UUW66

Bioresources Enhancement Case

October 2023

Chapter 8 supplementary document

This document sets out the service enhancement expenditure and activity that we will undertake, through our 2025-2030 business plan.

This case includes:

- Case 22: Sewage sludge drivers
- Case 23: Improving resilience in biosolids recycling to agriculture
- Case 24: Bioresources preparatory works for alternative outlets

United Utilities

Water for the North West

1. Bioresources Enhancement Cases

1.1 Structure

1.1.1 This document contains our Bioresources Enhancement cases and is structured as below:

- **Case 22**: Sewage sludge drivers
- **Case 23**: Improving resilience in biosolids recycling to agriculture
- **Case 24**: Biresources preparatory works for alternative outlets

UUW66

WINEP sewage sludge drivers

October 2023

Enhancement Case 22

United Utilities

Water for the North West

Contents

Appendices

1. Enhancement submission

<table>
<tr><th colspan="2">Enhancement submission</th></tr>
<tr><td>Title:</td><td>WINEP sewage sludge drivers

An enhancement case to enable delivery of the statutory requirements identified in the Water Industry National Environment Programme (WINEP) under the sewage sludge drivers and targeted at delivering resilience in the sludge management supply chain to agriculture.</td></tr>
<tr><td>Price Control:</td><td>Bioresources</td></tr>
<tr><td>Enhancement headline:</td><td>This documents sets out the enhancement case for £169.965 million totex investment to deliver the statutory requirements identified in the WINEP under the sewage sludge drivers. The sewage sludge drivers are focussed on actions to ensure the sustainable management of sewage sludge.

We collaboratively identified and agreed all actions with the Environment Agency and these were included in the finalised WINEP. The actions will deliver resilience in the sludge supply chain to agriculture and support the continued beneficial recycling of biosolids, in a compliant way, and so as not to cause harm to human health or pollution of the environment.

We prioritised WINEP actions that are compatible with our Long Term Delivery Strategy to ensure that all actions are considered no regrets investment in AMP8, and under all future plausible scenarios.

Actions will increase biosolids storage capacity and deliver enhanced sludge dewatering capability to deliver improvements in sludge quality and handling prior to storage and before supply to agriculture. Approved actions will also support compliance with AMP8 requirements under Environmental Permitting Regulations for the agricultural use of sludge. As these are new and more onerous service standards they are not covered by our base expenditure.</td></tr>
<tr><td>Enhancement expenditure

(FY23 prices)</td><td>
<table>
<tr><th></th><th>AMP8 Capex (£m)</th><th>AMP8 Opex (£m)</th><th>AMP8 Totex (£m)</th></tr>
<tr><td>Pre RPE and Frontier Shift</td><td>134.665</td><td>38.743</td><td>173.408</td></tr>
<tr><td>Post RPE and Frontier Shift</td><td>131.972</td><td>37.992</td><td>169.965</td></tr>
</table>

The table above shows the total expenditure on both a pre-efficiency (i.e. pre frontier shift and real price effects basis, consistent with the cost data tables), and a post efficiency and RPE basis (i.e. consistent with the value we propose to be recovered from price controls). All numbers referenced hereafter in this enhancement case are on a post efficiency and RPE basis.</td></tr>
<tr><td>This case aligns to :</td><td>Drainage and Wastewater Management Plan (DWMP) 2023

For full reconciliation between enhancement costs and data table lines, see enhancement mapping tabs in UUW117 – Project allocations CW3 and CWW3.</td></tr>
<tr><td>PCD</td><td>Yes</td></tr>
</table>

2. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	• All actions included within scope of this enhancement case have been reviewed and endorsed by the Environment Agency (EA), and are confirmed actions included in the WINEP. They comprise statutory obligations with a compliance date of 31 March 2030. • This case covers the enhancement costs associated with meeting these new obligations. As these are new and more onerous service standards they are not covered by our base expenditure. • The actions will deliver: – 60 days biosolids storage capacity to provide resilient contingency measures when business as usual is disrupted and the environment is put at risk. – Enhanced sludge dewatering capability for 29,000 tonnes dry solids of digested sludge to deliver improvements in sludge quality and handling prior to storage and before supply to agriculture. – EA permit fees and resources to comply with regulations controlling the agricultural use of sludge in AMP8, as activities are moved out of operating under a waste exemption and to operating under Environmental Permitting Regulations (EPR). – An enhanced biosolids surveillance programme to monitor biosolids quality and provide assurance over its quality, over and above the regulatory minimum. • We have taken a leadership role in collaborating with all other WaSCs and the EA, to define the risks and issues that the sewage sludge drivers are addressing. The robust and quantified evidence we have gathered, including landbank modelling and a biosolids storage assessment, ensures that the agreed interventions are necessary, we only do what we need to do, and the value to both business and customers is clear.	Section 4 4.5 4.4 4.6 4.3 3.4
Best option for customers	• We have considered a range of options including 'do nothing'. We are presenting the lowest cost compliance option on behalf of customers. • A detailed unconstrained to constrained options assessment has been completed to identify the most effective way of delivering a resilient sludge recycling to agriculture service. We considered options ranging from monitoring and control, to access to alternative outlets for biosolids disposal. • Landbank modelling has identified that changes to the regulation of sludge recycling to agriculture activities may lead to a national landbank shortage. However, there remains significant uncertainty over the scale and timing of the changes. The "Storage+" WINEP assessment specifically excluded options to move towards alternative disposal outlets, such as thermal destruction technologies. We have therefore deferred significant investment (up to an additional circa £1 billion) to implement actions to move away from biosolids recycling to agriculture and have instead focussed on WINEP actions that support the continued beneficial recycling of biosolids. We are promoting	Section 5 5.1 Table 5

	management of these significant landbank availability risks through an uncertainty mechanism (Notified item) in our wider Business Plan submission. • We have ensured that our proposed investment is efficient through alignment with our Bioresources Long Term Delivery Strategy (LTDS) to ensure that proposed investment is considered 'no regrets' under all future plausible scenarios. This approach ensures that environmental outcomes can be delivered and the risk of inefficient investment is minimised. We have established customer preferences to feed into our decision-making process over how to manage bioresources services in future, and aligned to AMP8 WINEP requirements.	4.9 5.4
Cost efficiency	• Our capital cost estimates are based on data collected over AMP3 to AMP7 and updated to reflect the present market. Mott Macdonald provides our estimating service, and also to a number of other water companies, which allows them to provide a benchmarked approach to our PR24 capital cost estimates. • WINEP compliance costs will vary across the sector depending upon regional variability in landbank availability, company approach to manage landbank risk, and existing asset base. Whilst costs for WINEP compliance across the sector are unknown as these are new requirements, assessment of the WINEP proposals (prior to EA assessment) indicated total industry investment of £1.783 billion in AMP8. Our proposed WINEP compliance costs are consistent with industry norms. • Our WINEP development approach, cost estimating and scope development have been independently assured by ARUP to ensure that we only do what we need to do and at the most efficient cost.	Section 6 6.1 6.2 6.3
Customer protection	• Customer investment will be protected via a Price Control Deliverable (PCD) aligned with delivery of WINEP outcomes. • The EA will ensure that the environment is protected in this area on behalf of customers through the common industry Environmental Performance Assessment metric for satisfactory sludge use/disposal. This investment contributes directly to the delivery of the same environmental outcomes. • In our wider Business Plan submission we promote management of significant regulatory risks impacting on landbank availability through an uncertainty mechanism (Notified item).	Section 7

3. Introduction

3.1 Document purpose

3.1.1 There are two statutory sewage sludge drivers included in the AMP8 Water Industry National Environment Programme (WINEP):

(i) **SUiAR_IMP**: Actions to improve resilience in the sludge supply chain to agriculture and other relevant use or disposal outlets; and

(ii) **SUiAR_ND**: Actions to meet requirements to prevent deterioration in soil quality or water quality.

3.1.2 The inclusion of sewage sludge drivers within the WINEP is new for PR24 and reflects increasing challenges, outside of company control, for biosolids recycling to agriculture. Actions contribute to a WINEP Tier 1 outcome of "*Water company contribution to manage sewage sludge sustainably*". The WINEP actions that have been approved by the Environment Agency (EA) for inclusion in the WINEP seek to provide contingency measures when business as usual is disrupted and the environment is put at risk.

3.1.3 We set out in this document the scope of the enhancement investment required to deliver the statutory obligations listed in the WINEP under these drivers. We explain why these requirements are outside of management control, our approach to solution development and how we have ensured costs are robust and efficient. Allowances made through the enhancement case will ensure regulatory compliance with our statutory sewage sludge obligations, and deliver increased resilience to in-year disruption of the sludge supply chain to agriculture.

3.1.4 The sewage sludge WINEP actions (and therefore the investment outlined in this document) does not address significant risks to landbank availability in AMP8. We have submitted two separate enhancement cases that seek to mitigate the risk of a shortfall in landbank availability for biosolids recycling:

- **Bioresources preparatory works for alternative outlets** [**UUW66**]: A £10.394 million enhancement case to deliver preparatory works for uncertain and long term options for alternative biosolids disposal outlets.
- **Improving resilience in biosolids recycling to agriculture** [**UUW66**]: A £54.133 million enhancement case to increase the resilience of the agricultural outlet for biosolids, by improving product quality through the enhanced removal of non-degradable contaminants (such as microplastics) and thereby support market acceptance of higher quality products.

3.1.5 Other aspects that are not addressed by the WINEP includes the evolving and more stringent regulation of sewage sludge treatment which is leading to increasing environmental protection requirements across our sludge treatment sites. These requirements are not discussed further in document, but in our separate cost adjustment claim:

- **Industrial Emissions Directive compliance at anaerobic digestion sites.** Document reference: UUW_CAC_004. This is an industry-wide adjustment (as it impacts on all companies) with a claim value for United Utilities Water of £172.594 million. This claim is specific to regulatory changes at our (biological) sludge digestion sites.

3.1.6 In addition, we seek to manage significant, but uncertain risks impacting on landbank availability through an in-AMP uncertainty mechanism (Notified item), should landbank availability decline and exceed trigger points within our Long Term Delivery Strategy (LTDS).

3.2 Structure of this document

3.2.1 We have divided our enhancement case into the following sections:

(a) The remainder of this section provides background on the collaborative development of WINEP actions and the EA assessment to approve actions to be included within the WINEP. We summarise the scope and cost of the approved WINEP actions.

(b) **Section 4** provides an overview of the increasing challenges on biosolids recycling to agriculture and the resulting need for the agreed actions under the sewage sludge WINEP drivers. The agreed actions will deliver new and more onerous service standards and we discuss why these activities should be considered as enhancement investment.

(c) **Section 5** sets out our approach to optioneering to demonstrate that we have considered a range of options, including 'do nothing', to deliver compliance with the statutory sewage sludge actions. Our enhancement case presents the least cost and best value solution for customers to meet the objectives of the WINEP drivers.

(d) **Section 6** provides evidence that our costs to comply with our agreed WINEP actions are efficient. Our WINEP development approach, cost estimating and scope development have been independently assured by ARUP to ensure that we only do what we need to do and at the most efficient cost.

(e) Finally, in **Section 7** we explain how customers are protected if the WINEP outcomes are not delivered.

3.3 Background to the sewage sludge drivers

3.3.1 We continuously produce treated sewage sludge (biosolids) with the majority of biosolids being beneficially recycled to agricultural land, in line with the UK best practicable environmental management approach, and providing multiple environmental and economic benefits to the North West and beyond.

3.3.2 Biosolids recycling to agriculture is entirely dependent on access to third party landbank and acceptance of our products by farmers and land managers. The reliance on agricultural land as an outlet makes this area of the business vulnerable to changing market demands. An increasing number of factors that are out of company control threaten the resilience of the supply chain of sewage sludge to agricultural land, such as; exceptional weather events preventing access to agricultural land; disease causing farmers to change their cropping plans; or regulatory or market requirements affecting land managers and the supply and demand of sludge to land.

3.3.3 In AMP7 we have seen multiple shocks and disruptions to the biosolids market and the EA have issued three Regulatory Position Statements (RPS) impacting the sludge supply chain to agriculture:

- **RPS C6 - Storing treated sewage sludge you cannot move because of COVID-19 restrictions**: Issued in April 2020 in response to HGV driver shortages due to the global pandemic affecting the ability to transport sludge.
- **RPS 252 - Spreading organic manure on agricultural land:** Issued in August 2021 to support the EA implementation of Farming Rules for Water. This prevented the recycling of biosolids to agriculture in autumn 2021, until Defra intervention in the market with statutory guidance that made the regulatory enforcement position clear and enabled farmers to accept biosolids product.
- **RPS 253 – Storing treated sewage sludge:** Delays generated by RPS 252, resulted in the issue of RPS 253 in November 2021 to enable water companies to temporarily store treated sewage sludge not at the place it will be used, whilst the delays in agreeing sludge supply contracts for the autumn were resolved.

3.3.4 Responding to these in-year resilience issues the EA have develop the two, new, sewage sludge drivers for AMP8. The driver guidance states that:

"A lack of access to alternative outlets or treatment technologies for sludge or ability to store sewage sludge temporarily in a compliant manner during times when agricultural land is not available demonstrates that contingency measures and long-term planning for sludge management require investment"[1].

3.3.5 The objective of the sewage sludge drivers is to deliver improvements in the resilience of the sludge management chain. It is additionally recognised that investments through these drivers will support requirements to prevent deterioration in soil quality or water quality, as well as helping the Government's and Water UK's net zero commitments to be realised.

3.4 Approach to developing sewage sludge WINEP actions

3.4.1 The sewage sludge drivers are unique within the WINEP, as rather than being prescriptive and geographically targeted with specific outcomes, they are more flexible, open to interpretation, and apply to the system wide biosolids recycling supply chain and a multitude of environmental and regulatory risks that may impact future resilience.

3.4.2 Following the WINEP methodology, it has been necessary to provide further granularity over the risks and issues that the drivers are addressing, along with clarification over the scale and the timeframe they will impact. We have taken a leadership role to develop an approach, collaborating with all other WaSCs and the EA, to ensure commonality in understanding. We welcome the recognition this approach received in Ofwat's final methodology for bioresources:

"We support engagement by companies with the EA and Defra as appropriate so that their business plans reflect a shared view of what needs to be delivered"[2].

3.4.3 The approach has resulted in the development of a risk and issue evidence log of over 50 different risks and issues that could be considered under this driver. The risks and issues can be summarised as improvements contributing to at least one of the following three aspects:

- **Landbank accessibility:** Resilience against in-year access issues such as agricultural epidemics.
- **Landbank availability:** Improvements to increase flexibility or timing of when biosolids may be applied, or improvements to reduce the overall landbank requirement.
- **Landbank quality:** Improvement to biosolids quality to reduce potential risk of harm to soil or water from nutrients, chemicals and microplastics in recycled biosolids.

3.4.4 The list was collaboratively reviewed by the industry and EA to determine where further evidence was needed to quantify the risks and understand company planning requirements. We have gathered the following quantitative supporting information to provide evidence of the need for our agreed WINEP actions:

- **National landbank modelling:** Specialist landbank consultants provided analysis of landbank availability and landbank requirements for biosolids in England, Wales and Scotland under five scenarios.
- **United Utilities regional landbank modelling:** Specialist landbank consultants provided analysis of landbank availability and landbank requirements, specific to our region. This followed the same approach and considered the same factors as the national landbank modelling.
- **Assessment of biosolids storage need:** Independent consultancy analysis of national biosolids storage drivers and needs.

[1] Environment Agency, *PR24 WINEP driver guidance – Sewage Sludge,* V0.3 Issued by email January 2022

[2] Ofwat, *Creating tomorrow, together: Our final methodology for PR24, Appendix 4: Bioresources control*, December 2022 [Online: page 13] https://www.ofwat.gov.uk/wp-content/uploads/2022/07/Appendix-4-Bioresources-control.pdf

3.4.5 WINEP actions have been developed on a regional basis, reflecting the systematic nature of bioresources. The scale and location of these interventions were optimised through use of our strategic planning tool, Regional Integrated Asset Plan (RIAP). Strategic planning capability is central to our asset strategy over the next 25 years and enables us to understand and optimise greenhouse gas emissions, capital and operational costs of planned WINEP actions across the entire bioresources system. This has ensured that we can maximise the value delivered through proposed WINEP actions and at the most efficient cost.

3.4.6 The WINEP development phase resulted in our proposal of six WINEP actions under the sewage sludge drivers in November 2022. These were proposed as an integrated package of interventions to meet the objectives of the driver guidance.

3.5 Environment Agency assessment of WINEP proposals

3.5.1 The EA assessed all proposed actions to ensure that they met the objectives of the sewage sludge drivers.

3.5.2 The assessment resulted in a minority of the industry's actions being approved under the sewage sludge drivers. The EA wrote to all companies on 22 March 2023 to justify the outcomes of the options assessment for the sewage sludge drivers. The EA described how the wider remit of the sewage sludge driver guidance, to address landbank accessibility, landbank availability and landbank quality issues, was set aside in favour of a "focussed approach". The EA stated:

"We have given an emphasis on effective storage in the sustainable supply and use of sewage sludge. This is seen as the minimum action necessary to deliver improved resilience in the sludge supply chain to agriculture and other relevant use or disposal outlets" [3].

3.5.3 Subsequent discussion and follow-up meetings with companies led to the EA issuing a revised, "Storage+ assessment", in a second draft release of the WINEP. This assessment broadened the scope of actions approved under the sewage sludge drivers as follows:

"It includes both storage and other actions which deliver environmental improvements of sludge quality and handling prior to storage and before supply to agriculture, such as enhanced dewatering and pelletisation. The assessment also supports in principle the options associated with future EPR requirements for the agricultural use of sludge" [4].

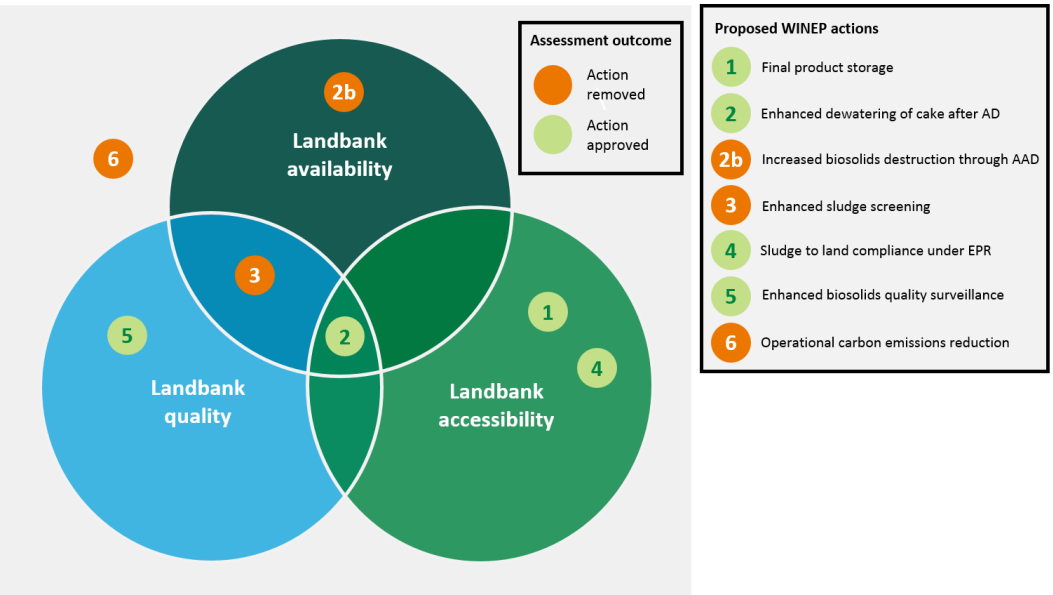
3.5.4 The outcome of the "Storage+ assessment" was finalised with the WINEP publication on 3 July 2023. The final WINEP confirmed approval of four out of the six actions we had proposed against these drivers. The enhancement case refers to approved WINEP actions only.

3.5.5 We present in Figure 1, a summary of the EA assessment outcome, and how this aligns with the broader objectives set out within the sewage sludge driver guidance to address landbank accessibility, landbank availability and landbank quality. It can be seen that landbank availability and landbank quality issues are not being fully addressed through the approved actions under the sewage sludge drivers.

[3] Environment Agency Information Letter (EA/09/2023), *Water Industry National Environment Programme - Sludge update*, 22 March 2023

[4] Environment Agency Information Letter (EA/12/2023), *Water Industry National Environment Programme - Sludge (Use in Agriculture) update*, 19 May 2023

Figure 1: Summary of approved actions and benefits against the sewage sludge driver objectives.



Source: United Utilities, 2023

3.6 Scope of this enhancement case

3.6.1 This enhancement case is for an additional £169.965 million above base totex in AMP8 to deliver our WINEP obligations under the sewage sludge driver. The breakdown of totex across the four WINEP actions is presented in Table 1.

Table 1: Summary of Sewage Sludge WINEP actions and enhancement expenditure

WINEP Action ID	WINEP Driver Primary (Secondary)	Action Name	Action Description	Regulatory date	Totex (£m)
08UU100130 (component a to j)	SUiAR_ND	Enhanced biosolids quality surveillance	Enhanced biosolids quality surveillance at 10 sites to manage sewage sludge sustainably	2030	0.171
08UU100132	SUiAR_ND (SUiAR_IMP)	Enhanced dewatering of cake after AD	Proposing enhanced dewatering of cake after AD to manage sewage sludge sustainably	2030	46.644
08UU100134	SUiAR_IMP	Final product storage	Regional final product storage to manage sewage sludge sustainably	2030	107.199
08UU100135	SUiAR_IMP	Sludge to land compliance under Environmental Permitting Regulations	Sludge to land compliance under Environmental Permitting Regulations to manage sewage sludge sustainably	2030	15.950
Total					**169.965**

Source: United Utilities, 2023

3.6.2 The full list of approved actions, with sub-components, is presented in Appendix A. The regulatory date to deliver all actions is 31 March 2030.

3.6.3 All actions align with the actions and objectives set out within our Drainage and Wastewater Management Plan (DWMP) 2023, to maximise the value created through recovery and re-use of sewage sludge and increase the resilience of our sludge to land operations.

3.7 Actions outside the scope of the WINEP sewage sludge driver

3.7.1 The focussed approach of the WINEP sewage sludge driver assessment means that significant landbank risks and drivers will not be addressed by the AMP8 WINEP (as summarised in Figure 1). The sewage sludge driver actions are based on the continued reliance of recycling of biosolids to land and there being sufficient available landbank.

3.7.2 The EA assessment specifically excluded actions to move away from sludge recycling to agriculture, and manage landbank availability risks, stating:

"The sludge (use in agriculture) driver supports actions to bring change to the way sludge is managed to ensure its soil conditioning and fertiliser value meets its full potential… there is a presumption that there is not support in principle for options such as thermal destruction technologies"[5].

3.7.3 Collaborative industry national landbank modelling has identified that changes to the regulation of sludge recycling to agriculture activities may lead to a national landbank shortage. Therefore we have submitted two separate enhancement cases that seek to undertake 'low regrets' investment to mitigate the risk of a landbank shortfall for biosolids recycling.

3.7.4 There remains significant uncertainty over the scale and timing of the changes. We have deferred significant, further investment (up to an additional circa £1 billion) and focussed on WINEP actions that support the continued beneficial recycling of biosolids, rather than seek to implement actions to move away from biosolids recycling to agriculture.

3.7.5 Should landbank investment needs crystallise in AMP8, the base cost allowance is insufficient to deliver the scale of investment that would be required to move away from biosolids recycling to agriculture. The impact is anticipated to be an entire step change in the business model for bioresources, and would take many years to implement fully. We are promoting management of these significant landbank availability risks through an uncertainty mechanism (Notified item) in our wider business plan submission.

3.7.6 To provide an example of the risks not covered by the sewage sludge WINEP drivers, we note that Ofwat's final methodology specifically calls out compliance with Farming Rules for Water as one of the risks to be managed through the WINEP sludge drivers. The methodology states:

"Farming rules for water: PR24 WINEP sewage sludge driver aims at delivering improvements in the resilience of the sludge management chain. This process provides a framework for addressing risks related to the use or disposal of sewerage sludge over the 2025 to 2030 period"[6].

3.7.7 We are keen to highlight that while this may have been the intention at the time the methodology was written, the subsequent "focussed assessment" by the EA, in collaboration with Ofwat and Defra, of items to approve for inclusion in the WINEP has meant that investment in several drivers, including adaptations to comply with Farming Rules for Water are out of scope. Should Farming Rules for Water risks (or any others) materialise, there must be recognition of these legitimate enhancement costs through another route, outside of the WINEP.

3.7.8 This enhancement case is only for actions included in the WINEP sludge drivers "Storage+ assessment".

[5] Environment Agency Information Letter (EA/12/2023), *Water Industry National Environment Programme - Sludge (Use in Agriculture) update*, 19 May 2023

[6] Ofwat, *Creating tomorrow, together: Our final methodology for PR24, Appendix 4: Bioresources control*, December 2022 [Onlie: page 13] https://www.ofwat.gov.uk/wp-content/uploads/2022/07/Appendix-4-Bioresources-control.pdf

4. Need for enhancement investment

4.1 Statutory sewage sludge WINEP driver

4.1.1 All actions included within scope of this enhancement case, have been reviewed and endorsed by the EA and comprise statutory WINEP obligations for AMP8. The regulatory compliance date for all actions is 31 March 2030.

4.1.2 We anticipate an increasingly constrained and regulated environment in which to operate our biosolids to agriculture recycling service in AMP8. The four approved WINEP actions are an integrated package of interventions, across our bioresources system, and will support a combined outcome to improve the resilience of our sludge management supply chain to agriculture and mitigate in-year disruption.

4.1.3 We have not presented specific AMP9 interventions due to the levels of uncertainty on landbank availability, although we indicated in our WINEP submission that Actions 08UU100132 (Enhanced dewatering of cake after AD) and 08UU100134 (Final product storage) are expected to continue into AMP9. The need and associated enhancement investment requirement will be reviewed at PR29.

4.1.4 In Table 2 we present a summary of the agreed WINEP actions, why they are required, and how they will support delivery of the WINEP outcomes.

Table 2: Summary of WINEP actions and alignment to the sewage sludge drivers

WINEP Action	Why is there a need to change?	How will this deliver the WINEP drivers?
08UU100130 Enhanced biosolids quality surveillance	Current regulatory requirements to monitor biosolids quality are restricted to beneficial properties and toxic elements. There is growing public and stakeholder concern over the potential for environmental harm to be caused by contaminants in biosolids recycled to agriculture. Without available data on biosolids quality for a wider range of contaminants we are unable to provide assurance over biosolids quality.	Enhanced biosolids quality sampling, over and above the regulatory minimum, will provide information on biosolids quality. This will support government aims and better inform UU's long-term sludge to land risk. It will additionally provide some potential mitigation against landbank loss from drop in societal / farmer acceptance over contaminant concerns.
08UU100132 Enhanced dewatering of cake after AD	There are significant and increasing resilience pressures, outside management control, on the sewage sludge supply chain to agriculture. We are heavily reliant on limited seasonal windows to supply sludge to agriculture which limits the resilience of our activities. Better matching of sludge production to agricultural demand will ensure that our sludge supply chain is more resilient to disruption.	Enhanced dewatering will deliver environmental benefit via improvements to sludge quality and handling prior to storage and before supply to agriculture. Enhanced dewatering will increase the proportion of enhanced quality product to allow grassland spreading and open up more landbank, thereby improving the resilience of our biosolids recycling operations.
08UU100134 Final product storage	Multiple drivers impact on the need for biosolids storage to provide resilience when there is disruption to the sludge supply chain to agriculture. In addition, AMP8 implementation of the EA Sludge Strategy will require biosolids storage on permitted sites, awaiting deployment approval.	Ensure sufficient biosolids storage to allow resilience against in-year landbank accessibility issues. Supports implementation of EA sludge strategy, requiring deployment approval, ahead of stockpiling sludge on land.
08UU100135 Sludge to land compliance under Environmental Permitting Regulations	AMP8 Implementation of EA Sludge Strategy will revoke Sludge Use in Agriculture regulations and move the regulation of sludge to land under Environmental Permitting Regulations.	Resources to adapt and comply with new regulatory requirements in AMP8 to recycle biosolids under Environmental Permitting Regulations.

Source: United Utilities, 2023

4.1.5 Each of the four WINEP actions summarised in Table 2, are discussed in turn in this section. We present evidence of the increasing number of factors that are out of company control that threaten the resilience of the supply chain of sewage sludge, and why investment is needed in AMP8. The robust evidence we have gathered ensures that the agreed interventions are necessary, we only do what we need to do, and the value to both business and customers is clear.

4.2 Alignment with strategic planning frameworks

4.2.1 All actions align with the actions and objectives set out within our DWMP (2023), to maximise the value created through recovery and re-use of sewage sludge and increase the resilience of our sludge to land operations.

4.2.2 Our actions are aligned to our long term water quality plan submitted to the Drinking Water Inspectorate which states:

"Our WINEP submission also includes a proposed programme of enhanced sludge quality surveillance to enable us to better understand quality across sites that recycle biosolids to agriculture."

4.3 08UU100130 - Enhanced biosolids quality surveillance

4.3.1 We propose to deliver proactive monitoring of the final quality of biosolids at our ten biosolids production sites to inform our understanding of the spatial and temporal variability in biosolids quality. Current regulatory requirements for biosolids recycling are monitoring for eleven toxic elements and plant available nutrients and organic matter. Through this action we will go over and above the regulatory minimum to provide quarterly information about the presence and concentration of emerging contaminants such as microplastics and persistent organic pollutants including perfluoroalkyl and polyfluoroalkyl substances (PFAS).

4.3.2 There is significant, and increasing, concern over the potential for environmental harm to be caused by contaminants in biosolids recycled to agriculture. As biosolids recycling to agriculture is entirely dependent on access to third party landbank and acceptance of our products by farmers and land managers the resilience of this outlet is subject to fluctuations in market demand. Loss of public sentiment and support for biosolids recycling across the food supply chain, due to contamination concerns, has the ability to drastically and rapidly cut acceptance rates for our biosolids products, risking a shortfall in available outlets for our product. It is notable that a loss of confidence in the market may be based on a perceived, rather than quantified risk, and accelerate ahead of regulation.

4.3.3 This risk was identified through the UKWIR research project, Biosolids to market: a strategic proposal to explore the threats to biosolids to land, which stated:

"In addition to the purely 'scientific' issues, public and stakeholder perception is an extremely important consideration. Alarmist headlines combined with alternative or erroneous interpretations of the science can be extremely damaging to the image and perception of biosolids recycling. Media attention on emerging issues such as plastics is increasing, so it is important that the Water Industry is seen to be proactive, taking action by working with others to address this and other potentially emotive issues such as nanoparticles and antimicrobial resistance."[7]

4.3.4 Emerging contaminants is one of the key risks to our bioresources business and is referenced in our Annual Report. Media headlines, scientific papers and government reports about the potential risks from the contamination of biosolids are numerous, and below we highlight only a fraction of the interest that is driving the need for action now:

[7] UKWIR, Biosolids to market: a strategic proposal to explore the threats to biosolids to land, No. 18/SL/01/9

- The Environmental Audit Committee Report (2022) was clear that action must be taken, recommending that "*the Government commission an independent evaluation of the potential risks to human health and the environment from spreading sewage sludge to farmland".*[8]
- The Marine Conservation Society published a comprehensive report titled; Sewage sludge: Why we need to stop pollution at source[9]. It called for action to be taken by water companies (amongst others) to produce a road map on how to reduce levels of contaminants for the whole wastewater treatment process, from source control of incoming pollutants, to sludge treatment and reuse.
- Cardiff University analysed historical data and found PFAS, which have been linked to health problems in both humans and wildlife, in Eurasian otters. It concluded that *"this suggests widespread pollution of British freshwaters today".* The study found most PFASs in otters were associated with wastewater treatment works or use of sewage sludge in farming, suggesting this was a *"significant and concerning"* route into rivers[10].
- In July 2022, the DWI published an information letter for water companies in England and Wales[11] requiring monitoring for a wider range of PFAS and update their risk assessments accordingly. It set out PFAS limits and required actions where elevated levels are present in drinking water and may require routine monitoring. It specifically identified active or historic sludge to land activities as a potential PFAS source to be considered as a minimum in risk assessments.
- Direct contact to our agricultural services team has also been increasing highlighting growing concerns over contaminants. Most recently, an information request from Lancaster City Council Environmental Health department asked for data over the quality and use of recycled biosolids to inform their private water supply risk assessments for PFAS.

4.3.5 Increasing customer, stakeholder and public concern makes it imperative that we understand the risks to inform our long-term sludge strategy and provide optimal resilience in sludge management. It is vital that we are proactive to quickly gather data to establish the quality of biosolids and particularly to use this data to determine if either biosolids recycling is a significant source of contaminants to the wider environment, or provide reassurance that it is not. It is essential that we align with the precautionary principle and try to understand and quantify the risks, rather than wait for evidence that biosolids recycling may be causing harm.

4.3.6 Levels of contamination in biosolids are poorly understood, although there is evidence of the presence of other contaminants in biosolids, beyond the range of the current regulatory analysis suite. Through previous iterations of the Water Industry Chemical Investigations Programme (CIP) the potential has been recognised for the removal of substances from wastewater to partition substances into sludge and be present in biosolids applied to land. As ever more stringent wastewater treatment standards are applied, and for a growing range of determinants, there is an increasing need to understand this risk.

4.3.7 The proposed sampling will go beyond the scope of planned AMP8 CIP investigations, which is limited to one treatment works in our region, and will instead extend to all our biosolids to land sites to analyse biosolids quality. Moreover, the sampling will be more frequent, quarterly sampling and extend over the course of the AMP to build-up a robust dataset. It is anticipated that the scope of the laboratory analysis will evolve depending on the findings and the latest scientific research and concerns.

[8] Water quality in rivers: Government Response to the Committee's Fourth Report of Session 2021–22 [Online] https://committees.parliament.uk/publications/22190/documents/164546/default/

[9] Marine Conservation Society, *Sewage sludge: Why we need to stop pollution at source*, June 21 [Online] https://marine-conservation-society-production.s3.amazonaws.com/documents/MCS_sewage_sludge_paper_june_2021_final.pdf

[10] O'Rourke et al., *Anthropogenic Drivers of Variation in Concentrations of Perfluoroalkyl Substances in Otters (Lutra lutra) from England and Wales*, American chemical society publications, Environ. Sci. Technol. 2022, 56, 1675−1687 [Online] https://pubs.acs.org/doi/10.1021/acs.est.1c05410

[11] Drinking Water Inspectorate, *Information Letter 03/2022*, 7 July 2022 [Online] https://dwi-content.s3.eu-west-2.amazonaws.com/wp-content/uploads/2023/01/13123351/IL_03-2022_PFAS_Guidance-4-1.pdf

4.3.8 The proposed monitoring will also support sludge supply chain resilience when the EA Sludge Strategy[12] is implemented in AMP8. Currently, biosolids recycling to agriculture is regulated under the Sludge Use in Agriculture Regulations (SUiAR), allowing an exemption from the EU Waste Framework Directive. The EA Sludge Strategy seeks to withdraw SUiAR and will move biosolids recycling to agriculture under the Environmental Permitting Regulations (EPR). It provides the mechanism to allow on-going and iterative improvements to sludge recycling by the EA, without seeking legislative change i.e. new biosolids quality constraints may be introduced with limited consultation or notice. Building up a biosolids quality dataset will help to us to mitigate against and prepare for any such changes.

4.4 08UU100132 - Enhanced dewatering of cake after AD

4.4.1 Through delivery of this action we seek to improve the supply and demand balance of our sludge recycling operations and increase the type and area of landbank we can apply biosolids. Better matching of biosolids production to agricultural demand will ensure that our sludge supply chain is more resilient to disruption, as we are less reliant on limited seasonal windows to supply biosolids to agriculture. At present, any agricultural disruption or closed periods impacting these limited spreading windows has a disproportionately large impact on our biosolids recycling operations.

4.4.2 We propose to provide circa 29,000 tonnes dry solids additional enhanced dewatering capacity at our largest sludge treatment centre to enable this site to dewater all biosolids on-site and increase the total regional production of biosolids classed as enhanced quality from 39 to 62 per cent. In addition, the dewatering will increase the dry solid content of the final biosolids cake above 25 per cent dry solids. This, as recognised through the outcome of the EA's "Storage+ assessment", will deliver environmental improvements through improved sludge quality and handling prior to storage and before supply to agriculture.

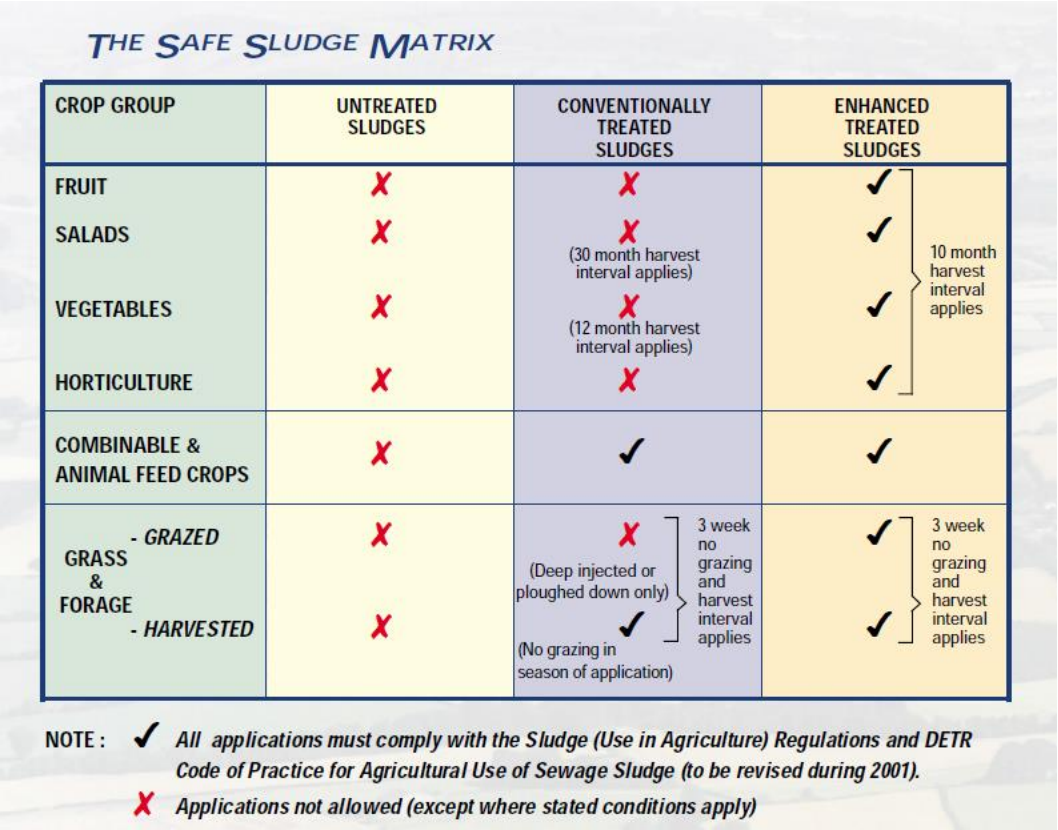
4.4.3 The proposals will deliver new capability at our largest sludge treatment centre. The existing dewatering capability is unable to achieve an enhanced product, and is only designed to achieve 25 per cent dry solids. The new capability delivered through this action will deliver a step change in performance and resilience of our biosolids to land activities.

4.4.4 An enhanced quality biosolids product is the optimal product that we can produce as it provides maximum flexibility (and therefore resilience) in biosolids recycling. Guidance for where biosolids can be spread is provided through the Safe Sludge Matrix, compiled by ADAS. We present in Figure 2 an extract from the Safe Sludge Matrix that demonstrates enhanced quality sludge's can be applied to all crop types. However, outlets for conventional quality sludge is significantly restricted by the crop types to which they can be applied. Compliance with the Safe Sludge Matrix is important as it enables farmers and growers to continue to utilise the beneficial properties in sewage sludge, and moreover it is a key requirement of compliance with the voluntary Biosolids Assurance Scheme (BAS) Standard[13].

[12]Environment Agency, Sludge strategy for safe and sustainable sludge use, July 2020 [Online] https://www.gov.uk/government/publications/environment-agency-strategy-for-safe-and-sustainable-sludge-use/environment-agency-strategy-for-safe-and-sustainable-sludge-use

[13]Assured Biosolids Limited, The BAS standard, July 2020 [Online] https://assuredbiosolids.co.uk/wp-content/uploads/2020/07/BAS-Standard-Issue-5-10th-July-2020.pdf

Figure 2: The Safe Sludge Matrix



THE SAFE SLUDGE MATRIX

CROP GROUP	UNTREATED SLUDGES	CONVENTIONALLY TREATED SLUDGES	ENHANCED TREATED SLUDGES
FRUIT	✗	✗	✓ (10 month harvest interval applies)
SALADS	✗	✗ (30 month harvest interval applies)	✓
VEGETABLES	✗	✗ (12 month harvest interval applies)	✓
HORTICULTURE	✗	✗	✓
COMBINABLE & ANIMAL FEED CROPS	✗	✓	✓
GRASS & FORAGE - *GRAZED*	✗	✗ (Deep injected or ploughed down only) (3 week no grazing and harvest interval applies)	✓ (3 week no grazing and harvest interval applies)
GRASS & FORAGE - *HARVESTED*	✗	✓ (No grazing in season of application) (3 week no grazing and harvest interval applies)	✓ (3 week no grazing and harvest interval applies)

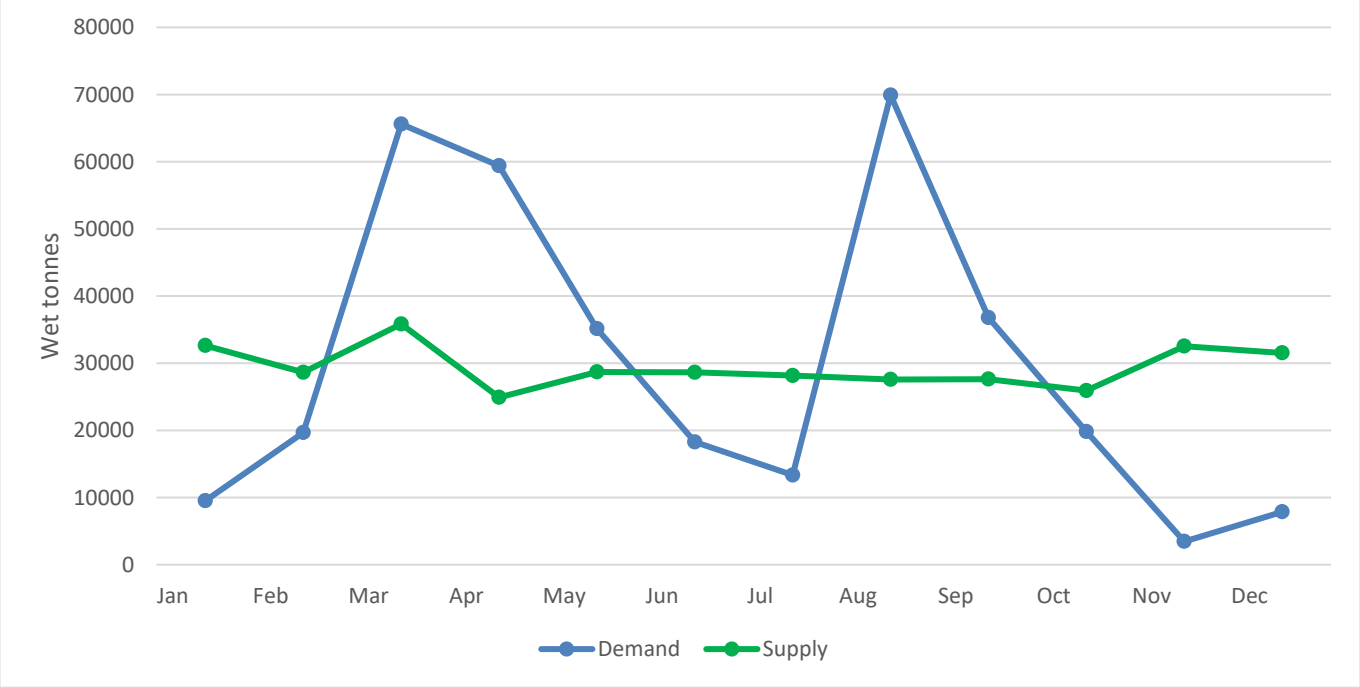
NOTE : ✓ *All applications must comply with the Sludge (Use in Agriculture) Regulations and DETR Code of Practice for Agricultural Use of Sewage Sludge (to be revised during 2001).*

✗ *Applications not allowed (except where stated conditions apply)*

Source: ADAS, The Safe Sludge Matrix: Guidelines for the Application of Sewage Sludge to Agricultural Land, 2001

4.4.5 We present in Figure 3 an illustration of the annual cycle of our biosolids recycling operations. It shows that although biosolids are produced relatively consistently throughout the year, there are two peak periods of biosolids demand in the spring and autumn. These peaks are aligned to arable farming calendars.

Figure 3: Supply (delivery) and demand (spreading) balance of our biosolids recycling operations 2022



Source: United Utilities, 2023

4.4.6 Our operations currently rely on disposal to arable land for over 90 per cent of biosolids, as we are able to supply conventional quality biosolids to arable land. However, reliance on one type of landbank limits the resilience of our activities. Two of the three RPS issued by the EA in AMP7 resulted from disruptions to arable agricultural recycling, and more particularly the inability to recycle biosolids to autumn arable landbank.

4.4.7 Through this action, we will increase the resilience of our activities and reduce the risk of further disruption in AMP8. Producing more enhanced biosolids, which are suitable to be recycled to arable land and grassland, has dual benefits of:

(i) Maximising the potential outlets for the biosolids as 62 per cent of biosolids will achieve enhanced biosolids quality and can be recycled to arable or harvested grassland. This is particularly important in the North West where grassland is the predominant type of agricultural land in proximity to our sludge treatment centres.

(ii) Extending the biosolids demand period across spring, summer and autumn as applications to harvested grassland are allowed between February and August. This will 'flatten' the demand peaks on Figure 3 enabling our supply and demand to be better balanced across the year.

4.5 08UU100134 - Final product storage

4.5.1 Through delivery of this WINEP action we propose to provide 60 days biosolids storage, equivalent to almost 45,000 metres squared of storage area. Storage is recognised by the EA as the minimum action necessary to deliver improved resilience in the sludge supply chain to agriculture.[14]

4.5.2 Our current biosolids recycling operations rely on field storage. Permitted sludge storage for contingency purposes requires new investment but will increase our flexibility and agility to allow operations to continue during disruption when we are not able to use field storage. This will provide resilience against the following risks:

- Closed agricultural periods due to adverse weather and exacerbated by climate change, or agricultural epidemic constraints.
- The changing regulatory framework, whereby implementation of the EA Sludge Strategy and recycling sludge to land under EPR will require permits for biosolids deployments in place ahead of stockpiling in fields. The extended period to agree permits will require access to permitted biosolids storage facilities.
- Disruptions to logistical activities such as HGV driver shortages.

4.5.3 Atkins was commissioned by the water industry, to gather evidence and provide industry-standard recommendations over sufficient biosolids storage capacity and capability to provide adequate resilience to the sludge supply chain to agriculture. The report[15] concluded (amongst other aspects) that:

- Biosolids storage capacity of up to three months is required in AMP8 to manage risks around the changing recycling regime and address ongoing resilience needs. Further storage capacity of up to six months should be considered in the longer term.
- Covered storage is essential to mitigate the risk of rewetting and has evidenced benefits to the dry solids content of biosolids ultimately recycled to agriculture.
- Climate change will result in increased periods where landbank access cannot be guaranteed, additional storage will be required to mitigate this, but as this is likely to occur over an undefined period of time, this capacity can be delivered incrementally.

[14] Environment Agency Information Letter (EA/09/2023), *Water Industry National Environment Programme - Sludge update*, 22 March 2023

[15] Atkins, *WINEP Sludge driver evidence support: Biosolids Storage*, 14 September 2022

4.5.4 Following the recommendations of this report we propose to deliver 60 days covered biosolids storage in AMP8. Provision of 60 days storage is considered as 'no regrets' investment in the context of our LTDS (see section 4.9). This storage can still be utilised to provide resilience even if we ultimately move away from sludge recycling to agriculture. Our historic experience of incineration recognises that there are significant planned and unplanned periods of downtime and contingency storage will still be essential. We consider that the provision of greater than 60 days sludge storage may become abortive, should we move away from biosolids recycling to agriculture in future AMPs, and because of the uncertainty, it does not represent efficient investment at this time. We have indicated in the WINEP action for AMP9 that additional storage greater than 60 days could be required. We will consider the need as part of our PR29 submission.

4.5.5 In line with the recommendations of the Atkins report, and our latest discussions with the EA, we are proposing covered storage in a cake barn or 'Dutch Barn'. Our cost estimates are not based on provision of fully enclosed and ventilated storage as we consider that this would not be necessary to obtain site permits and would be at a disproportionate cost. There is a risk that in future the EA may insist on fully enclosed and ventilated storage to meet Waste Framework Directive permitting standards.

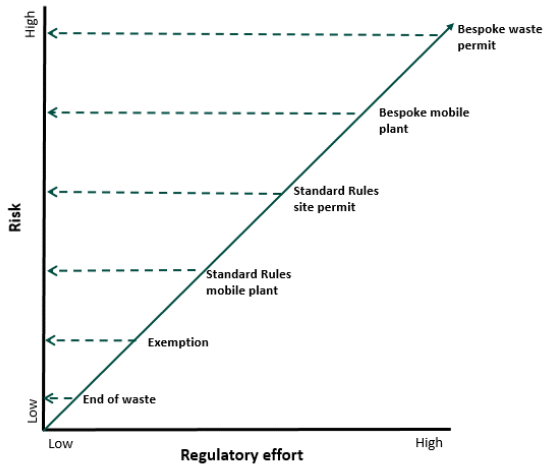
4.6 08UU100135 - Sludge to land compliance under Environmental Permitting Regulations

4.6.1 This WINEP action will ensure that we have the resources to comply with new regulatory requirements in AMP8 for biosolids recycling under EPR.

4.6.2 The EA Sludge Strategy sets out the ambition to revoke SUiAR and regulate biosolids recycling to agriculture under EPR. We expect that the EA Sludge Strategy will be implemented in AMP8. The EA recognise that this regulatory change will generate new investment requirements and the "Storage + assessment" of WINEP actions specifically approved in principle actions to meet future EPR requirements for the agricultural use of sludge.

4.6.3 The EA implements environmental permitting through the EPR framework, which uses a risk-based approach, dependent on the environmental risk of the activity. Regulation ranges from sufficiently low risk activities that can be registered at no cost under a waste exemption, to permitted activities that are required to comply with more exacting environmental standards and incur higher operational charges. A schematic to show these tiers of regulation is presented in Figure 4. It can be seen that the risks from biosolids recycling is now deemed higher than previously, with the proposal to move biosolids recycling to agriculture from an exemption, to standard rules permit.

Figure 4: Tiers of waste regulation that may be applied through the EPR framework



Source: United Utilities, 2023

4.6.4 The exact form of the EA Sludge Strategy is uncertain as it is still being developed, but it is very likely to have a significant impact on the process, logistics and operations associated with the recycling of biosolids to agricultural land.

4.6.5 We expect that recycling biosolids to agriculture under EPR will require:

- Every single sludge application to have a permit to be approved in advance of stockpiling in a field. The EA will assess each permit application against statutory guidance to evaluate the benefits and environmental risks of each and every field, crop type and seasonal timing.
- Compliance with land spreading standard rules permits No.4 and/or No.6 for all biosolids recycling activities[16].

4.6.6 The EPR framework also provides the mechanism for on-going and iterative improvements to sludge recycling by the EA, for example the introduction of new quality constraints such as limits for chemicals including PFAS, microplastics and antimicrobial resistance. The Waste Framework Directive is specifically designed to allow for these continuous updates to standards, and frequent and numerous changes to the EPR framework can be made within the EA's control, rather than requiring primary legislative change.

4.6.7 We propose enhanced opex expenditure to ensure that we have sufficient resources to be compliant with the new regulatory obligations in AMP8. The majority of costs will be incurred through deployment permit fees, as we will no longer be able to register sludge spreading activity free of charge under a waste exemption. Current deployment fees are £1562[17] and we anticipate that we will require 1200 deployments per annum. In addition, there are significant associated administration costs, including additional sampling to provide data on soil quality necessary for the permits, and resources to enable completion of the necessary paperwork and ensure that it is issued to the EA to the right quality and in a timely manner.

4.7 Management control

4.7.1 The investment associated with this enhancement case is required to comply with our statutory obligations under the WINEP sewage sludge drivers. The WINEP actions have been approved by the EA and identified as necessary to ensure compliance with new regulatory requirements in AMP8 and/or provide resilience in the sewage sludge supply chain to agriculture.

4.7.2 Biosolids recycling to agricultural land is aligned with the UK best practicable environmental management approach for sewage sludge. However, an increasing number of factors that are out of company control threaten the resilience of the supply chain of sewage sludge to agricultural land, such as; exceptional weather events preventing access to agricultural land; disease causing farmers to change their cropping plans; or regulatory or market requirements affecting land managers and the supply and demand of sludge to land. These factors make delivery of AMP8 WINEP obligations necessary for ensuring a robust and compliant bioresources service in AMP8.

4.7.3 While acknowledging that adaptations to comply with a more constrained biosolids recycling service in AMP8 result from factors outside of management control, we have taken steps to control costs:

- We will ensure that we deliver investment to meet new obligations, as efficiently as possible. In line with the WINEP methodology, we have considered a full range of options. We considered over 65 unconstrained options and methodically assessed them to ensure that we have developed actions

[16] For more details see, UK Government, *Guidance – Landspreading: how to comply with your permit*, July 2023 [Online] https://www.gov.uk/government/publications/landspreading-how-to-comply-with-your-permit

[17] Environment Agency, *The Environment Agency (Environmental Permitting and Abstraction Licensing) (England) Charging Scheme 2022*, V1.1 [Online] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1098117/Environment_Agency_EPR_and_Abstraction_Licensing_Charging_Scheme_2022.pdf

which represent the lowest cost and best value for customers (see Appendix B for the full range of options considered).

- In AMP7 we have absorbed the costs to be compliant against enhancements to the BAS standard (version 5[18]), going over and above the regulatory minimum to minimise the impact of biosolids recycling on diffuse water quality pollution. ABL is also proposing additional measures to support the EA's implementation of Farming Rules for Water. We are voluntarily working to the draft measures and we do not seek cost recovery of these activities.
- We have taken a leadership role in collaborating with all other WaSCs and the EA, to define the risks and issues that the sewage sludge drivers are addressing. The robust and quantified evidence we have gathered, including landbank modelling and a biosolids storage assessment, ensures that the agreed interventions are necessary, we only do what we need to do, and the value to both business and customers is clear.
- We have developed a regional, integrated package of WINEP actions, optimised through use of our RIAP strategic planning tool. Strategic planning capability is central to our asset strategy over the next 25 years and enables us to understand and optimise the greenhouse gas emissions, capital and operational costs of planned WINEP actions across the entire bioresources system.

4.7.4 No potential cost savings (i.e. spend to save opportunities) are anticipated from these improvements. Improvements in dewatering will generate operational efficiencies by reducing fleet movements around the region through production of a biosolids cake with increased dry solids content. However, more constrained landbank will require us to transport biosolids further than ever before. The enhancement expenditure presented within this case is net of any operational benefits.

4.7.5 All other interventions will not deliver any benefits to sludge quality or efficiencies in the operating process but are in place to ensure we can deliver a compliant and resilient biosolids recycling service in AMP8.

4.8 Need for enhancement expenditure (including implicit allowance)

4.8.1 This case is for £169.965 million enhancement investment over and above base totex. The costs set out within the enhancement case are the capital costs (and consequential ongoing opex) to deliver the actions under the sewage sludge drivers in the WINEP. The WINEP actions will deliver enhanced service levels to ensure a resilient, compliant and sustainable agricultural recycling service, in light of a more constrained and uncertain biosolids recycling environment in AMP8.

4.8.2 The bioresources cost models do not include any cost drivers that consider landbank resilience or more stringent regulation of biosolids recycling. The cost models are based only on the volume of sludge processed and sparsity factors, neither of which is a determining factor of the costs providing a resilient sludge to land service.

4.8.3 Our base cost allowance for sludge disposal is derived from historical costs and is founded the assumptions we present in Table 3.

[18] Assured Biosolids Limited, *The BAS Standard,* Issue number 5, 10 July 2020 [Online] https://assuredbiosolids.co.uk/wp-content/uploads/2020/07/BAS-Standard-Issue-5-10th-July-2020.pdf

Table 3: Base cost assumptions and forecast changes in AMP8

Base assumption	Description	Subject to change in AMP8
National surplus of agricultural landbank	All companies are able to find sufficient agricultural landbank within a reasonable distance of sludge treatment centres: There are limited pockets of competition for landbank between companies.	Yes – several national landbank model scenarios have indicated insufficient landbank available. Multiple factors can drive a reduction in landbank availability and landbank required leading to significant competition for landbank and the need for alternative outlets for biosolids.
Environmental regulations for sludge to agriculture	SUiAR provide an exemption from the Waste Framework Directive. This enables biosolids to be distributed to field stockpiles for storage and subsequent spreading free of charge and without the need for prior regulatory approval. Compliance is assessed by audit of the records retrospectively.	Yes – the EA Sludge Strategy aims to revoke the SUiAR and replace it with EPR. This will require prior regulatory approval through a permitting process for each and every field before biosolids can be distributed to field stockpiles, and payment of permitting fees.
Regulatory Position Statements	The industry has a reliance on the EA issuing Regulatory Position Statements to enable contingency storage on sites during periods of disruption to the supply chain to agriculture.	Yes - The EA expectation is that companies are more robust to in year disruptions to the supply chain to agriculture and the industry will not rely on Regulatory Position Statements.
Biosolids quality control	Controls are based on beneficial properties (e.g. plant available nutrients) and on potentially toxic elements as specified the relevant schedules the Sludge Use in Agriculture Regulations. It also requires conformance with the Safe Sludge Matrix which relates to microbial content.	Yes – additional controls over emerging contaminants such as the presence of non-degradable materials including plastics and microplastics, chemicals such as “forever chemicals”, and anti-microbial resistance have the potential to be introduced through the EPR.
Stable demand for biosolids	Stable and sufficient market demand for biosolids products, underpinned by compliance with the industry best-practice incorporated in the BAS standard.	Yes – acceptability of biosolids fluctuates and is significantly influenced by regulatory changes and market sentiment. One item of note could be adverse publicity of actual or perceived risks associated with biosolids, leading to a significant decrease in farmer acceptance for biosolids product.

Source: United Utilities, 2023

4.8.4 The biosolids recycling environment is changing and these assumptions will no longer hold true for AMP8. Base allowances are sufficient to deliver service standards to operate within the existing biosolids recycling environment. Therefore additional investment to meet enhanced service standards, and against a more constrained landbank outlook, are not reflected in base totex and should be considered as an enhancement allowance.

4.8.5 All companies will incur costs to comply with sewage sludge drivers in the WINEP. However, the agreed actions and level of investment required will vary across the sector depending upon regional variability in landbank availability, company approach to manage landbank risk, and a company’s existing asset base which impacts the landbank required. No costs will have yet been incurred by companies as these are new requirements for AMP8, and therefore no element of these costs will be reflected in base allowances.

Implicit allowance

4.8.6 There is no implicit allowance for this investment in cost models, as this reflects delivery of enhanced service standards to deliver a more resilient biosolids recycling service and comply with more stringent regulations in AMP8.

4.8.7 The scope of works within this enhancement case relates to new assets, not replacement or refurbishment of existing assets. We present in Table 4 a summary of our cost estimating assumptions to demonstrate that there is no implicit allowance for any of the individual scope elements that make up the enhancement case and we have minimised the costs.

Table 4: Estimating assumptions for development of this enhancement case

WINEP Action	Estimating assumptions	Included in enhancement case
08UU100130 Enhanced biosolids quality surveillance	Laboratory analysis costs included for new determinants over and above the regulatory minimum. No associated personnel, sampling or data management costs have been included and these will be absorbed through base expenditure.	Laboratory analysis costs included.
08UU100132 Enhanced dewatering of cake after AD	Cost estimates are for new sludge dewatering capability to treat 531,508m^3 of sludge and deliver a higher dry solids output and an enhanced quality product.	Capital cost for new dewatering technology included
08UU100134 Final product storage	Cost estimates are for new covered cake storage (aka 'Dutch Barn'). We currently have no covered strategic storage and new assets are required. We have excluded costs to provide fully enclosed and ventilated storage. We have excluded opex costs for use of the contingency storage which may lead to double handling of biosolids.	Costs included for Dutch Barn
08UU100135 Sludge to land compliance under Environmental Permitting Regulations	Costs have been included to allow for EA permitting fees, and associated administration fees. Additional costs to increase our landbank finding service will be absorbed through base expenditure. We will absorb costs to deliver IT software upgrades to support delivery of this new EPR process.	Costs included for permit and administration costs only

Source: United Utilities, 2023

Timing of expenditure

4.8.8 The WINEP enhancement expenditure will be delivered by 31 March 2030, to align with the regulatory date set by the EA. However, we seek to deliver compliance as soon as practicable in AMP8, to increase the resilience benefit to our biosolids recycling service to agriculture in AMP8.

4.8.9 Expenditure to ensure compliance with our AMP8 WINEP obligations cannot be accelerated to be delivered in AMP7. The scale of the investment required, £169.965 million, is too great a proportion of botex to be absorbed. Moreover implementation of the schemes such as final product storage are complex and will take significant time to deliver, needing to identify site locations and obtain necessary planning permission and permits, ahead of construction.

4.9 Long Term Delivery Strategy (LTDS) context

4.9.1 We have ensured that our proposed WINEP investment is efficient through alignment with our bioresources LTDS to ensure that proposed investment is considered 'no regrets' under all future plausible scenarios. Further details of our LTDS can be found in document *UUW12 - Long term delivery strategy*. Our approach ensures that environmental outcomes can be delivered and the risk of inefficient investment is minimised.

4.9.2 The bioresources core asset pathway, for Advanced Anaerobic Digestion (AAD) and biosolids recycling to agriculture, is a continuation of our approach for AMP7. It has three key overarching principles:

(a) Centralise sludge treatment into fewer, larger AAD hubs

(b) Increase resilience against sludge supply chain disruption; and,

(c) Phased reduction in reliance on agricultural landbank over the longer-term.

4.9.3 While our core pathway is a continuation of our approach for AMP7, on-going horizon scanning of new and emerging issues, in conjunction with the risk and issue review instigated by the sludge WINEP drivers, has identified the need for an acceleration of this pathway compared to our PR19 position. There is now a clear need to provide a greater level of sludge outlet resilience than planned at PR19. At PR19 the loss of the sludge recycling outlet to land was considered a long-term possibility, but this is now considered a near-term possibility, and a medium-term probability.

4.9.4 Given the uncertainty over the future availability of landbank and potential need for alternative outlets, we have developed an adaptive plan that enables us to navigate through the uncertainty and make significant investment decisions at an appropriate point in time. Recognising the full range of treatment and disposal options available, and aligned to the long-term strategy for bioresources in England[19], we have identified three pathways for biosolids disposal (in additional to our core pathway of biosolids recycling to agriculture):

(i) **AAD and incineration** - Combustion of sewage sludge to remove any requirement for recycling to land. The resulting ash can be recovered in construction or disposal to landfill. The long-term strategy for bioresources in England warns against use of short term, inflexible incineration solutions as an alternative to agricultural outlets as these will not increase the value recovered from bioresources.

(ii) **AAD and advanced thermal technologies** – A group of technologies including pyrolysis and gasification to convert sewage sludge feedstocks using high temperatures into outputs such as chars, oils and syngas. Outputs may be disposed of, used for energy generation or recovered and re-used in wider industrial markets. These are novel technologies not deployed at scale in the UK and there is a need for further work to assess feasibility and (if appropriate) accelerate deployment.

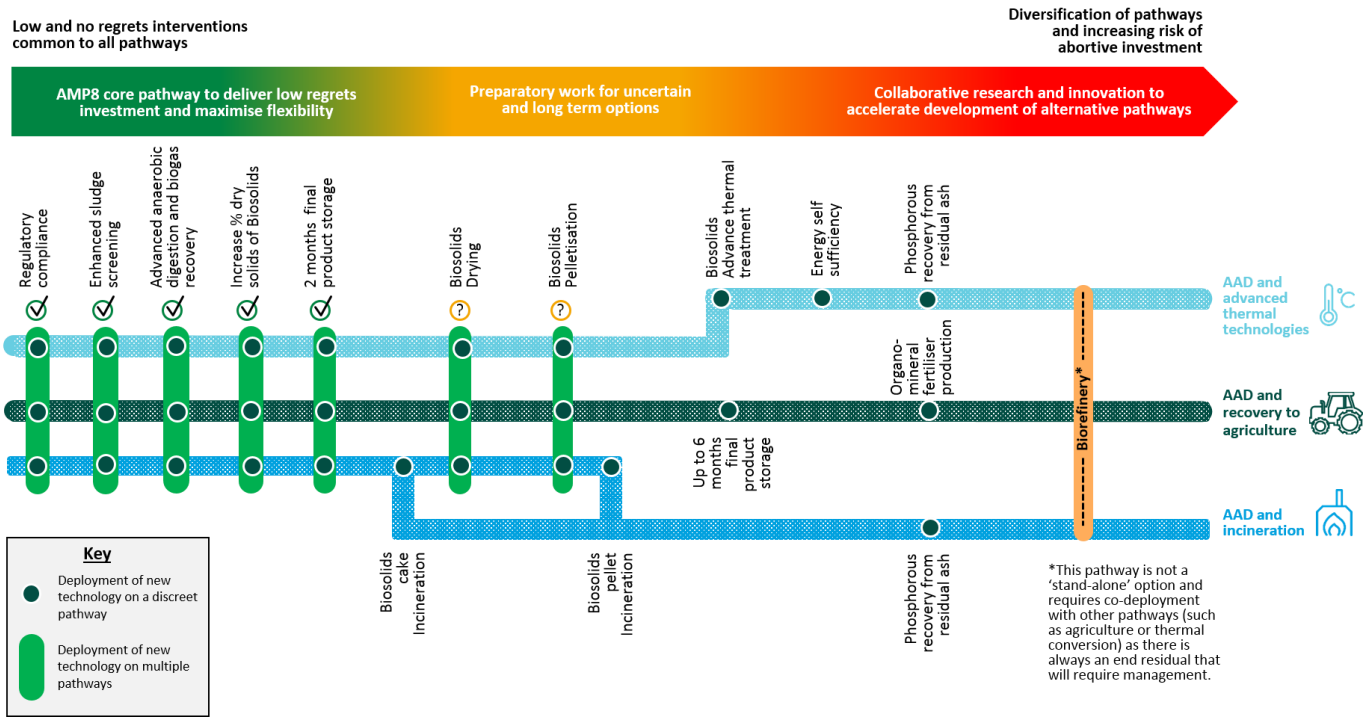
(iii) **Biorefinery** – A resource recovery hub whereby a multitude of products may be recovered from sewage sludge feedstocks. This pathway is not a 'standalone' option and requires co-deployment with other pathways (such as sustaining agriculture or advanced thermal technologies) as there is always an end residual that requires disposal via another route. The pathway is currently limited by technology readiness to deploy and the maturity of markets, specifications, regulations and potentially societal acceptance of outputs / products.

4.9.5 All alternative options for biosolids disposal require large-scale investment of circa £1 billion and will take multiple AMPs to deliver. A move to any of these alternative outlets represents an entire step-change in the bioresources business model.

4.9.6 We present in Figure 5 our proposed WINEP Actions overlaid on our core pathway. This demonstrates that if we switch to an alternative pathway from the core pathway the investment is still considered 'no regrets' in all scenarios. Each pathway is built on a common foundation of AAD, and new asset investment in contingency storage and enhanced dewatering capability remains beneficial under whichever pathway may ultimately deliver in future.

[19] The long-term strategy for bioresources in England was published in 2023. This collaborative piece of work, which UU were instrumental in initiating, provides direction for the English water sector on what the future for bioresources management may look like [Online] https://www.water.org.uk/sites/default/files/2023-09/WaterUK_BioresourceStrategy_FullReport_V2_15.08.23.pdf

Figure 5: Indicative illustration of how WINEP investment aligns with core and alternative pathways



Source: United Utilities, 2023

4.9.7 Moving to an alternative disposal outlet is not considered as part of the core pathway as these actions may be considered as abortive investment in the longer term, as there remains uncertainty over both timescales for change and the preferred alternative outlet for sludge disposal. We have therefore deferred significant investment (up to an additional £1 billion) to implement actions to move away from biosolids recycling to agriculture and have instead focussed on WINEP actions that support the continued beneficial recycling of biosolids.

4.9.8 Aligned with the LTDS, we have optimised the scale of sludge storage required in AMP8, and taken a risk-based approach to deliver 60 days storage, rather than the 90 days recommended by Atkins. This reduces the risk of potentially abortive investment should we move away from biosolids recycling to agriculture.

5. Best option for customers

5.1 Options assessment

5.1.1 Our enhancement case presents the least cost and best value solution for customers to deliver resilience in the sludge supply chain to agriculture.

5.1.2 We have followed the WINEP methodology and undertaken a significant options assessment exercise. We progressively screened and filtered options; from unconstrained, to constrained, to feasible options, to identify the most effective way to deliver a robust and sustainable sludge recycling to agriculture service.

5.1.3 A long list of potential WINEP actions and interventions was generated through a horizon scan using subject matter experts. In Appendix B, we present mapping of the wide range of identified generic control measures that could address the multitude of risks and issues included under the sewage sludge drivers. We identified through this initial unconstrained screening more than 65 potential technologies or interventions that may meet the objectives of the sewage sludge driver guidance. We considered options ranging from monitoring and control, to access to alternative outlets for biosolids disposal.

5.1.4 The following options were identified and discounted at the early stages of the optioneering process:

(1) **Do nothing:** this options was discounted as it would not meet the statutory objectives of the WINEP sewage sludge drivers and would result in environmental non-compliance.

(2) **'Business as Usual' interventions**: Options that could already be considered as 'standard practice' across the industry were discounted as any additional intervention would have marginal impact and not be considered as enhancement expenditure to be included within WINEP actions. For example provision of nutrient planning advice to farmers or optimising logistics operations.

(3) **Technologically immature interventions:** Solutions with Technology Readiness Level (TRL), less than TRL7 (System prototype demonstration in operational environment) were not considered feasible to be delivered within the WINEP timeframe and were therefore discounted.

5.1.5 In line with the WINEP methodology, if unconstrained options were deemed viable then additional screening was carried out to identify 'constrained' options, with further screening taking place to refine the feasible solutions and determine those to be progressed to detailed scope development and estimating. It is at this stage that the options were also assessed for deliverability, to ensure that all actions could be delivered within the WINEP timeframe.

5.1.6 In Table 5 we set out a summary of the feasible options we have considered to meet the needs under the sewage sludge drivers. A detailed engineered design was developed for all feasible solutions identified during this screening process in order to provide comprehensive cost and carbon data. In developing feasible options the impact on wider value and qualitative contribution to WINEP Wider Environmental Outcomes was taken into consideration.

5.1.7 Our preferred solution is a balanced approach that minimises costs as far as possible, while having a high confidence in delivering outcomes in AMP8 and meeting the objectives of the sewage sludge drivers.

Table 5: Options considered to deliver the objectives of the WINEP sewage sludge drivers

Option	Rationale	Capital cost	Whole life carbon (30 year)[20]	Select / reject	Reason
Deliver contingency using biosolids storage in isolation	Deliver full 6 months storage covered storage recommended by Atkins Clearly meets EA sewage sludge driver expectations Provides landbank accessibility benefits during disruption to business as usual.	£321m	76,920 t CO_2^{e-}	Reject	Risk of stranded and inefficient investment in future as we move away from biosolids recycling to agriculture. Storing this much material creates a significant logistical challenge. No benefit to reduce scale and likelihood of disruption. Doesn't deliver compliance with EA Sludge Strategy.
Move to alternative outlets: AAD and incineration	Investment in AAD core pathway to realise value from biogas and solids reduction. Permitting and investment for disposal at sludge treatment sites and upstream sludge thickening operations. Invest to upgrade and restart incineration at our closed incinerator (utilising and extending). Maximise resilience in our bioresources supply chain by seeking alternative incineration outlets and avoid reliance on agricultural outlets.	£980m	-15 t CO_2^{e-}	Reject	Doesn't align with the objectives of the sewage sludge driver guidance to supports actions realise value from sludge and sustainably manage soils. Risk of stranded and inefficient investment in future as the need to move away from Biosolids recycling to agriculture is uncertain. Considered lower value solution as it doesn't align with UK best practicable environmental management approach.
Move to alternative outlets: AAD and advanced thermal technologies	Investment continues in AAD core pathway to realise value from biogas and solids reduction. Permitting and investment for disposal at sludge treatment sites and upstream sludge thickening operations. Digested sludge pelletising and use for fuel for drying and digestion heating process. Maximise resilience in our bioresources supply chain by seeking alternative incineration outlets and avoid reliance on agricultural outlets.	£1,141m	-192 t CO_2^{e-}	Reject	Doesn't align with the objectives of the Sewage Sludge Driver guidance to supports actions realise value from sludge and sustainably manage soils. Risk of stranded and inefficient investment in future as the need to move away from Biosolids recycling to agriculture is uncertain. Considered lower value solution as it doesn't align with UK best practicable environmental management approach. Technologically immature solution. Requires further development and investment to be assured and outcomes and it would therefore require an extended transition period. Enhancement expenditure is sought to commence preparatory works via *UUW66 – Bioresources Enhancement Claims – case 24*
Optimised regional package of interventions including storage	Deliver a regional package of interventions to deliver 60 days sludge storage, deliver enhanced dewatering, additional sludge quality surveillance and compliance with EA Sludge Strategy. Provides landbank accessibility benefits during disruption to business as usual. Reduces likelihood and scale of disruption. Improves biosolids supply and demand balance.	£170m	14,146 t CO_2^{e-}	Select	A balanced approach that minimises costs as far as possible, while having a high confidence in acceptance of the proposals by the EA in meeting the objectives of the WINEP sludge drivers. Considered lowest cost and best value solution in AMP8.

Source: United Utilities, 2023

[20] Whole life carbon for alternative outlets are based on additional value being assigned to green gas and CO_2 capture. Future revenues are dependent on market value and are therefore illustrative.

5.2 Benefit and value appraisal

5.2.1 Our approach to delivering best value is robust and consistent across all of our enhancement cases. Our approach uses a rich mix of metrics to help us drive value and efficiency in developing our business plan. Consistency of the approach is driven through our PR24 Value Tool which allows us to quantify and value environmental and social benefits, costs and risks. For more detail on this approach please see *UUW45 - Our approach to deliver best value totex*.

5.2.2 We have sought to optimise WINEP actions to maximise the wider environmental benefit delivered, while meeting our statutory requirements. As summarised in Table 5, as more than one feasible option was identified, selection of the preferred solution was based on the comparison of value generated between the various options. The option selected has high confidence in delivering WINEP outcomes, at lowest cost and best value. Through our options development process we have sought to minimise the increased greenhouse gas emissions (embedded and operational) of the proposed solutions.

5.2.3 Whilst the benefits against WINEP Wider Environmental Outcomes have not been quantitatively assessed (as the prescribed WINEP methodology is not applicable to Bioresources interventions) we have calculated the greenhouse gas emission impacts and completed a value assessment. We used our bespoke company value assessment tool, to assess benefits and value by intervention type. The benefits were drawn from the MyRisk Risk Breakdown Structure used for company Asset Management practices and the outputs include a cost benefit analysis.

5.2.4 The benefits delivered through this investment are regulatory compliance with our statutory WINEP obligations. These are designed to achieve a high level of protection for the environment, reducing the risk of pollution or environmental harm resulting from disruption to business as usual biosolids recycling activities.

5.2.5 Recycling biosolids to agriculture is an effective, catchment based business model, and ensuring this model can continue for as long as possible will maximise benefits our of sludge recycling operations to the wider environment. Biosolids recycling supports the circular economy and nationally, around 3.5 million tonnes of biosolids are recycled to agricultural land per annum, providing more than £60 million of nutrient replacement value to agriculture[21]. We have therefore prioritised interventions that maintain this circular business model, rather than investing to move away from biosolids recycling to disposal technologies.

5.2.6 We present the benefits of this enhancement case in data table CWW15.

5.2.7 In Figure 6 we present a comparison of storage only options, described by the outcome of the EA assessment process as the minimum action necessary to deliver improved resilience in the sludge supply chain, with our preferred option. We show that our preferred option delivers almost equivalent benefit to 6 months biosolids storage capacity (the long-term maximum recommendation from Atkins' storage assessment). By delivering an integrated package of measures; storage; production of more enhanced biosolids to diversify our available landbank; and by providing additional dewatering to reduce the volume of material that requires storage; we are able to provide greater benefits, at a lower capital, with lower greenhouse gas emissions, and reduced risk of abortive investment by aligning with our LTDS.

[21] Assured Biosolids Limited, *About Biosolids*, 2023 [Online] https://assuredbiosolids.co.uk/about-biosolids/

Figure 6: Comparison of storage only interventions to the preferred integrated package of interventions

Source: United Utilities, 2023

5.3 Delivery of this scheme

5.3.1 The regulatory date to deliver all actions is 31 March 2030. We seek to deliver these requirements as quickly as possible in AMP8 to maximise the resilience benefits.

5.3.2 The following actions are subject to further regulatory approval, and we will not start to invest to deliver these actions until we have certainty in the scope required by the EA to avoid inefficient spend:

- **08UU100134 - Final product storage**: Permitting requirements for biosolids storage are likely to be highly site specific and will require additional surveys and assessments to be undertaken before we progress any permit applications.
- **08UU100135 - Sludge to land compliance under Environmental Permitting Regulations**: The requirements for sludge to land compliance under EPR are not yet confirmed as the EA Sludge Strategy set out four options for implementation. Whichever option is implemented will vary the requirements for biosolids recycling and is subject to parliamentary approval.

5.3.3 We have made an assessment of where use of markets for delivery of WINEP options may deliver greater value. All WINEP actions were considered too integrated with the day to day operation of sites to be able to be delivered through the markets, with the exception of 08UU100134 - Final product storage. We will continue to explore markets as a vehicle for delivery of this action in AMP8.

5.3.4 We do not forecast any third party investment to be secured to support delivery of this scheme as the works are entirely restricted to our asset base.

5.3.5 For completeness and for the avoidance of doubt, this scheme has not been identified to be delivered as Direct Procurement for Customers (DPC), as this is not applicable for projects within the bioresources price control.

5.4 Customer support for investment

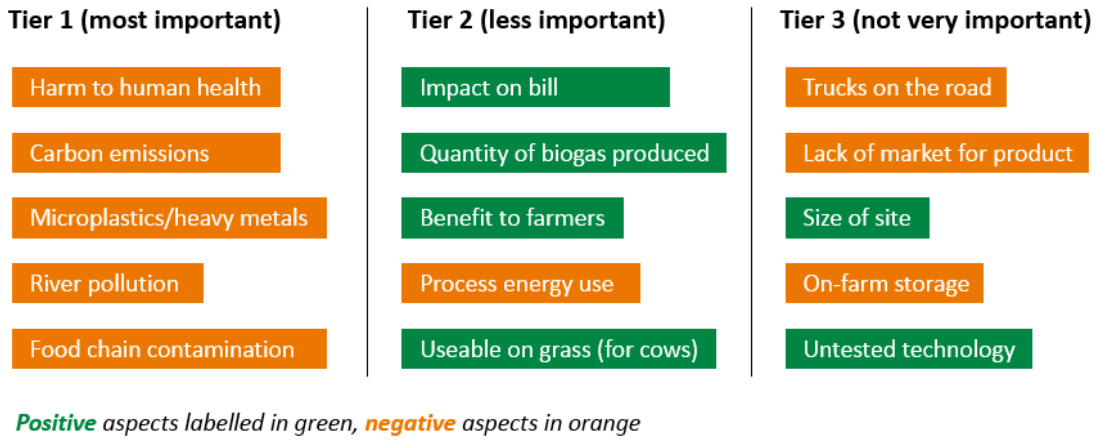
5.4.1 We have sought to develop a better understanding of the WINEP outcomes that will be delivered for customers. While we are meeting customers' expectations by delivering our regulatory obligations as efficiently as possible, it is important that our aspirations are in line with customers' expectations.

5.4.2 Bioresources Pathways Customer Research was undertaken in September 2022, which conducted five, three-hour deliberative workshops with a total of 60 current household customers and 12 'future bill payers', held at various locations across the North West. The research discussed the future pathways open to UU in the context of our bioresources LTDS to understand customers' preferences and priorities in relation to these pathways and to establish which pathway(s) are most acceptable to them.

5.4.3 Prioritisation was based on high-level considerations, for example the importance of reducing greenhouse gas emissions, in comparison to protecting watercourses, rather than specifics of costs and emissions volumes for each pathway. The workshops were designed to ensure customers were able to provide meaningful feedback on each of the pathways, with visual demonstrations and subject matter experts attending to answer any customer questions.

5.4.4 Customers' long-term priorities, as summarised in Figure 7, are for a bioresources service that provides reliable sludge treatment in a way that limits impact on human health, greenhouse gas emissions, and on water quality. For most, these are the non-negotiable responsibility of UU. Tier two priorities are important but just not as important as human health and pollution. Least important are the Tier three priorities as customers are too distant from these for them to be a priority.

Figure 7: Priority outcomes for customers regarding bioresources management



***Positive** aspects labelled in green, **negative** aspects in orange*

Source: DJS Research on behalf of United Utilities, Bioresources pathways customer research, October 2022

5.4.5 There was a clear consensus around not waiting for problems to occur and instead, to plan and invest now in additional capacity and functionality so that if and when problems occur, we are in the best position to deal with those problems. Our agreed WINEP actions will deliver benefits in line with customer priorities and with benefits to:

- Provide contingency storage so that if sludge supply chain disruption does occur we are able to deal with the disruption and minimise the risk of environmental harm.
- Open up access to more landbank to enable optimisation of the timing of biosolids spreading and reduce any associated water quality risks. Creation of a high quality, enhanced biosolids product will reduce microbial contamination.
- Biosolids quality sampling will ensure we better understand risks to human health and the environment and inform future decisions over sludge recycling. As a key customer concern it was vital that this was addressed through our WINEP actions.

5.4.6 Customers also recognised the need for research and development and the requirement to balance short and long-term investment. Following this feedback we have developed our approach to manage significant, but uncertain risks impacting on landbank availability through an in-AMP uncertainty mechanism. It would not align with customers views to move to an alternative pathway now, ahead of certainty in requirements, and before necessary research and development to optimise potential outcomes.

6. Cost efficiency

6.1 Development of efficient cost estimates

6.1.1 Costs for delivering our WINEP obligations have been developed using a fully documented UU optioneering approach, including third party assurance, to ensure that our cost estimates are efficient. We have undertaken a significant programme of engineering design and estimating to derive bottom-up costs for WINEP compliance. We have considered a wide range of actions, and have gathered collaborative, robust and quantitative evidence to ensure that the agreed interventions are necessary, we only do what we need to do, and the value to both business and customers is clear.

6.1.2 In Table 6 we present a summary of our efficient costs by WINEP action. The majority of the costs relate to actions to provide additional covered storage and provide enhanced dewatering capacity at our largest sludge treatment centre. Actions to comply with EPR and additional quality surveillance are opex only interventions.

6.1.3 We have limited the scope of the enhancement case to the WINEP actions where we have certainty in requirements e.g. for storage our cost estimates are based on 'dutch barns' rather than provision of fully enclosed and ventilated storage as we consider that this would not be necessary to obtain site permits and would be at a disproportionate cost.

6.1.4 As we discussed in Table 4 we have minimised the costs passed to customers and are only seeking investment for new assets. For instance, we have included only laboratory analysis costs under Action 08UU100130 (Enhanced biosolids quality surveillance), and will absorb additional costs for personnel, sampling and data management costs through base expenditure.

6.1.5 We have optimised the scale and locations of our planned interventions through use of our strategic planning tool, RIAP. Strategic planning capability is central to our asset strategy over the next 25 years and enables us to understand and optimise the greenhouse gas emissions, capital and operational costs of planned WINEP actions across the entire bioresources system, and have confidence the actions we propose will be efficient over the long term.

6.1.6 Within the options development process, unconstrained options were identified against the Generic High Level Solutions (GHLS) categories, as shown in Figure 8. Use of this hierarchy of interventions ensures that we have considered a full range of options, from monitoring and control to fully new build asset solutions. By considering a fully range of options we can be assured that our interventions are efficient, and we are not delivering new build solutions, where lower cost interventions, further down the hierarchy of interventions may provide best value for money.

Table 6: Summary of proposed enhancement expenditure by WINEP action

WINEP Action ID	Action Name	Rationale	Quantity	Unit	Capex (£m)	Opex (£m)	Totex (£m)
08UU100130 (component a to j)	Enhanced biosolids quality surveillance	A sampling programme of all ten sites that produce biosolids for agricultural outlets. Samples will be taken four times per year, for five years in AMP8.	40	Sampling event per annum	-	0.171	0.171
08UU100132	Enhanced dewatering of cake after AD	We propose to install dewatering capability to achieve an enhanced quality product and greater than 25 per cent dry solids for digested sludge at Manchester Bioresource Centre.	531,508	m3 dewatering capacity delivered	24.773	21.871	46.644
08UU100134	Final product storage	We propose to provide covered contingency storage capacity for treated biosolids	60	days of storage capacity provided	107.199	-	107.199
08UU100135	Sludge to land compliance under Environmental Permitting Regulations	A regional activity to produce and submit permit applications for recycling to agriculture under Environmental Permitting Regulations.	1200	Number of deployments per annum	-	15.950	15.950
Total	-	-	-	-	**131.972**	**37.992**	**169.965**

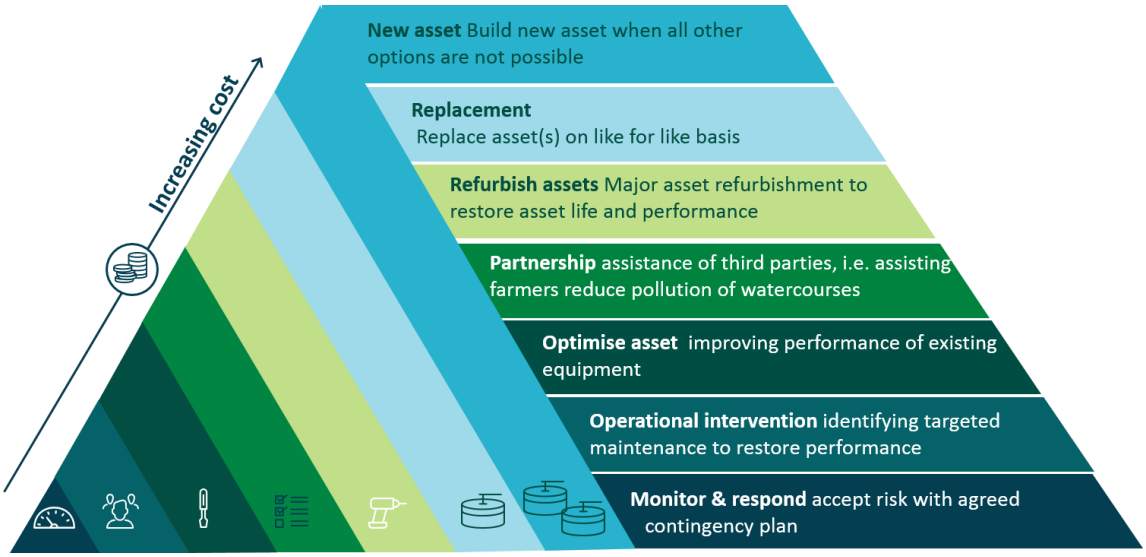
Source: United Utilities, 2023

6.1.7 Our PR24 capital cost estimating approach has been based on data collected over AMP3 to AMP7 and updated to reflect the present market conditions under which we and the UK water industry are operating. Mott Macdonald (MM) has provided us an estimating service over AMP6 and AMP7. They also provide an estimating service to a number of other UK water companies, which allows them to provide a benchmarked approach to our PR24 capital cost estimates.

6.1.8 MM have benchmarked UUW's direct costs and cost curves and assessed the water industry construction inflation based on their Construction Industry Basket of Goods index.

6.1.9 Delivery of this scheme will be across a portfolio of multiple projects, across multiple sites. We have experience of delivering work at all of these sites, and project managing the work to ensure that it is delivered effectively and efficiently, and as such we are confident that we have the technical skills and capabilities to deliver this work. Furthermore, we will drive delivery efficiencies through batching at a programme level or with other ongoing projects at site level.

Figure 8: Hierarchy of Generic High Level Solution (GHLS) categories



Source: United Utilities, 2023

6.2 Cost benchmarking

6.2.1 There are currently no agreed industry benchmarks for the cost of compliance with statutory sewage sludge WINEP obligations as this is a new regulatory requirement. WINEP compliance costs will vary across the sector depending upon regional variability in landbank availability, company assumptions and approach to manage landbank risks, and a company's existing asset base.

6.2.2 At the time of company WINEP submissions (and to this date) there is significant environmental uncertainty around landbank planning assumptions. The potential implications of this environmental uncertainty on the bioresources price control at PR24 and bioresources markets were raised at a meeting attended by DEFRA, EA, Ofwat and Water industry reps on 28 November 2022. An action from that meeting was to collate the WINEP submissions to understand the national impact of proposed company investments. Atkins undertook anonymised assessment of the industry's WINEP proposals (prior to EA assessment) in February 2023[22].

6.2.3 Atkins gathered company information on WINEP submissions, at a programme level to provide insights into the national Bioresources WINEP programme. The assessment indicated that the total proposed industry investment to meet the sewage sludge drivers in AMP8 was £1.783 billion. Variability in expenditure is significant, both between companies and the type of interventions proposed. There were four common themes identified across WINEP submissions:

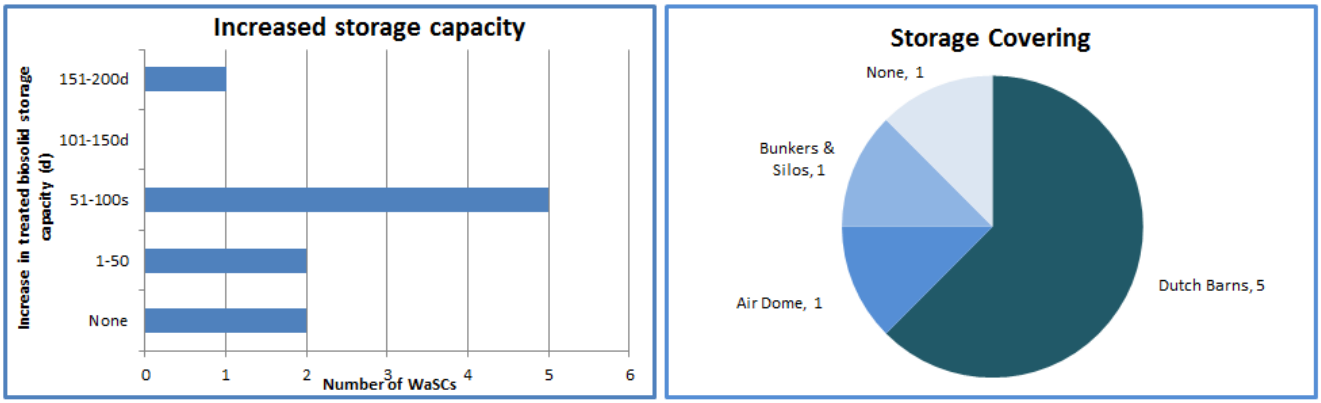
- Increased storage capacity
- Storage covering
- Increased AAD capacity
- Increased incineration capacity

6.2.4 Only actions to increase storage capacity and cover storage have been approved through the EA "Storage+ assessment". A summary of the proposed storage provision between companies is presented in Figure 9. Most company proposals are consistent with our own and provide between 51 and 100 days biosolids storage capacity. Moreover, the predominant type of biosolids storage capacity will be

[22] Atkins findings shared via presentation at Defra / EA / Ofwat / Water Industry Collaborative Bioresource Meeting, 10 February 2023 [Slides 9, 10, 11]

provided via Dutch Barns. The differing scale and technologies deployed will materially impact company compliance costs.

Figure 9: Anonymised proposed biosolids storage WINEP actions

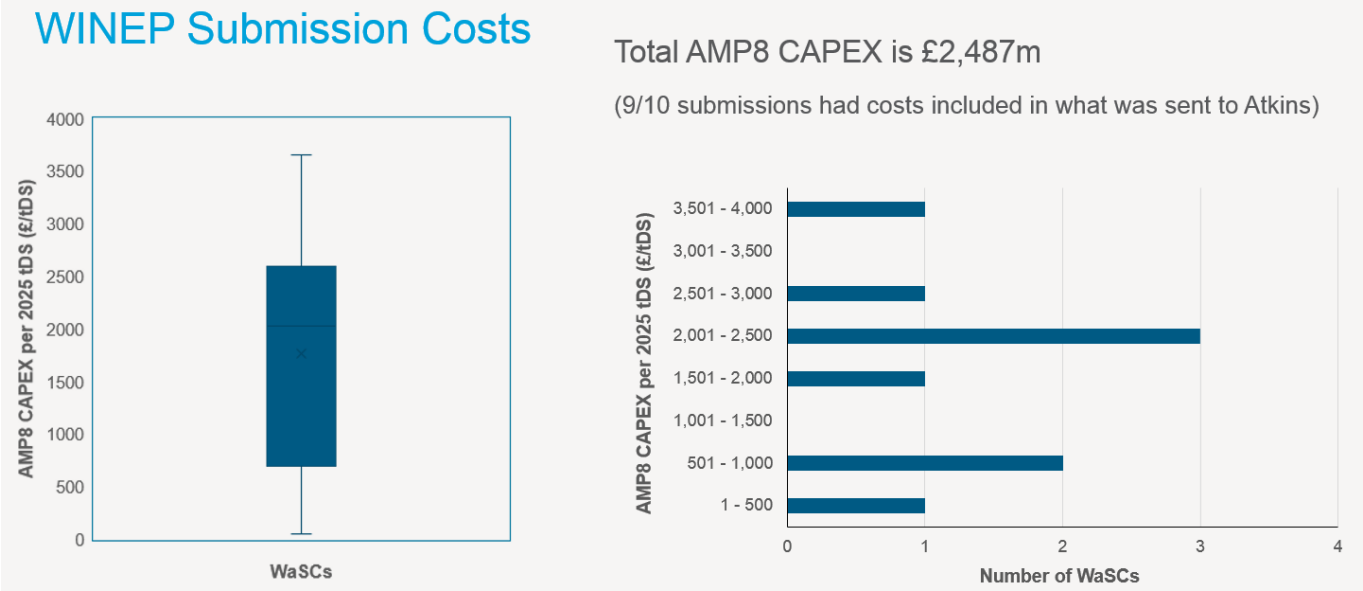


Source: Atkins anonymised assessment of Industry WINEP proposals, February 2023

6.2.5 The average costs of proposed WINEP actions across the industry ranges between less than £500 per tonnes of dry solids to over £3,500 per tonne of dry solids, noting significant company by company variability. Our proposed WINEP actions are at a cost of circa £800 per tonnes of dry solids.

6.2.6 A summary of the total WINEP submission costs by company is presented in Figure 10. It is not possible to directly compare our WINEP submission costs, as we are uncertain of the final approved WINEP scope, nor the assumptions used to build up costs at other companies. However, we note that our cost per tonne of dry solids is below the average presented across the industry.

Figure 10: Anonymised total WINEP submission costs by company



*£2,487million is the total value proposed for AMP8 and AMP9

Source: Atkins anonymised assessment of Industry WINEP proposals, February 2023

6.3 Assurance of this submission

6.3.1 Our WINEP development, including approach, cost estimating and scope development have been independently, technically assured by ARUP to ensure that we only do what we need to do and at the most efficient cost for customers. Relevant extracts from ARUP's assurance report is provided below:

"An efficient programme is proposed to maximise the benefits of the enhanced biosolids produced. The proposal will increase biosolids suitable for grassland. By including a substantial investment in storage, the latest submission has addressed the concerns about in-year events."

"The core pathway is straightforward to deliver, using well understood technology and presents an affordable option… The additional investments in screening, storage and enhanced sampling are in line with our expectations".

7. Customer protection

7.1 Introduction

7.1.1 It is important that customers have confidence that we will deliver the enhancement schemes that get reflected in our PR24 final determinations and they are suitably protected in the event of non-delivery, or if there are material changes to deliverables (including changes to dates), which leads to a change in cost (including changes in the timing of required expenditure). Ofwat proposes that, if companies fail to deliver or are late delivering improvements to customers, then price control deliverables (PCDs) should, where appropriate, be used to compensate customers. In our PR24 *Chapter 8 – Delivering at Efficient Cost, section 8.8.9* we have proposed an approach to PCDs that aims to provide customer protection, such that customers are fairly compensated for non-delivery (such as due to a change in regulatory requirements) or late delivery (including as a result of a change to a regulatory date), between PCDs, any related ODI underperformance payments, and cost sharing arrangements.

7.2 Price Control Deliverable

Table 7: PCD summary

Scheme delivery expectations	
Description of deliverable	Improvement to the resilience of the supply chain to agriculture
Output measurement and reporting	Final product storage will deliver increased resilience of the supply chain to agriculture against in-year disruption. Measuring the outcome in "days of final product storage capacity" enables flexibility and innovation in outcome delivery. We have discounted using a fixed storage volume as an outcome, as it would be inflexible and lead to a sole focus on building storage, whereas alternative interventions could provide greater value. Final product storage is a calculation based on the quantity of sludge despatched to agriculture and quantity of final product storage capacity: 60 days final product storage capacity=(sludge dispatched to agriculture (wet tonnes))/(365 days)*60 Our target is to deliver 60.00 "days of final product storage capacity" (to 2d.p.). We have used our forecast sludge to agriculture at 2030 as a baseline target and this will be reviewed each year. We will report PCD performance to Ofwat as an additional item as part of our Annual Performance Reporting (APR) process. The outcome may be delivered at one or more sites and delivery will be measured on 31 March each year, as demonstrated through either a Project in Use output for UU delivered solutions or third party assurance for market delivered solutions.
Assurance	We will report PCD performance to Ofwat as an additional item as part of our APR process. We will not rely on the standard WINEP outcome reporting approach as the outcome is for the full 60.00 days to be delivered by 31 March 2030, and this will not provide an annual report of delivery progress.
Conditions on scheme	None
Impact on PCs	None

7.2.1 In our PCD template *UUW32-PCD Excel Sheet* we have assumed a wholesale WACC of 3.23%, in line with Ofwat's guidance. We have assumed a 50% totex cost sharing rate, which is applied before calculating PCDs. We have applied a further 50% for Bioresources (where applicable), to ensure that only 25% of Bioresources totex is at risk from PCDs, given the lack of RCV guarantee, and general uncertainty in cost recovery from future Bioresources price controls. For late delivery we have applied a proportionate value of annual opex, and assumed 3.5% of capex, which provides a fair reflection of the time value of money of any related deferred capital spend.

Table 8: PCD delivery profile

	Unit	AMP8	2024	2025	2026	2027	2028	2029	2030	Ultimate delivery
Cumulative delivery target for PCD	**days**		**-**	**-**	**-**	**-**	**19.80**	**39.60**	**60.00**	**60.00**
AMP8 Capex (22/23 pb)	£	107,199,309	-	-	-	35,375,772	35,375,772	36,447,765	-	
AMP8 Opex (22/23 pb)	£	0	-	-	-	-	-	-	-	
ODI impact per unit of PCD volume	£/days	0.00								

Table 9: Price Control Allocation

Price Control	Unit	Price Control Allocation
Water resources	%	0.00%
Water network+	%	0.00%
Wastewater Network+	%	0.00%
Bioresources	%	100.00%

Table 10: PCD Incentive rates

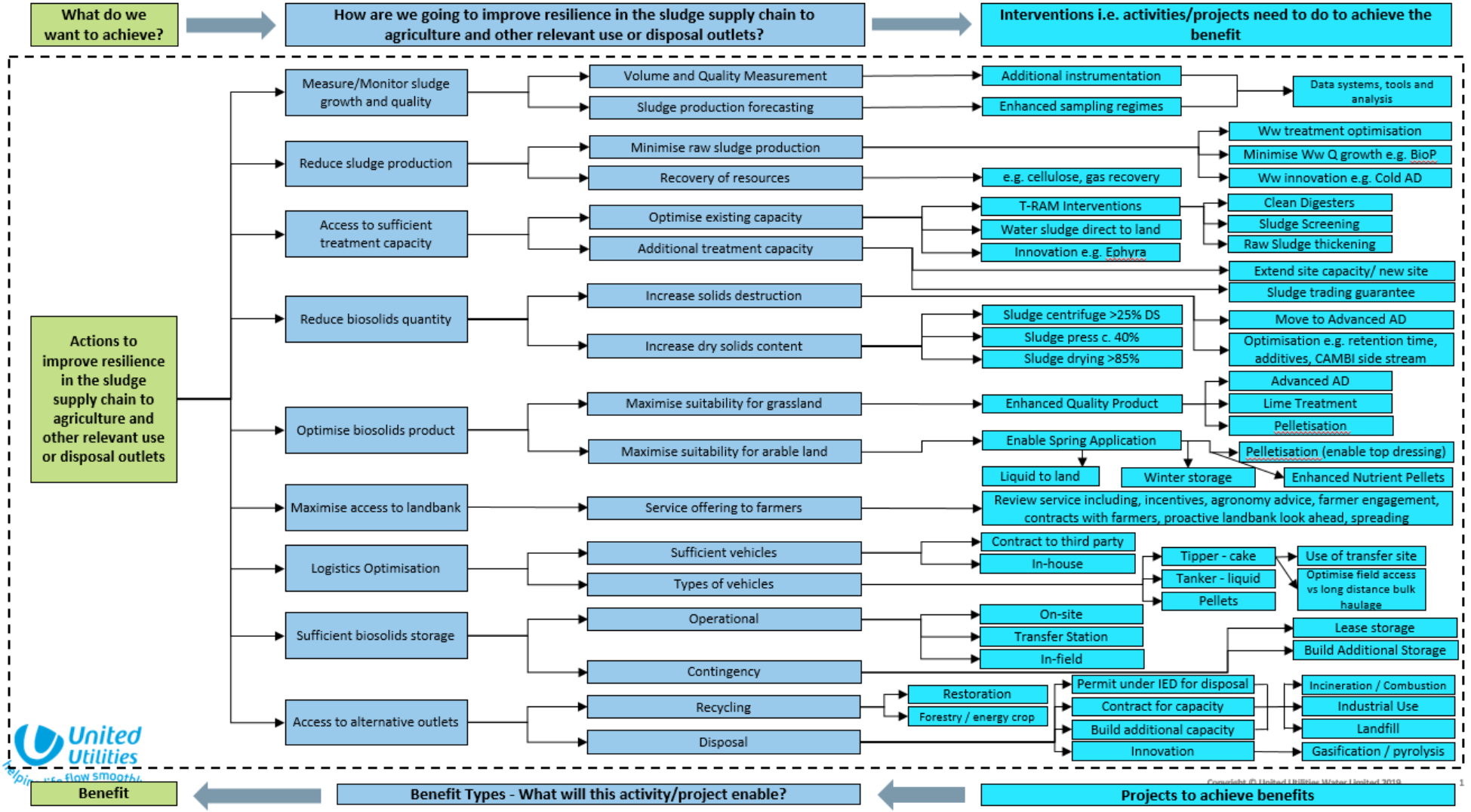
	Unit	WR	WN+	WwN+	BR
Overall delivery	£/days	0	0	0	446,664
Time value rate	£/days	0	0	0	14,427
Late delivery	£/days	0	0	0	30,060

Appendix A WINEP extract: Approved actions under the sewage sludge drivers

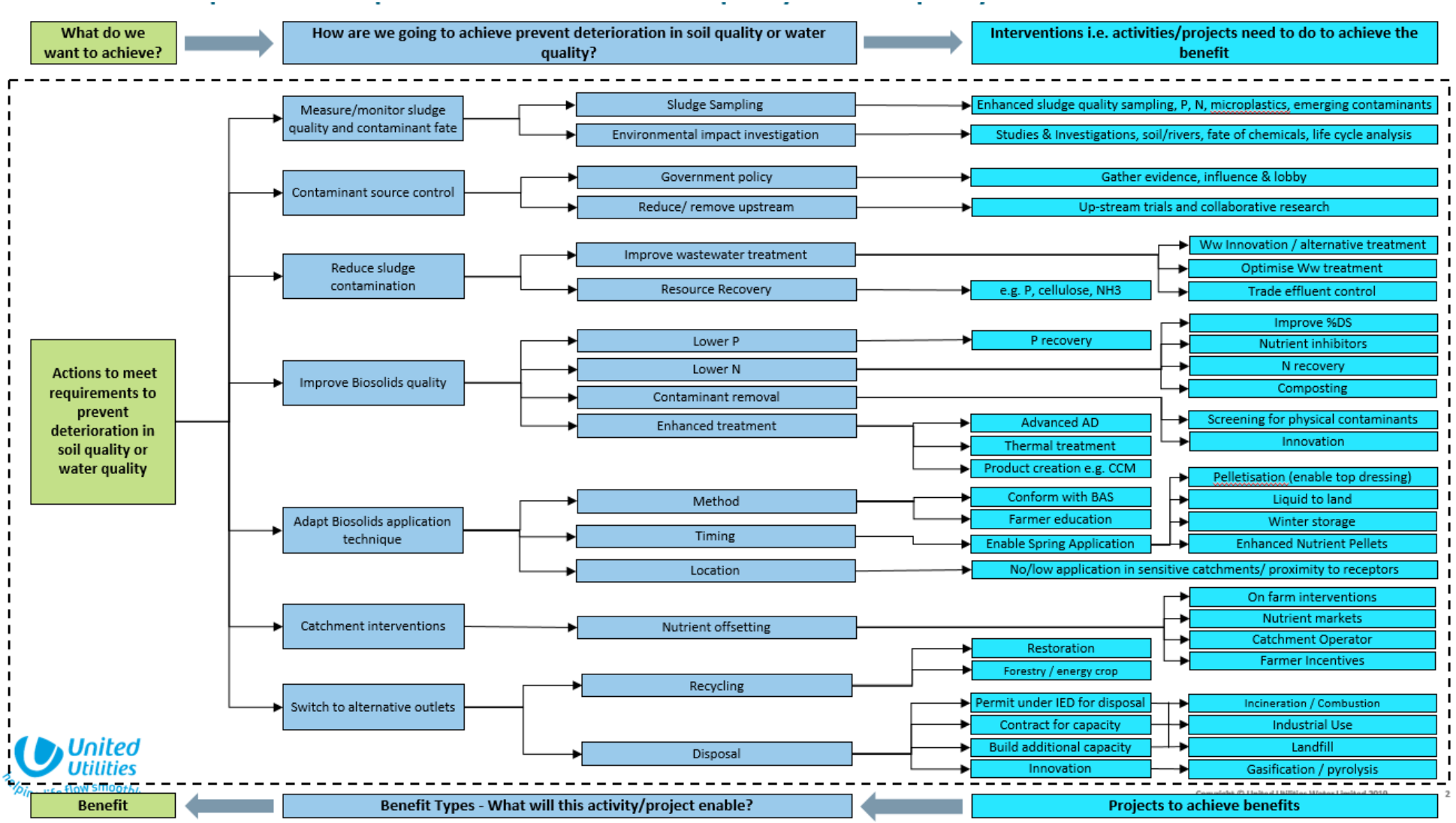
Action_ID	Action_Name	Action_Description	Completion_Date	Option_WC_Ref	Options_Assessment_Outcome
08UU100130	Enhanced biosolids quality surveillance at STOCKPORT WwTW	Proposing enhanced biosolids quality surveillance at STOCKPORT WwTW to manage sewage sludge sustainably	31/03/2030	D00000743	proceed
08UU100130	Enhanced biosolids quality surveillance at SOUTHPORT WwTW	Proposing enhanced biosolids quality surveillance at SOUTHPORT WwTW to manage sewage sludge sustainably	31/03/2030	D00000743	proceed
08UU100130	Enhanced biosolids quality surveillance at BLACKBURN WwTW	Proposing enhanced biosolids quality surveillance at BLACKBURN WwTW to manage sewage sludge sustainably	31/03/2030	D00000743	proceed
08UU100130	Enhanced biosolids quality surveillance at LANCASTER WwTW	Proposing enhanced biosolids quality surveillance at LANCASTER WwTW to manage sewage sludge sustainably	31/03/2030	D00000743	proceed
08UU100130	Enhanced biosolids quality surveillance at BURNLEY WwTW	Proposing enhanced biosolids quality surveillance at BURNLEY WwTW to manage sewage sludge sustainably	31/03/2030	D00000743	proceed
08UU100130	Enhanced biosolids quality surveillance at DAVYHULME WwTW	Proposing enhanced biosolids quality surveillance at DAVYHULME WwTW to manage sewage sludge sustainably	31/03/2030	D00000743	proceed
08UU100130	Enhanced biosolids quality surveillance at LEIGH WwTW	Proposing enhanced biosolids quality surveillance at LEIGH WwTW to manage sewage sludge sustainably	31/03/2030	D00000743	proceed
08UU100130	Enhanced biosolids quality surveillance at ELLESMERE PORT WwTW	Proposing enhanced biosolids quality surveillance at ELLESMERE PORT WwTW to manage sewage sludge sustainably	31/03/2030	D00000743	proceed
08UU100130	Enhanced biosolids quality surveillance at SHELL GREEN	Proposing enhanced biosolids quality surveillance at SHELL GREEN to manage sewage sludge sustainably	31/03/2030	D00000743	proceed
08UU100130	Enhanced biosolids quality surveillance at CARLISLE WwTW	Proposing enhanced biosolids quality surveillance at CARLISLE WwTW to manage sewage sludge sustainably	31/03/2030	D00000743	proceed
08UU100132	Enhanced dewatering of cake after AD	Proposing enhanced dewatering of cake after AD to manage sewage sludge sustainably	31/03/2030	D00000284	proceed
08UU100134	Final Product Storage	Proposing regional final product storage programme to manage sewage sludge sustainably	31/03/2030	D00000098	proceed
08UU100135	Sludge to land compliance under Environmental Permitting Regulations	Proposing sludge to land compliance under Environmental Permitting Regulations to manage sewage sludge sustainably	31/03/2030	D00000278	proceed

Source: Environment Agency, 2023

Appendix B Benefits mapping of generic control measures



Source: United Utilities, 2023



Source: United Utilities, 2023

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United Utilities

Water for the North West

UUW66

Improving resilience in biosolids recycling to agriculture

October 2023

Enhancement Case 23

United Utilities

Water for the North West

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1. Enhancement submission

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An enhancement case to increase the resilience of the agricultural outlet for biosolids, by improving product quality through the enhanced removal of non-degradable contaminants (such as microplastics) and thereby support market acceptance of higher quality products.</td></tr>
<tr><td>Price Control:</td><td>Bioresources</td></tr>
<tr><td>Enhancement headline:</td><td>This document sets out the enhancement case for £54.133 million totex investment to deliver enhanced screening of 100 per cent of UUW sludge. Without action in AMP8 we risk being unable to deliver our statutory obligation to provide a resilient sludge management service. The scope of this enhancement case is considered ‘no regrets’ in AMP8, and activity delivered through the enhancement case will:
• Address increasing public awareness, media attention, and government calls for action around microplastics as an urgent environmental issue;
• Follow the precautionary principle to minimise the risk of environmental harm from our activities;
• Mitigate the risk of a loss of market demand for our biosolids product due to contamination concerns; and,
• Ensure regulatory compliance with Environmental Permitting Regulations (EPR) by seeking to continuously improve quality standards to align with best available techniques.
As we discuss within this document, we have strong customer support to tackle physical contaminants in biosolids and we also have strong technical support from the Environment Agency (EA) to implement additional screening, despite this activity not being considered within scope of the ‘focussed’ assessment of the Water Industry National Environment Programme (WINEP) sewage sludge drivers.</td></tr>
<tr><td>Enhancement expenditure (FY23 prices)</td><td>
<table>
<tr><th></th><th>AMP8 Capex (£m)</th><th>AMP8 Opex (£m)</th><th>AMP8 Totex (£m)</th></tr>
<tr><td>Pre RPE and Frontier Shift</td><td>54.957</td><td>-0.065</td><td>54.893</td></tr>
<tr><td>Post RPE and Frontier Shift</td><td>54.196</td><td>-0.063</td><td>54.133</td></tr>
</table>

The table above shows the total expenditure on both a pre-efficiency (i.e. pre frontier shift and real price effects basis, consistent with the cost data tables), and a post efficiency and RPE basis (i.e. consistent with the value we propose to be recovered from price controls). All numbers referenced hereafter in this enhancement case are on a post efficiency and RPE basis.</td></tr>
<tr><td>This case aligns to :</td><td>Drainage and Wastewater Management Plan (DWMP) 2023.
For full reconciliation between enhancement costs and data table lines, see enhancement mapping tabs in UUW117 – Project allocations CW3 and CWW3.</td></tr>
<tr><td>PCD</td><td>Yes</td></tr>
</table>

2. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	This case covers the enhancement costs associated with delivering enhanced sludge screening to 0.6mm in two dimensions, a ten-fold improvement over current industry practice. In what we believe is a first for the industry, we will implement fine screening for all our sludge and across all our sites, setting a new level of best practice, to minimise as far as possible microplastics and other non-degradable material in biosolids recycled to land.	Section 4
	The additional expenditure requirement arises from enhanced service expectations driven through multiple factors including; increased landbank resilience challenges and the consequential need to ensure market acceptance through production of higher quality products; emerging concerns over the potential harm caused by biosolids recycling from contamination; and a new legal obligation to comply with guidance though the permitting process.	4.2 4.3 4.4
	Delivery of enhanced service standards are new requirements and cost models do not reflect this activity. Ofwat's modelled allowance is insufficient to fulfil our obligations to provide a resilient sludge disposal service against an increasingly uncertain and constrained biosolids recycling model. We have valued the implicit allowance and discounted the net book value of our existing screens to ensure customers will only pay for the incremental enhancement for improved screening capability.	4.5 4.6
	There are two factors which mean that there is no clear route to seek this investment through the price review process and enable us to respond to government calls for action, which has resulted in the need for this standalone enhancement submission: • Narrow focus of sewage sludge WINEP assessment which will not address landbank availability or landbank quality issues. • The water industry has no route to seek to recover efficient costs for meeting guidance standards and evolving best available technique standards under the Waste Framework Directive once the EA Sludge Strategy is implemented in AMP8. • The EA is clear that there is value in undertaking this activity. As it is deemed by them to not be in scope of the sludge driver, it is appropriate to seek this investment as an enhancement outside the WINEP process to improve the resilience of our biosolids to agriculture operating model.	3.4 3.3
Best option for customers	• We have considered a range of options including 'do nothing'. We are presenting the lowest cost and best value option on behalf of customers. • Through the WINEP process a detailed unconstrained to constrained options assessment has been completed to identify the most effective way of delivering a resilient sludge recycling to agriculture service. We considered options ranging from monitoring and control, to access to alternative outlets for biosolids disposal. • We have ensured that our proposed investment is efficient through alignment with our bioresources Long-term Delivery Strategy (LTDS) to ensure that proposed investment is considered 'no regrets' under all future plausible scenarios. This approach ensures environmental outcomes can be	Section 5 4.7

	delivered and the risk of inefficient investment is minimised. We have deferred significant investment (up to an additional £1 billion) and focussed on actions that support the continued beneficial recycling of biosolids, rather than seeking to implement actions to move away from biosolids recycling to agriculture. • We have strong customer support to tackle microplastics and have established customer's willingness to pay to tackle biosolids contamination issues.	5.4
Cost efficiency	• Our capital cost estimates are based on data collected over AMP3 to AMP7 and updated to reflect the present market. Mott Macdonald provides our estimating service, and also to a number of other water companies, which allows them to provide a benchmarked approach to our PR24 capital cost estimates. • We have provided clear estimating assumptions and a breakdown of the enhancement scope. We have identified and quantified secondary maintenance benefits to the sludge digestion process and have discounted £7.116 million of maintenance benefits in AMP8 to keep costs low. • Our development approach, cost estimating and scope development have been independently assured by ARUP to ensure that we only do what we need to do and at the most efficient cost.	Section 6 Table 7 Figure 5 6.3
Customer protection	• The EA will ensure that the environment is protected in this area on behalf of customers through the common industry Environmental Performance Assessment (EPA) metric for satisfactory sludge use/disposal. This investment contributes directly to the delivery of the same environmental outcomes. • Customer investment will be protected via a bespoke Price Control Deliverable (PCD) aligned with delivery of fine screening of our sludge • In our wider Business Plan submission we promote management of significant regulatory risks impacting on landbank availability through an uncertainty mechanism (Notified item).	Section 7

3. Introduction

3.1 Document purpose

3.1.1 There are increasing threats to biosolids recycling, outside of management control, which must be addressed to ensure that we can continue to provide a sustainable sludge management service. This document sets out the scope for £54.133 million enhancement investment to increase the resilience of the agricultural outlet for biosolids, by improving product quality through the enhanced removal of non-degradable contaminants (such as microplastics) and thereby support market acceptance of higher quality products. In what we believe is a first for the industry, we propose to implement fine screening for all our sludge across our region, to minimise as far as possible microplastics and other foreign material in biosolids recycled to agricultural land.

3.1.2 Without action in AMP8 we risk being unable to deliver our statutory obligation to provide a resilient sludge management service. The scope of this enhancement case is considered 'no regrets' in AMP8, and activity delivered through the enhancement case will:

- Address increasing public awareness, media attention, and government calls for action around microplastics as an urgent environmental issue;
- Follow the precautionary principle to minimise the risk of environmental harm from our activities;
- Mitigate the risk of a loss of market demand for our biosolids product due to contamination concerns; and,
- Ensure regulatory compliance with Environmental Permitting Regulations (EPR) by seeking to continuously improve quality standards to align with best available techniques.

3.1.3 As we discuss within this document, we have strong technical support from the Environment Agency (EA) to implement additional screening at our sludge treatment centres, despite this activity not being considered within scope of the 'focussed' assessment of the Water Industry National Environment Programme (WINEP) sewage sludge drivers. We are submitting this action as a standalone enhancement case through our PR24 business plan submission, as this activity is considered essential for the continuing resilience of biosolids recycling to agricultural land and is now considered outside the WINEP.

3.1.4 The actions set out within the scope of this enhancement case are complementary to two separate enhancement cases which form part of our PR24 submission:

- **WINEP sewage sludge drivers** [**UUW66**]: A £169.965 million enhancement case to enable delivery of the statutory requirements identified in the WINEP under the sewage sludge drivers. These actions seek to improve landbank resilience against in-year disruption.
- **Bioresources preparatory works for alternative outlets [UUW66]**: A £10.394 million enhancement case to deliver preparatory works for uncertain and long term options for alternative biosolids disposal outlets. This action starts to look at activities required to move away from our core pathway of biosolids recycling to agriculture.

3.1.5 Other aspects that are not addressed by the WINEP includes the evolving and more stringent regulation of sewage sludge treatment which is leading to increasing environmental protection requirements across our sludge treatment sites. These requirements are not discussed further in this document, but in our separate cost adjustment claim:

(i) **Industrial Emissions Directive compliance at anaerobic digestion sites.** UUW_CAC_004: This is an industry-wide adjustment (as it impacts on all companies) with a claim value for United Utilities Water of £172.594 million. This claim is specific to regulatory changes at our (biological) sludge digestion sites.

3.1.6 In addition, we seek to manage significant, but uncertain risks impacting on landbank availability through an in-AMP uncertainty mechanism, should landbank availability decline and exceed trigger points within our Long-Term Delivery Strategy (LTDS).

3.2 Structure of this document

3.2.1 We have divided our enhancement case into the following sections:

(a) The remainder of this section provides background on the evolving regulation of biosolids recycling and uncertainty over the future of the agricultural outlet, and how this is leading to the need for this enhancement case. It also sets out the context of the WINEP sludge drivers and the exclusion of landbank availability risks from the WINEP assessment.

(b) **Section 4** provides an overview of the increasing pressures on landbank availability, presenting the outputs of quantitative landbank modelling. We provide evidence of the need to address biosolids contamination concerns and why improving standards will become a regulatory obligation in AMP8.

(c) **Section 5** sets out our approach to optioneering to demonstrate that we have considered a range of options, including 'do nothing'. Our enhancement case presents the least cost and best value solution for customers to manage risks.

(d) **Section 6** provides evidence that our costs to deliver our enhancement scope are efficient. Our cost estimating and scope development have been independently assured by ARUP to ensure that we only do what we need to do and at the most efficient cost.

(e) Finally, in **Section 7** we explain how customers are protected if the investment outcomes are not delivered.

3.3 Regulation of biosolids recycling to agriculture

Background

3.3.1 We are responsible for the transport, treatment and disposal of over 200,000 tonnes per year of sludge in the North West of England. Sludge is predominantly treated using Anaerobic Digestion (AD), and the resulting biosolids are recycled to agricultural land.

3.3.2 Currently, biosolids recycled to land benefit from an exemption from the EU Waste Framework Directive by virtue of the recovery of biosolids to agricultural land being controlled under the Sewage Sludge Directive as implemented through the Sludge (Use in Agriculture) Regulations (SUiAR) 1989. The EA intend to remove this exemption and for biosolids recycled to land to be regulated under the Waste Framework Directive.

3.3.3 The EA policy paper "Strategy for safe and sustainable sludge use" (hereafter "EA Sludge Strategy") notified the industry of the ambition to revoke SUiAR and regulate biosolids recycling within the Environmental Permitting Regulations (EPR) framework, thereby requiring permits for biosolids recycling to land. We expect that the EA Sludge Strategy will be implemented in AMP8. The EA recognise that this regulatory change will generate new investment requirements. The "Storage + assessment" of WINEP actions specifically approved in principle actions to meet future EPR requirements for the agricultural use of sludge[1].

3.3.4 A principle for the development of the EA Sludge Strategy is to increase the level of control over biosolids recycling, with the EA stating:

[1] Environment Agency Information Letter (EA/12/2023), *Water Industry National Environment Programme - Sludge (Use in Agriculture) update*, 19 May 2023

"Modern sludge practices may harm the environment. To maintain industry and consumer confidence, we need to demonstrate that any new hazards are controlled"[2].

3.3.5 It is inherent that greater control will introduce new requirements on biosolids recycling, which cannot be considered a like for like regulatory change that does not introduce new statutory obligations.

3.3.6 The exact form of the EA Sludge Strategy is uncertain as it is still being developed, but it is very likely to have a significant impact on the process, logistics and operations of our biosolids recycling service. Presented in Table 1 is a comparison of the regulatory requirements for biosolids recycling to agriculture under SUiAR and EPR.

Table 1: Comparison of regulatory requirements between current and expected AMP8 regulatory framework

Controls under SUiAR (current regulation)	Controls under EPR (AMP8 regulatory model)
Exempt from EU Waste Framework Directive. The recovery of biosolids to agricultural land is controlled under the Sewage Sludge Directive as implemented through the Sludge (Use in Agriculture) Regulations (SUiAR) 1989.	Within scope of EU Waste Framework Directive. The recovery of biosolids is regulated under the Environmental Permitting Regulations (EPR).
Applications are made in accordance with the regulations and records are kept, which are inspected during a sludge registry inspection (typically annually). No fees are paid.	Each, individual biosolids application (or deployment – typically 1 per farm) will require a permit. We have assumed permits will be in the form of 'standard rules' permit, SR 2010 No.6 – mobile plant for land-spreading of sewage sludge. Permit fees are £1,562 per deployment[3].
Notification of stockpiling is made to the EA via an S3 exemption. No prior notification is required for spreading (only annual records inspection as above), increasing the flexibility of application to adapt to inclement weather or changes in farmer demand.	Permits are to be approved in advance of stockpiling in a field. Permit applications will be assessed by the EA to ensure compliance with statutory guidance, and to evaluate the benefits and environmental risks of each field, crop type and seasonal timing. Advanced notice has limited flexibility and the process cannot accommodate last minute changes due to inclement weather or changes in farmer demand.
Compliance with, Defra, Sewage Sludge in Agriculture: Code of Practice and Safe Sludge Matrix is not legally enforceable. Guidance is use to inform operator judgement over best practice.	Compliance with, Defra, Sewage Sludge in Agriculture: Code of Practice and Safe Sludge Matrix is legally enforceable as guidance is expected to be met through the permit approval process.
Compliance with the Biosolids Assurance Scheme (BAS) is a voluntary code of practice and not a statutory obligation.	Compliance with the Biosolids Assurance Scheme (BAS) has the potential to become a statutory obligation. It may form the basis for a regulatory earned recognition scheme, although the exact form of the EA Sludge Strategy is yet to be determined.
Updates to legislation require primary legislative change and parliamentary approval.	The Waste Framework Directive is specifically designed to allow for continuous updates to standards, and frequent and numerous changes to the EPR framework can be made within the EA's control, rather than requiring primary legislative change. Guidance can be updated on websites frequently and without formal consultation. This introduces a mechanism for the EA to demonstrate hazards are controlled, as set out in the principles of the EA Sludge Strategy e.g. introduction of new quality constraints such as limits for chemicals including poly- and perfluoroalkyl substances (PFAS), microplastics and antimicrobial resistance.

[2] UK Government, *Environment Agency strategy for safe and sustainable sludge use*, 15 July 2020 https://www.gov.uk/government/publications/environment-agency-strategy-for-safe-and-sustainable-sludge-use/environment-agency-strategy-for-safe-and-sustainable-sludge-use#why-change-is-needed [Section 6 Principles of the strategy].

[3] Environment Agency, *The Environment Agency (Environmental Permitting and Abstraction Licensing) (England) Charging Scheme 2022*, V1.1 [Online] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1098117/Environment_Agency_EPR_and_Abstraction_Licensing_Charging_Scheme_2022.pdf

Controls under SUiAR (current regulation)	Controls under EPR (AMP8 regulatory model)
Prevents co-treatment of waste (as this would no longer be classified as sludge and cannot be recycled under SUiAR).	Removes barriers to co-treatment of waste as this can be accommodated within the EPR regulatory framework.

United Utilities, 2023

3.3.7 Through our WINEP action, 08UU100135 (Sludge to land compliance under Environmental Permitting Regulations) we have identified the need for enhancement investment to comply with regulations as activities are moved under EPR when the EA Sludge Strategy is implemented. The costs are £15.950 million in AMP8 and are included within the following enhancement case:

- **WINEP sewage sludge drivers** [UUW66] An enhancement case to enable delivery of the statutory requirements identified in the Water Industry National Environment Programme under the sewage sludge drivers and targeted at delivering resilience in the sludge management supply chain to agriculture.

3.3.8 Enhancement costs are limited to permit fees and associated administration costs, and do not include costs of compliance with any new statutory obligations that may result from any additional controls the EA impose on biosolids recycling. Therefore costs do not double count with any costs included in scope of this enhancement case.

How the Waste Framework works differently

3.3.9 Environmental regulation of bioresources is undergoing a significant change as the sector is moved under the Waste Framework Directive. As well as implementation of the EA Sludge Strategy, since confirmation in 2019, sludge treatment centres are also regulated under the Waste Framework Directive. This is leading to significant investment needs to comply with Industrial Emissions Directive Installation permits and associated Appropriate Measures guidance.

3.3.10 We have submitted a cost adjustment claim to reflect the more onerous waste treatment standards under the Waste Framework Directive:

- **Industrial Emissions Directive compliance at anaerobic digestion sites**. This is an industry-wide adjustment (as it impacts on all companies) with a claim value for United Utilities Water (UUW) of £172.594 million. This claim is specific to regulatory changes at our (biological) sludge digestion sites.

3.3.11 An implication of regulation under the Waste Framework Directive, is that the bioresources price control operates under unique water industry circumstances. Significant environmental investment needs can arise, but these needs are not being recognised in the WINEP, and nor do they originate through primary legislative change, but through updated guidance.

As we explain in Table 1, integral to complying with EPR is an expectation to comply with the guidance that underpins EPR. Compliance with the Defra Sewage Sludge in Agriculture: Code of Practice[4] will become a legal requirement through the EPR permitting process in AMP8. The EA will be able to withhold the issue of any permits if they do not deem the permits to fully comply with the Code of Practice.

3.3.12 Under the guidance it includes requirements such as:

"As a producer, you must also remove as much non-degradable material (such as plastics) as possible, before it is spread."

3.3.13 Importantly, it is implicit that such standards, phrased "as much as possible" will continue to evolve, as improvements in best available technique are developed, driven by changes in technology and

[4] UK Government, *Guidance Sewage sludge in agriculture: code of practice for England, Wales and Northern Ireland*, 23/05/2018 [Online] https://www.gov.uk/government/publications/sewage-sludge-in-agriculture-code-of-practice/sewage-sludge-in-agriculture-code-of-practice-for-england-wales-and-northern-ireland

tightening of standards. Therefore, compliance with guidance will continue to attract periodic investment needs. The Waste Framework Directive is specifically designed to allow for these continuous updates to standards, and frequent and numerous changes to the EPR framework can be made within the EA's control, rather than requiring primary legislative change.

3.3.14 The EA can make changes to government websites and guidance without the need for public consultation. This can lead to new or tighter standards being implemented with a quick turnaround and these types of changes cannot always be predicted or accounted for in water company planning cycles. This can leave the operator with limited time to respond and it poses challenges in terms of the practicality and recovering efficient resources for delivery. Moreover, within the Waste Framework Directive, there is no 'hands-off period', unlike for wastewater discharge permits that prevent further guidance or permit changes for four years following a change. There is a possibility that investment decisions could be out of date before they are delivered, creating an additional level of investment risk.

3.3.15 Guidance documents under the Waste Framework Directive, although termed 'guidance', become legally enforceable through incorporation of the guidance requirements during the waste permitting process. While guidance itself is not law and does not operate to override legal duties or obligations, government advice and guidance, may in practice, have the "force of law" as the standards are incorporated in Environmental Permit conditions and associated compliance with those.

3.4 WINEP sewage sludge drivers

Background

3.4.1 Biosolids recycling to agriculture is entirely dependent on access to third party landbank and acceptance of our products by farmers and land managers. The reliance on agricultural land as an outlet makes this area of the business vulnerable to changing market demands. An increasing number of factors that are outside of company control threaten the resilience of the supply chain of sewage sludge to agricultural land, such as; exceptional weather events preventing access to agricultural land; disease causing farmers to change their cropping plans; or regulatory or market requirements affecting land managers and the supply and demand of sludge to land.

3.4.2 In AMP7 we have seen multiple shocks and disruptions to the biosolids market and the EA has issued three Regulatory Position Statements impacting the sludge supply chain to agriculture. Responding to these in-year resilience issues the EA has developed two new sewage sludge drivers for AMP8. The driver guidance states that:

"A lack of access to alternative outlets or treatment technologies for sludge or ability to store sewage sludge temporarily in a compliant manner during times when agricultural land is not available demonstrates that contingency measures and long-term planning for sludge management require investment"[5].

3.4.3 We have taken a leadership role to develop an approach, collaborating with all other WaSCs and the EA, to provide further granularity over the risks and issues that the WINEP drivers are addressing, along with clarification over the scale and the timeframe they will impact. The approach has resulted in the development of a risk and issue evidence log of over 50 different risks and issues that could be considered under this driver. The risks and issues can be summarised as improvements contributing to at least one of the following three aspects:

- **Landbank accessibility:** Resilience against in-year access issues such as agricultural epidemics
- **Landbank availability:** Improvements to increase flexibility or timing of when biosolids may be applied and future alternative outlets in the event there is insufficient landbank for recycling to agriculture

[5] Environment Agency, *PR24 WINEP driver guidance – Sewage Sludge,* V0.3 Issued by email January 2022

- **Landbank quality:** Improvement to biosolids quality to reduce potential risk of harm to soil or water from nutrients, chemicals and microplastics in recycled biosolids.

3.4.4 The WINEP development phase resulted in our proposal of six WINEP actions under the sewage sludge drivers in November 2022. These were proposed as an integrated package of interventions to meet the objectives of the driver guidance. The scope of this enhancement case was submitted as one of our submitted WINEP actions:

- 08UU100131, Enhanced sludge screening

Environment Agency assessment of WINEP proposals

3.4.5 The EA assessed all proposed actions to ensure that they met the objectives of the sewage sludge drivers.

3.4.6 The assessment resulted in a minority of the industry's actions being approved under the sewage sludge drivers. The EA wrote to all WASCs on 22 March 2023[6] to justify the draft outcomes of the options assessment for the sewage sludge drivers. The EA described that the wider remit of the sewage sludge driver guidance, to address landbank accessibility, landbank availability and landbank quality issues, was set aside in favour of a "focussed approach". The EA stated:

"We have given an emphasis on effective storage in the sustainable supply and use of sewage sludge. This is seen as the minimum action necessary to deliver improved resilience in the sludge supply chain to agriculture and other relevant use or disposal outlets".

3.4.7 Subsequent discussion and follow-up meetings with all WASCs led to the EA issuing a revised, "Storage+ assessment", in a second draft release of the WINEP. This assessment broadened the scope of actions approved under the sewage sludge drivers as follows:

"It includes both storage and other actions which deliver environmental improvements of sludge quality and handling prior to storage and before supply to agriculture, such as enhanced dewatering and pelletisation. The assessment also supports in principle the options associated with future EPR requirements for the agricultural use of sludge"[7].

3.4.8 The outcome of the "Storage+ assessment" was finalised with the WINEP publication on 3 July 2023.

3.4.9 We present in Figure 1, a summary of the final EA assessment outcome, and how this aligns with the broader objectives set out within the sewage sludge driver guidance to address landbank accessibility, landbank availability and landbank quality. It can be seen that landbank availability and landbank quality issues are not being fully addressed through the approved actions under the sewage sludge drivers.

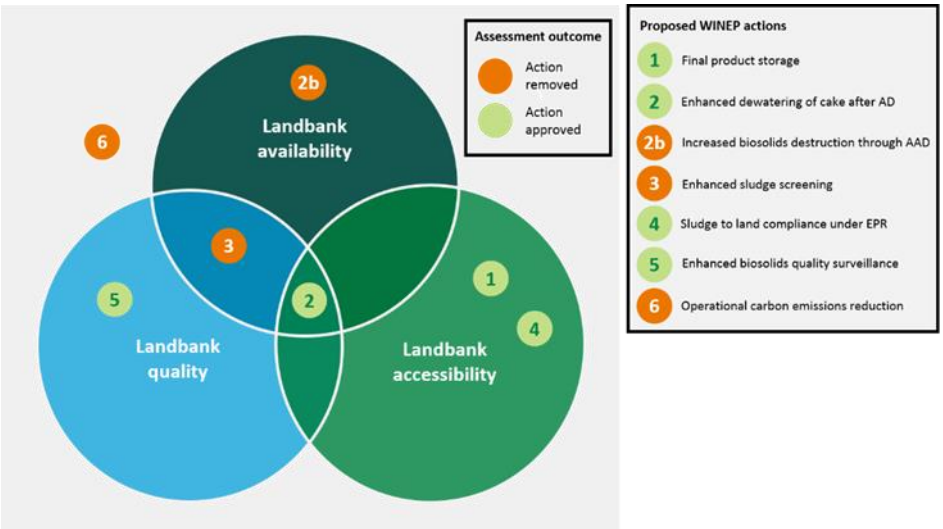
3.4.10 The scope of this enhancement case (WINEP Action 3 on Figure 1) to provide enhanced sludge screening was rejected as it addressed landbank quality issues, that were now considered out of scope of the WINEP drivers under the 'focussed' assessment. The exclusion of the risk and the rejection of the proposed action from the WINEP process does not mean that the investment needs are spurious. Rather, it reflects that these investment actions were not eligible under the WINEP assessment criteria established by regulators.

3.4.11 This enhancement case is fully aligned with the sewage sludge no deterioration driver which is described as "actions to meet requirements to prevent deterioration to soil and water quality".

[6] Environment Agency Information Letter (EA/09/2023), *Water Industry National Environment Programme - Sludge update*, 22 March 2023

[7] Environment Agency Information Letter (EA/12/2023), *Water Industry National Environment Programme - Sludge (Use in Agriculture) update*, 19 May 2023

Figure 1: Summary of approved actions within the WINEP under the sewage sludge driver against the objectives set out within the sewage sludge driver guidance.



Source: United Utilities, 2023

3.4.12 Investment to meet approved actions under the WINEP sewage sludge driver is not discussed in the remainder of this document, but in:

- **WINEP sewage sludge drivers** [UUW66] An enhancement case to enable delivery of the statutory requirements identified in the Water Industry National Environment Programme under the sewage sludge drivers and targeted at delivering resilience in the sludge management supply chain to agriculture.

Challenging the WINEP assessment outcome

3.4.13 We formally challenged the rejection of proposed action 08UU100131, Enhanced sludge screening on 16 June 2023. We raised four key areas of challenge:

- Enhanced screening will be a statutory obligation in AMP8, following implementation of the EA Sludge Strategy, requiring compliance with agricultural codes of practice as a legal obligation (conveyed through permits).
- The assessment outcome is not consistent with the wider objectives of the sewage sludge driver guidance and does not allow actions to address government landbank resilience and quality objectives.
- The conclusion that only a regulatory change can lead to approval of WINEP actions is inconsistent with the wider WINEP. Inherently best available technology requirements will continuously evolve and continue to attract new investment needs.
- The assumption that any intervention within a sludge treatment works to change the quality or nature of biosolids is inherently "optimisation of the anaerobic digestion process" and outside of the WINEP. The scheme has unreasonably been disallowed because it provides operational, as well as environmental benefits.

3.4.14 In response to our challenge to the removal of the Enhanced Sludge Screening action the EA wrote to us to explain their decision on 30 June 2023[8]. We have summarised the EA response to each of our challenges in Table 2.

[8] Environment Agency letter *UU Challenge Form_Bioresources-screening-30June2023-EA-letter*

Table 2: Summary of UU challenge of Enhanced Sludge Screening exclusion from the WINEP

Points raised in UU challenge	EA response to the challenge	Reasons this should be recognised as a standalone enhancement need
Enhanced screening is a statutory obligation in AMP8: Under land-spreading guidance, that informs the issue of EPR permits, it is a requirement that: "As a producer, you must also remove as much non-degradable material (such as plastics) as possible, before it is spread." We have an obligation to adopt latest technology, now that is it available, to ensure that we fully comply with the guidance.	Managing the quality of sludge so it is suitable for use in agriculture is an existing and long-standing regulatory obligation. Therefore, the expectation is that the activity of Enhanced Sludge Screening to manage plastic contamination in sludge is not a new requirement for United Utilities.	This decision failed to recognise that while the guidance is pre-existing, statutory compliance through permitting is not, and will only be the case once the EA Sludge Strategy is implemented. There is no stated limit set in regulation, or best practice, for the removal of non-degradable material, neither is there confirmation that current levels of contamination can be tolerated and retained on an ongoing basis. This decision failed to recognise that the technology advancement to remove ever finer non-degradable material particulates from sludge and biosolids must involve periodic investment to meet increasing expectations, and remove 'as much as possible'.
The assessment outcome is not consistent with the objectives of the sewage sludge driver guidance: The use of a "focussed approach" to assess WINEP actions fails to allow actions that deliver on the full breadth of the objectives of the sewage sludge driver guidance to tackle landbank quality and government objectives set out in the 2022 Environmental Audit Committee Report and 25 Year Environment Plan.	This action has been removed from the WINEP as it does not meet the sludge driver objective to create suitably robust contingency measures that deliver improvements in the resilience of the sludge (biosolids) management chain. Action to remove plastic and other non-biodegradable contaminants from a biological treatment process is a business normal operation. It helps maximise the efficiency of the treatment asset because; inclusion of non-biodegradable contaminants in an anaerobic digestion process reduces the effective capacity for treatment of the biodegradable component of sludge, leads to increased wear and tear on the treatment asset (such as the pumps), and creates greater maintenance and downtime costs (such as during desludging/ degriting of the digesters). It is accepted there will be a reduction in plastic in the final biosolids, which is an outcome of an investment for optimisation of the anaerobic digestion process.	The EA did not respond over our concerns raised to meet the objectives over the Government 25 Year Environment Plan to Manage Soils Sustainably, or the call for action from the Environmental Audit Committee report to address microplastic contamination. We therefore assume that the EA does not dismiss that these government directives are drivers for action. The decision failed to consider resilience measures beyond contingency in the event of disruption. We consider that it is equally appropriate to reduce the likelihood of disruption in the supply chain. Removing physical contaminants as far as possible represents an effective action to minimise the risk of a fall in demand for biosolids due to either actual or perceived quality concerns. We fundamentally disagree this action is a business normal operation. We have proposed a step change in technology for the industry in response to concerns from external parties (including the EA). We do not dispute that there will be operational benefits from the interventions. These were clearly identified through our cost build-up and our proposed costs are net of any operational benefit, making costs more efficient. We cannot agree that because a scheme will deliver multiple benefits for the environment, compliance, resilience and operational performance it should be excluded from the WINEP, as this is contrary to customer interests.

Points raised in UU challenge	EA response to the challenge	Reasons this should be recognised as a standalone enhancement need
The assessment of the sewage sludge actions is not consistent with the wider WINEP programme: The assessment approach indicates that only a regulatory change can lead to approval of WINEP actions. This assessment approach is inconsistent with the assessment of the wider WINEP programme. By way of comparison, the Urban Waste Water Treatment (England and Wales) Regulations were enacted in 1994, and yet have led to enhancement requirements being recognised in the WINEP over the course of many subsequent AMPs.	A movement of regulatory sludge controls from the SUiAR to EPR does not place a new requirement to screen sludge on the WaSCs. Equally, guidance to remove as much non-degradable material (such as plastics) as possible from sludge is not new and it has been in place since implementation of the SUiAR in 1989. The value gained by screening raw sludge in advance of its treatment is recognised. However and for reasons given above, this investment is not seen as appropriate for inclusion in the WINEP under the sludge driver.	We appreciate that the EA recognise the value of the proposed scheme. However, this decision failed to recognise that while the guidance is pre-existing, statutory compliance through permitting is not, and will only be the case once the EA Sludge Strategy is implemented. As this action is deemed to be outside the WINEP there must be a way to ensure that water companies are efficiently funded to meet their statutory obligations and improve the resilience of our operations.
Assessment criteria: The proposed Action will deliver new assets and provide an additional process stage to deliver a new standard of removal of non-degradable material, and a step change in biosolids quality. The assumption that any intervention within a sludge treatment works to change the quality or nature of biosolids is inherently optimisation of existing assets and a 'business as usual' activity is not sound nor reasonable.	We technically recognise a value obtained in sludge quality through Enhanced Sludge Screening. However, and with its relevance to treatment optimisation, it is not in scope of the sludge driver.	The EA is clear that there is value in undertaking this activity and as it is deemed by them to not be in scope of the sludge driver, it is appropriate to seek this investment as an enhancement outside the WINEP process to improve the resilience of our biosolids to agriculture operating model.

Source: United Utilities, 2023

3.4.15 While not overturning their decision, the value of the scheme was recognised by the EA. They supported the action stating that:

"The value gained by screening raw sludge in advance of its treatment is recognised. However and for reasons given above, this investment is not seen as appropriate for inclusion in the WINEP under the sludge driver."

3.4.16 We are disappointed that, although agreeing with the value the action will deliver, it is not considered as within scope of the WINEP driver.

Actions excluded from the WINEP sewage sludge drivers

3.4.17 The focussed approach of the WINEP sewage sludge driver assessment means that significant landbank quality and availability risks and drivers will not be addressed by the AMP8 WINEP. The sewage sludge driver actions are based on the continued reliance of recycling of biosolids to land and there being sufficient available landbank.

3.4.18 To provide an example of the risks not covered by the sewage sludge WINEP drivers, we note that Ofwat's final methodology specifically calls out compliance with Farming Rules for Water as one of the risks to be managed through the WINEP sludge drivers. The methodology states:

"Farming rules for water: PR24 WINEP sewage sludge driver aims at delivering improvements in the resilience of the sludge management chain. This process provides a framework for addressing risks related to the use or disposal of sewerage sludge over the 2025 to 2030 period"[9].

3.4.19 We are keen to highlight that while this may have been the intention at the time the methodology was written, the subsequent "focussed assessment" by the EA of items to approve for inclusion in the WINEP has meant that investment in several drivers (including Farming Rules for Water) are considered by regulators to be out of scope. We have therefore submitted this standalone enhancement case as there must be recognition of these legitimate enhancement costs, to drive improvements in landbank resilience and landbank quality through another route, outside of the WINEP.

3.4.20 In addition, we seek to manage significant, but uncertain risks impacting on landbank availability through an in-AMP uncertainty mechanism (Notified item), should landbank availability decline and exceed trigger points within our Long-Term Delivery Strategy (LTDS).

3.5 Summary of the need for enhancement investment

3.5.1 As set out above, there are significant and increasing risks to our biosolids recycling service, making it clear that we must increase the level of resilience of our operations. Resilience risks are compounded by proposed significant changes to the regulation of biosolids recycling to agricultural land that will lead to new and additional obligations on our biosolids recycling service in AMP8 and beyond. It is clear that we must invest to meet these overlapping needs. Enhanced sludge screening will provide multi-faceted benefits to efficiently and proportionately address multiple resilience and regulatory drivers. These drivers and the need for investment are set out in more detail in section 4.

3.5.2 However, there are two factors which mean that there is no clear route to seek investment through the price review process, which has resulted in the need for this standalone enhancement submission:

- **Narrow focus of WINEP approvals not meeting the full remit of the WINEP driver guidance**: "Focussed assessment" of actions to approve for inclusion in the WINEP has meant that investment in activities to increase landbank resilience (beyond in-year accessibility issues) or address landbank quality issues have been excluded from the WINEP assessment. There is no route to support actions to meet wider company obligations to increase landbank resilience or deliver government requirements set out in the Environment Act or Environmental Audit Committee recommendations.

[9] Ofwat, *Creating tomorrow, together: Our final methodology for PR24, Appendix 4: Bioresources control*, December 2022 [Online, page 13] https://www.ofwat.gov.uk/wp-content/uploads/2022/07/Appendix-4-Bioresources-control.pdf

- **Misalignment of regulatory frameworks**: Compliance with Sewage Sludge in Agriculture: Code of Practice, will become a legal requirement through the implementation of the EA Sludge Strategy to move the recycling of sludge to agriculture under EPR in AMP8. As this guidance already exists, it is not viewed the by EA as a 'new' requirement, although it becomes a new legal obligation on the industry with implementation of the EA sludge strategy. Moreover, through regulation via the Waste Framework Directive, guidance standards phrased 'as much as possible' will continue to evolve, as improvements in best available technique are developed, driven by changes in technology and tightening of standards, and therefore compliance with guidance will continue to attract periodic investment needs. The water industry has no route to seek to recover efficient costs for meeting guidance standards and evolving best available technique standards under the Waste Framework Directive.

3.5.3 This enhancement case is valid because:

- The additional expenditure requirement arises from enhanced service expectations driven through multiple factors including; increased landbank resilience challenges and the consequential need to ensure market acceptance through production of higher quality products; emerging concerns over the potential harm caused by biosolids recycling from sludge contamination; and a new legal obligation to comply with guidance though the permitting process. These drivers are outside of our control.
- Delivery of enhanced service standards are new requirements and cost models do not reflect this activity. Ofwat's modelled allowance is insufficient to fulfil our obligations to provide a resilient sludge disposal service against an increasingly uncertain and constrained biosolids to agriculture recycling model.

3.6 Scope of this enhancement case

3.6.1 The scope of this enhancement case is for an additional £54.133 million above base totex in AMP8 to deliver an enhanced fine screening process stage for 100 per cent of our sludge.

3.6.2 In Table 3 we present a summary of the AMP8 enhancement cost. A build-up of the costs by site and scope item is presented in section 6 (Cost efficiency).

Table 3: Summary of the AMP8 enhancement cost

Proportion of sludge screened	Totex (£ million)					
	FY26	FY27	FY28	FY29	FY30	AMP8
100%	17.885	17.878	18.413	-0.021	-0.021	54.133[10]

Source: United Utilities, 2023

3.6.3 This action will result in significant benefits:

- Removal of microplastics and other foreign matter at very small particulate size. New technology has the potential to screen down to circa 0.6 millimetres and potentially lower (in two dimensions). A step change from current industry best practice for wastewater inlet screening and sludge screening, where the existing aperture size is typically six millimetres (in two dimensions).
- Avoiding over 23,000 tonnes of non-degradable material (including microplastics) from being distributed to agricultural soil in biosolids per year, minimising the risk of environmental harm from our activities.

[10] The totex presented in Table 3 and CWW003 is exclusive of business rates. The full cost build up is presented in Table 7. Exclusive of business rates the data indicates a small operational efficiency, however, once increases in business rates costs are included it results in a small increase in on-going operational expenditure.

- The ability to promote the higher quality biosolids product to the agriculture sector to secure demand from farmers and sustain the agricultural outlet for biosolids, to enable the continued recycling of biosolids to agriculture, where and when it is beneficial.
- Asset performance improvement for assets downstream of the fine screening process. We explain in Section 4.6 how we have discounted maintenance benefits from this investment to ensure that the cost is efficient for customers.

3.6.4 The action aligns with the actions and objectives set out within our Drainage and Wastewater Management Plan (DWMP) 2023, to maximise the value created through recovery and re-use of sewage sludge and increase the resilience of our sludge to land operations.

4. Need for enhancement investment

4.1 Introduction

4.1.1 There are significant and increasing risks to our biosolids recycling service, making it clear that we must increase the level of resilience of our operations. Resilience risks are compounded by proposed significant changes to the regulation of biosolids recycling to agricultural land that will lead to new and additional obligations on our biosolids recycling service in AMP8 and beyond. It is clear that we must invest to meet these overlapping needs, and enhanced sludge screening to circa 0.6 millimetres in two dimensions will address these multiple drivers.

4.1.2 As we explain in this section, we have summarised the multiple and overlapping needs for investment in three areas:

(i) Minimising the risk of environmental harm from biosolids recycling

(ii) Improving our landbank resilience

(iii) Ensuring compliance with our statutory obligations

4.1.3 The proposed scope to deliver enhanced sludge screening aligns with the actions and objectives set out within our Drainage and Wastewater Management Plan (DWMP) 2023[11], to maximise the value created through recovery and re-use of sewage sludge and increase the resilience of our sludge to land operations.

4.2 Minimising the risk of environmental harm from biosolids recycling

4.2.1 The recycling of biosolids to land is recognised as being the best practicable environmental option in most circumstances by the European Union and UK Government (ABL, 2019). Biosolids applied to land are a valuable source of nitrogen and phosphorus, as well as other plant nutrients and organic matter, which can provide long-term benefits to soil structure and fertility. While biosolids recycling is carefully controlled through the Biosolids Assurance Scheme (BAS) to ensure risks are managed through best practice activities, it is becoming increasingly apparent that there are significant, emerging challenges from novel contaminants.

4.2.2 Levels of contamination in biosolids are poorly understood, although there is evidence of the presence of other contaminants in biosolids, beyond the range of the current regulatory analysis suite. Through previous iterations of the water industry Chemical Investigations Programme (CIP), the potential has been recognised for the removal of substances from wastewater to partition substances into sludge and end up in biosolids applied to land. As ever more stringent wastewater treatment standards are applied, and for a growing range of determinants, there is an increasing need to understand this risk.

4.2.3 One significant, emotive and high-profile risk is associated with microplastics[12] in biosolids, and there is a growing body of evidence about the presence of microplastics in biosolids. For example, a study by researchers at Cardiff University found that up to 650 million microplastic particles, measuring between 1mm and 5mm, entered one wastewater treatment plant in South Wales, every day[13]. All of these particles ended up in the sewage sludge, making up roughly one per cent of the total weight, rather than being released with the clean water. The industry CIP has found Wastewater treatment works have a high degree of effectiveness at removing microplastics from the influent both by number (average 99 per cent) and by mass (average 99.5 per cent). However, due to the effective capture in sewage sludge,

[11] United utilities Drainage and Wastewater Management Plan (DWMP) 2023, https://www.unitedutilities.com/corporate/about-us/our-future-plans/Our-long-term-plans/dwmp-publication-may-2023/

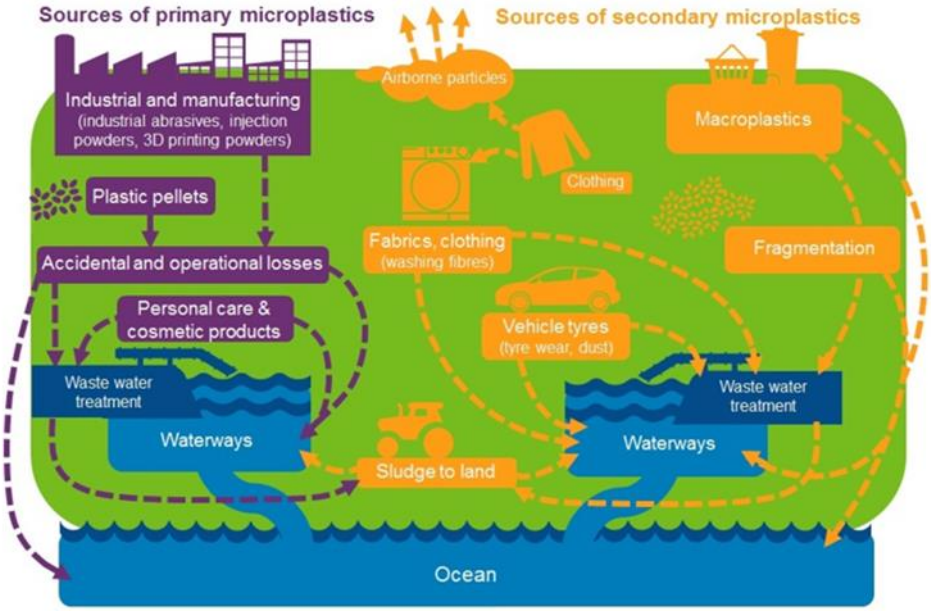
[12] While a universal standard definition of microplastics is not yet in use, they are typically described as “any synthetic or polymeric solid particles, with a regular or irregular shape, and with dimensions between 1 µm and 5 mm, of primary or secondary manufacturing origin, insoluble in water” From UKWIR CIP3, Volume 2 report

[13] Microplastics removal from a primary settler tank in a wastewater treatment plant and estimations of contamination onto European agricultural land via sewage sludge recycling. *https://www.sciencedirect.com/science/article/pii/S0269749122004122*

the export of microplastics via biosolids recycled to agriculture could be in the region of 2.25 trillion microplastic particles per day[14].

4.2.4 We present in Figure 2, an infographic highlighting the potential role that spreading biosolids to agriculture has as a pathway for microplastics in the environment. This risk is recognised by the industry, government, environmental NGOs and the EA.

Figure 2: Sources and transport of plastics in the environment



Source: Environment Agency, Plastics: challenges for the water environment, October 2021

4.2.5 The Materials to Land Phase 2 report[15] commissioned by the EA, identifies that perhaps the biggest risk to landbank is from the spreading and incorporation of physical contaminants, including microplastics, into agricultural soils. The risk, it explains, is that these will build up over repeated applications until the land becomes unsuitable for agriculture.

4.2.6 Soil health is a key government priority and, as referenced in the objectives of the WINEP sewage sludge drivers, the government has set targets through the 25 Year Environment Plan to use resources from nature more sustainably and efficiently and enable soil to be managed sustainably by 2030[16]. The bioresources business model is dependent on sustainable soil management and it is vital that we play our part to ensure that soils are managed sustainably and we continue to support the agricultural economy.

4.2.7 There are multiple direct calls for action by the water industry from the government, NGOs and the EA.

4.2.8 The paper, Water quality in rivers: Government Response to the Committee's Fourth Report of Session 2021–22, makes clear recommendations with regard to biosolids and microplastics:

"We recommend that the water industry work urgently with the Environment Agency and the farming sector to assess and mitigate the clear risk of microplastic pollution from this practice, and to develop a comprehensive plan for the separation of microplastics from biosolids at wastewater treatment works"[17].

[14] UKWIR, 2022, 22/EQ/01/23 - The National Chemical Investigations Programme 2020-2022, Volume 2, Investigations into the fate and behaviour of microplastics within wastewater treatment works. Prepared by UK Centre for Ecology & Hydrology.

[15] AECOM, *Materials to Land Phase 2 Technical Report*, Project reference, 60505110, 13 November 2017, prepared for the Environment Agency

[16] UK Government, *A Green Future: Our 25 Year Plan to Improve the Environment*, 2018 [Online] https://www.gov.uk/government/publications/25-year-environment-plan

[17] House of Commons Environmental Audit Committee, *Water quality in rivers Fourth Report of Session 2021-22*, 5 January 2022 [Online] https://committees.parliament.uk/publications/8460/documents/88412/default/

4.2.9 The Marine Conservation Society published a comprehensive report titled, Sewage sludge: Why we need to stop pollution at source[18]. It calls for action to be taken by the Government, regulators, businesses, individuals and water companies to address pollution issues. Water companies are asked to produce a road map on how to reduce levels of contaminants for the whole wastewater treatment process, from source control of incoming pollutants, to sludge treatment and reuse. Pertinent to this enhancement case is the call for:

"Applying Best Available Techniques to all treatment processes to reduce contaminant levels."

4.2.10 Business in the Community published a report in June 2023 titled, Optimising Bioresources: Reducing Water Pollution[19]. While highlighting the threat that microplastics, and other chemicals pose to the beneficial recycling of biosolids, water companies are specifically called to have:

"Effective wastewater treatment that enables recovery of problematic particles and other substances."

4.2.11 The need for action to reduce contaminants in wastes used in soil is a consistent and repeated theme throughout the EA written evidence to the EFRA soil inquiry[20]. The evidence specifically identified sewage sludge as a material where the EA highlighted the need for action, stating:

"These materials and wastes may be spread for their nutrient value, soil conditioning and organic matter benefits. However, many can contain harmful chemicals and pathogens (including antimicrobial resistance) and undesirable physical contaminants (including plastics). The EA wants to see better upstream controls and interventions, so limiting and removing contaminants at source as an action that can effectively tackle soil stresses created by soil contamination.[21]"

4.2.12 The increasing recognition of the potential risk of harm caused by biosolids recycling to agriculture, and the associated clamour for action to be taken by the water industry, has gone so far as to call for a temporary ban on biosolids recycling to agriculture. The Sustainable Soil Association submitted written evidence to the EFRA soil inquiry about prohibiting sewage sludge from being spread to soil stating:

"We recognise that such a measure [prohibiting sewage sludge from being spread to soil] will place a financial burden on water companies and should be balanced against the important role sludge has in our agricultural system, however an interim ban on the spreading of sewage sludge to soil until contamination levels fall should be considered."

4.2.13 The scope of this enhancement case, to deliver enhanced sludge screening, and to prevent approximately 23,000 tonnes a year of non-degradable material being spread to agricultural land is in direct response to these concerns and calls for action. We aim to align with the recommendations of government, EA and NGOs to take urgent action in significantly improving the quality of biosolids through delivery of an enhanced separation phase at our sludge treatment centres.

4.2.14 Technology has evolved to enable us to make this change. New technology has the potential to screen down to c. 0.6mm and potentially lower (in two dimensions). This is a step change from current industry practice for wastewater inlet screening and sludge screening, where the aperture size is 6mm in two dimensions. The non-degradable fraction will instead be disposed of safely and with greater environmental control (in this case to landfill) and not cause an environmental threat to productive agricultural soils.

4.2.15 Although at present there is limited direct evidence of the harm caused by non-degradable material from biosolids in the environment, it is our duty to act, ahead of evidence, and to follow a precautionary principle approach to minimise the risk of environmental harm from our activities. Indeed, the UK

[18] Marine Conservation Society, *Sewage sludge: Why we need to stop pollution at sources*, June 21 [Online] https://media.mcsuk.org/documents/MCS_sewage_sludge_paper_june_2021_final.pdf

[19] Business in the Community, *Optimising Bioresources: Reducing Water Pollution*, June 2023 [Online] https://www.bitc.org.uk/report/optimising-bioresources-reducing-water-pollution/

[20] This inquiry analysed the Government's role in preventing further soil degradation and restoring soils across England (2023)

[21] Written Evidence submitted by The Environment Agency (SH0044) to the EFRA soil inquiry

Government sets out in its 2023 Environmental principles policy statement[22] that the precautionary principle is one of the five principles in setting out the Environment Act. It states that where there are threats of serious or irreversible environmental damage, a lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

4.2.16 In line with the principles of the Environment Act, the proposal for enhanced sludge screening, is a cost-effective intervention with demonstrable benefits that will support the continued recycling of biosolids to agriculture. Further evidence over the potential harm would be required to make more costly interventions and seek alternative outlets for biosolids disposal, based on contamination concerns.

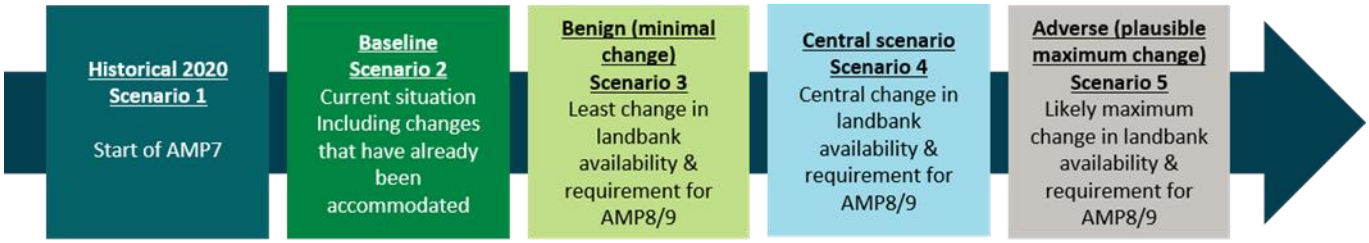
4.2.17 These actions are complementary to those of the proposed AMP8 CIP programme and microplastics investigations under the WINEP. These actions are limited to monitoring and research, rather than direct action to reduce the risk of harm to the environment. Enhanced screening will help sustain the agricultural outlet for biosolids recycling and the resilience of our bioresources business model in AMP8.

4.3 Improving our landbank resilience

4.3.1 The safe treatment and recycling of sludge is a critical part of our service to customers and the environment. Biosolids recycling to land is entirely dependent on access to third party landbank and the sufficiency of available landbank is fundamental to being able to continue to recycle biosolids to agriculture.

4.3.2 We have undertaken both national and company landbank modelling to quantify the risk of having insufficient outlet for biosolids disposal. Through the landbank modelling we have sought to identify the plausible extremes of landbank availability through identification of benign, central and adverse scenarios. In Figure 3, we summarise the increasingly stringent modelling scenarios. While all modelling scenarios were collaboratively agreed by the EA and water industry, and tried to capture the full range of variables to generate accurate modelling, several key uncertainties remain that cannot be modelled or forecast, and the impact of uncertainty increases as we project further into the future.

Figure 3: Increasingly stringent modelled landbank scenarios



Source: United Utilties, 2023

4.3.3 Landbank availability is a balance between the following two key parameters:

- **Landbank available:** The area of agricultural land available for biosolids recycling once topography, regulatory restrictions (i.e. proximity to water courses) and competition from farmyard manures and other organic wastes is taken into account.
- **Landbank required:** This is a factor of the quantity and quality of biosolids produced, and also accounts for return rates i.e. biosolids cannot be applied to the same field year-on-year. Therefore the landbank required is greater than the area that biosolids will be applied to in any one year.

4.3.4 Core to understanding the landbank required is an assessment of the market demand for our biosolids product. Despite the fact biosolids provide numerous benefits, there will always be those who are unlikely to accept biosolids for use on their land. Historically farmer acceptances rates have been

[22] Defra, *Environmental principles policy statement*, 31 January 2023 [Online] https://www.gov.uk/government/publications/environmental-principles-policy-statement/environmental-principles-policy-statement

relatively consistent, bolstered by voluntary compliance with the BAS and our team of highly qualified agricultural advisors who work hard to maintain good relationships with farmers.

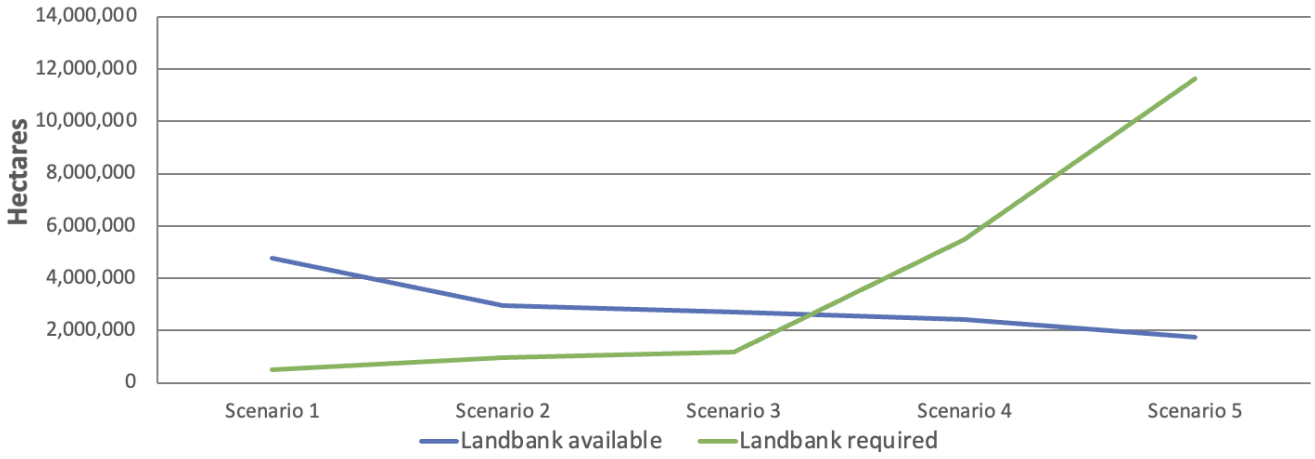
4.3.5 The increasing public awareness and media attention around biosolids contaminants, such as microplastics as an urgent environmental issue. It increases the prospect of a significant reduction in the food supply chain acceptability of biosolids recycled to agriculture. Loss of public sentiment for biosolids recycling has the ability to drastically and rapidly cut acceptance rates for our biosolids products, risking a shortfall in available outlets for our product. It is notable that a loss of confidence in the market may be based on a perceived, rather than quantified risk, and accelerate ahead of regulation.

4.3.6 Changing market demands are hard to forecast but the landbank modelling used decreasing farmer acceptance rates as a proxy to incorporate public perception issues and concerns over contaminants. Reducing acceptance rates were associated with the increasing stringency of each model:

- **Scenario 1** – Baseline per cent acceptance
- **Scenario 2** – Slight reduction (15 per cent)
- **Scenario 3** - Slight reduction (15 per cent)
- **Scenario 4** – Moderate reduction (25 per cent)
- **Scenario 5** – Significant reduction (40 per cent)

4.3.7 We summarise in Figure 4 the results of the national landbank modelling. Under all scenarios, landbank becomes progressively more difficult to access over time, and we will need to drive increasing distances, increasing our costs, to be able to continue to recycle all biosolids to land. Moreover, as available land becomes more limited, it becomes a shared resource with companies competing for landbank capacity.

Figure 4: Summary of landbank modelling results



Source: Grieve Strategic in association with RSK ADAS, National Landbank Assessment, 2023

4.3.8 For scenarios one, two and three there is sufficient available agricultural land to recycle all national biosolids. There are 'hotspots' of competition where biosolids will have to be transported further, but biosolids recycling under these circumstances is manageable. For scenarios four and five there is a step-change and there is insufficient available agricultural land to recycle all biosolids.

4.3.9 Although, as detailed above, public sentiment is indirectly incorporated within the model, the impacts are hard to predict and a loss of public sentiment for biosolids recycling may have immediate and binary impacts on the availability of landbank. This risk is particularly significant in the North West. In the North West we recycle a large proportion of biosolids to grassland, as livestock farming is the predominant type of available landbank. The direct food chain link between materials applied to grassland, incorporated in soils, subsequently grazed by livestock and directly ingested creates a more tangible risk than in areas where biosolids are predominantly supplied to arable land.

4.3.10 The risk of public perception as a resilience risk to biosolids recycling is widely established. An UKWIR research project, Biosolids to market: a strategic proposal to explore the threats to biosolids to land[23], concluded that:

"In addition to the purely 'scientific' issues, public and stakeholder perception is an extremely important consideration. Alarmist headlines combined with alternative or erroneous interpretations of the science can be extremely damaging to the image and perception of biosolids recycling. Media attention on emerging issues such as plastics is increasing, so it is important that the Water Industry is seen to be proactive, taking action by working with others to address this and other potentially emotive issues such as nanoparticles and antimicrobial resistance."

4.3.11 Furthermore, the impact of concerns over the actual and perceived risk of biosolids recycled to agriculture is already established in the market. Specific food chain stakeholders, distillers and brewers, have concerns over using crops grown on land where biosolids have been applied and the resulting exclusion clauses included in farmer's contracts amounts to a ban on the use of biosolids on certain crops in the food supply chain (excluding up to 1.5 million hectares).

4.3.12 Through the scope of this enhancement case we seek to address these challenges to landbank resilience, which are becoming increasingly important given the likelihood of landbank shortages. It is part of our statutory licence obligation that we must ensure long-term resilience in our operations. There is now a clear need to provide a greater level of sludge outlet resilience than planned at PR19. At PR19 the loss of the outlet to agricultural land was considered a long-term possibility, but this is now considered a near-term possibility, and a medium-term probability. It seems more likely that the outlet will be lost by insufficient national landbank resulting from the cumulative impacts of a multitude of drivers, rather than a direct regulatory ban which could provide time to plan against the change. The resilience of our biosolids disposal service is one of the company's top ten risks and is highlighted in our annual report.

4.3.13 A proactive biosolids management strategy is necessary to demonstrate that we understand societal concerns and have taken reasonable precautions and measures to ensure our biosolids are of the highest possible quality. Market sentiment is easily lost, and once lost it could take decades to recover. The calls for action are increasing and it is imperative that we take swift and proportional action. This concern is already manifesting in increased queries over the quality of our sludge. [✂

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4.3.14 Additionally, as we discuss in Section 5.4, during our customer engagement microplastic contamination was one of the primary concerns and priorities raised by customers, and where they wanted to see us take action.

4.3.15 It is important that we can market our product with a competitive advantage to sustain biosolids recycling against a backdrop of decreasing landbank availability, as farmers will have the power to choose which organic materials they wish to accept onto their land. Within the BAS there is currently no requirement for biosolids to be screened, and while screening is considered best practice within the water industry, this is to six millimetres in two dimensions, and we believe that we will be the first to deploy fine screening to circa 0.6 millimetres in two dimensions.

4.3.16 The market is moving to demand materials with significantly lower levels of physical contaminants. Other organic wastes, outside the water industry, such as food waste digestate have requirements on physical contaminants set out in Publically Available Specification (PAS) quality standards. This sets out the need to ensure removal of glass, metal, plastic and any "other" non-stone, man-made fragments down to 2mm. Quality Meat Scotland's Cattle & Sheep Standards, 2022 state applications of certified composts and digestates are permitted but only where the supplier confirms that the material meets

[23] UKWIR, *Biosolids to market: a strategic proposal to explore the threats to biosolids to land*, No. 18/SL/01/9

additional requirements for physical contaminants. These requirements are 50 per cent lower for composts and 92 per cent lower for digestates compared to the PAS standard requirements.

4.3.17 It is already established that the type and form of biosolids does have a significant effect on product acceptance rates. Information supplied by Grieve Strategic reports that biosolids acceptance rates range from less than 30 per cent for a lime treated cake (which is usually associated with increased odour) up to 95 per cent for thermally dried granules (which contain effectively no water and can be applied with typical agricultural fertiliser spreaders). Digested cake, the most common product type, has an average acceptance of 45 per cent with enhanced digested cake at 60 per cent, due to higher dry solids, greater nutrient content and more flexible use on grassland. We believe that by being able to produce an enhanced quality and fine screened biosolids product, with demonstrably less non-degradable material, will have a better and more a resilient acceptance rate.

4.4 Ensuring compliance with our statutory obligations

4.4.1 We expect that the EA Sludge Strategy will be implemented in AMP8, under which the SUiAR will be revoked and biosolids recycling will instead be regulated within EPR, thereby requiring permits for biosolids recycling to land. The EA recognise that this regulatory change will generate new investment requirements and the "Storage+ assessment" of WINEP actions specifically approved in principle, actions to meet future EPR requirements for the agricultural use of sludge.

4.4.2 A principle for development of the EA Sludge Strategy is to increase the level of control over biosolids recycling, with the EA stating:

"Modern sludge practices may harm the environment. To maintain industry and consumer confidence, we need to demonstrate that any new hazards are controlled"[24].

4.4.3 It is inherent that greater control will introduce new requirements on biosolids recycling. This includes the requirement that in order to comply with EPR, complying with the guidance that underpins EPR becomes a statutory obligation. Until the EA Sludge Strategy is implemented, compliance with the Defra, Sewage Sludge in Agriculture: Code of Practice is not legally required, but guidance is used to inform operator judgement over best practice. However, once the EA Sludge Strategy is implemented the EA will be able to withhold the issue of any permits if they do not deem the permits to fully comply with the requirements of the Code of Practice.

4.4.4 Under the guidance, it includes a requirement that:

"As a producer, you must also remove as much non-degradable material (such as plastics) as possible, before it is spread."

4.4.5 The EA rejected enhanced sludge screening for inclusion in the WINEP. The EA stated that managing plastic contamination in sludge is not a 'new' requirement as the guidance is pre-existing. We believe that this assessment misses two key points that mean we are in fact subject to new statutory obligations in AMP8:

(i) Although the guidance already exists and it is not viewed the by EA as a 'new' requirement, it will be a 'new' legal obligation for the water industry to comply once the EA Sludge Strategy is implemented. With the greater control over biosolids recycling the EA intend to achieve through the EA Sludge Strategy we cannot expect that anything other than full compliance with guidance will be required in order to have permits for biosolids recycling granted.

(ii) The standard set out in guidance is phrased 'as much as possible'. There is no limit set in regulation, or best practice, for the removal of non-degradable material, neither is there confirmation that current levels of contamination can be tolerated and retained on an ongoing

[24] UK Government, *Environment Agency strategy for safe and sustainable sludge use*, 15 July 2020 https://www.gov.uk/government/publications/environment-agency-strategy-for-safe-and-sustainable-sludge-use/environment-agency-strategy-for-safe-and-sustainable-sludge-use#why-change-is-needed [Section 6 Principles of the strategy].

basis. Inherently 'as much as possible' will continue to evolve, as improvements in best available technique are developed, driven by changes in technology and tightening of standards. Under the Waste Framework Directive, to ensure full compliance with guidance, means that our activities will continue to attract periodic investment needs, without a 'new' regulatory requirement or primary legislative change.

4.4.6 We believe that the scope of this enhancement case, to deliver enhanced screening across our regional asset base, fully meets the requirement to remove as much non-degradable material (such as plastics) as possible. While all our biosolids are screened to six millimetres in two dimensions, technology has developed to remove ever finer particulates from sludge and biosolids, meaning that is it now proportionate and cost efficient to make a step change in our activities, fulfilling the intent of the guidance.

4.4.7 Through the written evidence submitted to the EFRA committee the EA shared their intention to use EPR to tackle stresses on soil health, and going on to state that:

"We advocate the use of EPR in implementing the EA Strategy for Safe and Sustainable Sludge Use. This will help enable the beneficial gains to soil organic matter and soil nutrient levels from use of treated sludge (biosolids) while ensuring that use does not threaten soil health, endanger human health, or harm the wider environment.[25]"

4.4.8 It is clear from the evidence given by the EA to the EFRA soils committee that:

(i) The EA believe there is need to improve the management of biosolids to soil. As we are fully compliant with current regulatory standards, independently validated by the EA through compliance with the Satisfactory Sludge Use/ Disposal metric in the EPA assessment, improvements must fundamentally be though new standards, not currently required.

(ii) Through implementation of the EA Sludge Strategy and regulation under EPR, the EA intend greater control of biosolids recycling. As we are already compliant, it is inherent that greater control will introduce new requirements on biosolids recycling, which cannot be considered a like for like regulatory change that does not introduce new statutory obligations.

4.4.9 The exclusion of the risk and the rejection of the action from the WINEP does not mean that the investment needs are spurious. Rather, it reflects that these investment actions were not eligible under the WINEP assessment criteria established by regulators. We assume that the EA does not disagree with implementation of actions that will support the objectives set out in EA evidence to the EFRA committee. Investment needs must be addressed through another route at PR24.

4.4.10 As we reflected in Section 3.3, regulation under the Waste Framework Directive is leading to a misalignment in regulatory requirements and water company business planning. The water industry has no route to seek to recover efficient costs for meeting guidance standards and evolving best available technique standards under the Waste Framework Directive. It is these exact circumstances that have also necessitated a cost adjustment claim to ensure that our sludge treatment activities comply with the Industrial Emissions Directive and the 2022 Appropriate Measures guidance.

4.5 Management control

4.5.1 The need for investment to undertake enhanced sludge screening results from the contamination of sewage sludge with non-degradable material (including microplastics) and is largely outside of our control. Through our licence obligations we have a duty to provide a resilient sewage treatment service, however, there is limited control that the company can exert to positively influence the quality of incoming sewage. Moreover, it is recognised that through our increasingly effective wastewater treatment processes that over 99.5 per cent of non-degradable material is separated from final effluent, however, without additional separation this contaminates sewage sludge.

[25] Written Evidence submitted by The Environment Agency (SH0044) to the EFRA soil inquiry

4.5.2 The Urban Waste Water Treatment Regulations require reuse of sludge where practicable. Recycling to land of sewage sludge must take account of the nutrient needs of plants grown by a farmer and it must not impair soil or water quality. However, the contamination of sludge poses a threat to the circular economy model, and increasing contamination risks are likely to accelerate the loss of the agricultural outlet, and risks failure to meet our statutory obligations for a resilient and compliant sludge treatment and disposal service.

4.5.3 Through best practice wastewater and sludge treatment process we already do control the quality of sludge produced to a large extent. We screen incoming sewage at the inlet to our wastewater treatment works (to six millimetres in two dimensions) and have an additional grit separation phase, ahead of primary settlement. In this way the majority of screening and grit can be removed before the sewage enters the main wastewater treatment processes. Grit and screenings are disposed to landfill and do not contaminate the sewage sludge. However, these processes are not 100 per cent effective and some grit and screenings will be carried through to the main wastewater treatment process, and be ultimately separated to the sludge fraction through the process.

4.5.4 In addition, our sewage sludge has a second phase of screening (predominantly through strain press technology to six millimetres in two dimensions) ahead of our sludge treatment processes. The total volume of grit and screenings removed from the process is significant and each year approximately 7,000 tonnes of waste is disposed, rather than contaminating our biosolids which are recycled to land.

4.5.5 Source control is the ultimate solution to prevent non-degradable material from contaminating sewage in the first place, rather than having to separate this fraction at our treatment works. Indeed for some contaminants, such as PFAS which are persistent and challenging to treat, this may be our only option to prevent environmental harm. However, source control needs a multifaceted and cross sector approach requiring collaboration between households, business, government, water companies and technology providers. Source control is a long-term solution and there is already some work being done with manufacturers to look at filters in washing machines to reduce microplastic fibres from textiles entering and contaminating the sewage system.

4.5.6 We were a leading contributor to a Business in The Community project, "Optimising Bioresources: Reducing Water Pollution[26]" which brought a cross section of academia, businesses and regulators together to highlight the need for businesses, especially those that produce, use, or sell chemicals, textiles, tyres, and washing machines, to work together to reduce chemical and plastic pollution of wastewater. The report sets out a series of solutions, including a hierarchy of actions with the third highest priority being "effective wastewater treatment that enables the recovery of problematic particles and other substances".

4.5.7 In reality, we will need a dual approach incorporating source control and effective separation technologies at our sludge treatment centres. While we will continue to support the introduction of source control measures, for the reasons we set out, we must act now to introduce enhanced screening at our sludge treatment centres.

4.5.8 Our bioresources operating model is reliant on access to third party landbank, limiting the control that we have over the biosolids recycling, to guarantee an outlet for our product. We work to ensure the highest possible farmer acceptance rates, through voluntary compliance with the BAS standard, and our team of highly qualified agricultural advisors who work hard to maintain good relationships with farmers. However, the increasing resilience risks and requirements to demonstrate compliance with the agricultural code of practice, result from the application of the regulatory framework in England, and is outside of our control.

4.5.9 We have taken steps to control costs:

[26]Business in the Community, *Optimising Bioresources: Reducing Water Pollution*, June 2023 [Online] https://www.bitc.org.uk/report/optimising-bioresources-reducing-water-pollution/

- Improving the quality of biosolids to preserve the biosolids to agriculture recycling outlet is both the lowest cost, and best practicable environmental option for sludge disposal, in most circumstances. We seek to avoid requiring alternative outlets for biosolids disposal.
- In AMP7 we have absorbed the costs to be compliant against enhancements to the BAS standard (BAS "20 Measures" [27]), going over and above the regulatory minimum to minimise the impact of biosolids recycling on diffuse water quality pollution, and provide practical concessions to support the EA's implementation of Farming Rules for Water. We do not seek cost recovery of these activities.
- We have developed a regional, integrated package of AMP8 actions, optimised through use of our strategic planning tool, Regional Integrated Asset Plan (RIAP). Strategic planning capability is central to our asset strategy over the next 25 years and enables us to understand and optimise the carbon footprint, capital and operational costs of planned AMP8 actions across the entire bioresources system.
- We have supported collaboration between the EA, water companies and Assured Biosolids Limited (who administrate the BAS) to define the form of EA Sludge Strategy to be implemented and to minimise the operational impacts in AMP8.
- We will ensure that we deliver investment as efficiently as possible. In developing the proposal for enhancement sludge screening (through our integrated package of WINEP interventions) we have considered a full range of options, considering over 65 unconstrained options to ensure that we have developed actions which represent the lowest cost and best value for customers.
- Our proposed solution maximises the value of the investment through the delivery of multiple benefits. As well as meeting our regulatory obligations, reducing the risk of environmental harm and improving our resilience, it provides significant operational benefits.

4.5.10 Enhanced sludge screening will help over the long-term maximise the efficiency of the treatment asset because it will reduce the build-up of grit in digesters and reduce wear and tear on sludge pumps reducing maintenance needs. This benefit is fully reflected in the costs and reduces the overall opex requested through this enhancement case by £2.380 million per year. Clean out of digesters and tanks to remove any material already accumulated is not included within scope of this enhancement case and will be undertaken through base expenditure. Such a programme of digester cleaning will take many years (up to 10 years) to implement, in order to retain a balance of planned outages and resilient treatment capacity for ongoing operations. Only once this additional investment is implemented will the cost savings be fully realised.

4.6 Need for enhancement expenditure (including implicit allowance)

4.6.1 This case is for £54.133 million enhancement investment over and above base totex. The costs set out within the enhancement case are the capital costs (and consequential ongoing opex) to deliver enhanced sludge screening across our regional asset base. This investment will deliver a step change in the management of non-degradable particulates (including microplastics) in sewage sludge to prevent 23,000 tonnes of material a year from being recycled to agriculture and accumulating in the soil environment.

4.6.2 This action will deliver enhanced service standards to improve biosolids product quality. The existing asset system is configured to provide screening for asset protection and visible material, but it is not designed to remove material less than six millimetres in two dimensions. This solution goes beyond the minimum regulatory requirement as there is currently no specific requirement and standard to screen sludge in legislation, neither is screening a specific requirement in the BAS.

[27] Draft BAS 20 measures were shared with the EA in 2022 and the industry has voluntarily implemented the measures. Assured Biosolids Limited is continuing to finalise the measures for inclusion in an updated BAS standard.

4.6.3 The bioresources cost models do not include any cost drivers that consider landbank resilience or more stringent regulation of biosolids recycling under the EA Sludge Strategy. The cost models are based only on the volume of sludge processed and sparsity factors, neither of which is a determining factor of the costs providing a resilient sludge to land service.

4.6.4 Our base cost allowance for sludge disposal is derived from historical costs and is founded on the assumptions we present in Table 4.

Table 4: Base cost assumptions and forecast changes in AMP8

Base assumption	Description	Subject to change in AMP8
National surplus of agricultural landbank	All companies are able to find sufficient agricultural landbank within a reasonable distance of sludge treatment centres: There are limited pockets of competition for landbank between companies.	Yes – several national landbank model scenarios have indicated insufficient landbank available. Multiple factors can drive a reduction in landbank availability and landbank required leading to significant competition for landbank and the need for alternative outlets for biosolids.
Environmental regulations for sludge to agriculture	SUiAR provide an exemption from the Waste Framework Directive. This enables biosolids to be distributed to field stockpiles for storage and subsequent spreading free of charge and without the need for prior regulatory approval. Compliance is assessed by audit of the records retrospectively.	Yes – the EA Sludge Strategy aims to revoke the SUiAR and replace it with EPR. This will require prior regulatory approval through a permitting process for each and every field before biosolids can be distributed to field stockpiles, and payment of permitting fees.
Biosolids quality control	Controls are based on beneficial properties (e.g. plant available nutrients) and on potentially toxic elements as specified the relevant schedules the Sludge Use in Agriculture Regulations. It also requires conformance with the Safe Sludge Matrix which relates to microbial content.	Yes – additional controls over emerging contaminants such as the presence of non-degradable materials including plastics and microplastics, chemicals such as “forever chemicals”, and anti-microbial resistance have the potential to be introduced through the EPR.
Stable demand for biosolids	Stable and sufficient market demand for biosolids products, underpinned by compliance with the industry best-practice incorporated in the BAS standard.	Yes – acceptability of biosolids fluctuates and is significantly influenced by regulatory changes and market sentiment. One item of note could be adverse publicity of actual or perceived risks associated with biosolids, leading to a significant decrease in farmer acceptance for biosolids product.
Industry standard sludge screening to 6mm in two dimensions	Industry standard screening to 6mm in two dimensions. Finer screening is not deployed as standard. Compliance with agricultural code of practice to “remove as much non-degradable material (such as plastics) as possible” is advisory. There is no screening requirement within the BAS standard.	Yes - growing calls for action for the water industry to improve biosolids quality and reduce contamination. Compliance with agricultural code of practice to “remove as much non-degradable material (such as plastics) as possible”, becomes a statutory obligation under EPR.

Source: United Utilities, 2023

4.6.5 The biosolids recycling environment is changing and the assumptions in Table 4 will no longer hold true for AMP8. Base allowances will only provide resources to deliver service standards to operate within the existing biosolids recycling environment. Additional investment to meet enhanced service standards, against a more constrained landbank outlook, are not reflected in base totex and should be considered as an enhancement allowance.

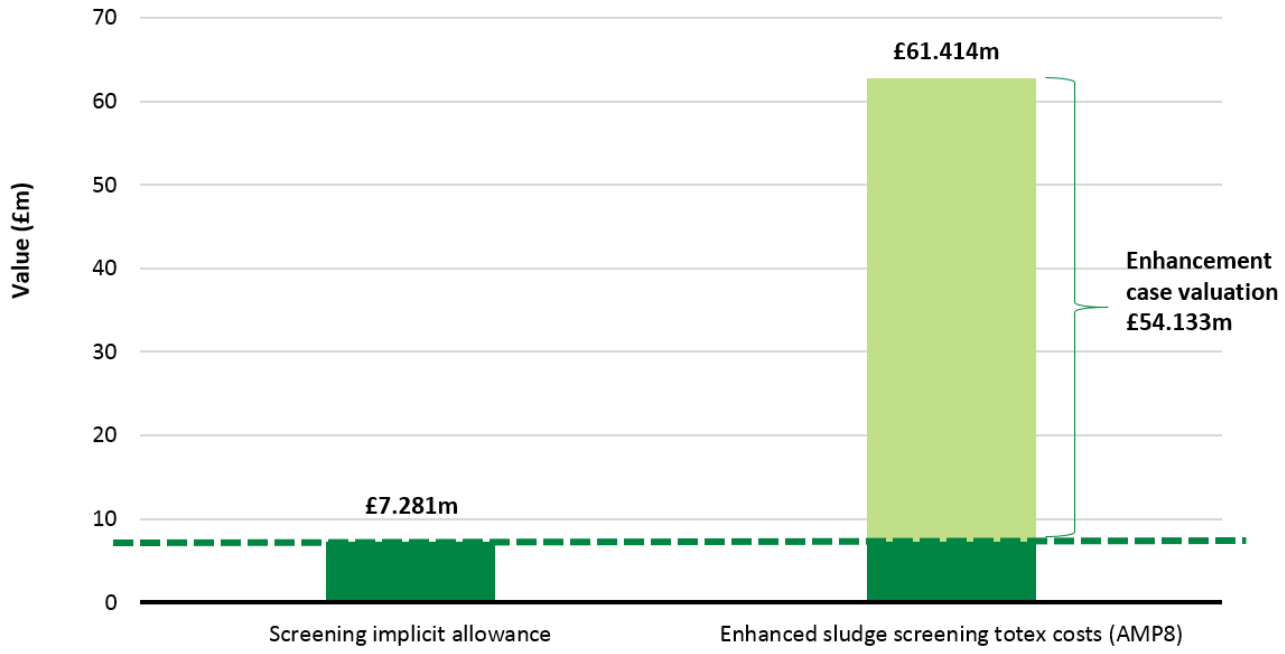
Implicit allowance

4.6.6 The scope of works within this enhancement case relates to the replacement of assets. Existing sludge screens (typically strain presses) will be replaced with the latest technology, able to operate to a higher technical specification, delivering a step change in service levels.

4.6.7 We have valued the implicit allowance for our existing screens as the actual replacement costs of our existing screens on the fixed asset register. The historic cost value i.e. purchase cost has been inflated to the FY23 price base. This gives a netbook value of £7.281m for the existing screens.

4.6.8 The requested cost for the enhancement case for enhanced sludge screening is the incremental cost, over and above the implicit allowance, as we summarise in Figure 5.

Figure 5: Valuation of implicit allowance for this enhancement case



Source: United Utilities, 2023

4.6.9 We present in Table 5 a summary of our cost estimating assumptions to demonstrate that there is no implicit allowance for any of the individual scope elements that make up the cost adjustment case.

4.6.10 Implementation of enhanced sludge screening will incur significant additional cost, notably landfill costs and landfill tax, for the disposal of non-degradable materials, as a more sustainable alternative to recycling to agriculture. These additional costs are partially offset by improved anaerobic digestion performance and we have discounted £2.380 million per year from the value of the enhancement case.

Table 5: Estimating assumptions for this enhancement case

Cost	Estimating assumptions	Included in enhancement case
Capex to install enhanced sludge screening across the regional asset base	Costs for new screening units, plus installation costs. Existing screens are unable to deliver the enhanced quality product and therefore new assets are required. We have valued the implicit allowance for our existing screens as the actual replacement costs of our existing screens on the fixed asset register, £7.281m. No associated personnel costs to run the new screens has been included and costs will be absorbed through base expenditure.	Capital costs to install enhanced sludge screening across the regional asset base are included, over and above implicit allowance for existing screens.
Power consumption	Additional power consumption costs for running new enhanced sludge screening assets.	Power costs included.
Screenings disposal	Enhanced sludge screening is anticipated to produce an additional 23,000 tonnes of screenings for disposal each year. It is assumed that this be disposed via a hazardous landfill facility, at a cost of circa £116 per wet tonne. This will displace the same volume of material from biosolids recycling, current sludge recycling costs are circa £27 per wet tonne.	Included in the enhancement case is the additional cost of screening disposal to hazardous landfill, net of the reduced cost of biosolids recycled to agriculture.
Maintenance benefit	Enhanced sludge screening will help over the long-term maximise the efficiency of the treatment asset because it will reduce the build-up of grit and reduce wear and tear on sludge pumps, reducing maintenance needs and downtime. This maintenance benefit is fully reflected in the costs.	Benefit of £2.380 million / full year opex incorporated.
Digester cleaning	Costs to clean out of digesters and tanks to remove any material already accumulated is excluded from scope of this enhancement case. Digester cleaning will be absorbed through base expenditure. Only once digester cleans are completed will benefits of increased hydraulic retention time and increased gas yield be realised.	Costs (and associated benefit) excluded.

Source: United Utilities, 2023

Timing of expenditure

4.6.11 The enhanced sludge screens will be delivered over a three year programme to 31 March 2028. There is no regulatory date for this activity, and the implementation date of the EA Sludge Strategy is unknown. We are delivering this activity in the start of AMP8 to maximise the value and benefits delivered in AMP8.

4.6.12 Expenditure cannot be accelerated to be delivered in AMP7, as the scale of the investment required of £54.133 million is too great a proportion of botex to be absorbed.

4.7 Long Term Delivery Strategy (LTDS) context

4.7.1 We have ensured that our proposed enhancement investment is efficient through alignment with our bioresources LTDS to ensure that proposed investment is considered 'no regrets' under all future plausible scenarios. Our approach ensures that environmental outcomes can be delivered and the risk of inefficient investment is minimised. Further details of our LTDS can be found in document *UUW12 - Long term delivery strategy.*

4.7.2 The bioresources core asset pathway, Advanced Anaerobic Digestion (AAD) and biosolids recycling to agriculture, is a continuation of our approach for AMP7. It has three key overarching principles:

(a) Centralise sludge treatment into fewer, larger AAD hubs;

(b) Increase resilience against sludge supply chain disruption; and,

(c) Phased reduction in reliance on agricultural landbank over the longer-term.

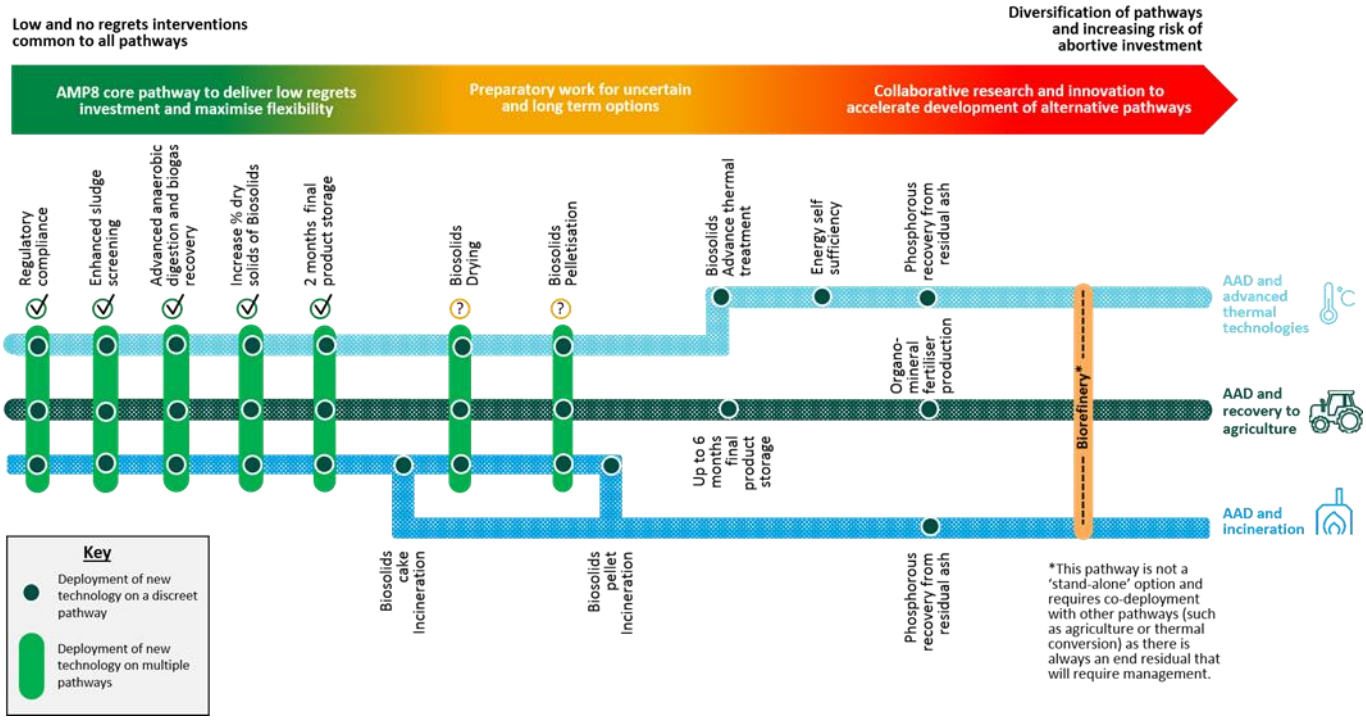
4.7.3 While our core pathway is a continuation of our approach for AMP7, on-going horizon scanning of new and emerging issues, in conjunction with the risk and issue review instigated by the sludge WINEP drivers, has identified the need for an acceleration of this pathway compared to our PR19 position. There is now a clear need to provide a greater level of sludge outlet resilience than planned at PR19. At PR19 the loss of the sludge recycling outlet to land was considered a long-term possibility, but this is now considered a near-term possibility, and a medium-term probability.

4.7.4 Given the uncertainty over the future availability of landbank and potential need for alternative outlets, we have developed an adaptive plan that enables us to navigate through the uncertainty and make significant investment decisions at an appropriate point in time.

4.7.5 We present in Figure 6 our planned AMP8 investment actions (including the scope of this enhancement case to deliver enhanced sludge screening) overlaid on our core pathway. This demonstrates that if we switch to an alternative pathway from the core pathway our enhancement investments are still considered no regrets in all scenarios and the risk of inefficient investment is minimised. Each pathway is built on a common foundation of AAD, and new asset investment in enhanced sludge screening remains beneficial under whichever pathway may ultimately deliver in future.

4.7.6 Moreover, it will support the future delivery of markets for sludge treatment by providing a better quality product that will attract a lower gate fee from treatment providers. The uncertainty over sludge quality, particularly the contaminant levels is a potential barrier to establishing a bioresources market. By improving raw sludge quality this will provide greater certainty on its specification for onward treatment, and final fate of the biosolids.

Figure 6: Indicative illustration of low and no regrets actions on our bioresources LTDS



Source: United Utilities, 2023

4.7.7 We are proposing to install enhanced sludge screening to treat 100 per cent of our sludge. The screens themselves are modular in size and additional modules may be deployed to accommodate sludge growth and upgrades to treatment capacity as required. Even if some of the existing anaerobic digestion site are closed, and converted to thickening and dewatering centres (in line with our core pathway) the

investment will not be abortive. The screening activity can still be undertaken at the thickening and dewatering hub, ahead of transfer to the consolidated AAD centre.

4.7.8 Moving to an alternative disposal outlet is not considered as part of the core pathway in AMP8 as these actions may be considered as abortive investment in the longer term, as there remains uncertainty over both timescales for change and the preferred alternative outlet for sludge disposal. These pathways will only be followed under more adverse landbank scenarios, and the additional activities may be described as 'higher-regret', relative to investments included in the core pathway. We have therefore deferred significant investment (an additional circa £1 billion) to implement actions to move away from biosolids recycling to agriculture.

5. Best option for customers

5.1 Options assessment

5.1.1 Our enhancement case presents the least cost and best value solution for customers to reduce contamination in biosolids and deliver against the following overlapping drivers:

- Address increasing public awareness, media attention, and government calls for action around microplastics as an urgent environmental issue;
- Follow the precautionary principle to minimise the risk of environmental harm from our activities;
- Mitigate the risk of loss of market demand for our biosolids product due to contamination concerns; and
- Ensure regulatory compliance with EPR by seeking to continuously improve quality standards to align with best available techniques.

5.1.2 The proposal for enhanced sludge screening was initially developed to form part of our integrated package of WINEP interventions. As such, we have followed the WINEP methodology and undertaken a significant options assessment exercise. We progressively screened and filtered options; from unconstrained, to constrained, to feasible options, to identify the most effective way to deliver a robust and sustainable sludge recycling to agriculture service.

5.1.3 A long list of potential WINEP actions and interventions was generated through a horizon scan using subject matter experts. In Appendix A, we present mapping of the wide range of identified generic control measures that could address the multitude of risks and issues included under the sewage sludge drivers. We identified through this initial unconstrained screening more than 65 potential technologies or interventions that may meet the objectives of the sewage sludge driver guidance. We considered options ranging from monitoring and control, to access to alternative outlets for biosolids disposal.

5.1.4 The following options were identified and discounted at the early stages of the optioneering process:

(1) **Do nothing:** this option was discounted as it would not meet the statutory objectives of the WINEP sewage sludge drivers and would result in environmental non-compliance, expose the business to intolerable resilience risks and not meet the expectations of customers.

(2) **'Business as Usual' interventions**: Options that could already be considered as 'standard practice' across the industry were discounted as any additional intervention would have marginal impact and not be considered as enhancement expenditure to be included within WINEP actions. For example provision of nutrient planning advice to farmers or optimising logistics operations.

(3) **Technologically immature interventions:** Solutions with Technology Readiness Level (TRL), less than TRL7 (system prototype demonstration in operational environment) were not considered feasible to be delivered within the WINEP timeframe and were therefore discounted.

5.1.5 In line with the WINEP methodology, if unconstrained options were deemed viable then additional screening was carried out to identify 'constrained' options, with further screening taking place to refine the feasible solutions and determine those to be progressed to detailed scope development and estimating. It is at this stage that the options were also assessed for deliverability, to ensure that all actions could be delivered within the WINEP timeframe.

5.1.6 In Table 6 we set out a summary of the options we have considered to reduce contamination in biosolids. Only one solution was selected as feasible to reduce contamination in biosolids. A detailed engineered design was developed in order to provide comprehensive cost and carbon data.

5.1.7 Our preferred solution is a balanced approach that minimises costs as far as possible, while having a high confidence in delivering multiple beneficial outcomes in AMP8; reducing physical contamination in biosolids; improving resilience in the biosolids markets, taking a precautionary approach to reduce the risk of environmental harm; and ensuring compliance with the EA sludge strategy.

Table 6: Options considered to tackle the overlapping drivers to reduce contamination in biosolids

Option	Rationale	Select / reject	Reason
Do nothing	Maintain 6mm (in 2 dimensions) screening at our sludge treatment centres. Take a reactive, rather than proactive approach to tackling the risk of contamination from non-degradable materials in biosolids.	Reject	This option was discounted as the resilience risks, and the potential loss of landbank through contamination concerns, are too significant to take no action. Furthermore, this does not deliver against customer priorities to tackle microplastic risks in the environment. Does not answer government calls for action to address microplastic risks and ensure that soils are managed sustainably by 2030. (See footnote 16, page 19). It would not demonstrate full compliance with the agricultural code of practice, to "remove as much non-degradable material (such as plastics) as possible" which is set to become a statutory obligation in AMP8.
Screening 100% of our raw sludge	Implement enhanced sludge screening to 0.6mm in 2 dimension, to treat all raw sludge upon reception at our sludge treatment centres.	Select	No regrets activity that delivers beneficial outcomes in all future scenarios. Implementation upstream of digestion avoids breakdown of plastics to produce secondary microplastics in the sludge treatment process. Provides additional benefit to the sludge treatment process, reducing overall costs.
Screening digested biosolids at 10 cake production sites	Implement enhanced sludge screening to 0.6mm in 2 dimension, to treat all digested sludge, prior to thickening and before dispatch to agriculture at our 10 biosolids cake production sites.	Reject	We considered the asset arrangement for this additional screening treatment step in our sludge treatment processes. We discounted screening the digestate prior to dewatering. The earlier sludge is screened in the process the more benefit this would provide: Avoids degradation of plastics to even smaller fragments in the digestion process which might then pass through final screening. Offers some further benefit to the sludge treatment process which is included in our whole life cost analysis.
Source Control	Implement source control to prevent non-degradable material from contaminating sewage in the first place. Source control needs a multifaceted and cross sector approach requiring collaboration between households, business, government, water companies and technology providers.	Reject	While we support the introduction of source control measures, the timescales for implementation are too long to realise benefits and we must act now to reduce contamination of biosolids. There are currently no proven techniques for source control of non-degradable fragments in biosolids. The development of future activities is considered complementary to the proposed scope, we will continue to explore collaborative source control opportunities in AMP8.

Option	Rationale	Select / reject	Reason
Enhanced screening of raw sewage	Implement enhanced screening of raw sewage to 0.6mm in 2 dimension at the inlet to all our wastewater treatment works	Reject	The costs are prohibitive to roll out this technology across circa 575 wastewater treatment works. The benefits of such an intervention are no greater than the proposed solution, but at a much greater cost.
Full scope to move to alternative outlets for sludge disposal	Address contamination risks by avoiding biosolids recycling to agriculture. Proactively invest to start delivering investment associated with alternative pathways and move away from recycling 100% biosolids to agriculture.	Reject	The current alternative pathway that could be deployed with confidence is incineration. This is an inflexible option that does not maximise the value of sludge. This route does not align with our bioresources LTDS and it does not have customer support. The costs are significant (circa an additional £1 billion). This option risks abortive or inefficient investment if we move to alternative outlets ahead of a confirmed landbank need.

Source: United Utilities, 2023

5.1.8 There is a complementary AMP8 WINEP microplastics investigation driver which is focussed on sampling for microplastics within wastewater and sludge and includes research into advanced thermal conversion technologies. This is an innovation activity that will inform future investment in solutions in AMP9 and beyond. There are many uncertainties with advanced thermal conversion technologies and a collaborative investigation driver is welcomed.

5.1.9 We discounted taking no further action on the management of microplastics in sludge in AMP8 and await for the results of the microplastics investigations. That approach does not align with our ambition to protect and enhance the environment, the views of customers, or the requirements set out by government who have called for urgent action to tackle this issue.

5.2 Benefit and value appraisal

5.2.1 Our approach to delivering best value is robust and consistent across all of our enhancement cases. Our approach uses a rich mix of metrics to help us drive value and efficiency in developing our business plan. Consistency of the approach is driven through our PR24 Value Tool which allows us to quantify and value environmental and social benefits, costs and risks. For more detail on this approach please see *UUW45 - Our approach to deliver best value totex*.

5.2.2 Recycling biosolids to agriculture is an effective, catchment based business model, and ensuring this model can continue for as long as possible will maximise benefits of sludge recycling operations to the wider environment. Biosolids recycling supports the circular economy and nationally, around 3.5 million tonnes of biosolids are recycled to agricultural land per annum, providing more than £60 million of nutrient replacement value to agriculture[28].

5.2.3 Current industry standard practice to screen to six millimetres in two dimensions is intended to remove visible fragments of plastic and other foreign material, and to provide adequate protection to sludge treatment assets from the possible damaging effect of screenings on mechanical equipment. This action proposes fine screens to remove non-degradable material down to circa 0.6 millimetres in two dimensions, a ten-fold improvement.

5.2.4 The technology[29] to be implemented is a solution not currently deployed within our asset base, and we believe that deployment across our entire asset base will be a first for the industry. We have undertaken trials in AMP8 to prove the efficacy of the proposed solution. Data extrapolated from the trials suggests that the investment will deliver the removal of approximately 23,000 wet tonnes of fine material, over

[28] Assured Biosolids Limited, *About Biosolids*, 2022 [Online] https://assuredbiosolids.co.uk/about-biosolids/

[29] CDE, S:MAX™ Static Sludge Screening System [Online] https://www.cdegroup.com/products/sludge-management/smax-static-sludge-screening

and above the material removed by six millimetre screening already in place. These additional screenings are non-degradable material that would otherwise have been passed through sludge treatment processes, into our biosolids product, and ultimately recycled to agricultural land.

5.2.5 At our Oldham sludge treatment centre we processed 3,786 cubic meters of sludge through the screens. This resulted in four tonnes of grit and rag each being collected. This is equivalent to each cubic meter of sludge containing 1.05 kilograms of grit and 1.05 kilograms of screenings. We present in Figure 7, photographs from one of our trials to demonstrate the physical contaminants that are removed from the sludge.

Figure 7: Photographs from a United Utilities screening trial demonstrating physical contaminants removed from sludge

Source: United Utilities, 2022

5.2.6 Over 20 per cent of all microplastics in sewage are retained in the grit fraction[30] and therefore we expect that enhanced screening to maximise grit removal from sewage sludge will provide a significant reduction in the concentration of microplastics in biosolids applied to agriculture. The benefits are two fold, firstly removing primary microplastics entrained with grit and other foreign material, and secondly removal of larger plastic fragments which could otherwise break down to secondary microplastics. The scale of the benefit is significant, the mass of biosolids to agriculture will be reduced through the removal of an additional 23,000 wet tonnes of screenings per year, and is equivalent to circa five per cent of the biosolids recycled to agriculture. This will eliminate over 920 truck movements to agriculture each year. By way of comparison our present conventional screening removes approximately 7,000 tonnes of screenings for disposal each year.

5.2.7 Secondary benefits, beyond the primary intent of the actions, have been assessed in our proposed solution. We used our system wide Regional Integrated Asset Plan to understand the combination of changes in costs and carbon emissions of the treatment and recycling activities. This incorporated benefits such as reduced solids quantity for transport to agriculture and the increased quantity of material sent to landfill for disposal. Our submission reflects the net financial position following investment. This ensures we are protecting soil quality, providing resilience in the supply chain, generating added value, and all at the lowest cost.

5.2.8 Delivery of this enhancement case will not impact on performance commitments in AMP8. We present the benefits of this enhancement case in table CWW15.

[30] EHCA, *Annex XV Restriction Report, Proposal for a restriction: Intentionally added microplastics, Version 1.2* , 22 August 2019 [Accessed at: https://echa.europa.eu/documents/10162/05bd96e3-b969-0a7c-c6d0-441182893720]

5.3 Delivery of this scheme

5.3.1 The enhanced sludge screens will be delivered over a three year programme to 31 March 2028. There is no regulatory date for this activity, and the implementation date of the EA Sludge Strategy is unknown. We are delivering this activity in the start of AMP8 to maximise the value and benefits delivered in AMP8.

5.3.2 We have made an assessment whether using markets to deliver the scope of this enhancement case may deliver greater value for customers. However, we concluded that installation of sludge screens is too integrated with the day to day operation of sites to be able to be delivered through a market provider.

5.3.3 We have undertaken trials in AMP7 of enhanced sludge screens at several sites using mobile, hired screens to demonstrate the concept and prove the benefits that may be delivered through additional screenings removal. The proposed technology provides a ten-fold increase in screenings capability and uniquely allows for separate rag and grit removal. There is potential to explore further treatment opportunities in AMP8 to further process the grit fragment, to make the material suitable for land restoration, rather than landfill. We have not proven this concept and the enhancement case assumes materials will be disposed to landfill.

5.3.4 The screening units are modular which enables installations to be sized for different sites and throughputs, and allow future expansion as necessary to deal with sludge growth.

5.3.5 [✂

]

5.3.6 We do not forecast any third party funding to be secured to support delivery of this scheme as the works are entirely restricted to our asset base.

5.3.7 For completeness and for the avoidance of doubt, this scheme has not been identified to be delivered as Direct Procurement for Customers (DPC), as this is not applicable for projects within the bioresources price control.

5.4 Customer support for investment

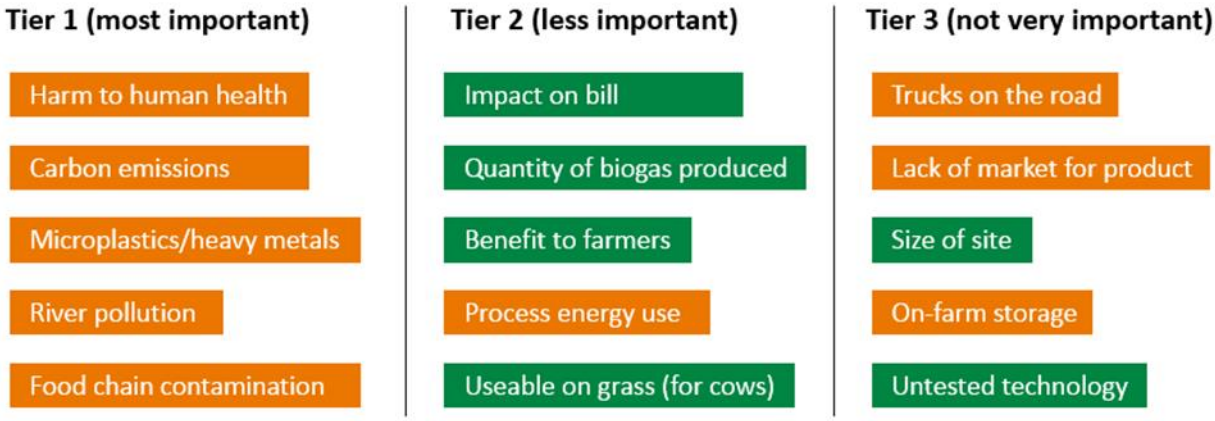
5.4.1 We have undertaken customer engagement to develop a better understanding of customer views on the future of biosolids recycling, as well as willingness to pay engagement, specific to the scope of this enhancement case.

5.4.2 Bioresources Pathways Customer Research was undertaken in September 2022, which conducted five, three-hour deliberative workshops with a total of 60 current household customers and 12 ‘future bill payers’, held at various locations across the North West. The research discussed the future pathways open to UU in the context of our bioresources LTDS to understand customers’ preferences and priorities in relation to these pathways and to establish which pathway(s) are most acceptable to them.

5.4.3 Prioritisation was based on high-level considerations, e.g. the importance of reducing carbon emissions, in comparison to protecting watercourses, rather than specifics of costs and emissions volumes for each pathway. The workshops were designed to ensure customers were able to provide meaningful feedback on each of the pathways, with visual demonstrations and subject matter experts attending to answer any customer questions.

5.4.4 Customers’ long-term priorities, as summarised in Figure 8, are for a bioresources service that provides reliable sludge treatment in a way that limits impact on human health, greenhouse gas emissions, and on water quality. For most, these are the non-negotiable responsibility of the company. Tier two priorities are important but just not as important as human health and pollution. Least important are the Tier three priorities as customers are too distant from these for them to be a priority.

Figure 8: Priority outcomes for customers regarding bioresources management



Source: DJS Research on behalf of United Utilities, Bioresources pathways customer research, October 2022

5.4.5 Microplastics were a common theme raised by participants during the customer research. While not unanimously understood, for those that were aware of what they are, microplastics are a real concern. In fact, for a minority it was the reason they attended the session. The negatives of microplastics were ever present in people's thinking and considerations of the future of bioresources. While sympathetic to the fact United Utilities are not the cause of microplastics, their presence is a cause for alarm for many.

5.4.6 Comments raised during the workshops included:

- *"We're all ingesting microplastics. Which we shouldn't be, we need to stop it."* A customer from our Preston workshop.
- *"Just news stories that you see. And documentaries you see on Netflix. I think it causes cancer and things like that."* A customer from our Warrington workshop.

5.4.7 It is very apparent that with such an emotive issue as microplastics we cannot wait to take action. This is an issue where customers value us taking action. While technology has developed to be able to deliver a reduction in the amount of mircoplastics spread to agriculture, we have a clear mandate for action.

There was a clear consensus around not waiting for problems to occur and instead, to plan and invest now in additional capacity and functionality so that if and when problems occur, we are in the best position to deal with those problems. Customers also recognised the need for research and development and the requirement to balance short and long-term investment.

Customers are willing to pay for fine screening

5.4.8 We have undertaken customer research that has demonstrated strong support for implementation of enhanced sludge screening technology. Furthermore, customers see the maximum predicted bill impact of £1.66 as an acceptable price to pay for the implementation of the technology.

5.4.9 In August 2023 we undertook customer research to develop a better understanding of customer's opinions on protecting the environment and our proposed enhancement investment to improve the quality of biosolids recycled to agriculture[31].

5.4.10 The key objectives of the research were:

(i) To gain insight into customer opinions on the advantages and disadvantages of enhanced screening; and,

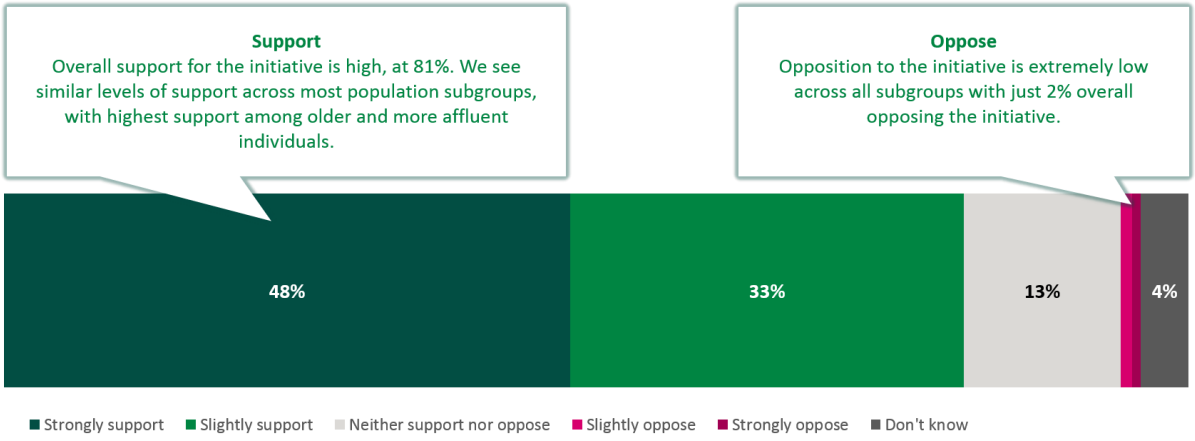
[31] DJS Research on behalf of United Utilities, Bioresources Enhanced Screening Research, September 2023

(ii) To understand if customers are willing to pay (and the amount of increase they are willing to pay) to deliver enhanced sludge screening.

5.4.11 The customer research consisted of 1,504 surveys, 100 of which were future bill payers, 1,425 were online and 79 were personal interviews with those who are digitally excluded. Results were weighted by age, region, gender, socio-economic grade and water meter status to ensure they are reflective of customer base.

5.4.12 The result shows strong customer support for the proposed enhanced screening technology, across all customer sub-groups, and with very limited opposition. We show in Figure 9 that 81 per cent of customers support the introduction of enhanced sludge screening technology, with only 2 per cent opposed to the initiative. The proposed enhancement aligns with customers' expectations of how companies should behave, crucially to minimise waste, and to protect wildlife and biodiversity.

Figure 9: Breakdown of opinions for enhanced screening



Source: DJS Research on behalf of United Utilities, Bioresources Enhanced Screening Research, September 2023

5.4.13 Customers considered the top three benefits of the investment are;

(i) the removal of more microplastics and other rubbish to a small size;

(ii) avoiding 23,000 tonnes of non-degradable material from being spread in agriculture per year; and,

(iii) enabling future opportunities to segregate and reuse waste rather than it all going to landfill.

5.4.14 For customers the most significant disadvantages of implementing enhanced sludge screening are;

(i) the technology is more expensive;

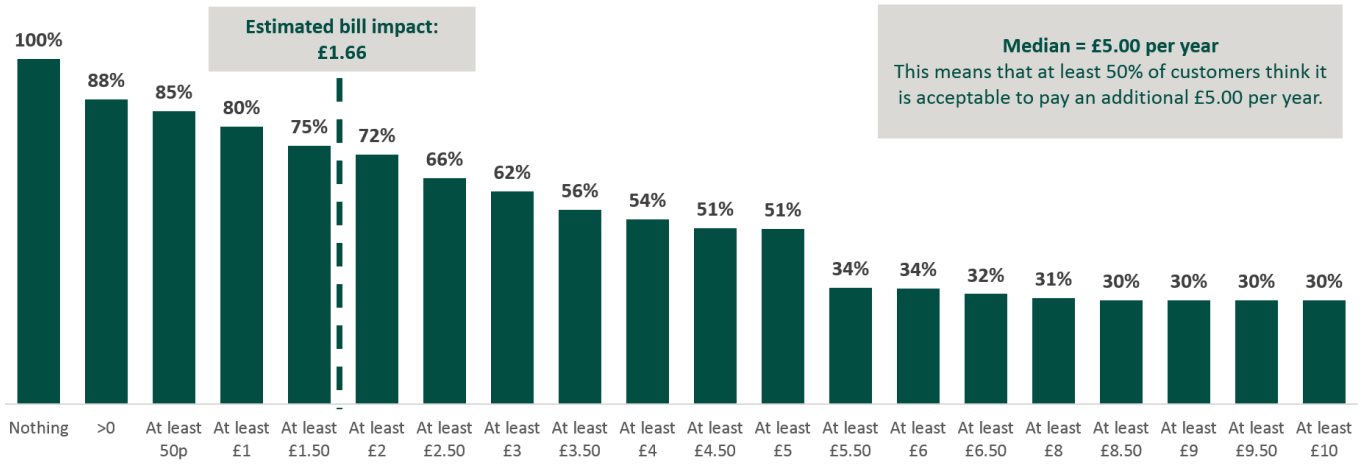
(ii) it cannot reduce the amount of microplastics in the sludge to zero; and,

(iii) separated material will need to go to landfill which is more expensive.

5.4.15 In addition to seeking to understand customer opinions on enhanced sludge screening, the customer research included a willingness to pay survey. We show in Figure 10 the results of the willingness to pay survey and the amount of increase customers are willing to pay to deliver enhanced sludge screening at different price points. The vast majority (88 per cent) of customers are willing to contribute for the implementation of the technology to remove contaminants from sludge.

88% of customers would contribute to removing contaminants from sludge

Figure 10: Percentage of customers willing to pay for fine screening against increasing cost.



Source: DJS Research on behalf of United Utilities, Bioresources Enhanced Screening Research, September 2023

5.4.16 We conclude from the willingness to pay survey that almost three quarters of customers find it acceptable to contribute the estimated bill impact of £1.66. This represents a strong acceptance of the projected bill impact from customers. At least 50 per cent of customers think that five pounds is acceptable, while thirty per cent of customers think it acceptable for them to contribute ten pounds or more each year.

Almost three quarters of customers find it acceptable to contribute the estimated bill impact of £1.66. This represents a strong acceptance of the projected bill impact from customers.

6. Cost efficiency

6.1 Development of efficient cost estimates

6.1.1 The costs for this enhancement case were originally developed as part of an integrated package of measures for our November 2022 WINEP submission. Cost estimates have been developed using a fully documented UUW optioneering approach, including third party assurance, to ensure that our cost estimates are efficient. We have obtained direct quotes from the screen supplier to derive robust and accurate bottom-up costs, which we extrapolated across all sites based on the volume of sludge processed.

6.1.2 In Table 7 we present a summary of the build-up of costs for enhanced sludge screening. Our estimating assumptions are presented Table 5. The majority of the costs relate to the capital costs to purchase and install the screens. The opex uplift for power and landfill disposal of screenings is significantly offset by the maintenance benefits recognised through this investment, minimising the overall cost.

Table 7: Summary of enhancement expenditure

Activity	Unit Rate	Capex (£m)	Opex (£m) AMP8	Totex (£m) AMP8
Screen purchase and installation	100% of UUW sludge	61.477	-	61.477
Power	100% of UUW sludge	-	1.402	1.402
Screenings disposal to landfill	23,000 tonnes per annum	-	5.658	5.658
Total cost of enhanced sludge screening	-	61.477	8.731	70.209
Implicit allowance (see section 4.6)	-	-7.281	-	-7.281
Maintenance benefit	100% of UUW sludge	-	-7.116	-7.116
Value of enhancement case		54.196	1.616	55.812

Source: United Utilities, 2023

6.1.3 Interventions are planned across our asset base to ensure that all our biosolids benefit from enhanced levels of screening and provide maximum flexibility in our future operations. The proposed arrangement is to install screens upstream of digestion assets to avoid breakdown of plastics to produce secondary microplastics in the sludge treatment process. This will also provide additional benefit to the sludge treatment process, reducing overall costs.

6.1.4 Furthermore, a universally screened product will support the future delivery of markets for sludge treatment by providing a better quality product that could attract a lower gate fee from treatment providers. By improving raw sludge quality this will provide greater certainty on its specification for onward treatment, and final fate of the biosolids. The arrangement maintains maximum flexibility, aligned with our LTDS, as should sites cease digestion in future as we consolidate activities, the screening activity can be maintained and the assets will continue to be beneficial as a screened sludge can be directly exported into the digestion process.

6.1.5 Our PR24 capital cost estimating approach has been based on data collected over AMP3 to AMP7 and updated to reflect the present market conditions under which we and the UK water industry are operating. Mott Macdonald (MM) has provided us an estimating service over AMP6 and AMP7. They also provide an estimating service to a number of other UK water companies, which allows them to provide a benchmarked approach to our PR24 capital cost estimates.

6.1.6 MM have benchmarked UUW's direct costs and cost curves and assessed the water industry construction inflation based on their Construction Industry Basket of Goods index.

6.1.7 Delivery of this scheme will be across a portfolio of multiple projects, across multiple sites. We have experience of delivering work at all of these sites, and project managing the work to ensure that it is delivered effectively and efficiently, and as such we are confident that we have the technical skills and capabilities to deliver this work. Furthermore, we will drive delivery efficiencies through batching at a programme level or with other ongoing projects at site level.

6.2 Cost benchmarking

6.2.1 There are currently no agreed industry benchmarks for the cost of enhanced sludge screening to 0.6mm in two dimensions. We believe that our proposal in an industry first, as we will implement fine screening for all our sludge and across all our sites, going beyond current best practice, to minimise as far as possible microplastics and other foreign material in biosolids recycled to land.

6.2.2 [✂

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6.3 Assurance of this submission

6.3.1 Our WINEP development, including approach, cost estimating and scope development have been independently, technically assured by ARUP to ensure that we only do what we need to do and at the most efficient cost for customers. At the time of assurance our enhanced sludge screening proposal formed part of our proposal submission and the need and cost estimating was assured through this process. Relevant extracts from ARUP's assurance report is provided below:

"An efficient programme is proposed to maximise the benefits of the enhanced biosolids produced."

"The core pathway is straightforward to deliver, using well understood technology and presents an affordable option… The additional investments in screening, storage and enhanced sampling are in line with our expectations".

7. Customer protection

7.1 Introduction

7.1.1 It is important that customers have confidence that we will deliver the enhancement schemes that get reflected in our PR24 final determinations and they are suitably protected in the event of non-delivery, or if there are material changes to deliverables (including changes to dates), which leads to a change in cost (including changes in the timing of required expenditure). Ofwat proposes that, if companies fail to deliver or are late delivering improvements to customers, then price control deliverables (PCDs) should, where appropriate, be used to compensate customers. In our PR24 *Chapter 8 - Delivering at efficient cost, section 8.8.9* we have proposed an approach to PCDs that aims to provide customer protection, such that customers are fairly compensated for non-delivery (such as due to a change in regulatory requirements) or late delivery (including as a result of a change to a regulatory date), between PCDs, any related ODI underperformance payments, and cost sharing arrangements.

7.2 Price Control Deliverable

Table 8: PCD summary

Scheme delivery expectations	
Description of deliverable	Sludge that has been fine screened.
Output measurement and reporting	The outcome is for 100.00% of our sludge to be fine screened to ensure that levels of non-degradable physical contaminants in biosolids as low as possible. There is a direct relationship between installing the fine screen capacity and the delivery of the outcome for customers. Sludge treatment centre throughput (TDS) is used to calculate the percentage contribution of each site to delivering the outcome of 100.00% of sludge that has been fine screened. We have used our 2022 baseline of sludge treatment centre throughput as a baseline target and this will be reviewed each year. 100% delivery of the PCD demonstrates all incumbent sludge across the region has been fine screened. We will report PCD performance to Ofwat as an additional item as part of our Annual Performance Reporting (APR) process. Performance will be measured on 31 March each year, and will be demonstrated through a Project in Use output. Sludge is managed as a system and the PCD outcome (Sludge that has been fine screened) will be delivered if screening capacity is in place anywhere within the system i.e. at the site of production, treatment or distribution to agriculture. This provides opportunities for flexibility, market delivery and innovation in the delivery of the outcome.
Assurance	We will report (and assure) PCD performance to Ofwat as an additional item as part of our APR process. Project in Use outputs will be used as evidence to confirm delivery of the PCD outcome.
Conditions on scheme	None
Impact on PCs	None

7.2.1 In our PCD template *UUW32-PCD Excel Sheet* we have assumed a wholesale WACC of 3.23%, in line with Ofwat's guidance. We have assumed a 50% totex cost sharing rate, which is applied before calculating PCDs. We have applied a further 50% for Bioresources (where applicable), to ensure that only 25% of Bioresources totex is at risk from PCDs, given the lack of RCV guarantee, and general uncertainty in cost recovery from future Bioresources price controls. For late delivery we have applied a proportionate value of annual opex, and assumed 3.5% of capex, which provides a fair reflection of the time value of money of any related deferred capital spend.

Table 9: PCD delivery profile

	Unit	AMP8	2024	2025	2026	2027	2028	2029	2030	Ultimate delivery
Cumulative delivery target for PCD	**%**				**-**	**33.00**	**66.00**	**100.00**	**100.00**	**100.00**
AMP8 Capex (22/23 pb)	£	54,196,143	-	-	17,884,727	17,884,727	18,426,689	-	-	54,196,143
AMP8 Opex (22/23 pb)	£	-63,021	-	-	-	- 6,955	- 13,911	- 21,077	- 21,077	- 63,021
ODI impact per unit of PCD volume	£/%	0.00								

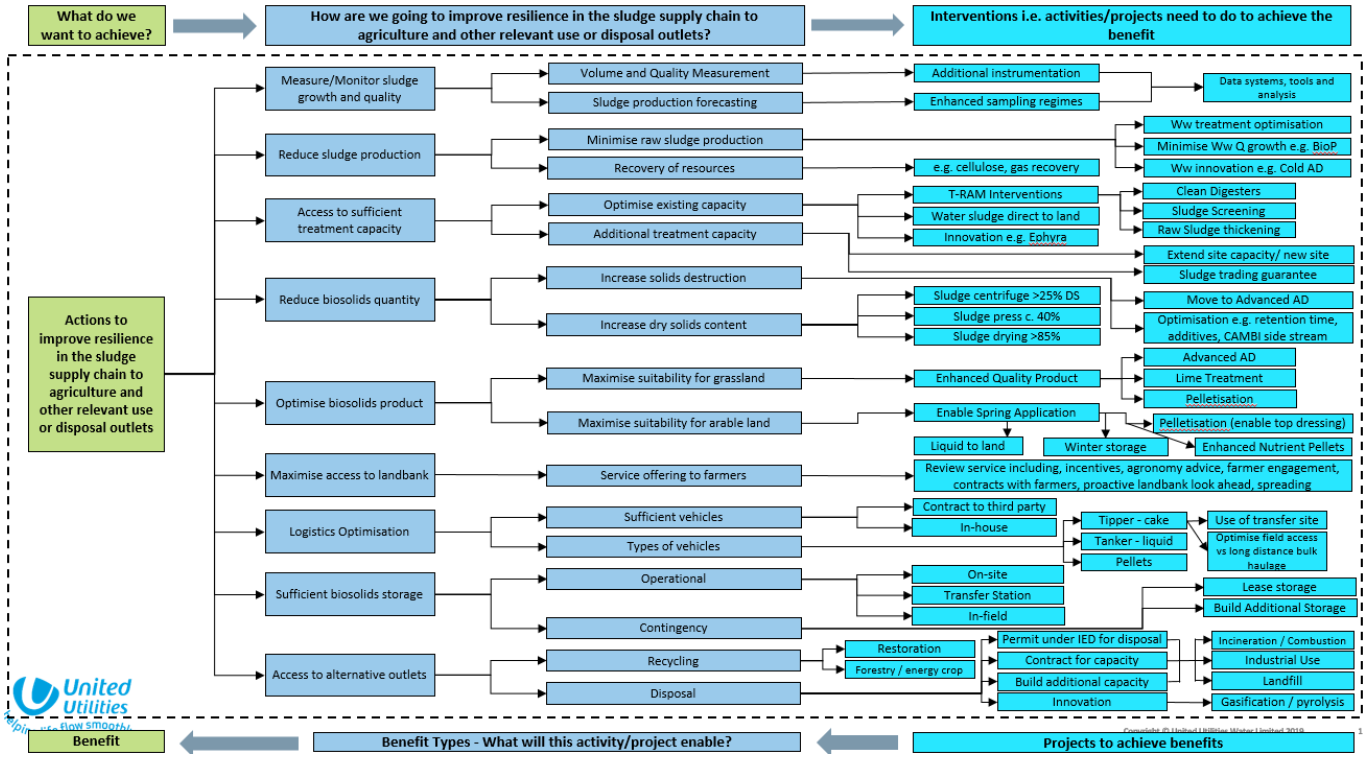
Table 10: Price Control Allocation

Price Control	Unit	Price Control Allocation
Water resources	%	0.00%
Water network+	%	0.00%
Wastewater Network+	%	0.00%
Bioresources	%	100.00%

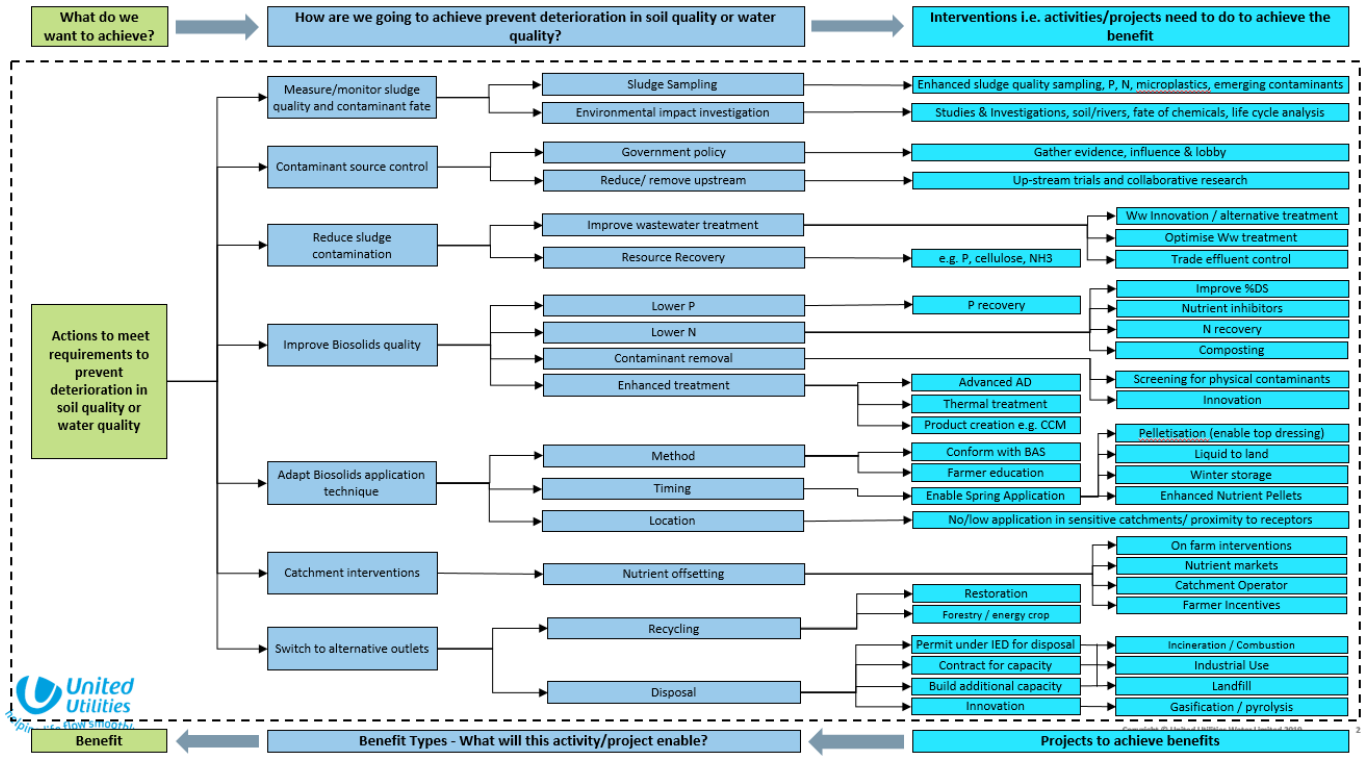
Table 11: PCD Incentive rates

	Unit	WR	WN+	WwN+	BR
Overall delivery	£/%	0	0	0	135,333
Time value rate	£/%	0	0	0	4,371
Late delivery	£/%	0	0	0	9,055

Appendix A Benefits mapping of generic control measures



Source: United Utilities, 2022



Source: United Utilities, 2022

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United Utilities

Water for the North West

UUW66

Bioresources preparatory works for alternative outlets

October 2023

Enhancement Case 24

United Utilities

Water for the North West

Contents

1. Enhancement submission

<table>
<tr><th colspan="2">Enhancement submission</th></tr>
<tr><td>Title:</td><td>Bioresources preparatory works for alternative outlets

An enhancement case to deliver preparatory works for uncertain and long term options for alternative biosolids disposal outlets.</td></tr>
<tr><td>Price Control:</td><td>Bioresources</td></tr>
<tr><td>Enhancement headline:</td><td>This document sets out the enhancement case for £10.394 million totex investment to deliver preparatory works for uncertain and long term options for alternative pathways in our bioresources Long Term Delivery Strategy (LTDS).

We anticipate that biosolids recycling to agriculture will reduce over time to match the growing environmental ambitions of customers and regulators. We led collaborative industry and Environment Agency (EA) national landbank modelling which has demonstrated that there is a significant risk of landbank shortfall for up to two thirds of biosolids nationally, although there remains considerable uncertainty over the scale and timing of this change.

Our core pathway is to continue to recycle biosolids to land, as this is considered the best practicable environmental option for sludge management in most circumstances. However, a lack of access to alternative outlets or treatment technologies for sludge when agricultural land is not available demonstrates that long-term planning for sludge management requires investment.

Unless we act now and start to plan and accelerate deployment of alternative, uncertain and long term options, we face a risk of being unable to provide a resilient sludge management service, and ultimately having no disposal outlet for sludge. The actions outlined in this enhancement case to start preparatory works in AMP8, will deliver feasibility assessments, planning, detailed design, and permitting of drying and thermal treatment technologies, as a higher value alternative to incineration. These advanced works have the potential to accelerate the implementation of these outlets by up to three years and to inform PR29 planning for landbank resilience needs.

These activities, relating to future enhancement activities, and increasing our level of business resilience in response to external challenges outside our control, are not covered by base expenditure.

Through this enhancement case we are aligning with the principles set out in Ofwat’s final methodology to seek to mitigate significant landbank risks by delivering low regrets preparatory works in AMP8, aligned with our LTDS.</td></tr>
<tr><td>Enhancement expenditure

(FY23 prices)</td><td>
<table>
<tr><th></th><th>AMP8 Capex (£m)</th><th>AMP8 Opex (£m)</th><th>AMP8 Totex (£m)</th></tr>
<tr><td>Pre RPE and Frontier Shift</td><td>10.569</td><td>0.000</td><td>10.569</td></tr>
<tr><td>Post RPE and Frontier Shift</td><td>10.394</td><td>0.000</td><td>10.394</td></tr>
</table>

The table above shows the total expenditure on both a pre-efficiency (i.e. pre frontier shift and real price effects basis, consistent with the cost data tables), and a post efficiency and RPE basis (i.e. consistent with the value we propose to be recovered from price controls). All numbers referenced hereafter in this enhancement case are on a post efficiency and RPE basis.</td></tr>
</table>

This case aligns to :	Bioresources Long Term Delivery Strategy Drainage and Wastewater Management Plan (DWMP), 2023. For full reconciliation between enhancement costs and data table lines, see enhancement mapping tabs in *UUW117 – Project allocations CW3 and CWW3.*
PCD	No

2. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	• This document sets out the enhancement case for £10.394 million totex investment to deliver preparatory works for uncertain and long term options for alternative pathways in our bioresources Long Term Delivery Strategy (LTDS). • Biosolids recycling to agriculture is entirely dependent on access to third party landbank and acceptance of our products by farmers and land managers. We led collaborative industry and Environment Agency (EA) national landbank modelling which has demonstrated that there is a significant risk of landbank shortfall for up to two thirds of biosolids, although there remains considerable uncertainty over the scale and timing of this change. • Unless we act now and start to plan for alternative, uncertain and long term options, we face a risk of being unable to provide a resilient sludge management service, and ultimately risk having no outlet for sludge disposal in future AMPs. • These actions will deliver: – Feasibility assessments, planning, detailed design, and permitting of sludge drying and thermal treatment technologies, as a higher value alternative to incineration, for up to 100 per cent of United Utilities' sludge. – The potential to accelerate the implementation of alternative pathways on our LTDS by up to three years, and inform PR29 planning over landbank resilience needs. – Alignment to the long-term strategy for bioresources in England, keeping alternative pathways open on our adaptive plan for maximum flexibility. • As these actions relate to future enhancement investment needs to increase bioresources service resilience standards, and in response to challenges outside management control, the investment need is not covered by base expenditure.	Section 4 4.2 4.3 4.6
Best option for customers	• We have considered a range of options including 'do nothing'. We are presenting the lowest cost option in AMP8 to ensure that we are able to plan for the future and improve the long term resilience of our sludge management service. • We have ensured that our proposed investment is efficient through alignment with our LTDS. We anticipate that biosolids recycling to agriculture will reduce over time to match the growing environmental ambitions of customers and regulators. However, there remains significant uncertainty over the scale and timing of the changes. We have therefore deferred significant investment (an additional circa £1 billion) to implement actions to move away from biosolids recycling to agriculture in AMP8. There is a risk that this investment may not be completely required and investing significantly now could be detrimental for customers. • Advanced planning for long term and uncertain activities ensures we are able to deliver the best long-term service for customers, rather than a short term focus on compliance with current regulations. • This investment will create new partnership opportunities, and the potential for collaborative innovation to accelerate deployment of new technologies for sludge treatment and disposal, and increase the long term value proposition for bioresources.	Section 5 5.1 5.2 5.4

Gate	Summary	Location reference
Cost efficiency	• Our capital cost estimates are based on data collected over AMP3 to AMP7 and updated to reflect the present market. Mott Macdonald provides our estimating service, and also to a number of other water companies, which allows them to provide a benchmarked approach to our PR24 capital cost estimates. • The requested costs represent a minimal one per cent of the total likely investment need in AMP9 and beyond, should we be required to move away from biosolids recycling to land. This proportion of investment spend upfront, where we have maximum ability to influence the overall success and outcome of the project, is in line with other projects of this scale and benchmarked norms for project delivery. • Our LTDS approach, cost estimating and scope development have been independently assured by ARUP to ensure that we only do what we need to do and at the most efficient cost.	Section 6 6.2 6.3
Customer protection	• It is part of our statutory licence obligation that we must ensure long-term resilience. We can achieve optimal resilience through alignment with our LTDS, to enable options with a longer lead-in time to be included in future programmes of work more effectively. • As a long term investment, this activity will not directly contribute to any AMP8 performance commitments and there is no cost sharing mechanism with customers in the bioresources price control. • This enhancement case is restricted to preparatory works only. Actions associated with construction and delivery of new assets to move to alternative outlets are outside scope of this enhancement case. The need for additional investment to progress with these activities will be determined at PR29 and will form part of our PR29 business plan submission, as appropriate. • In line with Ofwat's guidance on developing PCDs the scope of the enhancement case is significantly below the materiality threshold to require a Price Control Deliverable. • In our wider business plan submission we promote management of significant regulatory risks impacting on landbank availability through an uncertainty mechanism (Notified item), should risks accelerate in AMP8. Should we be required to accelerate deployment of these works in AMP8, this scope of works will not be abortive and would still be required for at least a significant proportion of our biosolids.	Section 7 7.1

3. Introduction

3.1 Document purpose

3.1.1 This document sets out the scope of the £10.394 million enhancement investment required to deliver planning and design activities for alternative outlets for biosolids disposal. These are currently uncertain and long term options, and additional work is required in AMP8 to define and accelerate these options, ahead of PR29, to inform our long term investment strategy.

3.1.2 Biosolids recycling to agriculture is the sole outlet for the majority of our biosolids, and is dependent on access to third party landbank and acceptance of our products by farmers and land managers. We anticipate that over time biosolids recycling to agriculture will become increasingly constrained to match the growing environmental ambitions of customers and regulators. It is therefore vital that we are resilient to the possibility of loss of this outlet. While we know that the future will not be 'business as usual' there is significant uncertainty over the scale and timing of this change.

3.1.3 This document explains why these landbank pressures are outside of management control and how we are seeking to manage and mitigate risks through our Long Term Delivery Strategy (LTDS). We explain our approach to solution development for alternative outlets and how we have ensured costs are robust and efficient. By undertaking advanced planning works now, we will accelerate delivery by up to three years and keep alternative pathways open on our adaptive plan for maximum flexibility.

3.1.4 We have submitted two separate enhancement cases to deliver 'no regrets' activities in AMP8 to improve landbank resilience to sustain biosolids recycling to agriculture. These enhancement cases are:

- **WINEP sewage sludge drivers** [**UUW66**]: A £169.965 million enhancement case to enable delivery of the statutory requirements identified in the Water Industry National Environment Programme (WINEP) under the sewage sludge drivers and targeted at delivering resilience in the sludge management supply chain to agriculture.
- **Improving resilience in biosolids recycling to agriculture** [**UUW66**]: A £54.133million enhancement case to increase the resilience of the agricultural outlet for biosolids, by improving product quality through the enhanced removal of non-degradable contaminants (such as microplastics) and thereby support market acceptance of higher quality products.

3.1.5 The two enhancement cases above aim to sustain biosolids recycling to agriculture and are considered 'no regrets' activities in our LTDS. This enhancement document differs as the scope of this case starts to look at activities required to move away from our core pathway of biosolids recycling to agriculture.

3.1.6 In addition, we seek to manage significant but uncertain risks impacting on landbank availability, through an in-AMP uncertainty mechanism (Notified item), should landbank availability decline and exceed trigger points within our LTDS and we need to accelerate investment activity into AMP8.

3.2 Structure

3.2.1 We have divided our enhancement case into the following sections:

(a) The remainder of this section provides additional background and summarises the scope of this enhancement case.

(b) **Section 4** provides an overview of the increasing pressures on landbank availability, presenting the outputs of quantitative landbank modelling. We provide an overview of our LTDS, including core and alternative pathways, and provide evidence of the need for enhancement investment to undertake further planning works in AMP8.

(c) **Section 5** sets out our approach to optioneering to demonstrate that we have considered a range of options, including 'do nothing'. Our enhancement case presents the least cost solution to manage long-term landbank resilience risks.

(d) **Section 6** provides evidence that our costs to deliver our enhancement scope are efficient. Our LTDS, cost estimating and scope development have been independently assured by ARUP to ensure that we only do what we need to do and at the most efficient cost.

(e) Finally, in **Section 7** we explain how customers are protected if the investment outcomes are not delivered.

3.3 The need for bioresources long-term adaptive planning

3.3.1 To ensure that we continue to deliver an efficient bioresources service we need to make decisions as to how best to manage sludge services now, and over the long term. We continuously produce sewage sludge with the majority of biosolids produced beneficially recycled to agricultural land, in line with the current UK best practicable environmental management approach in most circumstances. This practice provides multiple environmental and economic benefits to the North West and beyond.

3.3.2 As we described in our 2021 discussion paper[1], we are in an unprecedented period of change with regards to the management of sludge. Against a backdrop of increasing challenges from climate change, environmental standards, market competition, volume of sludge production and emerging risks posed by novel chemicals, we and the rest of the water industry, accept the need to continue to improve performance to protect and enhance the environment.

3.3.3 However, the unintended consequence of disparate environmental and economic regulatory changes is that it results in significant uncertainty over the management of sludge in the short, medium and longer term. Taken in isolation the true impact of these changes is not immediately evident, but when the cumulative impact of all these changes is considered, and in combination with the ambition to develop a contestable bioresources market, it has become clear that the industry is at a critical juncture: There is now considerable uncertainty over the sustainability of biosolids recycling to agriculture and it is no longer clear if recycling to agriculture, will continue to be viewed by all stakeholders as the best practicable environmental option.

3.3.4 Moreover, biosolids recycling to agriculture is entirely dependent on access to third party landbank and acceptance of our products by farmers and land managers. The reliance on agricultural land as an outlet makes this area of the business vulnerable to changing market demands. An increasing number of factors that are outside of company control threaten the availability of landbank for biosolids recycling. We led collaborative industry and EA national landbank modelling which has demonstrated that there is a significant risk of landbank shortfall for up to two thirds of biosolids nationally. The resilience of our biosolids disposal service is one of the company's top ten most significant event based risks and is highlighted in our annual report[2].

3.3.5 To date, all water company planning and cost model allowances have been based on a surplus of available landbank, and the assumption that companies do not need to compete for a finite landbank resource. Should landbank investment needs crystallise the base cost allowance is insufficient to deliver the scale of investment that would be required to move away from biosolids recycling to agriculture. We estimate our costs would be in the order of £1 billion. The impact is anticipated to be an entire step change in the business model for bioresources, and would take many years to implement fully.

3.3.6 Our 2021 discussion paper which highlighted the multitude of changes impacting on the sector, was instrumental in leading to developing the long-term strategy for bioresources in England (2023)[3]. The strategy identified that there are multiple alternative pathways for biosolids disposal, but there is need to innovate and develop the markets and technologies ahead of widespread deployment. The strategy

[1] United Utilities, *Unlocking greater value through a national bioresources strategy*, November 2021 [Online] https://www.unitedutilities.com/globalassets/documents/pdf/unlocking-greater-value-through-a-national-bioresources-strategy.pdf
[2] United Utilities Group PLC, *Integrated Annual Report and Financial Statements for the year ended 31 March 2023* [Online: page 69] https://unitedutilities.annualreport2023.com/media/2monspzj/31404-united-utilities-ar-2023-fully-linked-singles.pdf
[3] The long-term strategy for bioresources in England was published in 2023. This collaborative piece of work, which UU were instrumental in initiating, provides direction for the English water sector on what the future for bioresources management may look like. Reference: CIWEM, *Developing a long-term strategy for bioresources in England*, 19 September 2023 [Online] https://www.water.org.uk/news-views-publications/publications/strategy-bioresources

advises against the use of short term, inflexible incineration solutions as an alternative to agricultural outlets as these will not increase the value recovered from bioresources.

3.3.7 We have developed an adaptive plan that enables us to navigate through the uncertainty and make significant investment decisions at an appropriate point in time. Our bioresources LTDS, aligning with the multiple alternative pathways set out in the long-term strategy for bioresources in England, is detailed in *UUW12 - Long term delivery strategy*.

3.3.8 We have identified through our LTDS that insufficient outlet for biosolids disposal is the most significant factor triggering deviation to alternative pathways on our adaptive plan. Moreover, these routes are dependent on technological development and innovation and therefore we need to accelerate planning works associated with moving to alternative outlets. Unless we undertake these critical planning activities now, we will lose flexibility within our LTDS to adopt the pathways when required, as the implementation time will be too great if we wait to exceed a trigger to move away from biosolids recycling to land.

3.3.9 While there remains significant uncertainty over the scale and timing of potential landbank constraints, we have deferred significant investment to implement actions to move away from biosolids recycling to agriculture in AMP8. There is a risk that this investment may not be completely required and this could be more detrimental for customers. We are instead presenting the lowest cost option in AMP8, to undertake preparatory works for long term options, to ensure that we are able to plan for the future and improve the long term resilience of our sludge management service.

3.3.10 We note within Ofwat's final methodology, whilst there remains scepticism over the need for the adaptive planning framework to address risks regarding the use or disposal of sludge, there is a readiness to *"consider any proposals from companies against key principles for funding preparatory work for uncertain and long-term options"*[4]. Through this enhancement case we are aligning with the principles set out in Ofwat's final methodology to seek to mitigate significant landbank risks by delivering low regrets preparatory works in AMP8, aligned with our LTDS.

3.3.11 As we discuss further in supplementary document UUW58 – Bioresources Business Plan, given the level of uncertainty and substantial level of investment potentially required across the sector, it would be appropriate for there to be national policy, accompanied by a plan agreed with regulators, for any transition from landbank to alternative outlets. This would provide the certainty required to implement a proactive and successful adaptive plan for the bioresources sector. This may be defined through further collaborative work to deliver the recommendations set out in the long-term strategy for bioresources in England.

3.4 Alignment with the sewage sludge drivers in the WINEP

3.4.1 Recognising that an increasing number of factors that are outside of company control threaten the resilience of the sewage sludge supply chain to agriculture, the EA has developed two new WINEP sewage sludge drivers for AMP8.

3.4.2 Actions included in the WINEP and approved by the EA under the sewage sludge drivers, fit within the EA's focussed "Storage+ assessment". Approved actions are only storage and other actions which deliver improvements in sludge quality and handling prior to storage and before supply to agriculture. The narrow approach of the WINEP sewage sludge driver assessment means that significant landbank risks and drivers will not be addressed by the AMP8 WINEP. The sewage sludge driver actions are based on the continued reliance of recycling of biosolids to land and there being sufficient available landbank.

3.4.3 The EA assessment specifically excluded actions to move away from sludge recycling to agriculture, and manage landbank availability risks, stating:

[4] Creating tomorrow, together: *Our final methodology for PR24 Appendix 4 – Bioresources control,* December 2022 [Online page 12] https://www.ofwat.gov.uk/wp-content/uploads/2022/07/Appendix-4-Bioresources-control.pdf

"The sludge (use in agriculture) driver supports actions to bring change to the way sludge is managed to ensure its soil conditioning and fertiliser value meets its full potential… there is a presumption that there is not support in principle for options such as thermal destruction technologies"[5].

3.4.4 To provide an example of the risks not covered by the sewage sludge WINEP drivers, we note that Ofwat's final methodology specifically calls out compliance with Farming Rules for Water as one of the risks to be managed through the WINEP sludge drivers. The methodology states:

"Farming rules for water: PR24 WINEP sewage sludge driver aims at delivering improvements in the resilience of the sludge management chain. This process provides a framework for addressing risks related to the use or disposal of sewage sludge over the 2025 to 2030 period"[6].

3.4.5 We are keen to highlight that while this may have been the intention at the time the methodology was written, the subsequent "focussed assessment" by the EA, in collaboration with Ofwat and Defra, has meant that several investment drivers, including adaptations to comply with Farming Rules for Water are out of scope of the WINEP. Should Farming Rules for Water risks (or any others) materialise, there must be recognition of these legitimate enhancement costs through another route, outside of the WINEP.

3.4.6 We are proposing this enhancement case, to proactively address risks of a shortfall in landbank, as a standalone enhancement case, as this is now clearly outside of the AMP8 WINEP.

3.5 Scope of this enhancement case

3.5.1 We propose minimal AMP8 enhancement investment to fund preparatory work for uncertain and long-term options, associated with alternative pathways and outlets on our bioresources LTDS. Full adaptation to alternative pathways will cost in the order of £1 billion, and this case is for £10.394 million which represents one per cent of the total cost. This minimal, low regrets investment will keep options open for the long term and accelerate timescales for delivery, helping to mitigate the risk that we have no alternative outlet in the event of a loss of landbank.

3.5.2 The costs of this enhancement case are summarised in Table 1 below. We will deliver early project development activities to progress the project sufficiently, that upon completion, we are in a position (if required) to commence formal procurement with a defined project scope and cost for sludge drying and thermal treatment technologies, for up to 100 per cent of our sludge. All activities will be complete to inform our PR29 submission.

Table 1: Summary of enhancement case costs

	FY26	FY27	FY28	FY29	FY30	Totex (£m)
Capex	2.079	3.638	3.638	1.039	-	10.394

Source: United Utilities, 2023

3.5.3 This work goes beyond concept and innovation trials, to determine how to deploy alternative outlets for biosolids disposal, including land requirements, planning and permitting requirements, heat and energy balance, integration with existing assets, and operational and maintenance requirements.

3.5.4 The milestone outputs on completion of the enhancement case scope of works includes:

- Land purchase agreements (as necessary)
- Outline planning permission
- Environmental Impact Assessment complete and submitted to regulators

[5] Environment Agency Information Letter (EA/12/2023), *Water Industry National Environment Programme - Sludge (Use in Agriculture) update*, 19 May 2023

[6] Ofwat, Creating tomorrow, together: *Our final methodology for PR24, Appendix 4: Bioresources control*, December 2022 [Online page 13] https://www.ofwat.gov.uk/wp-content/uploads/2022/07/Appendix-4-Bioresources-control.pdf

- Employers Works Information complete

3.5.5 The completed output will ensure that we are able to commence formal procurement, with a defined project scope and cost, if required at that time.

3.5.6 This enhancement case is restricted to preparatory works only. Actions associated with construction and delivery of new assets to move to alternative outlets are outside scope of this enhancement case. The need for additional investment to progress with these activities will be determined at PR29 and will form part of our PR29 business plan submission, as appropriate.

3.5.7 Should landbank availability decline and exceed trigger points within our LTDS mid-AMP and we need to accelerate investment activity into AMP8 to delivery these activities, we seek to manage this risk through an in-AMP uncertainty mechanism (Notified item). Please refer to *UUW58 – Bioresources Business Plan* for more detail.

4. Need for enhancement investment

4.1 Obligation to provide a resilient sludge disposal service

4.1.1 The safe treatment and recycling of sludge is a critical part of our service to customers and the environment. Typically within the UK, sludge is treated using anaerobic digestion, and the resulting biosolids are mostly recycled to agricultural land. This process has many significant environmental and economic benefits; anaerobic digestion creates the opportunity to generate renewable electricity or green gas; and biosolids applied to land are a valuable source of nitrogen and phosphorus, as well as other plant nutrients and organic matter, which can provide long-term benefits to soil structure and fertility and sequester carbon.

4.1.2 The recycling of biosolids to land is recognised as being the best practicable environmental option by the European Union and UK Government in most circumstances. The water industry has increasingly invested in advanced anaerobic digestion to recover greater quantities of renewable energy, whilst also producing a higher quality biosolids product to recycle to agriculture and ensure that the value recovered is maximised.

4.1.3 Biosolids recycling is carefully controlled through voluntary compliance with the Biosolids Assurance Scheme (BAS) standard to ensure risks are managed through best practice activities. However, it is becoming increasingly apparent that there are significant, emerging challenges. The reliance on agricultural land as an outlet makes this area of the business vulnerable to changing market demands and an increasing number of factors that are out of company control threaten the availability of landbank for biosolids recycling. There is now considerable uncertainty over the sustainability of biosolids recycling to agriculture and it is no longer clear if recycling to agriculture will continue to be viewed by all stakeholders as the best practicable environmental option.

4.1.4 The obligation for water companies to plan their sludge recycling operations is succinctly described in the NEP:

"We expect Water and Sewerage Companies (WaSCs) to manage their sewage sludge in a sustainable way and follow circular economy principles in line with the Urban Waste Water Treatment Regulations (UWWTR) 1994 and associated legislation. Optimal resilience in sludge management is achieved through the development of a long-term sludge strategy, therefore WaSCs should plan to a time horizon to enable options with a longer lead-in time to be included in future programmes of work more effectively. While it may not be possible to identify all the longer-term actions required, we expect to see the decision points for this longer-term programme of work in business plans. The overall strategic direction is to balance the need to have an end use for sewage sludge (against environmental impact (including water quality and soil health), land availability and crop need. This Driver requires water companies to consider the lifecycle of the sewage sludge they create to deliver a resilient sludge management chain for current and future needs[7]".

4.1.5 There is now a clear need to provide a greater level of sludge outlet resilience than planned at PR19. At PR19 the loss of the sludge recycling outlet to land was considered a long-term possibility, but this is now considered a near-term possibility, and a medium-term probability. It seems more likely that the outlet will be lost by insufficient national landbank resulting from the cumulative impacts of a multitude of drivers, rather than a direct regulatory ban which could provide time to plan against the change. The resilience of our biosolids disposal service is one of the company's top ten most significant event based risks. Unless we act now and start to plan for alternative, uncertain and long term options, we face a risk of being unable to provide a resilient sludge management service, and ultimately risk having no outlet for sludge disposal in future AMPs.

[7] Natural Resources Wales, *NRW PR24 Driver – Biosolids and Bioresources*, 05 April 2022, Version 1

4.1.6 It is part of our statutory licence obligation that we must ensure long-term resilience. We note that Ofwat's duties[8] under Section 2 of Water Industry Act 1991 as amended, enable this activity to:

"Further the resilience objective to secure the long-term resilience of water companies' water supply and wastewater systems; and to secure that they take steps to enable them, in the long term, to meet the need for water supplies and wastewater services".

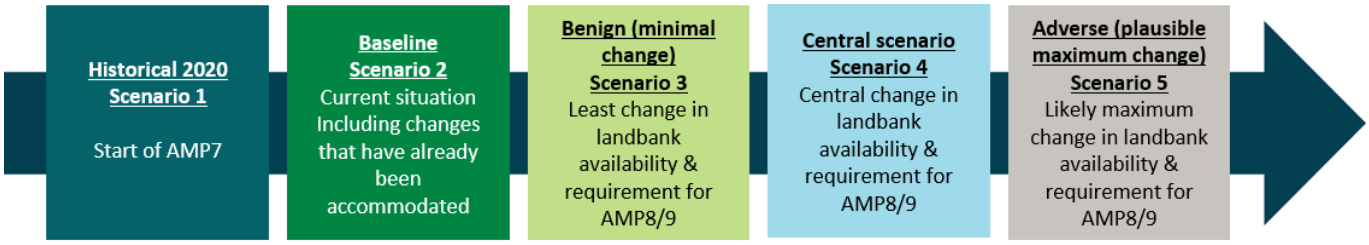
4.1.7 We need to adapt our bioresources service to ensure that we meet our obligations to treat and dispose of wastewater responsibly and help to deliver a cleaner, healthier environment, benefitting people and the economy. In the absence of a statutory planning framework for bioresources we, uniquely across the industry, included consideration of sludge management needs within our 2023 Drainage and Wastewater Management Plan (DWMP). Within this plan it is clear that we need to increase the resilience and capacity of our sludge management system to be able to continue to provide a resilient disposal service. It is important to take a long term view with regard to bioresources management to ensure that we are able to continue to provide a resilient service and that options represent best value in the long term.

4.2 Landbank constraints

4.2.1 We have undertaken both national and company landbank modelling to quantify the risk of having insufficient outlet for biosolids disposal. Sludge recycling to land is entirely dependent on access to third party landbank and the sufficiency of available landbank is fundamental to being able to continue to recycle biosolids to agriculture. Collaborative landbank modelling was instigated through the risk and issue identification process for the WINEP sewage sludge drivers, although actions to address landbank availability risks are now out of scope of approved actions under the WINEP drivers (see Section 3.4).

4.2.2 Through the landbank modelling we have sought to identify the plausible extremes of landbank availability through identification of benign, central and adverse scenarios. In Figure 1 below we summarise the increasingly stringent modelling scenarios. While all modelling scenarios were collaboratively agreed by the EA and water industry, and tried to capture the full range of variables to generate accurate modelling, several key uncertainties remain that cannot be modelled or forecast, and the impact of uncertainty increases as we project further into the future.

Figure 1: Increasingly stringent modelled landbank scenarios



Source: United Utilities, 2023

4.2.3 Landbank availability is a balance between the following two key parameters:

- **Landbank available**: Total agricultural area available, less legislative and physical restrictions including topography, watercourses, environmental designations, crops unable to accept biosolids and odour buffer zones.
- **Landbank required**: Assessment of the probable acceptability of biosolids products on farm, the application rate and the minimum frequency of return to land. This is influenced by background soil phosphorus concentrations and competition from other organic wastes (i.e. livestock farms have a surplus of their own farmyard manures). As biosolids cannot be applied to the same field year-on-year the landbank required is greater than the area that biosolids will be applied in any one year.

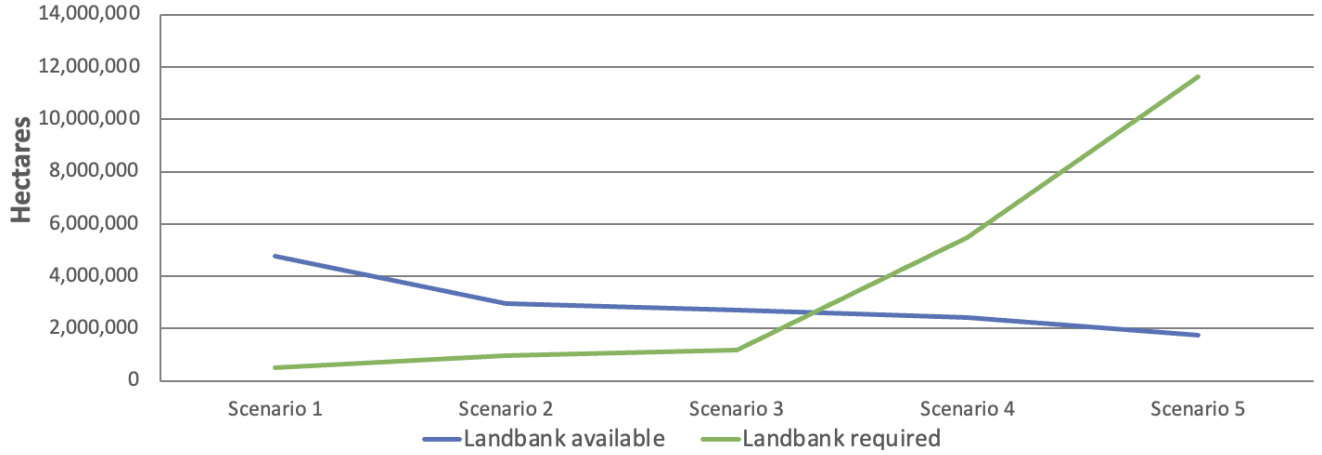
[8] Ofwat, *Our duties*, [Access Online September 2023] https://www.ofwat.gov.uk/about-us/our-duties/

4.2.4 Raw sludge growth is being driven by population growth and is accelerated by stringent wastewater final effluent standards to meet Environment Act phosphorus targets[9]. By 2030, the annual total quantity of sewage sludge produced in the North West is forecast to increase by around 11,500 TDS per annum from current levels. As well as a greater volume of sludge for disposal leading to a greater landbank requirement, we expect that more stringent phosphorus final effluent standards will lead to a doubling of phosphorus loading in biosolids. Phosphorus is a limiting factor in determining biosolids applications rates and greater concentrations will increase the biosolids application return rate, creating a significantly greater landbank requirement.

4.2.5 We summarise in Figure 2 below the results of the national landbank modelling. Under all scenarios, landbank becomes progressively more difficult to access over time, and we will need to drive increasing distances, increasing our costs, to be able to continue to recycle all biosolids to land. Moreover, as available land becomes more limited, it becomes a shared resource with companies competing for landbank capacity.

4.2.6 It is important to note there are other factors which are difficult to model, but may have quite immediate and binary impacts on the availability of landbank, for example, the loss of public sentiment supporting biosolids recycling to agriculture. This may lead to a rapid and permanent collapse of the biosolids market to agriculture.

Figure 2: Summary of landbank modelling results



Source: Grieve Strategic in association with RSK ADAS, National Landbank Assessment, 2023

4.2.7 For scenarios one, two and three there is sufficient available agricultural land to recycle all national biosolids. There are 'hotspots' of competition where biosolids will have to be transported further, but biosolids recycling under these circumstances is manageable. For scenarios four and five there is a step-change and there is insufficient available agricultural land to recycle all biosolids.

4.2.8 The drivers causing the greatest impact in moving from scenario three to scenarios four and five are:

- Constraints on nitrogen in relation to autumn applied biosolids, and increased phosphate constraints to meet the EA interpretation of Farming Rules for Water, rule 4(1). The effect of the constraints on autumn applied biosolids equates to an extra circa 2.5 million hectares landbank required under scenario four and an extra circa 6 million hectares for scenario five (over scenario two).
- Increased biosolids quantities and phosphorus content of biosolids (driven by wastewater WINEP investment). Increased quantities and phosphorus content constraints of scenario four equates to an extra circa 750,000 hectares landbank required and an extra circa 2 million hectares for scenario five

[9] UK Statutory Instruments, the Environmental Targets (Water) (England) Regulations 2023, No. 93, PART3. Regulation 10: The second target in respect of water is that the load of total phosphorus discharged into freshwaters from relevant discharges is, by 31st December 2038, at least 80% lower than the baseline. [Online] https://www.legislation.gov.uk/uksi/2023/93/regulation/10/made

(over scenario two). However, even if using 'current' biosolids quantity and quality data there will still be insufficient land under scenarios four and four.

- New restrictions in sensitive sites/catchments to meet government nutrient neutrality ambitions.

4.2.9 Under scenario four, there is only sufficient land available to accommodate the continued recycling of approximately one third of all national biosolids. Alternative treatment and/or disposal outlets may be required for the remaining two thirds of biosolids.

4.2.10 It is clear the risks over landbank availability, whilst uncertain, are significant. Given the timescales involved to implement the scale of transformation required to move away from landbank, there must be a managed transition. We must act now and start to plan for alternative, uncertain and long term options, or risk being unable to provide a resilient sludge management service. Moreover, in the event of insufficient landbank being available there must be a mechanism to seek investment aligned to alternative pathways on our adaptive plan.

4.2.11 We note that a piecemeal approach by individual companies to adapt to alternative treatment and disposal outlets will lead to inherently inefficient and sub-optimal outcomes. We suggest that should we be required to move to alternative outlets for biosolids disposal there should be a coordinated industry approach enabled by alignment between the environmental and economic regulatory frameworks.

4.3 Long Term Delivery Strategy context

4.3.1 Given the uncertainty over the future availability of landbank and potential need for alternative outlets, we have developed an adaptive plan that enables us to navigate through the uncertainty and make significant investment decisions at an appropriate point in time. Further details of our LTDS can be found in document *UUW12 - Long term delivery strategy*. Our approach ensures that environmental outcomes can be delivered and the risk of inefficient investment is minimised.

4.3.2 The bioresources core asset pathway, for Advanced Anaerobic Digestion (AAD) and biosolids recycling to agriculture, is a continuation of our approach for AMP7. It has three key overarching principles:

(a) Centralise sludge treatment into fewer, larger AAD hubs

(b) Increase resilience against sludge supply chain disruption; and,

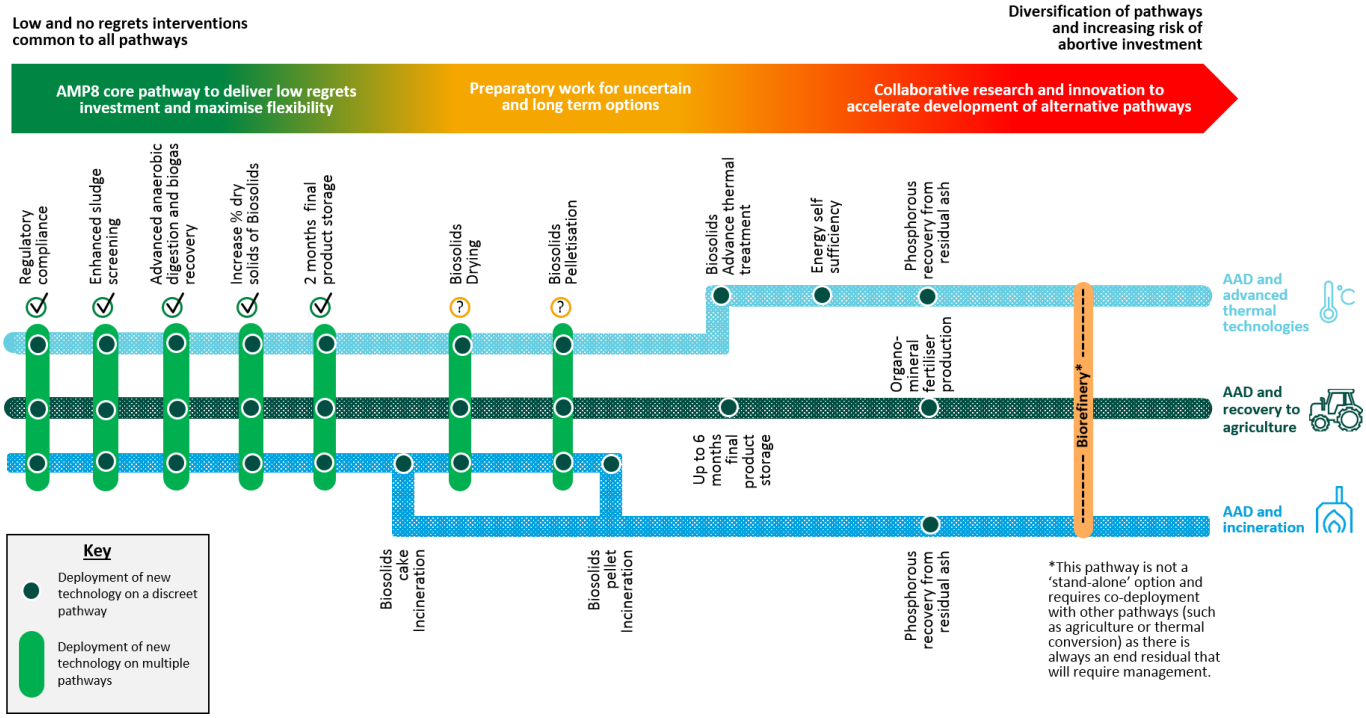
(c) Phased reduction in reliance on agricultural landbank over the longer-term.

4.3.3 This approach aligns to the best practicable environmental option for biosolids management in the UK, in most circumstances.

4.3.4 Whilst our core pathway is a continuation of our approach for AMP7, on-going horizon scanning of new and emerging issues, in conjunction with the risk and issues review instigated by the sludge WINEP drivers, has identified the need for an acceleration of this pathway compared to our PR19 position. There is now a clear need to provide a greater level of sludge outlet resilience than planned at PR19. At PR19 the loss of the sludge recycling outlet to land was considered a long-term possibility, but this is now considered a near-term possibility, and a medium-term probability.

4.3.5 We have submitted two separate enhancement cases to deliver 'no regrets' activities in AMP8 to improve landbank resilience to sustain biosolids recycling to agriculture. These actions are additional to work already completed in AMP7 to meet the latest BAS improvements. We demonstrate in Figure 3 that no regrets actions are common interventions that are beneficial across all potential pathways for biosolids disposal. This is shown by the green bars which span all three strategic pathways. Delivery of no and low regrets actions in AMP8 are indicated with ticks on the left hand side of the figure. Focus on these actions ensures environmental outcomes can be delivered and the risk of inefficient investment is minimised.

Figure 3: Indicative illustration of low and no regrets actions on our bioresources LTDS



Source: United Utilities, 2023

4.3.6 Moving to an alternative disposal outlet is not considered as part of the core pathway in AMP8 as these actions may be considered as abortive investment in the longer term, as there remains uncertainty over both timescales for change and the preferred alternative outlet for sludge disposal. These pathways will only be followed under more adverse landbank scenarios, and the additional activities may be described as 'higher-regret', relative to investments included in the core pathway. We have therefore deferred significant investment (an additional circa £1 billion) to implement actions to move away from biosolids recycling to agriculture.

4.3.7 However, as we set out in Section 4.2 landbank risks are significant and too great to do nothing in AMP8. Without action we risk shutting off alternative options, as they have a significant lead time (circa ten years) to implement when they may be needed. The minimal, low regrets investment set out in this enhancement case will keep options open for the long term and accelerate timescales for delivery, helping to mitigate the risk that we have no outlet in the event of a significant loss of landbank.

4.3.8 The long-term strategy for bioresources in England was published in 2023. This collaborative piece of work, which we were instrumental in initiating, provides direction for the English water sector on what the future for bioresources management may look like. The strategy identified that there are multi-faceted options available for the industry to deploy and consider, alongside regulatory, technological and market constraints. There are many beneficial environmental outcomes that are achievable through effective, circular bioresources management but there are also several environmental and health impacts that must be carefully mitigated.

4.3.9 We present in Table 2, a summary of the potential alternate outlets available. We show that the technology choice to treat and recycle sludge has a significant impact on the environmental outcomes which can be achieved. We highlight that these outcomes will not be delivered without concerted and congruent focus. The industry, regulators and stakeholders should agree on a workable vision for the future and the conscious outcomes we are working towards, to enable the full potential of the sector to be realised. In achieving these outcomes, we must also balance the opportunities against any risks associated with sludge.

4.3.10 Recognising the full range of treatment and disposal options available, and aligned to the long-term strategy for bioresources in England, we have identified three pathways for biosolids disposal (in additional to our core pathway of biosolids recycling to agriculture):

(i) **AAD and incineration** - Combustion of sewage sludge to remove any requirement for recycling to land. The resulting ash can be recovered in construction or disposal to landfill. The long-term strategy for bioresources in England warns against use of short term, inflexible incineration solutions as an alternative to agricultural outlets as these will not increase the value recovered from bioresources.

(ii) **AAD and advanced thermal technologies** – A group of technologies including pyrolysis and gasification to convert sewage sludge feedstocks using high temperatures into outputs such as chars, oils and syngas. Outputs may be disposed of, used for energy generation or recovered and re-used in wider industrial markets. These are novel technologies not deployed at scale in the UK and there is a need for further work to assess feasibility and (if appropriate) accelerate deployment.

(iii) **Biorefinery** – A resource recovery hub whereby a multitude of products may be recovered from sewage sludge feedstocks. This pathway is not a 'standalone' option and requires co-deployment with other pathways (such as sustaining agriculture or advanced thermal technologies) as there is always an end residual that requires disposal via another route. The pathway is currently limited by technology readiness to deploy and the maturity of markets, specifications, regulations and potentially the societal acceptance of outputs / products.

4.3.11 All alternative options for biosolids disposal require large-scale investment of circa £1 billion and will take multiple AMPs to deliver. A move to any of these alternative outlets represents an entire step-change in the bioresources business model.

4.3.12 ADAS in their 2022 report, assessing alternative routes for biosolids, concluded that:

"The only current technologies available for treatment, final use or disposal developed at a scale (other than use in agriculture) that can be implemented are those of incineration."[10]

4.3.13 This enhancement case is aligned with investment along the "AAD and advanced thermal technologies" pathway. This pathway has the potential to create significantly more beneficial outcomes than the incineration pathway, but there is need to understand thermal conversion outputs, operations, markets for outputs, integration within existing treatment works and the fate of contaminants within the process and outputs. The scope of this enhancement case is not restricted to one technology type, but will undertake a technological review as part of the scope of works, to understand what technology may be most appropriate to deploy. The planning and permitting works will be required, regardless of the final technology deployed.

[10] ADAS, *An assessment and evaluation of the loss of the biosolids-to-agricultural-land recycling outlet*, 23/03/2022

Table 2: Summary of biosolids treatment and outlet attributes

	Technology readiness	Scalability	CO_2 emissions	Renewable energy generation	Soil health	Water quality	Circular economy	Air quality	Emerging contaminants	Societal acceptability	Affordability	Practicality
Biosolids recycling to land (Advanced AD)	✓	✓	✓	✓	✓	✓	✓	✓	?	✓	✓	✓
Biosolids recycling to land (AD)	✓	✓	✓	✓	✓	✓	✓	✓	?	✓	✓	✓
Lime treated biosolids to land	✓	✓	x	x	✓	✓	✓	✓	?	x	✓	✓
Sludge disposal via incineration	✓	✓	x	✓	x	✓	x	✓	✓	x	x	x
Advanced thermal conversion	x	?	?	✓	x	✓	✓	✓	?	?	?	x
Digested sludge recycling to land restoration	✓	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	x
Raw sludge recycling to land restoration	✓	x	✓	x	✓	✓	✓	✓	✓	✓	✓	x
Raw sludge disposal to landfill	✓	x	✓	x	x	✓	x	✓	✓	x	x	x
Nutrient recovery	x	x	?	x	x	?	✓	✓	?	?	x	x

Key - Alignment with outlet attribute: ✓ = good alignment; ✓ = moderate alignment; X = poor alignment; = poor evidence

Source: ADAS, An assessment and evaluation of the loss of the biosolids-to-agricultural-land recycling outlet, 23/03/2022

4.4 Enabling access to alternative outlets

4.4.1 As highlighted in Section 4.2, the scale of the potential landbank challenge is hugely significant. Nationally, needing to move two thirds of bioresources away from biosolids recycling to agriculture, would require management of circa 2.5 million tonnes of sludge per year via alternative outlets. Planning, permitting and construction of alternative outlets will require significant lead time of circa ten years, meaning that the industry needs to plan alternatives now, for operation by 2035, ahead of defined landbank triggers.

4.4.1 In identifying sufficient access to alternative outlets there are two core challenges:

(i) **Clear objectives:** There is no clear policy guidance on how the multiple risks and benefits associated with the management of sewage sludge should be balanced and prioritised to deliver the optimal overall outcomes in the national interest, and at an affordable cost to society. The need for partnership and collaboration is clear; the strategic, yet concrete problem, on what is optimal biosolids management, requires multiple parties to collaborate (private, public, third sector and academia). We need to build open collaboration to tackle this challenge.

(ii) **Scale of the change**: The challenge is so significant no single company can absorb the first-mover disadvantage by moving out of landbank and developing and deploying new technologies in isolation. Innovation will be at the heart of our transformation to deliver new technologies that ensure that we embrace and realise the benefits of a more circular economy, generating higher value products that reduce our impact on the environment and deliver significant benefits to society. Collaborative delivery of the long-term strategy for bioresources in England outputs could enable pathways through research, innovation, regulatory change and market development.

4.4.2 Following on from our 2021 discussion paper and support for the findings of the 2023 long-term strategy for Bioresources in England, we are leading in the sector to try to develop common pathways and technologies to bolt on to existing sites to keep options open. It is recognised that there is a need to accelerate deployment of innovative sludge treatment and disposal technologies to allow a move away from landbank. We are keen to collaborate with others to innovate and lead on aspects that are key to our LTDS. By doing so, we are ensuring that through our adaptive plan we are flexible and keeping as many alternative options available as possible.

4.4.3 An example of this is the Bioresources Energy Recovery System project that was proposed to the Ofwat Innovation Fund. This £6 million project aimed to collaboratively develop a low-energy sludge drying and pelletisation sludge disposal solution to improve resilience, reduce cost and impacts of transportation, reduce Greenhouse gas emissions and promote the circular economy. The outcome was to provide more resilient operations for water companies whilst reducing the cost to serve customers. The project proposal successfully progressed through stage one, but was unsuccessful at stage two. We are currently considering the feedback and the possibility of resubmitting an updated proposal.

4.4.4 On-going collaboration and work at the innovation level will take multiple AMPs to develop alternative pathways and outlets for biosolids disposal. The loss of landbank may be more immediate leading to a significant short-term problem.

4.4.5 Currently, we rely upon land restoration outlets as an alternative for recycling to agriculture. Biosolids, when combined with on-site mineral substrates, such as subsoil or coal shale can help to create functioning soils on brownfield or degraded land through the provision of nutrients and organic matter. A limited fraction of our sludge may be recycled to these outlets per annum, particularly during disruption at our sludge digestion centres. Use of land restoration currently provides reliable contingency for our operations, although at greater cost than biosolids recycling to agriculture. The outlets for land restoration are short term and transient by nature, and typically we are required to travel greater distances than recycling to agriculture. Moreover, should there be a national landbank

challenge competition for land restoration capacity will increase, and the market would be unregulated in price and subject to variation by supply and demand.

4.4.6 Incineration was identified through ADAS' 2022, Alternative routes for biosolids disposal report, as the only current alternative for biosolids disposal available to deploy at scale. However, there is insufficient available capacity nationally to meet a shortfall in national landbank for biosolids recycling. According to ADAS there are 54 operational municipal solid waste (MSW) incinerators in the UK with an additional 15 under construction giving a current capacity of 20 megatonnes per year. However, the dominant 'moving-grate' technology used in MSW incinerators is not suited to small-fraction or powder-like materials such as biosolids. Similarly, operating licenses and permits must be confirmed and there is no evidence these are in place to receive sludge. Furthermore estimates suggest that 90 per cent of current MSW incinerator capacity is already in use.

4.4.7 Historically, our operating model has incorporated the use of sludge disposal at our incineration plant at Shell Green to mitigate against the constrained landbank of the North West, and ensure provision of a resilient sludge disposal service. Incineration of up to 20 per cent of our biosolids reduced our landbank requirement and the distance to travel to recycle biosolids to agriculture, outside our region.

4.4.8 We ceased incineration in 2018, however we retain the site as an operational dewatering facility and retain the necessary planning and permitting requirements for sludge incineration. In the event of the loss of the biosolids outlet this would provide some mitigation against landbank losses for a proportion of our biosolids. Retention of the site permit keeps this pathway open on our LTDS, for maximum flexibility. This pathway is not preferred by customers and has less desirable environmental outcomes but may provide a short term solution. We note that it would still take a significant time to re-start the incineration plant, which has been out of service for a number of years. Moreover, in the intervening period the Best Available Technique conclusions for incineration have been upgraded to be more stringent[11], and enhancement investment would be required to meet the latest regulatory standards before incineration could recommence. Furthermore, regulation of upstream waste treatment under the Industrial Emissions Directive (IED) reflects a system approach, and following a move to sludge disposal via an incineration outlet any upstream sludge thickening sites would also require new and additional IED installation permits (and significant investment to meet IED standards).

4.4.9 A lack of access to alternative outlets or treatment technologies for sludge when agricultural land is not available demonstrates that long-term planning for sludge management requires investment. The scope of this enhancement case is complementary to other alternative outlets of land restoration or incineration. This will align with the "AAD and advanced thermal technologies" pathway on our LTDS. This pathway has the potential to create significantly more beneficial outcomes than the incineration pathway, but is considerably less developed or deployable. By acting now and making minimal investment along this pathway we will ensure maximum flexibility and not close off this pathway on our LTDS.

4.5 Management control

4.5.1 The need for investment to undertake preparatory works for uncertain and long term options for alternative biosolids disposal outlets results from threats to landbank resilience which are outside of our control. As noted by the sewage sludge WINEP driver methodology there are an increasing number of factors that are out of the control of companies that threaten the resilience of the supply chain of sewage sludge to agricultural land. These include exceptional weather (exacerbated by climate change), regulatory requirements affecting land managers, fluctuating market demand and agricultural disease.

4.5.2 We have a statutory duty, not only to provide a resilient sludge management service, but to manage sludge in a sustainable way and follow circular economy principles in line with the Urban Waste Water

[11] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021D2326 Waste Incineration Directive BAT conclusions published in November 2021. We have varied our incineration permit to include a pre-operational condition to demonstrate compliance with BAT on resumption of the incineration activity.

Treatment Regulations (UWWTR) 1994. With growing threats to the established bioresources business model, and questioning of the accepted best practicable environmental option for sludge management it is necessary to undertake a greater level of planning than ever before. Optimal resilience in sludge management is achieved through the development of a long-term sludge strategy.

4.5.3 Even when confronted with the banning of sludge disposal to sea in December 1998 the industry had a clear regulatory objective and timeline that enabled companies to plan and adapt. In addition, there was strong government policy and incentives over sludge recycling to agriculture and energy recovery from anaerobic digestion facilities that provided clear government objectives for bioresources management.

4.5.4 While acknowledging that the increased landbank risks, and the ensuing uncertainty in long term disposal outlets for sludge, result from factors outside of management control, we have taken steps to minimise the risk of losing the biosolids outlet and improve resilience:

- We have delivered 100 per cent compliance with the voluntary industry BAS standard in AMP7 to ensure that we provide a quality product to our agricultural partners.
- We have led collaboration with all other WASCs and our regulators to both define the risks and issues impacting landbank resilience, and quantify the resilience risk through joint national landbank modelling.
- We have led regulator engagement on behalf of the industry over the unintentional impacts of the EA's proposed interpretation of Farming Rules for Water in AMP7. We have adapted our practice to comply with the stringent draft 'BAS 20 measures[12]' requirements to demonstrate compliance with Farming Rules for Water. Costs to comply with BAS 20 measures have been accommodated within base expenditure.
- We have identified the need for two separate enhancement cases to deliver 'no regrets' activities in AMP8 to sustain biosolids recycling to agriculture. These enhancement cases are:
  - **WINEP sewage sludge drivers** [**UUW66**]: A £169.965 million enhancement case to enable delivery of the statutory requirements identified in the Water Industry National Environment Programme (WINEP) under the sewage sludge drivers and targeted at delivering resilience in the sludge management supply chain to agriculture.
  - **Improving resilience in biosolids recycling to agriculture [UUW66]**: A £54.133 million enhancement case to increase the resilience of the agricultural outlet for biosolids, by improving product quality through the enhanced removal of non-degradable contaminants (such as microplastics) and thereby support market acceptance of higher quality products.
- We have been instrumental in leading the collaboration to develop the long-term strategy for bioresources in England, with the aim of unpicking the uncertainty surrounding the bioresources business and developing a roadmap for the future of the sludge management in England.
- We have tried so far as possible to ensure that our costs are efficient, by aligning our investment with our bioresources LTDS. Through this enhancement case we are seeking minimal investment (one per cent of total project cost) to keep alternative options for biosolids disposal open.

4.5.5 These actions to improve our landbank resilience have been made against a backdrop of ceasing sludge incineration in AMP6, increasing our overall landbank requirement. This has been delivered through improvements to our landbank finding service and service provision to farmers. To find adequate landbank we have a greater distance to travel to recycle than any other company[13], which will result in higher sludge recycling costs. Operational efficiencies gained from ceasing incineration have been offset

[12] Draft BAS 20 measures were shared with the EA in 2022 and the industry has voluntarily implemented the measures. Assured Biosolids Limited is continuing to finalise the measures for inclusion in an updated BAS standard.

[13] Grieve Strategic, National Landbank Modelling (2023) demonstrates that under current regulatory conditions the average maximum haulage distance we are required to travel to recycle biosolids to land is 71km, compared to an industry average maximum haulage distance of 46km.

by the increasing quantity of biosolids recycled to agriculture and the consequential greater distance to travel from our sludge treatment centres.

4.5.6 No potential cost savings (i.e. spend to save opportunities) are anticipated from these improvements. Biosolids recycling to agriculture is the lowest cost outlet for sludge disposal and any move away from this business model will increase costs.

4.6 Need for enhancement expenditure (including implicit allowance)

4.6.1 The bioresources cost models for PR24 utilise an average revenue control promoting a focus on efficiency. They include no cost drivers that consider landbank availability or the need to increase outlet resilience. The cost models are based only on the volume of sludge processed and sparsity factors, neither of which is a determining factor in outlet costs for biosolids disposal.

4.6.2 The lowest cost outlet is to recycle biosolids to agricultural land. However, as landbank becomes more limited, it becomes a shared resource with companies competing for landbank capacity. Given the significant uncertainty over the scale and timing of landbank availability we are needing to make additional enhancement investment now to manage the risks of being unable to provide a resilient sludge management service.

4.6.3 Should landbank risks materialise the PR24 price control for bioresources provides no safety net for overspend and, unlike other price controls, companies are fully exposed to additional expenditure. This risk is compounded by a first mover disadvantage that exists for any company moving to alternative outlets at a higher cost, as this creates landbank capacity for other market participants.

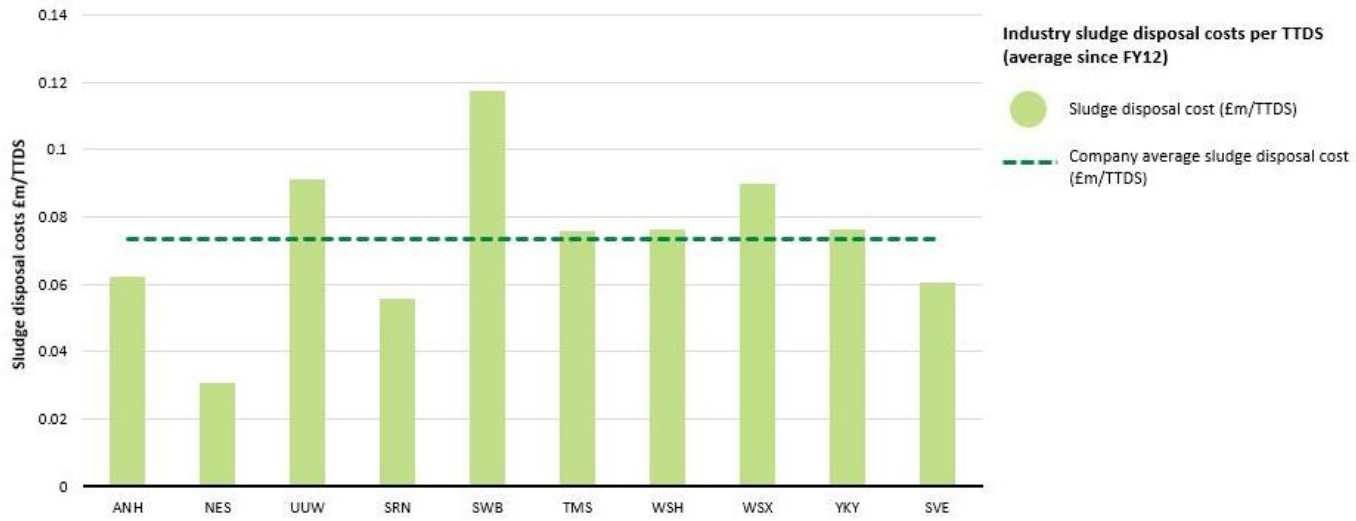
4.6.4 Without RCV protection there is no surety that investment will be returned, this drives caution on any investment. That caution alongside the uncertainty of need and first mover disadvantage creates inertia. Inertia could lead to an inability to respond to changes in environmental regulation, or alternatively those companies who invest first will likely lose financially. There is a need to work collaboratively with all stakeholders to resolve these challenges efficiently.

4.6.5 We propose minimal enhancement investment to ensure that we can provide a resilient sludge management service. However, this approach is reliant on AMP8 landbank risks being managed through an in-AMP uncertainty mechanism (Notified item), should landbank availability decline and exceed trigger points within our LTDS and we need to accelerate investment activity into AMP8.

4.6.6 Resilience risks are particularly pressing in the North West, as landbank is already constrained with only 50 per cent of agricultural landbank being available for recycling. Of the agricultural land available, only 16 per cent is arable, which is the most flexible in the type of biosolids which can be recycled. We adopted our historical operating model, incorporating the use of sludge disposal at our incineration plant to mitigate against the constrained landbank of the North West, and ensure provision of a resilient sludge disposal service. Incineration of up to 20 per cent of our biosolids reduced our landbank requirement and the distance to travel to recycle biosolids to agriculture, outside our region.

4.6.7 For these reasons we have incurred higher than average sludge disposal costs. A summary of sludge disposal costs is presented in Figure 4.

Figure 4: Industry average sludge disposal costs



Source: Ofwat's cost assessment dataset

4.6.8 This greater cost for disposal is compounded by an increased regulatory burden at our sludge treatment centres to supply sludge to a disposal, rather than recovery outlet, thereby increasing base costs above those experienced by other companies.

4.6.9 A move away from biosolids recycling will incur even greater costs. The full costs are anticipated to be in the order of an additional £1 billion and an entire step change in the bioresources business model.

Implicit allowance

4.6.10 There is no implicit allowance for the use of alternative outlets for biosolids disposal. New assets for alternative disposal outlets to meet constrained landbank and increasing regulator expectations for biosolids recycling are an addition to base service provision. The costs set out within the enhancement case are the capital costs for preparatory works for moving to alternative outlets, and if implemented represent a step change in the bioresources business model. The scope of works within this enhancement case relates to planning and development for new assets. It will not deliver capital works on the ground to deliver new assets, replacement assets or refurbishment of existing assets.

4.6.11 The decision to stop incineration has led to some efficiencies in our operating model. Any costs savings from stopping incineration, bring our costs closer in line with others in the sector, but are offset by the additional work done, and distance to travel to recycle biosolids to agriculture.

4.6.12 We are unaware of any companies incurring any monies to date to seek to deliver preparatory works for moving to alternative outlets and away from biosolids recycling to land. There is, therefore, no element of alternative outlet costs in historical data.

5. Best option for customers

5.1 Options assessment

5.1.1 Our enhancement case presents the least cost solution for customers to mitigate risks associated with uncertain and long term options for alternative outlets for biosolids disposal.

5.1.2 Presented in Table 3 below is a summary of the options considered to address the long-term risks of having no access to alternative outlets.

5.1.3 Options were assessed against our LTDS to minimise the risk of abortive or inefficient investment. The assessment took into consideration the impact on wider value generated through each of the potential solutions. We discounted "doing nothing" as it would not address long-term resilience risks and we would not be meeting our statutory obligations to ensure that we can provide a resilience sludge management service.

Table 3: Options considered to mitigate risks of uncertain and long term biosolids disposal options

Option	Rationale	Select / reject	Reason
Do nothing	Defer any investment in alternative pathways to move away from biosolids recycling to land until this becomes a confirmed need and we exceed landbank availability trigger points in our LTDS.	Reject	Waiting until this is a confirmed need risks being too late and closes off pathways on our LTDS. The significant lead time anticipated to deploy technologies (up to 10 years) would leave the company vulnerable to having no outlet for biosolids disposal, and we would not meet our statutory obligation to ensure that we can provide a resilient sludge management service.
Full scope to move to alternative outlets for sludge disposal	Proactively invest to start delivering investment associated with alternative pathways and move away from recycling 100% biosolids to agriculture.	Reject	The current alternative pathway that could be deployed with confidence is incineration. This is an inflexible option that does not maximise the value of sludge. This route does not align with the long-term strategy for bioresources in England. This option risks abortive or inefficient investment if we move to alternative outlets ahead of a confirmed landbank need. Does not align with our core pathway to maximise value of sludge by recycling to agriculture and it does not have customer support.
Deliver preparatory works to move to alternative outlets	Undertake preparatory works for long term and uncertain options in our LTDS for alternative outlets for biosolids disposal.	Select	Low regrets activity. Minimum spend in AMP8 while fulfilling our statutory obligations to provide a resilient sludge management service. The potential to accelerate the implementation of alternative pathways in our LTDS by up to three years, and will inform PR29 planning over landbank resilience needs. Undertaking these critical planning activities now will maintain flexibility within our LTDS to adopt alternative pathways when required. If we wait, the implementation time may be too great to move away from biosolids recycling to land efficiently.

Option	Rationale	Select / reject	Reason
Build a demonstration site through collaborative innovation opportunities	Accelerate technology development through collaborative deployment of a demonstration or pilot site. Fund through innovation avenues.	Reject	There is no guaranteed funding route to rely on collaborative innovation. For example, our Ofwat innovation fund phase 2 bid for Bioresources Energy Recovery System was unsuccessful in 2023. Accelerated technological development, would not assist company specific planning to progress how the technology could be implemented within the existing asset base, or gain the necessary planning or permitting approvals. This would not minimise the overall lead time for deployment. Collaborative innovation is considered complementary to the proposed scope, and as discuss in Section 5.4 we will continue to explore opportunities in AMP8.

Source: United Utilities, 2023

5.1.4 Our preferred solution is a balanced approach that minimises cost, and the risk of abortive or inefficient investment as far as possible. This solution will accelerate the development of long term solutions but stops short of delivery in AMP8.

5.1.5 Full adaptation to alternative pathways will cost in the order of £1 billion, but this case is for only one per cent of total costs to undertake minimal, low regrets investment to keep options open for the long term. This is considered lowest cost and best value in AMP8 and, as we discuss in Section 5.5, is supported by customers.

5.1.6 The scale of the landbank challenge is so significant that no single company can absorb the first-mover disadvantage to move out of landbank and develop and deploy new technologies in isolation. As we explain in Section 5.4 we will keep open options to work with others to deploy and pilot new technologies in AMP8. It is considered complementary to the scope of this enhancement case to advance the deployment of innovative technologies using partnership and collaboration.

5.2 Benefit and value appraisal

5.2.1 Our approach to delivering best value is robust and consistent across all of our enhancement cases. Our approach uses a rich mix of metrics to help us drive value and efficiency in developing our business plan. Consistency of the approach is driven through our PR24 Value Tool which allows us to quantify and value environmental and social benefits, costs and risks. For more detail on this approach please see *Chapter 6 – Delivering Social and Environmental Value*.

5.2.2 Recycling biosolids to agriculture is an effective, catchment based business model, and ensuring this model can continue for as long as possible will maximise benefits our of sludge recycling operations to the wider environment. Biosolids recycling supports the circular economy and nationally, around 3.5 million tonnes of biosolids are recycled to agricultural land per annum, providing more than £60 million of nutrient replacement value to agriculture[14].

5.2.3 Our LTDS prioritises interventions that maintain this circular business model, rather than investing to move away from biosolids recycling to disposal technologies. We are only investing minimally through this enhancement case to keep open alternative options in the event that it is no longer feasible to recycle biosolids to agriculture.

5.2.4 Alternative disposal outlets are not currently considered the best practicable environmental option for biosolids management, in most circumstances. While alternative disposal options may become inevitable in the event of loss of landbank, they are inherently less beneficial than biosolids recycling, as these options are lower down the waste hierarchy. Therefore, should a move to alternative disposal

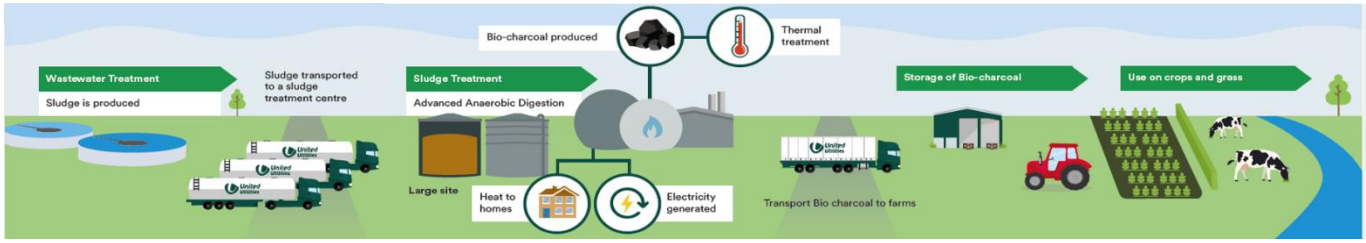
[14] Assured Biosolids Limited, *About Biosolids*, 2023 [Online] https://assuredbiosolids.co.uk/about-biosolids/

outlets be required, it is imperative that we do this in the most sustainable and beneficial way, ensuring that we deliver our long-term ambitions by continuing to maximise the value recovered from sludge.

5.2.5 Through this enhancement case we seek to identify and accelerate deployment of alternative sludge disposal technologies. At present the only deployable alternative to biosolids recycling at scale is incineration. However, incineration is not supported by customers, and has much poorer environmental outcomes; it doesn't support the circular economy or sustainable agriculture; and has significant air quality impacts. The exact technology that may be deployed as an alternative to incineration is as yet underdetermined as it is subject to technological development. Through this enhancement case we will undertake a technological review to include drying and combustion technologies, pyrolysis and gasification.

5.2.6 In Figure 5 we present an indicative model of a future bioresources business, including the value and benefits that could be created, aligned to an alternative pathway.

Figure 5: Indicative representation of the alternative pathway to be deployed through this enhancement case



Source: DJS Research on behalf of United Utilities, Bioresources pathways customer research, October 2022

5.2.7 An indicative comparison of the potential costs and benefits of incineration versus alternative thermal treatment technologies is presented in Table 4 below. This enhancement case supports Alternative 2 (AAD and advanced thermal technologies) pathway. It can be seen that through delivery of this enhancement case we will accelerate deployment of alternative technologies, which have the potential to create long term carbon reduction opportunities, green energy opportunities, and long term efficiencies that can be shared with customers in the form of lower bills. If we do not make the minimal investment required now through this enhancement case, we risk closing off these opportunities on our LTDS.

Table 4: Comparison of costs of benefits of incineration and other thermal treatment technologies for biosolids disposal

	Alternative 1 (AAD and incineration) pathway	**Alternative 2 (AAD and advanced thermal technologies) pathway**
Additional activities	Investment continues in AAD core pathway to realise value from biogas and solids reduction. Permitting and investment for disposal at sludge treatment sites and upstream sludge thickening operations. Investment and additional operating costs for biosolids incineration (utilising and extending existing capacity). Focus on biogas to combined heat and power and power generation from incineration. Management of residual ash.	Investment continues in AAD core pathway to realise value from biogas and solids reduction. Permitting and investment for disposal at sludge treatment sites and upstream sludge thickening operations. Digested sludge pelletising and use for fuel for drying and digestion heating process. Move to maximising biomethane production and CO2 capture from biogas. Management of residual ash.
Sludge disposal (rather than recycling)	Up to 100%	Up to 100%

	Alternative 1 (AAD and incineration) pathway	Alternative 2 (AAD and advanced thermal technologies) pathway
Indicative additional capex (£m)	£980m	£1,141m
Additional opex (£m/yr)	£3.5m	-£14.7[15]*
Operational carbon emissions (tCO2e/yr) (from today's baseline benefits of core pathway delivered through options)	-15	-192

Source: United Utilities, 2023

5.2.8 All pathways (including the core pathway of biosolids recycling to agriculture) build on the common foundation of centralised sludge treatment at AAD centres. This provides the following opportunities:

- Economies of scale;
- Supports opportunities such as production of green gas;
- Creates opportunities to reduce operational greenhouse gas emissions from sludge treatment;
- Reduces the mass of biosolids and increases the versatility of higher quality biosolids products for recycling to agriculture; and,
- Provides a platform to subsequently bolt-on technologies, if required, to move to alternative outlets.

5.2.9 By identifying and acknowledging these similarities between pathways it allows us to invest in AMP8 in areas of 'certainty' which form our AMP8 core pathway to deliver low regrets investment and maximise flexibility (see Figure 3). Additional activities, beyond AAD may be described as 'higher-regret', relative to investments included in the core pathway, and therefore they form part of our preparatory work for uncertain and long term options, rather than being fully included as part of our AMP8 core pathway. This approach ensures the risk of inefficient investment is minimised but is reliant upon a mechanism to seek investment aligned to the alternative pathway once a trigger is reached, should this occur mid-AMP.

5.2.10 The benefits of the minimal, low regrets activity within scope of this enhancement case is increased resilience in our sludge management service. Investment will accelerate the implementation of alternative pathways on our LTDS by up to three years, and will inform PR29 planning over landbank resilience needs, reducing the overall risk of having insufficient outlets for biosolids.

5.2.11 We present the benefits of this enhancement case in table CWW15. Delivery of this enhancement case will not impact on performance commitments in AMP8.

5.3 Delivery of this scheme

5.3.1 We anticipate completion of the scope of this enhancement case in sufficient time for the outputs to inform our PR29 submission.

5.3.2 Our standard engineering screening process has identified that delivery of the full scope of works to move to alternative outlets for biosolids disposal is not only high cost (circa £1 billion) but also has a high complexity. Moreover, implementation of combustion technologies will require planning permission and likely be subject to an Environmental Impact Assessment. We anticipate that there may be high levels of public interest and this may lead to a lengthy planning process for approval.

5.3.3 Given these factors, it is appropriate that this project does not follow a standard project delivery route, but will benefit from an enhanced project definition phase. We will deliver early project development activities to progress the project sufficiently that upon completion we are in a position (if required) to

[15]This is based on additional value being assigned to green gas and CO_2 capture. Future revenues are dependent on market value and are therefore illustrative.

commence formal procurement with a defined project scope and cost for sludge drying and advanced thermal treatment technologies, for up to 100 per cent of UUW sludge in line with our long term delivery strategy and bio-refinery ambition. Focussing in AMP8 on early project development, through concept and definition phases, we are able to add the most amount of value and ensure the full scope of works developed will maximise outcome delivery.

Through this scope of works we will determine the site(s) where assets for alternative disposal outlets may be located. We anticipate that a full move away from biosolids recycling to agriculture for 200,000 tonnes dry solids of sludge per annum may require up to three new sludge disposal centres. [✂

]

5.3.4 We will engage markets through this enhancement case to undertake a full technology review of available market solutions to support a transition to sludge disposal. We anticipate that if the full scope of works to move away from biosolids recycling to agriculture is delivered in AMP9 (or beyond), due to the specialist design, construction and operational requirements for advanced thermal technologies, we would seek to engage markets for delivery, ensuring costs are efficient.

5.3.5 For completeness and for the avoidance of doubt, this scheme has not been identified to be delivered as Direct Procurement for Customers (DPC), as this is not applicable for projects within the Bioresources price control.

5.4 Opportunities for partnership and collaboration

5.4.1 The scale of the landbank challenge is so significant that no single company can absorb the first-mover disadvantage by moving out of landbank and developing and deploying new technologies in isolation. We recognise this need and in AMP8 we need to work in parallel to:

(i) **Accelerate innovation:** We will work in partnership and collaboration with others in AMP8 to accelerate innovation, ensuring development of feasible technologies as an alternative to biosolids recycling to land, while maximising efficiency and efficacy.

(ii) **Undertake detailed planning:** Determine how best to deploy innovative technology with our asset base i.e. energy balance, integration with existing assets and planning and permitting.

5.4.2 This enhancement case covers the detailed planning aspects only. The project will deliver early project development activities to progress the project sufficiently that we are in a position (if required) to commence formal procurement with a defined project scope and cost for up to 100 per cent of UUW sludge.

5.4.3 We have excluded from the enhancement scope undertaking pilots or technology trials. We considered these works are complementary to the scope of this enhancement case, but are best undertaken using partnerships and collaboration to advance the deployment of innovative technologies. There are no opportunities for third-party investment through this enhancement case, as the works are restricted to developing asset solutions for biosolids disposal outlets, for our sludge's and to integrate with our existing asset base.

5.4.4 We have a strong track-record of innovating in the field of Bioresources. We have secured £3 million of funding from the Department of Energy Security and Net Zero Hydrogen BECCS Innovation Competition. The Government-funded collaboration is a first for the UK water industry and will see Levidian's innovative LOOP technology used to decarbonise biogas created within the wastewater treatment

process. As well as producing hydrogen, the technology will also produce graphene, a highly useful material which was first discovered in Manchester which is stronger than steel and thinner than paper.[16]

5.4.5 We proposed a Bioresources Energy Recovery System project, a £6 million project aimed to collaboratively develop a low-energy sludge drying and pelletisation sludge disposal solution to improve resilience, reduce cost and impacts of transportation, reduce carbon emissions and promote the circular economy. The project proposal successfully progressed through stage one and was unsuccessful at stage two. We are currently considering the feedback and the possibility of resubmitting an updated proposal.

5.4.6 It has been our experience that technologies approved through the Ofwat Innovation Fund for bioresources are focussed on longer term options, not accelerating assets for immediate resilience activities. No projects have been approved that look at technologies for moving biosolids out of landbank, so we cannot currently rely on this route alone to manage uncertain and long term options.

5.4.7 Our ongoing innovation and partnership working activities will ensure that we continue to consider all new technologies and do not close any routes on our LTDS.

5.5 Customer support for investment

5.5.1 It is important that customers' opinions are fed into our decision-making process over how to manage Bioresources services in future, and so we have established customer preferences over options set out within the Bioresources LTDS.

5.5.2 Bioresources Pathways Customer Research was undertaken in September 2022, which conducted five, three-hour deliberative workshops with a total of 60 current household customers and 12 'future bill payers', held at various locations across the North West. The research was structured to build customers' knowledge of the topic area and introduce the sludge treatment process, carbon net zero and the environmental impacts of Bioresources. Once this foundation of knowledge had been established, the conversation turned specifically to the future pathways open to UUW. The purpose of this second section was to understand customers' preferences and priorities in relation to these pathways and to establish which pathway(s) are most acceptable to them.

5.5.3 Prioritisation was based on high-level considerations, for example the importance of reducing greenhouse gas emissions, in comparison to protecting watercourses, rather than specifics of costs and emissions volumes for each pathway. The workshops were designed to ensure customers were able to provide meaningful feedback on each of the pathways, with visual demonstrations and subject matter experts attending to answer any customer questions.

5.5.4 The research concluded that health and environmental concerns are at the heart of customers' priorities, even more so than their bills (at the time the research was conducted). Due to limitations on bill impacts available, cost and bills were discussed at a high level, with customers able to see a ranking of which pathways had a higher cost impact on their bills, but not the figures themselves. This research was conducted at a time where energy bills and other household expenses were rising, and future increases seemed unpredictable. Due to this, participants recognised that the cost of living is an ever-changing situation and appeared more sensitive to their water bill costs rising. However, it was still rare for respondents to completely prioritise cost over health and environmental impact.

5.5.5 Customers' long-term priorities are for a Bioresources service that provides reliable sludge treatment in a way that limits its impact on human health, greenhouse gas emissions, and on water quality.

5.5.6 Our LTDS has been developed utilising feedback from customers over their preferred routes for biosolids recycling. The foundation of all our pathways on our LTDS, AAD and consolidation to hubs, was seen by customers as the favoured sludge treatment process when compared to AD. AD was viewed as a

[16] Hydrogen Industry News & Market Intelligence, Sewage Biogas Produced in Manchester is all Set to Become a Sustainable Feed Source for Graphene and Hydrogen Production Thanks to a Pioneering Partnership Between Levidian and United Utilities, July 2023 [Online] https://hydrogen-central.com/sewage-biogas-produced-manchester-become-sustainable-feed-source-graphene-and-hydrogen-production-thanks-to-a-pioneering-partnership-between-levidian-and-united-utilities/

lesser technology due to its lower gas yield, higher carbon footprint and limited versatility as a product to agriculture. Most customers understood that AAD treatment was needed before any of the alternative pathways to be most efficient.

5.5.7 In line with the objectives of this enhancement case, there was a clear consensus around not waiting for problems to occur and instead, to plan and invest now in additional capacity and functionality so that if and when problems occur, we are in the best position we can be to deal with those problems. Customers also recognised the need for research and development and the requirement to balance short- and long- term investment.

5.5.8 Of all the six alternative pathways discussed, AAD and advanced thermal technologies with heat recovery pathway was customers' preferred pathway option. Customers were positive that this pathway presented the most 'balanced' option, appealing to customers' priorities for a pathway that protects farmland and rivers from contamination and makes efficient use of the biogas generated. Customers cited the fact that the technology showed fewer 'extremes', making it an 'optimum' middle path while simultaneously tapping into their core priorities.

5.5.9 In contrast, the alternative pathway, AAD plus incineration had muted support from customers. Customers had significant concerns over carbon emissions and local air quality and was viewed as "*a massive step backwards… from recycling*" (Customer, from Trafford Workshop). As such, use of incineration would only be our preferred alternative pathway to sludge recycling to land, in the event of a rapid transition away from landbank, whereby this is the only feasible option to deliver a reliable Bioresources service.

6. Cost efficiency

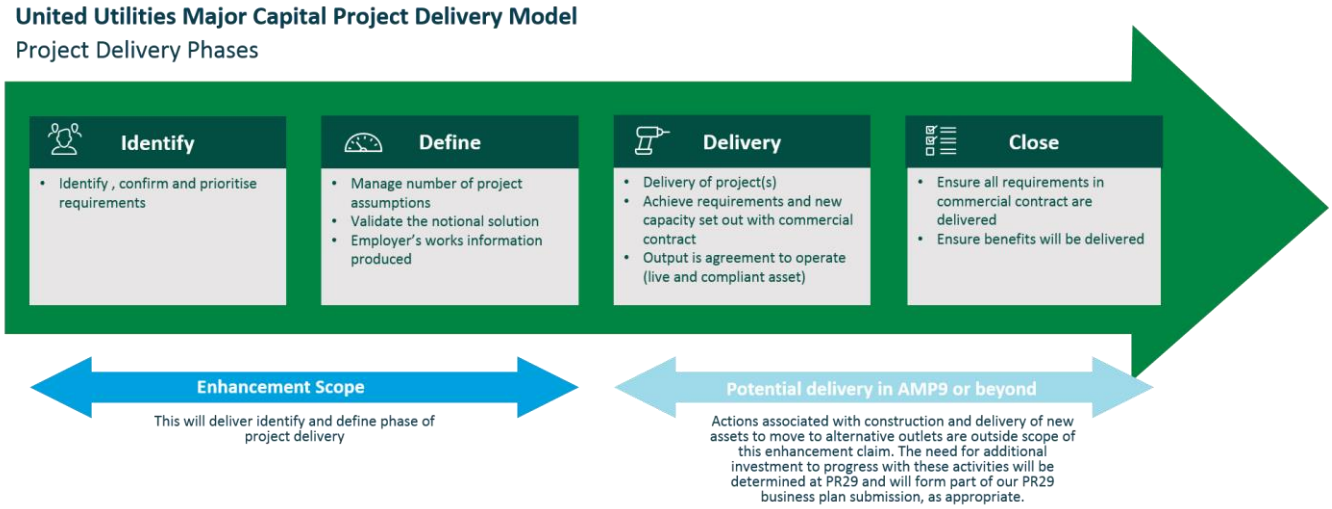
6.1 Development of efficient cost estimates

6.1.1 Through our WINEP submission we submitted two alternative proposals for developing alternative outlets for up to 100 per cent of biosolids. The full estimated cost, associated with the "AAD and advanced thermal technologies" pathway, as we present in Table 4, is circa £1.141 billion.

6.1.2 This document sets out the enhancement case for £10.394 million totex investment to deliver preparatory works for accelerating the development and deployment of the advanced thermal technology pathway. This pathway has the potential to create significantly more beneficial outcomes than the incineration pathway, but there is need to understand thermal conversion outputs, operations, markets for outputs, integration within existing treatment works and the fate of contaminants within the process and outputs.

6.1.3 We present our typical project delivery phases for a major capital project in Figure 6. Through the scope of this enhancement case we will deliver the 'identify' and 'define' phases. 'Delivery' and 'close' phases would only be delivered at PR29 or beyond, when there becomes a compelling need to move to alternative outlets for biosolids disposal.

Figure 6: Project delivery phases in scope of this enhancement case



Source: United Utilities, 2023

6.1.4 Through the preparatory works phases we will ensure that we optimise the scale and location(s) of our planned interventions through use of our strategic planning tool, RIAP. Strategic planning capability is central to our asset strategy over the next 25 years and enables us to understand and optimise the carbon footprint, capital and operational costs of planned actions across the entire bioresources system, and have confidence the actions we propose will be efficient over the long term.

6.1.5 The milestone outputs on completion of the enhancement case scope of works includes:

- Land purchase agreements (as necessary)
- Outline planning permission
- Environmental Impact Assessment complete and submitted to regulators
- Employers Works Information complete

6.1.6 The completed output will ensure that we are able to commence formal procurement, with a defined project scope and cost, if required at that time.

6.1.7 We present in Table 5 the build-up of the cost estimate to deliver preparatory works by scope item. The scope has been further broken down by UUW internal resources, and external fees for specialist resources. Of the estimated total spend, approximately two thirds will be spent through markets to engage specialist resources. The UUW resource requirement is equivalent to five full time equivalent members of staff over the life of the project.

Table 5: Enhancement case activity breakdown

Activity	UU Resources (£m)	Third Party Costs (£m)	Totex (£m)
Identify prioritise and confirm requirements (through RIAP)	0.362	0.076	0.438
Site selection	0.363	0.152	0.515
Site risk assessment including air quality modelling and environmental permitting	0.486	0.152	0.638
Technology review based on performance requirements	0.226	0.266	0.492
Conceptual design	0.681	0.509	1.190
Land purchase agreements	0.335	1.469	1.805
Public engagement	0.323	0.140	0.462
Outline planning permission	0.447	1.140	1.587
Environmental Impact Assessment	0.159	2.192	2.350
Early contractor involvement for estimating and procurement options	0.232	0.685	0.917
Total	3.613	6.781	10.394

Source: United Utilities, 2023

6.2 Cost benchmarking

6.2.1 The standard bioresources operating model in England and Wales is for sludge treatment via anaerobic digestion, with the resulting biosolids recycled to agricultural land. The proposed technology, to seek to move to alternative outlets and treat and dispose of sludge using advanced thermal technologies is not currently deployed in the UK and therefore there are no agreed industry benchmarks for moving to alternative outlets.

6.2.2 This enhancement scope represents a minimal one percent of the total likely investment need in AMP9 and beyond, should we be required to move away from biosolids recycling to land. This proportion of investment spend upfront, where we have maximum ability to influence the overall success and outcome of the project, is in line with other projects of this scale and benchmarked norms for UUW project delivery.

6.2.3 The full project scope has been estimated using our PR24 capital cost estimating approach has been based on data collected over AMP3 to AMP7 and updated to reflect the present market conditions under which we and the UK water industry are operating. Mott Macdonald (MM) has provided us an estimating service over AMP6 and AMP7. They also provide an estimating service to a number of other UK water companies, which allows them to provide a benchmarked approach to our PR24 capital cost estimates.

6.2.4 MM have benchmarked UUW's direct costs and cost curves and assessed the water industry construction inflation based on their Construction Industry Basket of Goods index.

6.2.5 Whilst there are no benchmarked costs for advanced thermal technologies, we have been able to extrapolate construction, operational and maintenance costs from our historical disposal outlet at Shell Green. Analysis of historical incineration capital costs was undertaken by ADAS in 2022. ADAS identified that in 2022 municipal waste incineration costs were between £110-120 per tonne of waste at the gate

(disposal only and not transport or pre-processing of sludge). However, there is insufficient available capacity should the industry require alternative outlets, and they highlighted that current incineration costs cannot take account of the exposure of the sector to market pricing for residual incineration capacity, nor the timescale and planning costs for new processes.

6.2.6 To move 100 per cent to an alternative outlet for biosolids disposal would require circa 400,000 tonnes of incineration capacity. In addition to incineration costs directly, scope could include digestion capacity to reduce the volume of material for incineration, dewatering capacity, operational costs, land procurement, planning application, permitting and licensing costs. A number of key factors including technology choice will influence capex requirements, e.g. grate or the fluidised bed, biosolids pre-processing and the level of flue gas cleaning required. It is also worth noting that the latest Waste Incineration Directive, Best Available Techniques for incineration were published in September 2021. These guide the level of environmental protection to be delivered through incineration and older project data will not have been required to be delivered to these standards. These costs will also exclude the costs to meet IED installation permits at any physical or chemical sludge thickening site that provides feedstock to the incineration process.

6.2.7 Due to the specialist design, construction and operational requirements for advanced thermal technologies, should we be required to deliver the full scope of works, we would seek to engage markets for delivery, ensuring costs are efficient.

6.3 Assurance of this submission

6.3.1 Our WINEP development, including approach, cost estimating and scope development have been independently, technically assured by ARUP in the context of our LTDS. ARUP validated our LTDS approach and an extract from ARUP's report is provided below:

"The core pathway is straightforward to deliver, using well understood technology and presents an affordable option".

"The alternative pathways are clear and the triggers that would drive change are also well defined. Both alternatives address the challenges presented in the different scenarios. Alternative 1 – sludge incineration is a high carbon, low value option that uses well developed technology. Alternative 2 – integrates biosolids combustion for drying and AAD heat provision, which supports maximising biogas availability for energy production, e.g. green gas. This provides enhanced additional benefits and less significant impact on whole life cost of the LTDS."

6.3.2 Through their assessment (constrained to our WINEP submission) ARUP noted that:

"There is no reference investment planned in strengthening the understanding of the novel technologies required to deliver alternatives 2 and 3 (gasification and pyrolysis) and nutrient recycling. As the value landscape is changing these alternatives are likely to become more important and we would recommend investing in trials to prepare UUW for the eventuality they become preferable."

6.3.3 We fully agree with the findings of the ARUP assessment, and through this enhancement case we propose to address this important issue which is fundamental to having a robust LTDS and ensuring we can continue to provide a robust and resilient biosolids recycling service. The enhancement case will be coupled with collaborative research and trials as appropriate.

7. Customer protection

7.1 Introduction

7.1.1 It is important that customers have confidence that we will deliver the enhancement schemes that get reflected in our PR24 final determinations and they are suitably protected in the event of non-delivery, or if there are material changes to deliverables (including changes to dates), which leads to a change in cost (including changes in the timing of required expenditure). Ofwat proposes that, if companies fail to deliver or are late delivering improvements to customers, then price control deliverables (PCDs) should, where appropriate, be used to compensate customers. In our PR24 *Chapter 8 -Delivery at efficient cost, section 8.8.9* we have proposed an approach to PCDs that aims to provide customer protection, such that customers are fairly compensated for non-delivery (such as due to a change in regulatory requirements) or late delivery (including as a result of a change to a regulatory date), between PCDs, any related ODI underperformance payments, and cost sharing arrangements.

7.2 Price Control Deliverable

7.2.1 We have not included a PCD for this area as it is small in size, and below Ofwat's indicated threshold.

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