a BAT and AM gap analysis for each site to identify the site-specific improvement needs. Improvement solutions have been developed at site level to produce a scope list for each site. Due to the delays in the permitting process and scale of investment required, we expect the delivery of the required site improvements to be in AMP8. We do not consider the

			EA's proposed deadline for IED compliance by December 2024 to be feasible.
C	Does the proposed enhancement investment or any part of it overlap with activities to be delivered through base, and where applicable does the company identify the scale of any implicit allowance from base cost models?	Industrial Emissions Directive	The costs associated with the provision of new assets (such as secondary containment, covers for open sludge tanks, etc.) for IED compliance have been allocated as enhancement costs. The costs of additional maintenance required to improve the condition or performance of existing assets to meet BAT for IED compliance have been allocated as base costs. We have submitted a cost adjustment claim to argue that the additional maintenance costs due to IED would need to be included in the base cost modelling in PR24. Please refer to WSX09 – Annex 5 – CAC5 for more details on this claim.
D	Does the need and/or proposed enhancement investment overlap or duplicate with activities or service levels already funded at previous price reviews (either base or enhancement)?	Industrial Emissions Directive	We did not propose any IED investments in PR19.
E	Is the need clearly identified in the context of a robust long-term delivery strategy within a defined core adaptive pathway?	Industrial Emissions Directive	Our proposed IED investments will bring all five of our AD sites to BAT and AM standards so that they comply with their IED permits. Our proposed IED investments in AMP8 will provide the required mitigation measures to control and minimise air and land emissions from the sludge treatment processes at our IED sites. The improvements made will contribute towards our carbon and net zero goals.
F	Where appropriate, is there evidence that customers support the need for investment (including both the scale and timing)?	N/A	N/A
G	Is the investment driven by factors outside of management control? Is it clear that steps have been taken to control costs and have potential cost savings (e.g., spend to save) been accounted for?	Industrial Emissions Directive	Our proposed IED investments are to meet IED compliance and are therefore driven by the requirements set out in BAT and AM guidance. The interpretation of what improvements or measures constitute compliance is driven by the EA. The EA have a very strict interpretation of the requirements under BAT and AM. This means that the EA will only accept alternative solutions that provide the same level of environmental protection as the measures prescribed in AM guidance, which limits our ability to propose solutions that have potential cost savings. For example, containment solutions must meet CIRIA 736 standard as per AM guidance. We proposed alternative containment solutions

			that are more cost-efficient using a risk-based approach, but they were rejected by the EA as they did not meet CIRIA 736.
2. Best option for customers			
A	Has the company considered an appropriate number of options over a range of intervention types (both traditional and non-traditional) to meet the identified need?	Industrial Emissions Directive	See 1G.
B	Has a robust cost–benefit appraisal been undertaken to select the proposed option? Is there evidence that the proposed solution represents best value for customers, communities, and the environment over the long term? Is third-party technical assurance of the analysis provided?	N/A	Due to the EA's strict interpretation of BAT and AM guidance, most IED requirements can only be met with single solutions. For each solution: • we have developed a 30-year NPV to quantify overall TOTEX and unit rate changes, • quantified the carbon impact (embodied and operational carbon) and natural capital benefits, and • quantified the profile of improvement on the relevant service drivers (i.e., needs, such as permit compliance, sludge diverted from landfill, greenhouse gas emissions, etc.) Atkins have been commissioned to provide assurance for the scope of our IED solutions.
C	In the best value analysis, has the company fully considered the carbon impact (operational and embedded), natural capital and other benefits that the options can deliver? Has it relied on robustly calculated and trackable benefits when proposing a best value option over a least cost one?	N/A	See 2B.
D	Has the impact (incremental improvement) of the proposed option on the identified need been quantified, including the impact on performance commitments where applicable?	N/A	See 2B.
E	Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where forecast option utilisation will be low?	Industrial Emissions Directive	The costs and carbon benefits of our proposed IED solutions have been benchmarked externally. We have considered lower risk solutions that are more cost effective, but they have not been accepted by the EA.

F	Has the scale of forecast third party funding to be secured (where appropriate) been shown to be reliable and appropriate to the activity and outcomes being proposed?	N/A	N/A
G	Has the company appropriately considered the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable?	N/A	N/A
H	Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided sufficient information (including alternatives and its contribution to addressing the need) to have informed views?	N/A	N/A
3. Cost efficiency			
A	Is it clear how the company has arrived at its option costs? Is there supporting evidence on the calculations and key assumptions used and why these are appropriate?	N/A	All IED solutions have been scoped using a bottom-up approach at site level. A gap analysis of BAT and AM was undertaken to identify the IED requirements at each site. The cost estimates have been produced by our in-house engineering team based on a scope list using costs from previous schemes of similar nature. The carbon benefits were estimated by Mott MacDonald based on a scope list using data from the Carbon Accounting Workbook. The cost estimates of our IED investment proposal for Trowbridge have been externally benchmarked by ChandlerKBS. They concluded the following: *Due to the level of scope definition provided at Business Planning stage, we would identify the estimate class, as defined by the Association for the Advancement of Cost Engineering (AACE), as a Budgetary Estimate or Class 3 and, therefore, an expected accuracy range of between -20% and +30% to the outturn cost.* *Based on the AACE classification, the ChandlerKBS and Wessex Water accuracy ranges overlap which indicates a high probability of the outturn costs falling in this range. Therefore, the estimates can be deemed to be robustly efficient for Business Planning.*

			The assurance report on our IED investment proposal for Trowbridge is included in WSX45 – Annexes – assurance reports. For details on our cost assurance strategy, please refer to WSX44 – Our assurance strategy and assurance statements. For details on our cost estimating methodology, please refer to WSX37 – Resilience, risk management and decision frameworks.
B	Is there evidence that the cost estimates are efficient (for example using similar scheme outturn data, industry and/or external cost benchmarking)?	N/A	See 3A.
C	Does the company provide third party assurance for the robustness of the cost estimates?	N/A	See 3A.
4. Customer protection			
A	Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?	N/A	We have not proposed a price control deliverable as customers would be protected from non-delivery in this area through our proposed uncertainty mechanism which will trigger if the requirements change. This is discussed in more detail in document WSX31 titled 'Risk and Return'.
B	Does the protection cover all the benefits proposed to be delivered and funded (e.g., primary and wider benefits)?	N/A	N/A
C	Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including how customers are protected against third-party funding risks?	N/A	N/A

7.2. Environmental Permitting Regulations (EPR) compliance

*Table 22 - Enhancement case assessment - **Environmental Permitting Regulations (EPR) compliance.***

	Requirement	See chapter	Comment
1. Need for enhancement investment			
A	Is there evidence that the proposed enhancement investment is required (i.e., there is a quantified problem requiring a step change in service levels)? This includes alignment agreed strategic planning framework or environmental programme where relevant.	Future landbank availability Investment plans	Waste permit compliance under the EPR will be a regulatory requirement. We anticipate that our four lime treatment centres will need to be permitted under the EPR in AMP8 when the EA publishes their Sludge Strategy, which will detail the permitting requirements for all sludge treatment operations. These sites will likely be issued bespoke waste operation permits and they will need to be upgraded to meet Appropriate Measures (AM) standards. Like the IED sites, the areas of improvement that require significant capital investment will be the provision of secondary containment to CIRIA 736 standard and the covering of all open tanks for abatement of fugitive emissions. Failure of compliance with EPR waste permits may impact our environmental performance assessment (EPA) score and enforcement action from the EA.
B	Is the scale and timing of the investment fully justified, and for statutory deliverables is this validated by appropriate sources (for example in an agreed strategic planning framework)?	Future landbank availability Investment plans	Our proposed EPR investments have been scoped using a bottom-up approach. We have undertaken an AM gap analysis for each site to identify the site-specific improvement needs. Improvement solutions have been developed at site level to produce a scope list for each site. There is uncertainty in the timescale of when our lime treatment centres will be permitted as this is dependent on when the EA publishes their Sludge Strategy. We expect this to be in the next few years (possibly 2025) and a 2-year transition period will likely be given. Therefore, we anticipate that the EA will require our sites to be EPR compliant in AMP8 and the delivery of the required site improvements to also be in AMP8.
C	Does the proposed enhancement investment or any part of it overlap with activities to be delivered through base, and where applicable does the company identify the scale of any implicit allowance from base cost models?	Future landbank availability Investment plans	Our proposed EPR investments are allocated as enhancement investments as they provide new assets (such as secondary containment, covers for open sludge tanks, etc.) for an improved level of service.

D	Does the need and/or proposed enhancement investment overlap or duplicate with activities or service levels already funded at previous price reviews (either base or enhancement)?	Future landbank availability Investment plans	We did not propose any EPR investments in PR19.
E	Is the need clearly identified in the context of a robust long-term delivery strategy within a defined core adaptive pathway?	Future landbank availability Investment plans	Our proposed EPR investments will bring our four lime treatment centres to AM standards so that they will comply with their future EPR waste permits. Our proposed EPR investments in AMP8 will provide the required mitigation measures to control and minimise air and land emissions from the sludge treatment processes at our EPR sites. The improvements made will contribute towards our carbon and net zero goals.
F	Where appropriate, is there evidence that customers support the need for investment (including both the scale and timing)?	N/A	N/A
G	Is the investment driven by factors outside of management control? Is it clear that steps have been taken to control costs and have potential cost savings (e.g., spend to save) been accounted for?	Future landbank availability Investment plans	Our proposed EPR investments are to allow our lime treatment centres to comply with their future EPR waste permits and are therefore driven by the requirements set out in the AM guidance. The interpretation of the guidance, as well as the required measures or improvements to achieve compliance, are driven by the EA. We expect the EA to have a very strict interpretation of their AM guidance for EPR compliance (based on how they interpret their AM guidance for IED compliance). This means that the EA will likely only accept alternative measures that provide the same level of environmental protection as the measures prescribed in the AM guidance, which limits our ability to propose solutions that have potential cost savings.
2. Best option for customers			
A	Has the company considered an appropriate number of options over a range of intervention types (both traditional and non-traditional) to meet the identified need?	Future landbank availability Investment plans	See 1G.
B	Has a robust cost–benefit appraisal been undertaken to select the proposed option? Is there evidence that the proposed solution represents best value for customers, communities, and the	N/A	Due to the EA's strict interpretation of the AM guidance, most EPR requirements can only be met with single solutions. For each solution: • we have developed a 30-year NPV to quantify overall TOTEX and unit rate changes,

	environment over the long term? Is third-party technical assurance of the analysis provided?		• quantified the carbon impact (embodied and operational carbon) and natural capital benefits, and • quantified the profile of improvement on the relevant service drivers (i.e., needs, such as permit compliance, sludge diverted from landfill, greenhouse gas emissions, etc.)
C	In the best value analysis, has the company fully considered the carbon impact (operational and embedded), natural capital and other benefits that the options can deliver? Has it relied on robustly calculated and trackable benefits when proposing a best value option over a least cost one?	N/A	See 2B.
D	Has the impact (incremental improvement) of the proposed option on the identified need been quantified, including the impact on performance commitments where applicable?	N/A	See 2B.
E	Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where forecast option utilisation will be low?	Future landbank availability	The costs and carbon benefits of our proposed EPR solutions have been benchmarked externally. We have considered lower risk solutions that are more cost effective but have not progressed them as we expect the EA to reject them, based on their position on our IED solutions.
F	Has the scale of forecast third party funding to be secured (where appropriate) been shown to be reliable and appropriate to the activity and outcomes being proposed?	N/A	N/A
G	Has the company appropriately considered the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable?	N/A	N/A
H	Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided sufficient information (including alternatives and its contribution to addressing	N/A	N/A

	the need) to have informed views?		
3. Cost efficiency			
A	Is it clear how the company has arrived at its option costs? Is there supporting evidence on the calculations and key assumptions used and why these are appropriate?	N/A	All EPR solutions have been scoped using a bottom-up approach at site level. A gap analysis of AM was undertaken to identify the EPR requirements at each site. The cost estimates have been produced by our in-house engineering team based on a scope list using costs from previous schemes of similar nature. The carbon benefits were estimated by Mott MacDonald based on a scope list using data from the Carbon Accounting Workbook. As the scope of EPR improvements is similar to the scope of IED improvements, we consider the cost benchmarking exercise undertaken by ChandlerKBS for Trowbridge's IED proposal to cover our EPR proposals as well. Please refer to the cost efficiency section of the IED enhancement case assessment for the conclusion of their cost assurance on Trowbridge's IED proposal. For details on our cost assurance strategy, please refer to WSX44 – Our assurance strategy and assurance statements. For details on our cost estimating methodology, please refer to WSX37 – Resilience, risk management and decision frameworks.
B	Is there evidence that the cost estimates are efficient (for example using similar scheme outturn data, industry and/or external cost benchmarking)?	N/A	See 3A.
C	Does the company provide third party assurance for the robustness of the cost estimates?	N/A	See 3A.
4. Customer protection			
A	Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?	N/A	We have not proposed a price control deliverable as customers would be protected from non-delivery in this area through our proposed uncertainty mechanism which will trigger if the requirements change. This is discussed in more detail in document WSX31 titled 'Risk and Return'.

B	Does the protection cover all the benefits proposed to be delivered and funded (e.g., primary and wider benefits)?	N/A	N/A
C	Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including how customers are protected against third-party funding risks?	N/A	N/A

7.3. Biosolids storage

*Table 23 - Enhancement case assessment - **biosolids storage**.*

	Requirement	See chapter	Comment
1. Need for enhancement investment			
A	Is there evidence that the proposed enhancement investment is required (i.e., there is a quantified problem requiring a step change in service levels)? This includes alignment agreed strategic planning framework or environmental programme where relevant.	Future landbank availability	The national landbank model produced by Grieve Strategic showed that the changes in the Farming Rules for Water regulation will most likely result in insufficient agricultural land for all biosolids to be recycled on a national level by 2035. The move of biosolids to a deployment system (due to EPR implementation on sewage sludge recovery and disposal) results in potential delays in transport and land application of biosolids. Atkins have review this in their biosolids storage assessment and recommended that at least 3 months' storage is provided for all biosolids as a mitigation measure.
B	Is the scale and timing of the investment fully justified, and for statutory deliverables is this validated by appropriate sources (for example in an agreed strategic planning framework)?	Future landbank availability Investment plans	We assessed our storage requirements based on our forecast biosolids volume and current available storage capacity. Based on the need to provide 3-4 months' storage for all our biosolids, we quantified the additional storage capacity that we would need to provide in AMP8.
C	Does the proposed enhancement investment or any part of it overlap with activities to be delivered through base, and where applicable does the company identify the scale of any implicit allowance from base cost models?	Future landbank availability Investment plans	Our proposed storage investment provides new storage capacity, so the investment is allocated as an enhancement investment.
D	Does the need and/or proposed enhancement investment overlap or duplicate with activities or service levels already funded at previous price reviews (either base or enhancement)?	Future landbank availability Investment plans	We did not propose any biosolids storage investments in PR19.
E	Is the need clearly identified in the context of a robust long-term delivery strategy within a defined core adaptive pathway?	Introduction Future landbank availability Investment plans	The need for additional biosolids storage capacity is clear from the national landbank assessment by Grieve Strategic and biosolids storage assessment by Atkins. Additional biosolids storage is required for mitigating the risk associated with the changes to the Farming Rules for Water regulation. The provision of additional biosolids storage capacity will improve resilience in the biosolids recycling activity.

F	Where appropriate, is there evidence that customers support the need for investment (including both the scale and timing)?	N/A	N/A
G	Is the investment driven by factors outside of management control? Is it clear that steps have been taken to control costs and have potential cost savings (e.g., spend to save) been accounted for?	Future landbank availability Investment plans	We do not have control over the future availability of landbank as this is driven by the changes in the Farming Rules for Water regulation. We have limited control on the required storage period as this is largely dictated by the deployment system under EPR. In assessment storage solutions for our WINEP submission, we reviewed the option of just providing biosolids storage barns, and the option of providing biosolids storage barns with 100% sludge drying to reduce sludge volume for storage. The EA rejected our proposal for 100% sludge drying as they considered this to be outside the scope of the sludge driver in the WINEP. We agreed with the EA a storage solution of additional biosolids storage barns and small-scale drying at Avonmouth. The drying at Avonmouth reduces the storage capacity requirements on that site, which make the storage solution more cost-efficient.
2. Best option for customers			
A	Has the company considered an appropriate number of options over a range of intervention types (both traditional and non-traditional) to meet the identified need?	Future landbank availability Investment plans	See 1G.
B	Has a robust cost–benefit appraisal been undertaken to select the proposed option? Is there evidence that the proposed solution represents best value for customers, communities, and the environment over the long term? Is third-party technical assurance of the analysis provided?	N/A	For each option: • we have developed a 30-year NPV to quantify overall TOTEX and unit rate changes, • quantified the carbon impact (embodied and operational carbon) and natural capital benefits, and • quantified the profile of improvement on the relevant service drivers (i.e., needs, such as permit compliance, sludge diverted from landfill, greenhouse gas emissions, etc.) • Our investment decision tool, EDA assesses the 30-year NPV, carbon benefits, natural capital benefits, and improvements of service drivers when evaluating the best-value solution. The scope of the storage solution is based on a previous storage scheme with similar requirements. We are therefore confident that the scope is robust.
C	In the best value analysis, has the company fully considered the carbon impact (operational and	N/A	See 2B.

	embedded), natural capital and other benefits that the options can deliver? Has it relied on robustly calculated and trackable benefits when proposing a best value option over a least cost one?		
D	Has the impact (incremental improvement) of the proposed option on the identified need been quantified, including the impact on performance commitments where applicable?	N/A	See 2B.
E	Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where forecast option utilisation will be low?	Future landbank availability	The costs and carbon benefits of our proposed storage solution has been benchmarked externally. Our proposed storage solution is modular as the storage capacity will be provided through Dutch barns. Storage for a specific site can be easily scaled up through the provision of additional barns on the site.
F	Has the scale of forecast third party funding to be secured (where appropriate) been shown to be reliable and appropriate to the activity and outcomes being proposed?	N/A	N/A
G	Has the company appropriately considered the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable?	N/A	N/A
H	Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided sufficient information (including alternatives and its contribution to addressing the need) to have informed views?	N/A	N/A
3. Cost efficiency			
A	Is it clear how the company has arrived at its option costs? Is there supporting evidence on the calculations and key assumptions	N/A	All options have been scoped using a bottom-up approach based on forecast biosolids volume produced from each bioresources centre.

	used and why these are appropriate?		The cost estimates have been produced based on a previous storage scheme of similar requirements. The carbon benefits were estimated by Mott MacDonald based on a scope list using data from the Carbon Accounting Workbook. The cost estimates have been externally benchmarked by ChandlerKBS. They concluded the following: *Due to the level of scope definition provided at Business Planning stage, we would identify the estimate class, as defined by the Association for the Advancement of Cost Engineering (AACE), as a Budgetary Estimate or Class 3 and, therefore, an expected accuracy range of between -20% and +30% to the outturn cost.* *The probability of the outturn costs falling outside of the AACE class range is high indicating a high risk of cost variance to the estimates. This is due to the unprecedented cost volatility of the key material prices for steel in the design.* *We recommended that the key material prices are monitored throughout the delivery* *programme to reduce the risk of inefficient prices.* *Therefore, due to the high volatility of key material costs, there is low confidence in the current Wessex Water Sludge Barn cost estimates for Business Planning.* The assurance report on our sludge storage barn proposal is included in WSX45 – Annexes – assurance reports. Our strategy for mitigating the risk of high volatility in material costs is detailed in WSX08 – Base cost assessment commentary and analysis. For details on our cost assurance strategy, please refer to WSX44 – Our assurance strategy and assurance statements. For details on our cost estimating methodology, please refer to WSX37 – Resilience, risk management and decision frameworks.
B	Is there evidence that the cost estimates are efficient (for example using similar scheme outturn data, industry and/or external cost benchmarking)?	N/A	See 3A.
C	Does the company provide third party assurance for the	N/A	See 3A.

	robustness of the cost estimates?		
4. Customer protection			
A	Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?	N/A	Our proposed storage investment is covered under the price control deliverable PCDWW24. For details on this PCD, please refer to WSX26 – Price Control Deliverables (PCDs).
B	Does the protection cover all the benefits proposed to be delivered and funded (e.g., primary and wider benefits)?	N/A	Please refer to PCDWW24 in WSX26 – Price Control Deliverables (PCDs).
C	Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including how customers are protected against third-party funding risks?	N/A	N/A

7.4. Sludge growth

*Table 24 - Enhancement case assessment - **sludge growth**.*

	Requirement	See chapter	Comment
1. Need for enhancement investment			
A	Is there evidence that the proposed enhancement investment is required (i.e., there is a quantified problem requiring a step change in service levels)? This includes alignment agreed strategic planning framework or environmental programme where relevant.	Sludge production forecast	Our forecast total sludge production in AMP8 exceeds our current availability capacity.
B	Is the scale and timing of the investment fully justified, and for statutory deliverables is this validated by appropriate sources (for example in an agreed strategic planning framework)?	Sludge production forecast Introduction	We have used a bottom-up approach to forecast sludge volumes and quantify the additional required capacity, including headroom for resilience. We have matched the capacity provision (from our proposed growth solution) to the profile of sludge production growth.
C	Does the proposed enhancement investment or any part of it overlap with activities to be delivered through base, and where applicable does the company identify the scale of any implicit allowance from base cost models?	Introduction Investment plans	Our proposed investment provides new capacity, so the investment is allocated as an enhancement investment.
D	Does the need and/or proposed enhancement investment overlap or duplicate with activities or service levels already funded at previous price reviews (either base or enhancement)?	Introduction Investment plans	We did not propose any growth enhancement investments in PR19.
E	Is the need clearly identified in the context of a robust long-term delivery strategy within a defined core adaptive pathway?	Introduction	Our proposed investment in new digestion and lime treatment capacity is aligned with our long-term strategy to maximise sludge digestion and provide sufficient resilience through lime treatment to ensure 100% of our sludge is treated and disposed safely.
F	Where appropriate, is there evidence that customers support the need for investment (including both the scale and timing)?	N/A	N/A

G	Is the investment driven by factors outside of management control? Is it clear that steps have been taken to control costs and have potential cost savings (e.g., spend to save) been accounted for?	Introduction Investment plans	We have limited control on increases in sludge volume due to population growth. In our assessment of growth solutions, we have investigated a range of options, such as AD, THP (advanced AD), lime treatment and 3rd party trading. THP was discounted as it was not a cost-effective solution. No viable 3rd party solutions were identified through market engagement. A solution with AD and lime treatment was found to be the lowest cost and provide the best benefits.
2. Best option for customers			
A	Has the company considered an appropriate number of options over a range of intervention types (both traditional and non-traditional) to meet the identified need?	Introduction Investment plans	See 1G.
B	Has a robust cost–benefit appraisal been undertaken to select the proposed option? Is there evidence that the proposed solution represents best value for customers, communities, and the environment over the long term? Is third-party technical assurance of the analysis provided?	N/A	For each option, • we have developed a 30-year NPV to quantify overall TOTEX and unit rate changes, • quantified the carbon impact (embodied and operational carbon) and natural capital benefits, and • quantified the profile of improvement on the relevant service drivers (i.e., needs, such as permit compliance, sludge diverted from landfill, greenhouse gas emissions, etc.) Our investment decision tool, EDA assesses the 30-year NPV, carbon benefits, natural capital benefits, and improvements of service drivers when evaluating the best-value solution.
C	In the best value analysis, has the company fully considered the carbon impact (operational and embedded), natural capital and other benefits that the options can deliver? Has it relied on robustly calculated and trackable benefits when proposing a best value option over a least cost one?	N/A	See 2B.
D	Has the impact (incremental improvement) of the proposed option on the identified need been quantified, including the impact on performance commitments where applicable?	N/A	See 2B.

E	Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where forecast option utilisation will be low?	Introduction	Our proposed solution of AD and lime treatment provides the flexibility of different scale-up options in AMP9 to adapt to different growth profiles.
F	Has the scale of forecast third party funding to be secured (where appropriate) been shown to be reliable and appropriate to the activity and outcomes being proposed?	N/A	N/A
G	Has the company appropriately considered the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable?	N/A	N/A
H	Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided sufficient information (including alternatives and its contribution to addressing the need) to have informed views?	N/A	N/A
3. Cost efficiency			
A	Is it clear how the company has arrived at its option costs? Is there supporting evidence on the calculations and key assumptions used and why these are appropriate?	N/A	All options have been scoped using a bottom-up approach. The cost estimates have been produced by our in-house engineering team based on a scope list using costs from previous schemes of similar nature. The carbon benefits were estimated by Mott MacDonald based on a scope list using data from the Carbon Accounting Workbook.
B	Is there evidence that the cost estimates are efficient (for example using similar scheme outturn data, industry and/or external cost benchmarking)?	N/A	See 3A.
C	Does the company provide third party assurance for the	N/A	See 3A.

	robustness of the cost estimates?		
4. Customer protection			
A	Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?	N/A	We have not proposed a price control deliverable as customers would be protected from non-delivery in this area through our proposed uncertainty mechanism which will trigger if the requirements change. This is discussed in more detail in document WSX31 titled ‘Risk and Return’.
B	Does the protection cover all the benefits proposed to be delivered and funded (e.g., primary and wider benefits)?	N/A	N/A
C	Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including how customers are protected against third-party funding risks?	N/A	N/A