# Appendix
# YKY48_Bioresources Sludge Strategy

YKY48 Bioresources Sludge Strategy

YorkshireWater

# Navigating this document

## This Appendices document is separate to and supports the main business plan document.

### Links outside of this report

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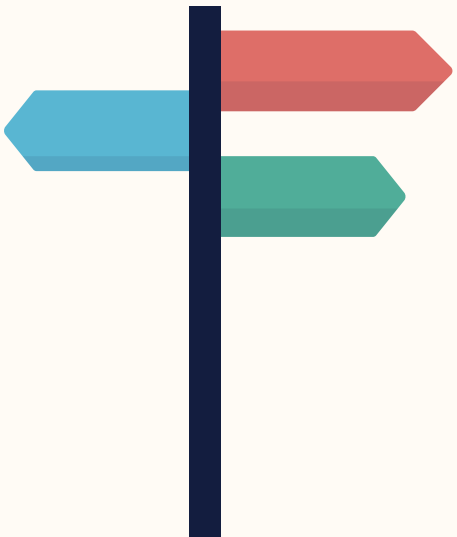
This icon can be clicked on to go to the main Yorkshire Water Business Plan document where more information can be found.

More detail on this subject can be found in **Chapter 8 of the main business plan.**

Our bioresources plan aims to grow resilience and drive efficiency into the collection, treatment and recycling of sludge by taking a commercial approach which considers alternative delivery routes and revenue streams. It does this whilst starting to respond to a number of challenges including net zero, a growing volume of sludge and a changing regulatory landscape.

Our Bioresources Sludge Strategy (this document) sets out our future plans, our track record on work done so far and how we've been collaborating with the sector; working to identify solutions in partnership and to provide a route for new companies into the industry. Our Bioresources section within Chapter 8 of the main business plan document provides a summary version of this content.



# Contents

# 1. Introduction

## 1.1 What is Bioresources?

Our Bioresources business is responsible for the transport, treatment and disposal of sewage sludge. We take partially treated sewage and generate renewable energy and quality products that go to agriculture, thereby creating value from waste.

In 2022/23 Yorkshire Water produced 144 thousand dry tonnes of sludge (TDS). The sludge arises from over 600 Sewage Treatment Works (STWs) and is transported to the sludge treatment centres by tanker or by truck. Tanker movements are movements of liquid sludge at an average of around 3% solids matter, and mostly collect sludge from our smaller STWs. Truck movements transport sludge that has been dewatered to around 22% dry solids prior to transport. Once sludge is in movement from a STW, or if sludge is dewatered, the activity and assets become classified as Bioresources.

The sludge is currently transported to 14 Sludge Treatment Centres (STCs). As well as receiving the imported sludges, these sites are co-located with their own STW. 71% of our sludge is co-located with the rest arriving as imported tanker or truck movements.

At the STC the sludge is biologically treated through digestion processes. Primarily Yorkshire Water uses conventional digestion; we also use thermal hydrolysis at Esholt, and lime addition post digestion at Hull, Knostrop, and Huddersfield. These additional processes are used to assist with the pathogen kill and reduce the need for storage and simplify product quality processes. Thermal Hydrolysis can also increase the solids destruction increasing the biogas production and reducing the mass of biosolids to be recycled.

## 1.2 The need for transformational change

Yorkshire Water Bioresources came from a position of inefficiency in early AMP6 due to a combination of an ageing and inefficient asset base and flooding events. This left us at the back of the pack in terms of opex efficiency. Since then, the business has been working to make significant changes to the way it operates, including:

- Significant investment in the asset base to move away from Incineration to Anaerobic Digestion and operating as an energy factory,
- Setting up the Bioresources function to make decisions on a price control basis and to deliver schemes through a proportionate asset management approach,
- Increasing use of markets to deliver projects on our behalf including outsourcing of tankering and Design, Build, Finance, Operate and Maintain (DBFOM) of Gas to Grid and solar arrays across a number of our sites.

This shift in approach has resulted in a step change in base totex, improving our annual performance from £74m (at 22/23 price base) at the beginning of AMP7 (20/21) to a forecast of £62m at the end of AMP8 (29/30 at 22/23 price base).

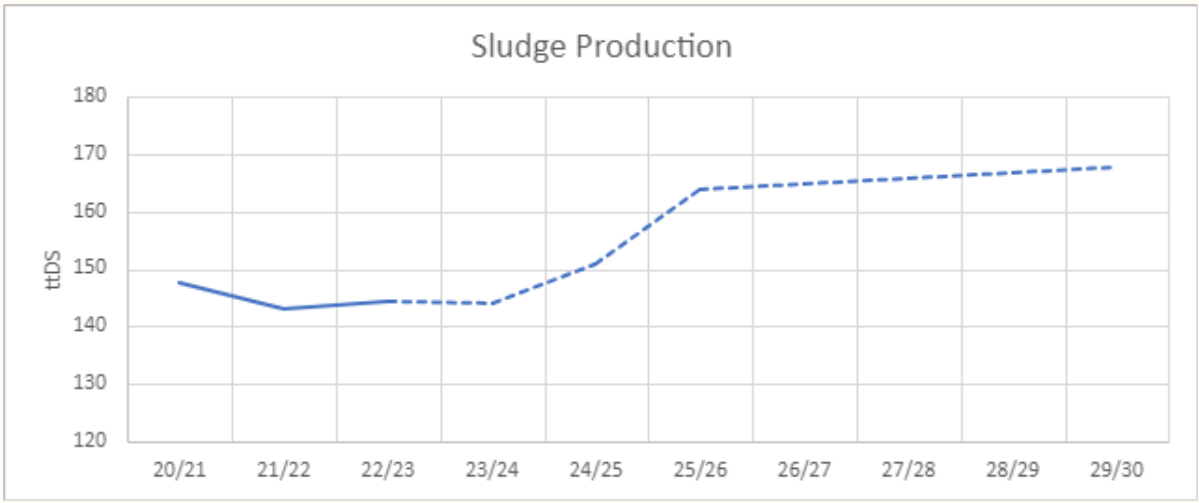
### 1.2.1 **Upcoming Challenges**

Whilst we continue to improve our position relative to the rest of the industry, we're also faced with a number of challenges which our plan has had to consider.

#### 1.2.1.1 Increased sludge production

A growing volume of sludge driven by population growth and environmental schemes means we'll need to find a net additional 16.4 thousand TDS treatment capacity (c.10%) by the end of 2025 and a further 4.9 thousand TDS by 2030 whilst minimising TOTEX and carbon.

**Figure 1: Sludge Production Forecast**




In addition to this several of our sludge treatment facilities are aging and require significant investment or an alternative treatment solution to maintain performance.

#### 1.2.1.2 IED Appropriate Measures

The regulation of sludge treatment is undergoing significant upheaval as a result of several key Environment Agency (EA) changes already made. In April 2019 the EA confirmed sewage sludge anaerobic digestion facilities needed to comply with the Industrial Emissions Directive (IED). The EA published the 'Biological waste treatment: appropriate measures for permitted facilities' in September 2022, commonly known as Appropriate Measures, which introduces even more prescriptive and tighter controls WaSCs must comply with beyond those already specified within the IED requirements.

#### 1.2.1.3 Recycling to land

In 2022/23 we recycled 80,145 TDS/year of treated sludge. The vast majority is recycled to agriculture, recovering value from the nutrients in the treated Biosolids and contributing to the circular economy. As an Industry we recognise this as the best environmental solution for the treatment of sludge. This is also currently the position of the Environment Agency (EA).

The EA does however have concerns over the management of nutrients on farmland ("the farming rules for water"), and the storage and management of biosolids which are currently managed through the Sludge Use In Agriculture Regulations. The EA sludge strategy is to move sludge recycling over to Environmental Permitting Regulations requiring deployments of materials to farms. These create considerable risk to the landbank we use. This has already led to having to increase the distance we travel to find suitable farms for recycling, something we anticipate continuing over the next five years, even with no further movement to enforce their interpretation by the Environment Agency.

National modelling of the EA sludge strategy and interpretation of the farming rules for water has shown that if the EA implement fully their currently stated interpretations of these, there would be insufficient farmland in the UK to continue with industry practice in full. As a result, the industry will likely need to invest in alternative recycling or destruction options. These restrictions could materialise rapidly; and in the worst case faster than we could adapt through the provision of alternatives.

#### 1.2.1.4 Rising cost of living

Like the rest of the industry and the UK we've seen substantial increases in our costs to operate and our costs to deliver schemes, regardless of the delivery method. In AMP7 energy and chemical inflation significantly impacted operating costs.

Energy prices have steadily increased during AMP7 and unhedged energy was exposed to a very volatile energy market. Yorkshire Water continues to manage price risk by hedging according to the company's energy purchasing policy and making trades according to carefully governed price targets. As of 31 March 2023, Yorkshire Water had fixed over 77% of its forecast baseload power requirements for the remainder of AMP7, including 98% for the year to 31 March 2024.

As a result of increased fuel, energy and raw material prices we saw significant market pressures in the chemical supply chain. This resulted in accelerated price increases from suppliers being passed through. Throughout AMP7 we have focused on performance and optimisation to help absorb the inflationary costs pressures.

#### 1.2.1.5 Carbon neutral

The water industry has made a commitment to be carbon neutral in relation to its operational scope 1 and 2 emissions by 2030. With the generation of methane through digestion, Bioresources has a critical role in terms of maximising best use of biogas and reducing our process emissions.

Our strategy has tried to balance these risks with the need to minimise cost to customers whilst also protecting the environment.

# 2. Our Bioresources Ambition

## 2.1 Customer and stakeholder priorities

Our customers tell us that continuing to treat wastewater to a high standard is important to them. Whilst Bioresources is generally not well understood by customers, we know that being an effective Bioresources business is critical to a cost effective, resilient, sustainable and operationally efficient wastewater service.

Our customers value these services and rely on us to maintain them.

Keeping bills affordable for all is also a key priority for our broader customer base and is something we have strived to meet through our commercial approach, utilising alternative delivery routes and revenue streams to deliver more for less.

## 2.2 Our 25-year ambition

Our long-term ambition is to be a frontier provider of Bioresources services. We will be a resilient business that is adaptive to deal with new and emerging challenges facing the industry, provide excellent environmental performance, and continue our outstanding safety record.

Through embracing new technologies and markets, we'll continue to improve our performance to achieve Industry-leading efficiency. Key to achieving this is a commercial approach which considers alternative delivery routes and revenue streams. Over the last 5 years we've worked with a large section of the market to understand ways we can help each other. These range from investors interested in developing new treatment assets, other WaSCs on joint ways of developing capacity, to small specialist companies that can work with us to reduce our operating costs or introduce new income to offset some of it.

We will move to a smaller number of larger, more efficient sites which we'll be able to more easily adapt to changing regulatory or customer requirements, or roll-out technology innovations and new commercial opportunities. We've begun work to rationalise our digestion assets as they near end-of-life this AMP and this will continue over future planning periods.

We will continue to improve our environmental performance through a focus on maintenance and improving asset health. New investment will allow our sites to operate to higher standards in line with future environmental permits. Our environmental focus will also encompass both operational and embedded carbon emissions as part of Yorkshire Water's transition to net zero by 2050.

Finally, we will continue to influence and collaborate to shape the direction of travel for the sector, including working with the industry to inform material regulatory changes such as the future of sludge to land, and wider, to influence the future of the Bioresources Market.

## 2.3 Our 5-year ambition

Our ambition for AMP8 is to target an upper quartile efficient and resilient service for our customers; keeping bills affordable and protecting our region's natural environment for our community to enjoy. We will continue to operate safe and compliant sites and work to minimise our carbon emissions, playing a leading role in Yorkshire Water's ambition to be carbon neutral for our operational emissions by 2030.

Our plan over the next 5 years is to invest wisely in our assets, using markets solutions where most efficient to do so, to drive down longer term totex. We plan to move to a smaller number of larger, more efficient Sludge Treatment Centres (STC's) where it is cost effective to do so. These larger sites will have a strong focus on process improvement and energy generation, utilising new technologies and market delivery and financing to help keep down capital costs whilst ensuring customers benefit from the opex savings. In addition to generation, we'll also be looking to the market for the most beneficial energy offtake solution to help us achieve some of the financial benefits we've missed in previous AMPs.

We will continue to rationalise our smaller sites and use existing market capacity through trades to plug any capacity shortfall. Consolidating sites in this way will also place ourselves in a better

position to respond to meet changing landbank requirements or to improve our assets to reduce process emissions.

Whilst there are no longer Performance Commitments in Bioresources we are still prioritising those same elements of service which we see as crucial; protecting the quality of product we send to agriculture and maximising our biogas utilisation. The former will in future be regulated through the new EA Sludge Strategy. For the latter, this strategy overall reduces the amount of energy that is produced but unused by 76% (110 GWH/year) and increases the amount of energy that is produced and used (whether by Bioresources, networks plus or third parties through biomethane exports) by 108% (208GWH/year).

Whilst doing all this we will continue to collaborate to pursue new opportunities and identify further synergies with the wider industry. We will be engaging with third parties to identify new products within Bioresources, that can be used elsewhere to reduce costs or benefit our carbon position. We will also continue to explore trade opportunities in addition to the 5 thousand TDS/year trade we have already gone to market for.

## 2.4 Work to Date

At PR19 we set out our plans to use markets to bring in new technologies and approaches to drive efficiency and performance, whilst offsetting capital investment. This was based on a largescale market testing exercise which considered over 80% of our original Bioresources capital programme. Two major initiatives identified were market delivery of sludge treatment capacity and outsourcing of biogas management, which have continued to be focus areas.

We've also been working on other initiatives to help us improve our comparative opex position, for instance outsourcing our tanker fleet and market delivery of solar arrays across our sites.

### 2.4.1 Market delivery of sludge treatment capacity

At PR19 we recognised a need for further treatment capacity; having engaged with the market during our PR19 planning we recognised that a traditional rebuild was not the best option and sought to refine our approach.

This AMP we have continued that exercise and explored a myriad of alternative delivery methods, from more efficient capital delivery through our in-house Bioresources Asset Management function to use of third-party markets, or new innovative methods of extending capacity in conjunction with York University. A key premise underlying the latter two approaches involves using existing capacity more effectively, either in our own assets or the wider market.

We also invested in a new Strategic Model, which is industry leading and allows us to compare opex and capex of hundreds of thousands of combinations of potential asset solutions in a way we've never been able to before. Use of this model has allowed us to take a data-led, commercial approach to determining how to provide our sludge treatment capacity. Further information on the engagement work done this AMP can be found in Section 8 of this document: Encouraging Greater Collaboration.

The output of this work has meant that two ageing sites in the North of our region will stop digesting by the end of AMP7 and become export centres. Some of the capacity shortfall will be met by a strategic market trade; we are currently in procurement for a c. 5 thousand TDS/year contract for at least the next 5 years. Current uncertainty over landbank presents higher risk and therefore cost entering any longer-term contract, removing the opportunity for additional efficiencies.

The remaining shortfall will be met by running our assets slightly differently to expand their existing capacity. We are in the process of converting our digesters to run in series at our largest site in Leeds. This is a relatively new approach identified through our market engagement. The approach achieves greater volatile solids destruction which allows us to put more sludge through the system. The extra destruction gives the added benefits of greater biogas capture and, as a result, reduced methane emissions, and comparatively less cake to go to landbank. As the changes involve reconfiguration of existing assets and investment in some ancillary equipment such as import facilities, it is a far more efficient way of creating additional capacity rather than for instance, building additional digesters.

### 2.4.2 Outsourcing biogas management

In AMP7 we developed and delivered a procurement exercise for the first market delivered, owned and operated gas to grid facilities at two of our largest sites. This was a huge piece of work and required the acquisition of new knowledge and specialist skills within Yorkshire Water which will set us up for future markets projects.

Biogas will be sold to the third-party who will then be responsible for converting it to green gas which will be injected to grid and subsequently used as green vehicle fuel. Biogas from these two sites alone will deliver a c8,500t carbon reduction for the environment by offsetting the use of fossil fuels in road transport and deliver an opex benefit to Yorkshire Water without the need for capital investment. Contracts for these two sites were signed in June 2023 and the facilities are expected to go live by the end of AMP7. We are currently refining our procurement approach ready to include further sites within this scope.

### 2.4.3 Outsourcing tanker fleet

In June 2020 we successfully outsourced our business-as-usual liquid sludge tankering requirements, as well as other opportunities to reduce the cost and emissions impact of reactive tankering linked to asset failure. Other sludge transportation of raw and treated cake were already outsourced, with the raw cake operations included within the scope of change with liquid tankering.

The outsourcing was successfully delivered and the operational change accompanying this is currently outperforming our expectations. One of the exciting opportunities within the outsourcing process is a benefit sharing mechanism agreed with the third-party for future efficiency improvements in sludge transportation activities which we continue to work collaboratively on. This is an area where we see the market operating at near-full potential.

### 2.4.4 Market delivered energy

During AMP7 we have also been working to implement a first phase of market delivered solar arrays at 28 of our sites which will deliver c.3% of our total energy requirements. These facilities are designed, built, financed, operated and maintained by the market, with Yorkshire Waters' only involvement being the purchase of power. At the time of writing contracts have been signed for the first phase of 28 sites with the delivery phase well underway, and a subsequent 50 sites now in procurement.

We have also been collaborating with a neighbouring Energy from Waste facility to develop a solution for the provision of green power and heat to our site and will seek out this opportunity in other regions where applicable. This approach complements our sale of biogas by maintaining our sites carbon position whilst benefitting the carbon position of Yorkshire through the production of renewable vehicle fuel.

### 2.4.5 Market delivered FOGs removal

We are undertaking a trial of a new technology for the Water Industry, aimed at purifying Fats, Oils and Greases (FOGs) for use as renewable vehicle fuel. The solution collects material from the food industry, which would otherwise deposit it down the sewer, and extracts the FOG and dry organic solids leaving a reusable effluent which is treated in our sewage works.

This presents a great opportunity for us to start removing FOGs from our sewers, which can otherwise cause blockages, and use the recovered material to power some of our fleet. It could also improve the quality of a proportion of the waste going through our works in addition to bringing a small income stream.

We have now signed a contract for a trial of this market-delivered FOG removal technology at one of our sites. In this model the third-party will run the trial site, identifying FOG producers and selling on the refined product. Yorkshire Water will benefit from a higher quality imported effluent into our works. If successful, we see potential for this to be rolled out across our region.

# 3. Plans for AMP8

In line with our ambition, our plan for AMP8 is to move towards a smaller number of larger, more efficient digestion sites, supplemented by market capacity trading. Our plan is to use technology to further optimise our existing large sites to achieve additional sludge throughput. Taking this commercial approach utilising new technology and markets will continue to drive efficiency into our operations and position us for an even more efficient price control in AMP9.

There are two key routes through which we plan to deliver this optimisation. The first includes utilising advanced digestion at some sites, one method for which is described in Section 2.4 (digesters in series), which we identified through our extensive market engagement.

This will be supplemented by the results of studies carried out by the University of York where we have been working to test how digesters can be run more effectively to increase throughput and biogas generation. Initial research in the lab at York has shown retention times of less than 8 days with no impact on biogas production. This is under 'optimum' conditions. We're working to understand what this would look like in real-world conditions in addition to the impact on other factors such as digester stability, sludge dewaterability and solids destruction. Following further experimentation on a larger scale we expect this to play a prominent part in our plans.

### Case Study: University of York Research

The AD Transformation project builds on previous work with the University of York to develop System-60, a unique laboratory facility comprising 60 individual reactors used to screen, test and verify anaerobic digester optimisation concepts.

The initial priority is to prove that defined interventions such as mixing and temperature can facilitate major improvements in biological efficiency and therefore digester throughput. This will assist with Bioresources' challenge to treat more sludge in fewer assets, realising capital and operational efficiencies.

It is becoming increasingly unlikely that sludge recycling to agriculture can continue in its present form. The alternative is sludge destruction such as incineration or gasification, and under that scenario digesters could become surplus to requirements. To prevent digesters becoming stranded assets, a further use of the lab facilities is to develop alternative uses for our digesters to recover additional value from sludge. Examples could include dark fermentation for hydrogen or acetic acid recovery.

As we optimise our larger sites, our smaller sites will gradually convert into sludge export centres as they otherwise require significant investment on the digestion assets. This means in future AMPs any investment can be focussed on the larger sites. It does also mean these fewer sites will need to be more resilient, and our plans include improving ancillary equipment such as cake import facilities and thickening and dewatering, and delivering a more evolved, proactive maintenance approach.

### Case Study: New Maintenance Approach

Critical to a reliable asset base is effective maintenance. Throughout AMP7 Yorkshire Water has been operating a number of long-term Modernisation programmes designed to enable an evolution in the maturity of our approach to reliable, data-led maintenance. This has included investing in 45,000 new smart assets (e.g. auto-reversing pumps) and monitoring devices across the Wastewater asset base, including Bioresources and upstream assets, and upgrading our computerised maintenance management system (SAP) to be able to create new dynamic maintenance plans and improvements in asset data.

Thanks to this enhanced data provision we can now start to trigger operational and maintenance interventions before performance is impacted by asset failure. In addition to making our Bioresources assets more resilient this approach will also benefit Totex efficiency by prolonging asset life.

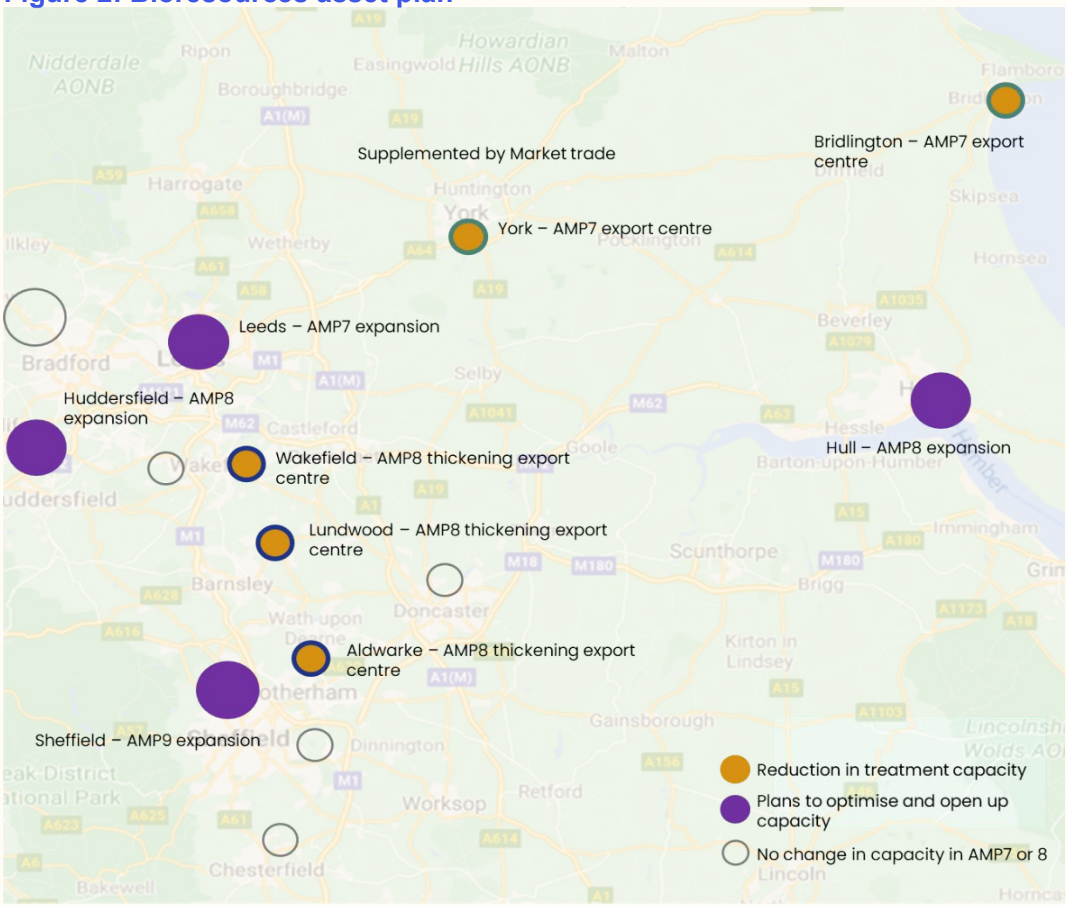
## 3.1 Our AMP8 asset plan

Figure 2 below illustrates our planned changes to our asset base over the next 12 years. We expect this rationalisation transition to run over several AMPs. We have already started to deliver these plans this AMP with the Northern sites, discussed under Section 2.4, planned to close by 2025, taking our digestion sites from 14 to 12. In AMP 8 we expect to close a further 3 sites, taking our digestion sites to 9, with potentially a further 1 or 2 in AMP9.

### 3.1.1 Driving further efficiency into our plans

Our extensive modelling shows that the optimum number of sites for our region is between 7 and 9, depending on what alternative treatment solutions emerge over the next 10 years. Beyond that the large transport distances between regions and back to the landbank become prohibitive. Should the industry change to use an alternative sludge outlet to the landbank (see Section 6), this may change.

**Figure 2: Bioresources asset plan**




A perceived advantage of fewer sites is that as requirements change there are less sites to update. We believe moving in this direction sets us up for future change in that we can more cost-effectively enact any necessary alterations. This could be for example as a result of changing landbank availability. It could also be a result of changing technologies and techniques which we wish to roll-out to keep improving our sites.

As described under Section 2.4, we have already enacted a number of new approaches to improve the performance and efficiency of our sites and see huge opportunity in collaborating with the industry, the supply chain or other neighbouring organisations to bring in new technologies or market-delivered schemes. We will continue to explore similar opportunities that can be used to further reduce costs or increase benefit to our carbon position with new projects already underway as listed below:

- **Waste heat for local housing**: We have been working with several Local Councils to understand the role Yorkshire Water can play in contributing to their net zero goals. This includes looking into whether waste heat from our sites can be used to supply future local housing developments. In addition to benefitting the local area this would be making a product from something that is currently not used.

- **Final effluent re-use:** We have been speaking to several large business customers about the potential for final effluent re-use from our sites for process water. Whilst this does not provide any economic or performance benefit to Bioresources, it would replace the use of (and therefore production of) potable water, benefitting our sustainable supply-demand balance and the carbon position of the company and region.
- **Converting sludge to aviation fuel**: We are collaborating with a third party looking to convert treated sludge into aviation fuel. With the increasing risk around availability of the landbank we see this as a huge opportunity. Not only would it alleviate a growing risk but provide a more sustainable and environmentally friendly way of travelling.
- **Converting sludge to energy:** We are engaging with several Energy from Waste plants as to whether screenings or treated sludge can be used as a fuel. As for the example above this would help address a risk, provide a new fuel source and (for the screenings) avoid a waste to landfill.
- **Energy offtake solutions:** We expect each of our remaining larger sites to operate as energy-efficient generation hubs, maximising the production of biogas and contributing to Yorkshire Water's net zero target. As part of that vision, we will be working with the market to identify the most beneficial energy offtake solution. We have already entered a market-delivered contract to convert two of our largest sites to biogas to vehicle fuel and expect to do the same with a third. Where practical we will complement this by partnering with third parties to replace grid power with green energy generated from waste.
- **Explore future trade opportunities:** Whilst our plans are not designed to deliver much in the way of spare treatment capacity we will have some at times and will work with our neighbouring companies to explore mutually beneficial opportunities.

## 3.2 The impact of our plans

Our plans provide a route to deliver our 5-year ambition of providing an efficient and resilient service for our customers, whilst setting us on the right path to longer-term Frontier performance.

### 3.2.1 Comparative Efficiency

Delivery of our plans will require £347.4m base totex over the next 5 years as shown in figure 3. This level of efficiency is achieved by delivering:

- A market trade to deliver 5 thousand TDS additional capacity,
- New technology to supplement onsite capacity, delivered through market financing,
- Gas to vehicle fuel opex benefit at our biggest sites; and,
- Opex benefit of increased sludge destruction, resulting in increased generation and less sludge to recycle.

**Figure 3: AMP8 Base totex breakdown**

| AMP8 Capex | AMP8 Opex | AMP8 Totex |
|---|---|---|
| £119.995m | £227.411m | £347.406m |

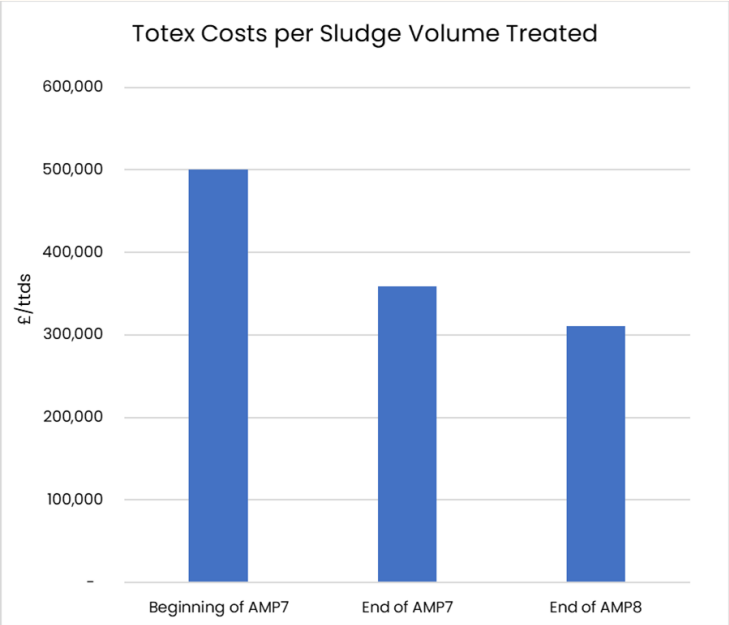
Utilising this strategy we expect to make better use of biogas through additional generation and higher utilisation, with energy generated and used doubling (whether energy is used in bioresources, networks plus, or by third parties). We also expect to reduce the energy generated in bioresources that is unused by about 76%.

Our forecasts show an additional 16.4 thousand TDS treatment capacity will be required by the end of 2025 and a further 4.9 thousand TDS by 2030. Our plans absorb this additional treatment

capacity, without the need for an enhancement claim. We believe this delivers exceptional value to customers.

Beyond AMP8 we expect to see a continued decrease in base totex as more rationalisation and markets schemes, including biogas optimisation, come online. As such our plans establish a route for maintaining an efficient Price Control over the next 15 years.

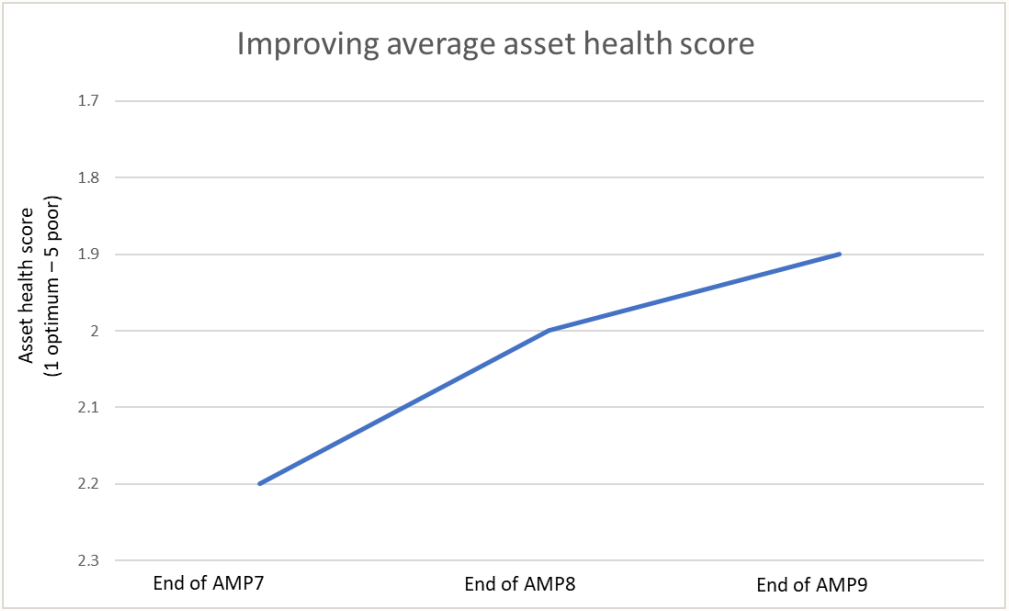
**Figure 4: Improving Totex Unit Costs (£/tTDS)**




### 3.2.1 Asset health and environmental performance

Our plan features the gradual closure of smaller, ageing digestion assets over several AMPs and corresponding investment in resilient larger assets. As such we expect to see a trend of improving asset health over the next 12 years and a corresponding continued improvement in environmental performance.

**Figure 5: Predicted asset health scores of co-located STW and STC sites**




Our shift to advanced digestion will also result in greater biogas capture and subsequently a reduction in methane emissions from the digestion process due to greater volatile solids destruction. A model of process emissions on our digesters for AMP8 estimates a 21% reduction compared to keeping our assets in their current configuration, delivering a significant carbon benefit. Further information on our carbon plans is provided under Section 7.

In addition to the environmental benefits of a more resilient asset base our colleagues will benefit from a better working environment and a further reduced risk of safety incidents. Health and Safety is one of our top priorities at Yorkshire Water and that can be seen in our industry leading performance on process safety.

#### 3.2.2 Risk Mitigation

This rationalisation approach provides some mitigation to known risks described in the following sections: 5. Mitigation of Emissions and 6. Sludge Recycling to Land.

For both risks there are benefit in moving to a smaller number of sites:

- Fewer assets to adapt in future: Once the requirement around sludge recycling or emissions mitigation is better understood we will have fewer assets to adapt to meet the new requirements, reducing the investment but also time required to implement.
- Reduction in biosolids: specifically for the sludge to land risk, our strategy results in less biosolids generated per unit of sludge produced because of the greater solids destruction in advanced digestion. If we were to operate digesters in series at our main three sites, despite increases in sludge production of 16% from 2022/23 to 2029/30, the quantity of sludge disposed of increases only by about 6% over this period.

## 3.3 Assumptions

Our plans do not provide any funding in base to manage significant changes to recycling sludge to land or potential requirements for IED Appropriate Measures. For the purpose of our base plan we have assumed:

1. There is minimal further change in landbank availability; any change will be addressed through an uncertainty mechanism (see Section 6.4)
2. There are no IED requirements beyond what we have invested in AMP7; requirements associated with IED Appropriate Measures have been raised in an Enhancement Case (see Section 5.1).

# 4. Long-term asset plans

Longer-term our expectation is that some, or all, of our sludge will be subject to additional drying of sludge to pellets, or solids destruction technologies, with the rest of our asset base adapted to the most economical way of delivering this. This will most likely involve a handful of drying or destruction centres with more of our sites geared to exporting sludge there. These centres might be spread across the Yorkshire Water region, situated at regional boundaries and delivered with other WaSCs or dotted around the country and operated by an external third party under a gate fee.

Exactly what this looks like is difficult to establish due to the lack of clarity over the long-term plans for recycling biosolids to agriculture, in particular to what extent and where the landbank is impacted. Further information on this risk is provided under Section 6. Sludge Recycling to Land, but in summary we are expecting some level of delay and uncertainty associated with:

a) The Environment Agency (EA) Sludge Strategy deployment process,

b) Restrictions on spreading that could lead to a significant shrinking of available land each year, including following investigations next AMP into microplastics and PFAS in sludge,

c) Changing public perception of biosolids, and therefore the approach taken by the food industry.

Whilst we are exploring other alternatives, such as sludge use in aviation fuel (Section 3.1.1), the only currently deliverable solution to address this risk is further drying of sludge to pellets, enabling changes to either agricultural practice or alternate disposal routes, and/or solids destruction technologies (incineration or advanced thermal conversion), potentially with the recovery of some nutrients. These would need to be implemented in such a way as to minimise the impact on objectives around emissions to land, air and water, the Government's 2050 net zero target and Yorkshire Water's energy reduction ambitions.

To try and develop our long term plans the Water Industry has been working together to try and lessen this uncertainty including commissioning national landbank modelling. This collaboration will need to continue as landbank losses can impact cross company. Yorkshire Water requested funding to begin investigating potential solutions as part of this activity in our WINEP SUiAR submission but this was rejected by the EA. Instead, the industry is now proposing the introduction of a common reopener limited to the Bioresource price control, discussed further under Section 6.4 Bioresources uncertainty mechanism.

Whilst further work is clearly needed to map out our longer-term asset plans, our Bioresources PR24 plans are designed to support this anticipated need for alternative treatment in two key ways:

- **Rationalising sites**: the high costs associated with drying or destruction mean the likely solution is a smaller number of very large centres. In starting to rationalise our smaller sites now we are taking steps towards this operating model, as well as reducing expenditure on reinvigorating aging assets that may not have a longer-term economic future.
- **Minimal additional Biosolids storage**: we have tried to balance short-term cost and longer-term risk on biosolids storage, providing enough storage for deployment delays no greater than 10 days (see WINEP SUiAR Enhancement Case). This will not be sufficient to address the growing risks outlined above, however providing yet more storage could lead to redundant assets being provided if we move to a destruction approach for some of our sludges, and may not offer value to customers in the medium to long term.

# 5. Mitigation of Emissions (Compliance with IED)

As highlighted under Section 1.2.1 Upcoming Challenges, the regulation of sludge treatment, and it's recycling to agriculture, is undergoing significant upheaval as a result of several key Environment Agency (EA) changes already made and some which are forecast in the near future.

In April 2019 the EA confirmed to the Water and Sewerage Companies (WaSCs) operating in England that their sewage sludge anaerobic digestion (AD) facilities needed to comply with the Industrial Emissions Directive (IED). The IED itself was entered into force in 2011 and transposed into UK law in 2013.

The initial approach to our IED applications adopted the guidance provided by the EA, namely that for existing facilities, that risk assessments could be used to demonstrate an equivalent level of environmental protection. In practice however, through the first 3 permit applications it became apparent that the risk-based approach was not acceptable. As a result, throughout this period there has been significant uncertainty as to the solutions required, with a wide cost range leading to a delay in beginning work on site.

Yorkshire Water has been taking measures to comply with the IED within AMP7 including new permit applications, capital improvements such as secondary containment and new covers for uncovered tanks. However, owing to the uncertainty of final permit conditions, there is a likelihood that Yorkshire Water will not achieve full compliance by the EA target deadline of 31st December 2024 and therefore probable that some IED related expenditure will overhang into AMP8.

## 5.1 Appropriate Measures Enhancement Case

The EA published the 'Biological waste treatment: appropriate measures for permitted facilities' in September 2022. It introduces more prescriptive and tighter controls than the existing Industrial Emissions Directive (IED) discussed above, essentially defining higher standards and removing the ability to risk assess options such as tank covering which the IED allows for.

An IED supporting document completed by Atkins (dated 31st May 2023) on behalf of Water UK into the impact of IED and Appropriate Measures, concludes that the Appropriate Measures guidance is legally enforceable and changes to it can be made without the need for public consultation.

Key concerns for the industry that Appropriate Measures introduces are:

- All related tanks & lagoons must be covered.
- All cake storage pads must be fully enclosed, and odour controlled.
- Existing and proposed T21 exemption sites, e.g. thickening and dewatering sites, could be required to comply.

Yorkshire Water is submitting an enhancement case to cover the additional expenditure required to comply with this guidance. The extensive requirements require a material change to the operation of our existing digestion facilities, beyond what could have been foreseen for compliance with IED. The most significant requirement that this guidance introduces is the need for all of Yorkshire Water's biosolids to be stored in contained or enclosed buildings. None of our biosolids storage is currently in fully contained or enclosed buildings, with the majority being on uncovered concrete storage pads, the area of which is over 136,000m2 (equivalent to 19 football pitches in size).

To develop the most efficient solution to achieve adherence with this guidance Yorkshire Water has considered all feasible options, before determining the most efficient option from a cost and environmental impact. Covering all our existing pads is estimated to cost more than £430m, whilst drying technology at one site alone was forecast at greater than £57m. Therefore, it was concluded that the best option would be to convert all our sites to lime dosing, which reduces

the storage time and therefore required storage size. At more than £100m the costs are still significant and bring new operational challenges but present the best balance of cost vs risk given the requirement to cover.

Read more about this in the
**Appropriate measures enhancement case**

# 6. Sludge Recycling to Land

There is a likelihood over the coming AMPs that the availability of the landbank for treated sludge will have reduced, if not ceased, meaning the industry will need to invest in alternative recycling or destruction options.

We have already started to see the impact of these changes. Since 2020 the average distance we have had to travel to reach suitable landbank has increased by 29%. This is a result of changes to our operational processes, the “farming rules for water” discussions, and the “20 measures” that were adopted last year and are being written into the BAS Standard.

## 6.1 Future anticipated changes in landbank availability

It is likely the availability of suitable landbank will continue to decrease further, however it is unclear to what extent and when the landbank will be impacted. Landbank availability may vary due to 3 main reasons:

a) Delays caused by a Deployment-Based System

The EA sludge strategy is to move to a deployment-based system under environmental permitting regulations. It is possible that this could create significant delays and paperwork to remain compliant. In our WINEP SuiAR submission Yorkshire Water have requested funding for additional storage to manage deployment delays no greater than 10 days. Any additional storage provision is likely to require covering and odour control under IED Appropriate Measures, significantly increasing costs.

In addition to the practicalities of storing sludge for longer periods, this may also mean working with farmers becomes impracticable as material needs to be used at times in short notice periods. This can be due to cropping and harvesting intervals, weather dependent restrictions on spreading and incorporating, and the need to line up sales to farmers with uncertainty on delivery dates. We supply some farmers on a tip and spread basis, in which the material should be supplied from our site and spread and then incorporated on their land within 12 hours. This practice will become increasingly difficult to manage.

b) Further changes to rules and guidance around applying our product

The EA have strongly indicated through discussions with the industry that they interpret the requirements around crop need for nutrients to be more restrictive than current practice, with it being applied at the point of spreading and incorporation rather than over the cropping season.

Under this interpretation the Environment Agency would impose restrictions to spreading in autumn to cereal crops. This would not require any legislative change and will require a change in practice so that:

I. Where possible timing of surface application moves to spring. This is undesirable and very challenging due to ground conditions, running on growing crops, and potential for odour due to lack of incorporation. For example, spreading in spring is very restricted due to restrictions on spreading in waterlogged soil, the soil structure is easily damaged by heavy machinery. Many farmers are likely to be unable to adapt to these conditions.

II. Alternatively seek to move application to other crops. Around 70-75% of water industry biosolids is to these crop types – only a small fraction of replacement crops is likely to be able to be found.

    The Environment Agency have also challenged current practice of how application rates are calculated for crops growing on different P-classification soils. This could result in a significant reduction in the application rates to land at P indices 3 and 2. Should this happen, there will not be enough agricultural landbank in the UK to support recycling of all biosolids nationwide. Alternative outlets (a return to destruction technologies) would have to be sought by all WASC’s.

c) Market acceptability of our products

Even if deployment rules do not change further, it is possible that farmers do not want to use our product because of increasing consumer pressure over issues such as micro plastics and persistent chemicals, which may move faster than the market directly regulates for. The Environment Agency here agrees with the water industry that the scientific evidence is unclear. Investigatory work is planned for the next AMP. However, consumer pressure may move faster than the science and regulation move.

As well as the above restrictions, there are dozens of smaller risks which we continue to manage but are likely to increase steadily. These Increasing restrictions on how, when and where agriculture can use the material that we produce will continue to reduce both the number of fields we can apply biosolids to, and the amount of biosolids applied in each field. For example, under climate change we anticipate wetter winters, which will restrict both the storage and spreading activities that can be carried out on farmland.

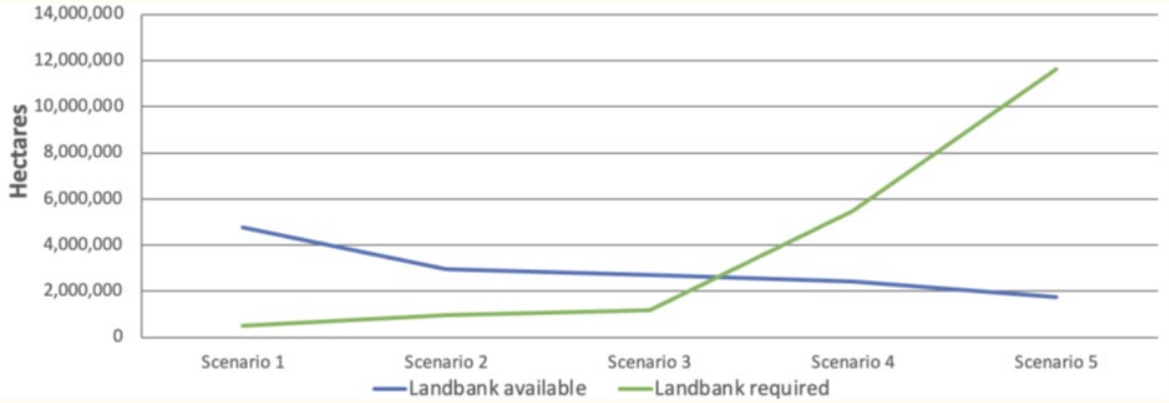
Any of the above scenarios could materialise and do not necessarily require any change in legislative practice or nutrient guidance.

#### 6.1.1 Modelled impact of these changes

Should application rates and return application frequencies increase, through the EA sludge strategy or otherwise, national landbank modelling shows insufficient land available for all UK biosolids. The Grieve report analysed national lank bank availability assuming five different scenarios. According to this report, the most likely scenario – scenario 4, will result in a reduction in land bank availability of 19% by the end of AMP9 compared to the baseline scenario.

The graph below, however, illustrates the extent of the problem. As can be seen, when return frequencies to land are increased (primarily due to phosphate restrictions) the landbank required increases dramatically and quickly exceeds the land that is available. This would mean that there is insufficient agricultural land available for companies to recycle biosolids to.

**Figure 6: Modelled landbank scenarios**[1]




If changes in public perception are considered – scenario 5, land bank availability will be further impacted – down by 41%, with the difference between landbank available and landbank required even more pronounced than in scenario 4. And although scenario 5 is not considered the most likely scenario, the uncertainty and speed at which public perception can change would require an urgent industry-wide response, suggesting a flexible regulatory approach would be beneficial.

Both Scenario 4 and 5 require more land than is available. This would require a move so that a proportion of biosolids is no longer recycled to agriculture.

### 6.2 Allowance in our plans

Our current plans assume landbank restrictions continue at a similar rate as we have seen recently and recognise that the amount of sludge we will produce is forecast to increase by 16%

[1] National Landbank Assessment, Grieve Strategic, 21st July 2023

by 2030, as we continue to improve river water quality through our investments in sewage treatment.

Our base plan, set out in this document, provides some slight mitigation for landbank changes as mentioned under Section 3.2.3 Risk mitigation. Due to the increased volatile solids destruction of the technology we expect to see a 10 to 15% reduction in treated cake (per unit of sludge treated) produced by those plants going through this process. Furthermore, having fewer treatment sites means should new treatment technologies need to be deployed, we are in a better position to roll it out.

### 6.3 WINEP SUiAR Enhancement Case

Yorkshire Water's WINEP SUiAR submission requests funding for additional storage to manage deployment delays no greater than 10 days (reason a) above). This is thought likely to be a best-case scenario. We have not gone beyond this because any additional storage provision is likely to require covering and odour control under IED Appropriate Measures, significantly increasing costs. In these cases, storage of biosolids cake becomes increasingly unviable, and it may be more cost effective to dry sludge to pellets.

Read more about this at
**In the WINEP Enhancement Case**

### 6.4 Bioresources uncertainty mechanism

Whilst our strategy lessens the proportion of biosolids generated per unit of sludge produced, this is not sufficient to mitigate a shrinking landbank. Uncertainty over both the scale and timing of land bank loss and the locations in the country where it could occur means that the costs, timings and best value solutions also remain uncertain. We have identified a worst-case scenario AMP8 cost to Yorkshire Water of £164.3m but this value is highly uncertain. We believe the introduction of a common reopener limited to the Bioresource price control is the most appropriate way to address this.

More detail on this subject can be found in **Chapter 9: Risk and Reward, in the PR24 Business Plan**

# 7. Bioresources Carbon

The UK Government has set a legally binding target to deliver net zero carbon emissions by 2050. Yorkshire Water is committed to playing its part in the transition to net zero, including achieving carbon neutrality on operational scope 1 and 2 emissions by 2030, and our Bioresources business is no different.

Bioresources contributes around 50% of Wastewater's scope 1 process and fugitive emissions through the release of methane following generation. Our AMP 8 investment will focus on reducing operational emissions by moving digestion from standard to advanced anaerobic digestion, which will result in greater methane capture during the digestion process, and recovering methane post digestion by vacuum degassing.

Some of this benefit is delivered in our base plans through the reconfiguration of our sites in Leeds, Hull and Huddersfield. A model of process emissions from our digesters based on expected 2029/30 sludge throughput estimates a 21% reduction in methane emissions by running our digesters in series compared to keeping our assets in their current configuration.

In our carbon enhancement case for wastewater we want to reduce these process emissions further. We are proposing to deliver advanced digestion at a further two sites; this will not be used to increase the capacity of these sites in AMP8 but solely to improve the biogas capture and methane emissions. This will be complemented by vacuum degassing at our 5 biggest sites, giving an overall 67% reduction in the same model. We will also increase monitoring and leak detection, which will provide an improved view of residual emissions and actions to be taken to address these in the longer term.

Our Bioresources plans will result in some further changes to our carbon position. Due to a combination of sludge growth, rationalisation and loss of landbank we expect to see a 65% increase in scope 3 emissions from logistics. In contrast we expect to make better use of biogas through additional generation and higher utilisation, with energy generated and used doubling (whether energy is used in bioresources, networks plus, or by third parties). We also expect to reduce the energy generated in bioresources that is unused by about 76%.

Our sale of biogas at sites in Leeds and Sheffield will provide overall a c8,500tCO2e/yr carbon benefit for the environment by offsetting the use of fossil fuels in road transport. That net benefit takes into account an additional 15,000tCO2e/yr generated at the Yorkshire Water sites through the use of replacement fossil fuels. Our plans are to offset our increase initially through the purchase of green certificates which will help from a market-based reporting perspective. Meanwhile we are working with local Energy from Waste plants to ultimately meet our energy needs through a green heat and power private agreement (PPA), providing a location-based benefit.

We are also in the exploratory phases of a number of markets projects which may further improve our carbon position in AMP8 and beyond, discussed earlier in this document (Section 3.1.1), such as waste heat re-use, replacing potable water with final effluent for process water and the conversion of treated sludge into aviation fuel, providing a more sustainable and environmentally-friendly way of travelling.

Our net zero focus through to 2050 will require a wider approach to reduce embedded emissions associated with purchased goods and services (in particular chemicals) and arising from our capital investments. We will look in all instances for solutions with lower embedded carbon. This will require a combination of innovation – piloting new solutions and aiming to drive emissions down by up to 90% compared to our baseline. Effective use of our biogas will continue to play an important part in reducing our emissions and may also continue to extend this benefit to the wider community.

Read more about this in the
**Net zero enhancement case**

# 8. Encouraging Greater Collaboration

In developing our Bioresources Sludge Strategy we've consulted widely. This chapter sets out how we've been collaborating with the sector and how that market engagement has informed our plans.

## 8.1 Extensive collaboration has informed our plans

We've been transparent about the challenges we face, such as growing sludge volumes and ageing assets, and collaborated with other WaSCs and a whole range of non-regulated entities to understand what solutions can be developed by working in partnership.

We explored a myriad of alternative delivery methods, from more efficient capital delivery through our in-house Bioresources Asset Management function to use of third-party markets, or new innovative methods of extending capacity in conjunction with York University. A key premise underlying the latter two approaches involves using existing capacity more effectively, either in our own assets or the wider market.

We also evaluated whether rationalising our digestion facilities to a smaller number of bigger sites makes us more efficient over the long term, and how we might introduce new revenue streams to allow us to do more.

Key to assessing the efficiency of all these options has been our investment in a new Strategic Model, which is industry leading and allows us to compare opex and capex of hundreds of thousands of combinations of potential asset solutions in a way we've never been able to before.

To stride towards greater efficiency, we need to deliver the lowest cost per TDS in a sustainable way that's affordable within each AMP. Use of this model has allowed us to take a data-led, commercial approach to our Sludge Strategy.

Some of the many treatment options investigated with input from the sector include:

### 8.1.1 Third-party expansion of Yorkshire Water assets

We've been engaging with the market to understand the potential and appetite for third parties to develop a limited number of Yorkshire Water sites, including converting our Leeds site to a Thermal Hydrolysis Plant and our York site to a dewatering export centre. These agreements are often referred to as DBFOM, where a third-party company Designs, Builds, Finances, Maintains and even sometimes Operates elements of the site, recovering its costs through a gate fee. The advantage to Yorkshire Water would be spreading the costs over a longer period and potentially gaining a more efficient site, which we otherwise couldn't afford to do.

### 8.1.2 Yorkshire Water refurbishment or expansion of existing assets

In year 1 of AMP7 we developed our own Asset Management function within the Bioresources team, which aims to go further down the supply chain to deliver more for less. Some of the schemes considered through this route have included refurbishment of two spare digesters at our site in Hull, conversion of digestion facilities to dewatered sludge export centres and investment to remove bottlenecks at key sites.

### 8.1.3 Different ways of operating our assets to maximise capacity

We're working with the University of York to investigate whether it's possible to accommodate future sludge volumes within the existing digester fleet by reducing hydraulic retention times at a number of sites. Several ways to achieve this will be investigated including but not limited to Digester and Digestate Mixing.

Whilst this research continues, we've considered slight decreases in retention times to 14 days at key sites, supplemented by investment to remove bottlenecks and to fund a greater amount of more proactive maintenance.

We've also been exploring new technology with the market including reconfiguring digesters to run in series, which can deliver some additional capacity and an improved opex performance.

#### 8.1.4 Trading & outsource agreements

As an alternative to building new sludge treatment capacity, we've looked into the option of long-term trade agreements with neighbouring WaSCs or other digestion sites. For instance, sites which currently digest farm waste, which may either be interested in converting some of their digestion facility to sewage waste or co-digesting when the regulations support this. Making use of existing market capacity removes the need for costly new builds and reduces carbon, although we have had to take into account resilience of the various options when considering them. We are currently in procurement for a c. 5 thousand TDS/year contract for at least the next 5 years, further information on which is provided under Section 2.4.1.

We've also been developing business cases for several commercial arrangements with third parties where there is opportunity to either reduce our own costs or bring revenue into Bioresources. In bringing this value into the price control we have the opportunity to do more, including investing funds that we wouldn't otherwise have access to.

Some of these commercial opportunities are covered in more detail in Sections 2.4 and 3.1, including selling our biogas for third-party conversion to vehicle fuel or buying green power from a local site at a lower rate than we could from the grid. An example of an outsourced agreement we've already enacted is that of sludge tankering, which was outsourced to Suttons in June 2020. This deal saved us £4.8m in capex from avoiding replacing our tanker fleet, and through outsourcing the operation we have been able to make further improvements internally on how we create, manage and deliver sludge movements within our business.

As set out in Section 3, our plans for AMP8 have been developed on the back of this engagement, with our modelling selecting the most efficient combination of options. We will continue this collaboration with the industry in order to keep our strategy optimised as new approaches come to light and new legislation needs to be met.

### 8.2 Methods of engagement

Our plans for AMP7 and now our PR24 submission have both heavily featured use of the market in enabling us to provide services to customers. As such we've put a lot of effort into proactively reaching out to the sector and sharing our challenges. We see this as key to developing the Bioresources Market, which we depend on developing to realise our ambitions. We've done this through a number of engagement routes.

#### 8.2.1 Supplier Days

We've held a number of supplier days and follow-up sessions whilst developing our plans, to understand available market solutions and refine them sufficiently to feed into our modelling.

As examples, at the beginning of 2023 we held two supplier days. One involved a series of open forum discussions targeted at known players in the market where we sought feedback on our plans in order to refine them further.

With the second we aimed to reach out to the wider sector, especially companies we hadn't necessarily encountered before. In the media we set out 5 big challenges and asked the market to come and tell us how they could help us address them, for instance how they can help reduce our energy use, the carbon impact of the chemicals we use and process emissions on site. We also sought advice from a specialist technology consultancy to help us identify companies we might not otherwise reach. Those companies which responded with a solution then joined us for a face-to-face discussion at a Supplier Day in March, or virtually at a later date, with the most promising options featuring in our plans or being looked at as trials.

#### 8.2.2 Supplier one on one meetings

Following the supplier days, or as a result of companies approaching us directly, we've worked with WaSCs and third parties to further explore solutions and develop them into proposals which can be considered in our modelling. For instance, a number of options where third parties invest in and deliver a solution on our behalf (DBFOM) including a digester site full rebuild and site expansion through thermal hydrolysis, in addition to the digester in series solution which we are currently pursuing at our site in Leeds.

We're also progressing a number of these proposals as trials to see if they can introduce further efficiency or performance improvements into our operations. We partnered with Isle Utilities through their Trial Reservoir and Orege for a successful test of their thickening unit, and are currently looking into a number of others.

#### 8.2.3 Industry Groups and Regional Planning

We participate in various industry discussions aimed at sharing information and developing a joined-up approach to industry challenges. As an example we meet quarterly with other WaSCs, facilitated by Jacobs, to discuss opportunities for both short and longer-term trading opportunities, in addition to any barriers to longer term trades. We also meet separately with neighbouring companies. In the last year these discussions have enabled several sludge exports from Yorkshire Water and at the time of writing we are importing sludges from United Utilities into our site in Huddersfield.

Through WaterUK we meet regularly with the rest of the sector to try and lessen uncertainty on key issues, including some of those identified in Jacobs' bioresources market review report. We have been working collaboratively to better understand the impact of:

- Farming rules for water and other landbank restrictions, including collaborating on national landbank modelling and jointly commissioning the Grieve/ADAS landbank report.
- Water Industry National Environment Programme (WINEP) drivers including research into the safety of biosolids, for instance Microplastics.
- IED and Appropriate measures implementation, including commissioning an Atkins report on standards required under these.

Through these groups we have also developed the "Twenty Measures" to provide additional assurance over agricultural recycling and have ongoing discussions with the Environment Agency over nutrient management requirements.

#### 8.2.4 Partnership approaches

We are driving the development of the market through our partnership with York University, where we have been working to test how digesters can be run more effectively to increase throughput and biogas generation.

After understanding the challenges Yorkshire Water bioresources face, the team at York University design a series of tests to find novel ways to improve the position using System-60; a unique laboratory facility comprising 60 individual reactors used to screen, test and verify anaerobic digester optimisation concepts. In its first phase, research of this nature demonstrated that it was possible to digest humus sludge at our site in Bradford which was previously thought not digestible due to organic chemical contamination. Consequently, additional sludge disposal costs of £0.67M per year were avoided, totalling approximately £2M benefit over 3 years.

#### 8.2.5 Information Sharing

As mentioned earlier, we think being transparent about our challenges is crucial to developing the Bioresources market. All the engagement methods described above start with us being open about what we are trying to address.

In addition, we publish a Bioresources Market Information spreadsheet annually and provide details in our Bioresources Bid Assessment Framework to support market understanding of where and how they can get involved. We have also been heavily involved in the recent work to develop a bioresources market growth collaborative decision support tool carried out by BMA.

#### 8.2.6 Procurement

We have run several procurement processes seeking market solutions, through which we've informed the market of our intentions and sought back solutions we can implement to improve our performance. This includes the outsourcing of tankering, market delivered gas to grid solutions, and the currently live 5 thousand TDS 5-year sludge market trade.

### 8.3 Future engagement

Going forwards we plan to continue the engagement activities featured here. Historically one of our biggest challenges has been an anticipated shortfall in capacity; since we now have a plan to address that we expect our focus for engagement will shift slightly to introducing greater efficiencies and preparing more for potential upcoming changes, for instance the need to implement destruction technologies.

We will continue, in particular, to fully participate in sector groups aimed at understanding and influencing changes to environmental legislation to ensure that the industry enacts the best possible solution for customers.

We also plan to partner with other specialist technology consultancies to get a more regular scan of market ready technologies, so we are better able to seek innovation out rather than asking it to come to us.