PR24

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A3-20 WINEP SEWAGE SLUDGE

NES34

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1. INTRODUCTION

Our wastewater sludge is transported from more than 400 sewage treatment works (STWs) to six strategically located handling centres where it is thickened. It is then transported to the two Primary Sludge Treatment Centres (PSTCs) at Bran Sands and Howdon. The treatment centre locations incorporate Advanced Anaerobic Digestion processes to maximise sludge solids destruction, producing an enhanced treated biosolid material. This harnesses the opportunity of injecting the generated biogas into the natural gas grid. 100% of our biosolids are disposed to agriculture land currently within our operating region. This business case covers the extra dewatering of the post digestate cake, off site storage of the final biosolids and enhanced systems to manage its subsequent deployment to land.

This business case delivers part of our Bioresources Strategy which explains how we intend to respond to the regulatory uncertainty associated with likely Environment Agency interpretations of the Farming Rules for Water (FRfW) and pending[1] transition from Sludge Use in Agriculture Regulations (SUiAR) to the new Environment Agency Sludge Strategy, both of which will realise limitations on landbank accessibility and availability.

This case focuses specifically on the WINEP enhanced investment for providing resilience in the sludge supply chain when business as usual measures have been disrupted and the environment is put at risk. Our actions within this business case relate to:

- Provision of 90 days strategic cake storage and increased high solids dewatering which provide resilience in the supply chain to manage the short-term impacts of landbank availability;
- The extra reporting requirements as a result of the change in the regulatory framework to bring bioresources into an evolved version of the Environmental Permitting Regulations. This will make sure we have a higher level of data instantaneously available and sufficient information to make sure of compliance to new regulations.

These actions have been agreed by the Environment Agency as falling under the WINEP new statutory obligations for sludge. In accordance with Environment Agency guidance[2], Table 1 sets out the exclusions actions which the Environment Agency have specified as being covered in other business cases:

[1] Environment Agency, Email received on 9 August 2023, confirmation that the Environment Agency strategy for safe and sustainable sludge use - GOV.UK (www.gov.uk) was published on 1 August 2023 but the timeline for implementation is currently under review. The Environment Agency still considers the move to Environmental Permitting Regulations as critical for the effective and efficient regulation of sludge.
[2] Environment Agency, 22 March 2023, Information Letter EA/09/2023

TABLE 1: ACTIONS RELATED TO SLUDGE AND RELEVANT BUSINESS CASE

Driver	Business Case
P-Removal	WINEP Nutrient Neutrality
Chemical Investigations	WINEP Water Framework Directive
Nutrient Removal investigation	WINEP Water Framework Directive
Alternative Biosolids Outlets Investigations	WINEP Water Framework Directive
Microplastics Investigations	WINEP Water Framework Directive

Source: Environment Agency

We are not making an enhancement investment case for population growth for sludge. This enhancement case is for **£80.746m** of capital expenditure and **£3.875m** of operating expenditure over the AMP8 period.

2. NEED FOR ENHANCEMENT INVESTMENT

2.1. ALIGNMENT WITH STATUTORY PLANNING FRAMEWORKS

This business case is produced in accordance with the WINEP Statutory Planning Framework. This includes new statutory obligations, considering SUiAR 1989 which is aimed at delivering resilience improvements of the sludge management supply chain, improving management practices, and creating suitably robust contingency measures. The timing of investment is set out within the WINEP framework driver guidance[3] as shown in Table 2.

[3]Environment Agency, March 2023, PR24 WINEP driver guidance – Sludge V0.3

TABLE 2: STATUTORY WINEP DRIVERS RELATING TO SLUDGE

Driver Code	Description	Legal obligation	Required by date	Tier 1 outcome
SUiAR_IMP	Actions to improve resilience in sludge supply chain to agriculture and other relevant use or disposal outlets.	Statutory	31/03/2030	Water company contribution to manage sewage sludge sustainably
SUiAR_ND	Actions to meet requirements to prevent deterioration in soil quality or water quality.	Statutory	31/03/2030	

Source: Environment Agency

On 22 March 2023, the Environment Agency wrote to all companies to provide further guidance as to what should be included under the WINEP driver. This clarified that:

- Needs for this business case should concentrate on actions relating to developing more resilient contingency measures when business as usual is disrupted and the environment is put at risk. The emphasis is 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. Permitted sludge storage would be a new investment as Water and Sewerage Companies currently rely on field storage.
- Needs relating to existing regulatory requirements, business as usual and optimisation of existing treatment processes and activities have been rejected or removed from the WINEP drivers. Items related to population growth, P removal schemes and chemical investigations programme and microplastics have been removed from the Sludge WINEP driver due to double counting with other actions.

These are statutory requirements, the timing of which and the method for overlaps with other business cases being specified within the guidance. We are therefore not requesting enhancement investment which overlaps or duplicates with activities already funded at previous price reviews or in other business cases. We are only requesting expenditure for new assets which are required to meet the statutory requirements. Funding relating to efficiency or refurbishment of existing assets is included within base expenditure.

In producing our Bioresources strategy we have used a holistic, systems based long-term approach to plan how we manage all bioresources drivers including landbank availability, nutrient levels within soil, population growth, P removal, chemicals, asset health, efficiency, changes in the regulatory framework and investigations into innovative processes. These have then been split for the purposes of making our individual business cases for enhanced investment.

2.2. OUR PROGRESS UP TO 2025

In preparation for the statutory changes due in AMP8, we have been bringing in house a number of outsourced activities under our NWGrow (recycling to agriculture) initiative. We see this as providing a huge opportunity to better communicate the agricultural services we provide and thereby enhance the service provisional to our agricultural stakeholders. This offers us greater control and resilience and also enables further alignment with the FRfW. The types of activities we have insourced include raw sludge tankering, principal farmer facing liaison, field sourcing services, direct communications with farmers, biosolids field risk assessments and coordination of recycling activities.

We have continued to implement efficiency projects in our bioresources activities and the findings in section 4.1.2 show that we are frontier performance on costs for bioresources.

2.3. NEED FOR ENHANCEMENT EXPENDITURE IN AMP8

2.3.1 Process for identifying needs

The need for enhanced expenditure is being driven by the availability and accessibility of the landbank for disposal of bioresources. The new statutory regulations prevent soil deterioration, so that bioresources can only be disposed to land when the soil needs it. This means there will be restrictions on autumn applications, and we will have to balance disposal over the year and find alternative land further away.

We have actively contributed to the industry Bioresources WINEP Engagement Working Group. This group commissioned Grieve Strategic to carry out modelling to assess the impact of the new regulations on landbank availability and the increased haulage distances. Table 3 summarises modelling outputs for 4 scenarios[4]:

- Scenario 2: Current situation – including changes that have already been accommodated – current base case (Figure 1).
- Scenario 3: 10-year minimal change – best case position for AMP8/9.
- Scenario 4: 10-year most likely change – most likely position for AMP8/9. (Figure 2).
- Scenario 5: 10-year plausible maximum change – likely maximum regulatory change for AMP8/9.

[4] Scenario 1 relates to historic scenarios which are not relevant to this investment case.

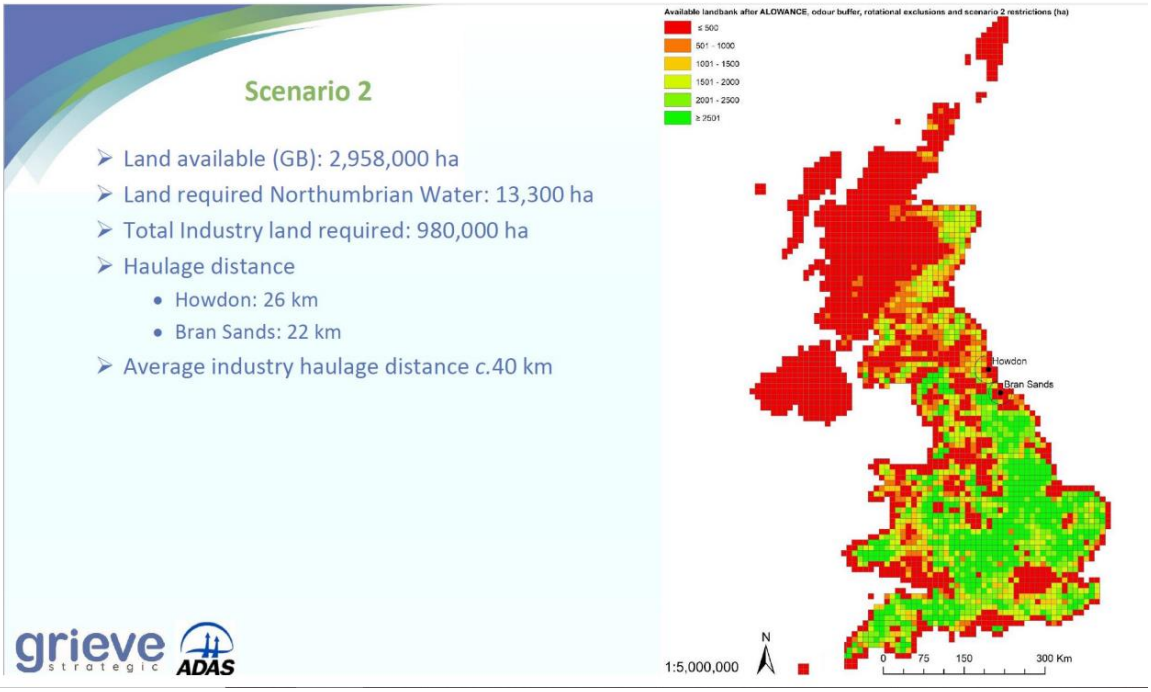
TABLE 3: IMPACT ON HAULAGE DISTANCES

Criteria	Unit	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Land available (Great Britain)	Ha	2,958,000	2,688,500	2,407,000	1,745,000
Land required (Northumbrian Water)	Ha	13,300	16,300	102,800	187,900
Land required (Great Britain)	Ha	980,000	1,195,800	5,475,900	11,628,700
Haulage distance from Howdon	Km	26	27	84	158
Haulage Distance from Bran Sands	Km	22	24	84	158
Industry average haulage distance	Km	40	50	200	>500

Source: Northumbrian Water

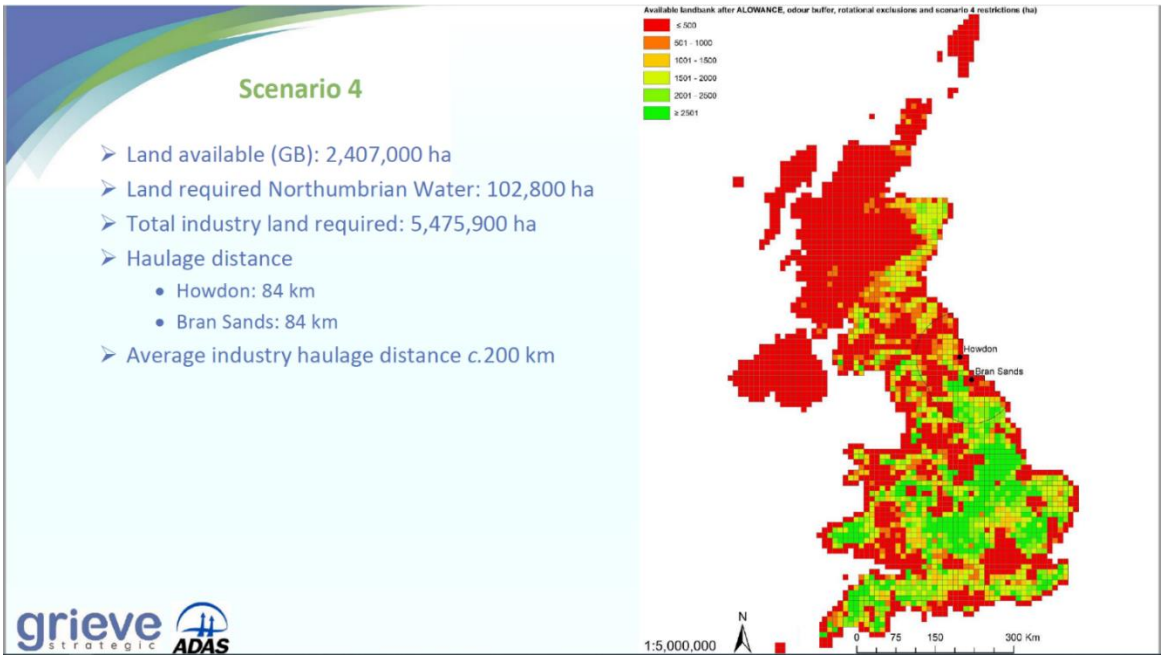
Table 3 shows that our haulage distances would increase by 250% from the current position of 22 km and 26 km to 84 km under the most likely scenario for AMP 8/9. Haulage costs would increase by £718k a year as shown in line CWW3.144 of the data tables. These changes put pressure on the available landbank and current biosolids storage capacity within our system in parallel with the time constraints of Environmental Permitting Regulation deployments.

FIGURE 1: LANDBANK ANALYSIS SCENARIO 2 - CURRENT SITUATION



Source: Grieve Strategic

FIGURE 2: LANDBANK ANALYSIS SCENARIO 4 – MOST LIKELY POSITION FOR AMP8/9



Source: Grieve Strategic

The scale of investment for AMP8 has been agreed through a series of discussions with the Environment Agency and two meetings on 6 and 8 June 2023 as shown in Table 4. These represent a no regrets approach for AMP8 while work is ongoing by the Environment Agency to develop its Sludge Strategy. It was anticipated that this strategy would be published and enacted late within the PR19 period, however based on the latest email received from the Environment Agency on 9 August 2023 this is likely to start early within the PR24 period.

TABLE 4: NEEDS AGREED WITH ENVIRONMENT AGENCY

Driver	Need	Need description	Root Cause
SUiAR_IMP	Improve sludge to land supply chain resilience to 90 days strategic storage.	Achieve the Environment Agency's future interpretation of FRfW[5] and autumn deployments limitations driving requirements for 90 days storage[6] to make sure of business continuity during periods of extreme weather or agriculture challenges which prevent access to landbank.	At present 100% of our final biosolids are disposed to land with circa 80% being deployed to autumn crops. Our current position with respect to cake storage is two days at Howdon and eight days at Bran Sands.
SUiAR_IMP	Improve sludge to land supply chain resilience from high solids dewatering at Howdon and Bran Sands.	Increase the capacity to provide another 36 days storage by increasing the percentage of dry solids to circa 33%.	Current percentage of dry solids is at 27%.
SUiAR_ND	Environmental Permitting Regulations (EPR) compliance.	To be compliant with these regulations, we require extra information to monitor/analyse the sludge quality as per Biosolids Assurance Scheme requirements (prior to and during land application). For example, application rates/periods and to manage sludge transfer/source history (what, where, how, volume and treatment process). The information will be set out to allow for ease of producing reports to the Environment Agency.	The Environment Agency's strategy for safe and sustainable sludge describes the intention to evolve Environmental Permitting Regulations to include sludge. This will require current data management packages to be enhanced to capture a higher degree of accuracy and detail in real time.

Source: Environment Agency

[5]Secretary of State, 2018, 'The Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018'

[6]Environment Agency, 14 September 2022, AMP8 Sector wide assessment WINEP Sludge Driver Evidence Support – Biosolids Storage

2.3.2 Link to long term strategy

This investment is needed as part of the 'protecting the local environment' investment area under our Long-Term Strategy (LTS) core pathway. This investment includes:

- sludge storage barn facilities required to satisfy the FRfW [7]
- advanced sludge dewatering required to satisfy the FRfW; and
- investment to meet pending EPR requirements.

We consider these as low/no regret investments because they are needed to meet statutory requirements in 2025-30 and in the case of EPR requirements, anticipated statutory requirements. The EPR investments have been approved in principle by the Environment Agency and we expect these delivery requirements to be included in the Environment Agency's Sludge Strategy. We have or expect to have a legal obligation to deliver this investment package by 2030. We therefore consider this investment necessary in 2025-30 to deliver our LTS.

There are no adaptive pathways for sludge, as per the PR24 guidance.

2.4. CUSTOMER SUPPORT FOR THE NEED AND SOLUTION

These projects are all a consequence of statutory requirements, and so we have not discussed the specific needs with customers. That is because our research shows that customers expect us to meet our statutory obligations, and it is not appropriate to discuss delaying or phasing investment where there are no alternatives to meet the statutory requirement to deliver our part of WINEP.

Our research shows that customers support investment in the environment, including the wider environmental and social benefits – though they do not necessarily think they should always pay for this through their water and wastewater bills. In particular, our customers rank dealing with sewage effectively and improving the quality of rivers as two of their "medium" priorities (**prioritisation of common PCs**, NES44).

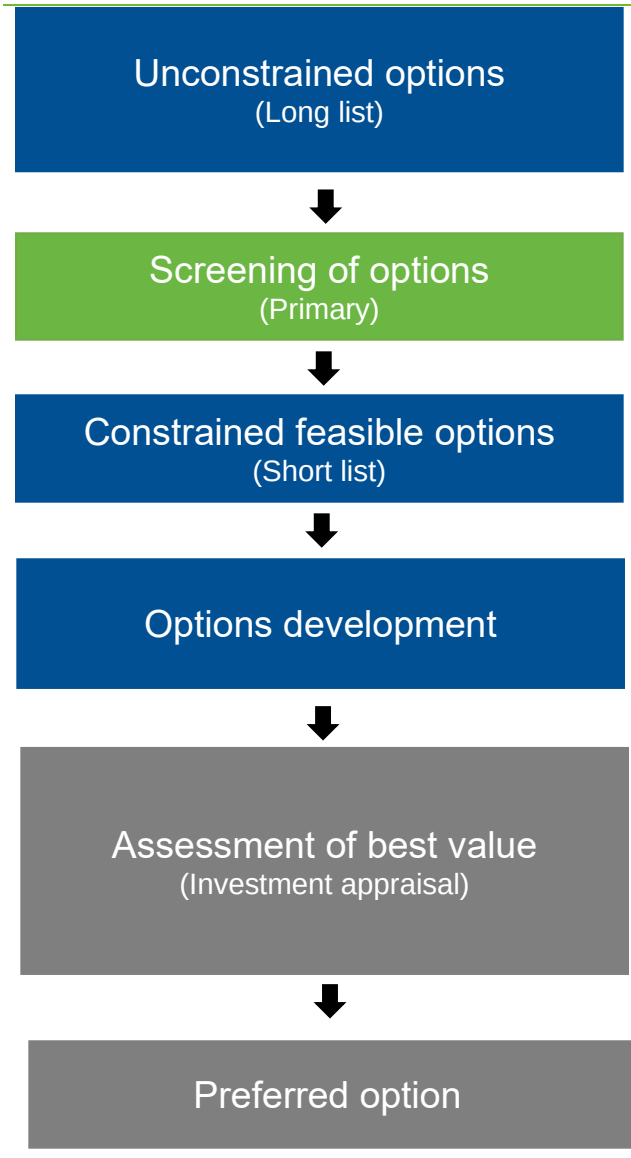
In our **qualitative affordability and acceptability testing** (NES49), customers supported our "preferred" plan which included these bioresources investments. Customers found this plan acceptable because it focused on the right things, is good for future generations, and is environmentally friendly. Customers who did not find this plan acceptable said that this was expensive, and water companies should pay out of their own profits. We did not ask specifically about bioresources investments (as our individual items were limited only to the largest investments), but customers supported maintaining rivers and reducing pollution (NES49). In our **quantitative research** (NES50), 74% of customers supported our preferred plan, including this investment.

[7] GOV.UK, 2022, Applying the farming rules for water - GOV.UK (www.gov.uk)

3. BEST OPTION FOR CUSTOMERS

Figure 3 shows our process for identifying the best option for customers which is based on the principles of the HM Treasury, The Green Book: Central Government Guidance on Appraisal and Evaluation[8] and the WINEP Options Development Guidance. A full description of each of the steps and the output from it is contained in the following sections.

FIGURE 3: PROCESS FOR DEVELOPING AND FILTERING OPTIONS



Unconstrained list of technology options (section 3.1)
We have developed a broad range of options in our bioresources strategy in accordance with section 7.2.1 of the WINEP Options development guidance. The number of options has been constrained more than it would normally be as the Environment Agency has rejected a number of options as a result of pursuing a no regrets approach.

Constrained list of technology options (section 3.2)
We have screened the unconstrained list of options against:
1) expected to meet statutory obligation and need as agreed by the Environment Agency, and
2) aligns with our bioresources strategy, and
3) technically feasible

in accordance with section 7.2.2 of the WINEP Options development guidance.

Options development (section 3.3)

We have developed the dewatering and EPR options to level 2 scope and the cake barn to level 3. We have carried out a deliverability assessment and all options are deliverable within the regulatory timescale of 2030.

Assessment of best value (section 3.4)

We have carried out an assessment of benefits and net present value for each of the options from the constrained list at each site using the guidance in section 7.3 of WINEP options development guidance.
We have also assessed each option against the Wider Environmental Outcomes Metrics in accordance with section 7.2 of WINEP Options Development guidance.

Preferred option (section 3.4.2)
We have selected the preferred option and all options selected are least cost no regrets options.

Source: Northumbrian Water

Table 5 sets out how we have met the options development principles.

[8] HM Treasury, The Green Book, Central Government Guidance on Appraisal and Evaluation 2022

TABLE 5: WINEP OPTIONS DEVELOPMENT PRINCIPLES

Expectation	How this has been met
Environmental net gain	We have carried out an assessment of environmental net gain for each option using the potential environmental impacts including the natural environment, net zero, catchment resilience, and engagement.
Natural capital	We have assessed each of our options against the full range of natural capital metrics and wider environmental objectives as part of our WINEP assessment to the Environment Agency. The measures that apply to our options are shown in Table 10 For each option we scored the impact of continuing business as usual and then we scored each of the relevant options. Benefits are scored over time for a 30-year time horizon. This scoring takes into account the certainty of benefits being realised for different types of options. For the cake storage the pollution risk and the utilisation of bioresources is the same for all investment options. The options which include odour control will have more air quality benefits although we cannot monetise these. A fewer number of sites is also likely to mean less carbon and less disruption to customers, although actual volumes will depend on knowing the final locations of sites which will continue to be defined during the delivery process. The main differentiator will be cost and carbon. High solids dewatering will provide air quality benefits and carbon benefits. Disposal to land will be better for the environment than disposal to landfill. The main differentiator on options is cost. We have not applied a benefit to improved EPR reporting. . The main wider environmental objectives metrics affected are net zero and air quality. These have been qualitatively assessed in our benefits assessment which is described in section 3.4.1.
Catchment and nature-based solutions	There are no nature-based solutions which are relevant to these needs. Solutions relate to constructing cake storage, dewatering and modifications to our computers systems.
Proportionality	We have taken a proportional approach to options development based on green book principles. The feedback from the Environment Agency following our WINEP submission in November 2022 has led to a proportional no regrets approach for AMP8, while extra options for addressing landbank and soil deterioration are investigated in conjunction with the rest of the industry for AMP9.
Evidence	The evidence to underpin our option selection is described within sections 3 and 4 of this document. We clearly record the reasons for discarding options. Further supporting evidence of our solutions development and our data sets is available in our Options Development Report and Options Assessment. Our WINEP submission has been independently audited by a third party (Jacobs) and there are no outstanding actions.
Collaboration	We have collaborated with the Environment Agency to define the list of needs and interventions. Collaboration with local stakeholders and planning authorities will occur as part of the delivery process. We continue to be engaged within the Bioresources arena, participating within Water UK networks and discussion groups with the Environment Agency. Also, being part of the Biosolids Assurance Scheme

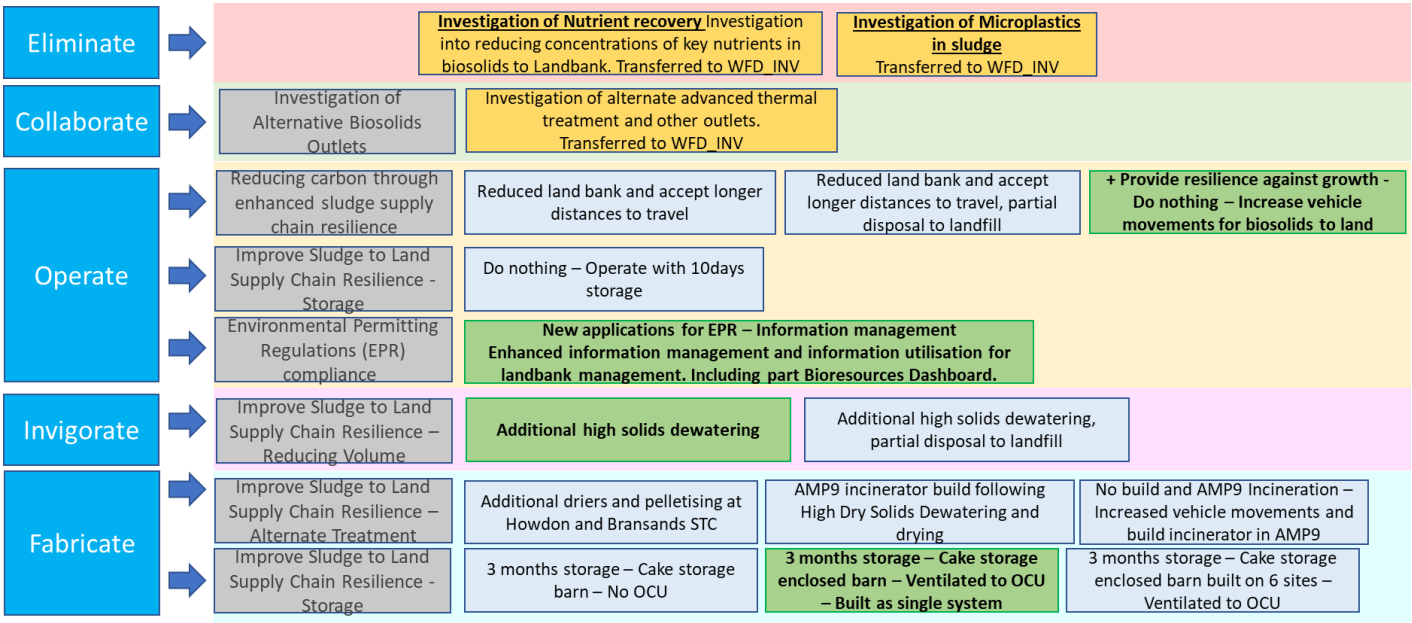
Expectation	How this has been met
	(BAS) allows shared industry experiences, emerging issues and trends to be easily shared and discussed. We are also involved locally with the North East Recycling Forum, which encourages communication and contacts within the broader organic community as well as spreading knowledge, trends, regulatory updates and best practice among the diverse recycling operators and farmers within the North East of England. The forum includes members from commercial anaerobic digestion operators, national and local recyclers, reclamation, and compost operators, and allows us a voice and participation within the local and national sector.

Source: Northumbrian Water

3.1. BROAD RANGE OF OPTIONS

To determine the best option for customers to address the Need, we have followed an options identification and screening process. Firstly, we identified a broad list of options, as shown in Figure 4, which are a subset of the options considered as part of our Bioresources Strategy for managing landbank and soil quality in the short and medium term. The boxes shaded in green are the short term no regrets options which have been accepted by the Environment Agency relevant to this business case.

FIGURE 4: INTERVENTION FRAMEWORK CONSIDERING RANGE OF APPLICABLE INTERVENTIONS



Source: Northumbrian Water

Our broad range of options considers options with differing levels of costs and benefits categorised as follows:

- Eliminate – identification of processes and practices that can be stopped possibly by stakeholder management or other, and by challenging the need for existence. Eliminate options are likely to have the lowest costs to deliver the benefit. They may be used in combination with other options. There are no eliminate options as these are new statutory requirements.

- Collaborate - work with stakeholders to re-assign the issue or co-fund. Costs can be shared with third parties either to deliver the same or an extra level of social and environmental benefit. Our optioneering considers collaborative research to understand the lack of resilience in the supply chain of sludge to agricultural land, and cross border treatment of sludge – there are currently no options identified to collaborate with stakeholders other than those Sludge investigations which the Environment Agency have agreed we should include within the WINEP Water Framework Directive Business case. We will continue to work the farming community during the transition to the new statutory requirements.
- Operate - improved operational management practices to enhance existing capacity. The consequence of restrictions on when sludge can be applied to land will mean an increasing in tanker movements for up to 84km. We have calculated that an extra 9 tanker loads per week will be required.
- Invigorate - invest in the existing infrastructure to improve performance. These options will provide an increased level of benefit but may be of a lower cost than fabricate options.
- Fabricate - new assets to augment or replace existing. These options are likely to have the highest costs. Green options will have lower carbon and potentially higher biodiversity and amenity benefits. There are no green options for sludge. Traditional grey options are likely to have highest certainty that service-related benefits will be realised. Innovative options have the potential for greater benefits and lower costs but have the lower certainty that benefits will be realised.

3.2. PRIMARY SCREENING OF OPTIONS

In accordance with the WINEP options assessment guidance section 6, we have carried out screening of each of the technology options shown in Figure 4 to make sure that:

- The option meets statutory requirements. The option is expected to meet the changes in future legislation and has been accepted by the Environment Agency as a part of the WINEP Sludge case.
- The option aligns with our bioresources strategy. The option provides a balanced approach to compliment future pathway opportunities, it is beneficial to carbon footprint reduction and greenhouse gas emissions and it makes sure of the quality and integrity of the biosolids cake.
- It is technically feasible to implement the option.

If the option does not meet these criteria, then the option is discarded. The results and reasons for discarding interventions are shown in Table 6, Table 7, Table 8 and Table 9. There is only one option for meeting the requirements to monitor and analyse sludge quality as per Biosolids Assurance Scheme requirements.

TABLE 6: PRIMARY SCREENING OF OPTIONS FOR EPR COMPLIANCE

Option	Meets Statutory Obligation?	Meets our bioresources strategy?	Technically Feasible?	Reason for discarding	PR24 data table line
Continue business as usual	No	No	Yes	**Discarded –** does not keep to regulatory guidance for EPR	-
Improved reporting for EPR compliance • Upgrade the existing Gemini system to manage future requirements of EPR deployment and to meet the requirements of the biosolids assurance scheme. • Provide data capture of real-time CO2/environmental data from our logistics fleet by upgrading to next generation SAMSARA software. • Extra mapping / GIS modelling - Develop an all-encompassing mapping / GIS package capturing key aspects of management tools and information providing the end user with live data to make fully informed and accurate decisions. • Develop and apply a field-based duplication of data held within the Gemini management system allowing personnel to be fully informed of supporting key discussions with stakeholders. • Develop an EPR operational dashboard capturing critical management and compliance KPI's.	Yes	Yes	Yes	**Carried forward**	Sludge treatment - other

Source: Northumbrian Water

Table 7 shows the options required in the short term to protect soil deterioration by increasing haulages in line with scenario 4.

TABLE 7: PRIMARY SCREENING OF OPTIONS FOR INCREASED HAULAGE FOR SCENARIO 4

Option	Meets Statutory Obligation?	Meets our bioresources strategy?	Technically Feasible?	Reason for discarding	PR24 data table line
Do nothing	No	No	Yes	**Discarded –** does not keep to statutory guidance to restrict autumn application of sludge.	-
Continue business as usual Travel from 22km or 26km to 84km to dispose of sludge.	Yes	Part	Yes	**Carried forward**	Sludge treatment other

Source: Northumbrian Water

Table 8 shows the range of options considered for provision of 90 days cake storage. Options will continue to be refined as part of the delivery programme to look at alternative locations and numbers of sites. It should be noted that discussions continue to confirm its location within our operating region and also the potential benefits of two or more storage barns at a reduced size compared to the current proposal of one large barn.

TABLE 8: PRIMARY SCREENING OF OPTIONS FOR INCREASING CAKE STORAGE TO 90 DAYS

Option	Meets Statutory Obligation?	Meets our bioresources strategy?	Technically Feasible?	Reason for discarding	PR24 data table line
Continue business as usual	No	No	Yes	**Discarded –** does not keep to guidance to provide 90 days storage.	-
Single cake storage at a location to be confirmed with odour control 90 days storage at a single storage site totally enclosed leachate collection and with odour control.	Yes	Yes	Yes	**Carried forward**	Sludge storage – Cake pads/bays
Single cake storage at a location to be confirmed without odour control 90 days storage at a single storage site totally enclosed leachate collection and with odour control.	Yes	Yes	Yes	**Carried forward**	Sludge storage – Cake pads/bays

Option	Meets Statutory Obligation?	Meets our bioresources strategy?	Technically Feasible?	Reason for discarding	PR24 data table line
Cake storage at six sites with odour control 90 days storage spread across 6 sites (dewatering and sludge transfer sites) enclosed leachate collection and with odour control.	Yes	Yes	Yes	**Carried forward**	Sludge storage – Cake pads/bays

Source: Northumbrian Water

Table 9 shows the range of options considered for increasing the percentage of dry solids from 27% to 33%. Our bioresources strategy considered other options which included different methods for disposal in AMP9 such as incineration, but these were rejected by the Environment Agency as the level of soil deterioration was not yet sufficient to demonstrate that this option was required during AMP8.

TABLE 9: PRIMARY SCREENING OF OPTIONS FOR INCREASING THE % OF DRY SOLIDS

Option	Meets Statutory Obligation?	Meets our bioresources strategy	Technically Feasible?	Reason for discarding	PR24 data table line
Continue business as usual	Yes	No	Yes	**Discarded –** does not reduce the water content of sludge	-
High solids dewatering land disposal Extra centrifuge dewatering at Bran Sands and Howdon with higher solids dewatering and dispose to land.	Yes	Yes	Yes	**Carried forward**	Sludge treatment – Thickening and/or dewatering
High solids dewatering partial disposal to landfill Extra centrifuge dewatering with higher solids dewatering at Bran Sands and Howdon per TC with partial disposal to landfill.	Yes	No	Yes	**Carried forward**	Sludge treatment – Thickening and/or dewatering
Extra driers and pelletising at Howdon and Bran Sands STC Installing dryers and pelletising at Howdon and Bran Sands STCs and dispose to landbank.	Yes	Yes	Yes	**Carried forward**	Sludge treatment – Thickening and/or dewatering.

Source: Northumbrian Water

3.3. OPTIONS DEVELOPMENT PROCESS

For each of the options carried forward we developed a scope of work. The options for cake storage have been supported by the evidence presented in report WINEP Sludge Driver Evidence Support – Biosolids Storage (August 2022) issued to all members of the WINEP Working Group. In the optioneering process we have made the following assumptions:

- For landbank modelling, assumed scenario 3 is possible but scenario 4 is likely based on recent discussions.
- In line with above report, development of 3 months biosolids storage, inclusive of ventilation and odour control.
- Average monitored dry solids content of 26.5% can be enhanced to 33% dry solids content with implementing high dry solids dewatering technology to the current dewatering equipment.

In addition to the standard constrained screening methodology, an initial assessment was completed on the solutions per constrained options. This utilised the criteria as indicated in the WINEP guidance.

The screening methodology was also used to assist with the development of a plan taking into account the current available information, such as the likely landbank outcome, the Environment Agency changes to EPR, the likely legislative and strategies currently under development relating to sludge to land. We also carried out a deliverability assessment in accordance with WINEP.

3.4. BEST VALUE

3.4.1 Benefit scoring

For each of the technology options carried forward to this stage we carried out a benefits assessment using our value framework which contains performance commitments, wider environmental outcomes[9] and other metrics. The full range of metrics used for assessment is included in using the remaining two criteria in the section 6:

- how they contribute to the WINEP Wider Environmental Outcomes; and,
- the likelihood that the benefits will be realised (deliverability).

We have incorporated the Wider Environmental Outcomes Metrics[10] into our Value framework, which is embedded into our portfolio optimisation tool used to carry out appraisal of options. Table 10 shows the range of benefits, the quantification and monetisation values we have used for the assessment of sewage sludge. These include carbon impact (operational and embedded), natural capital and other benefits. Note that biodiversity could only be assessed for those needs where a change in land use was considered applicable.

[9]Environment Agency, March 2022, WINEP Options Assessment Guidance

[10] Environment Agency, 07.04.2022, WINEP Wider Environmental Outcome Metrics V2.1

TABLE 10: RANGE OF BENEFITS IDENTIFIED FOR SEWAGE SLUDGE

Value measures	Description	Unit	Value	WEO	Performance Commitment
Cat 3 pollution incident	Number of pollution incidents	Num	£1,738 £224,187	No	Yes – avoided benefit
Utilisation of bioresources				No	No
Air quality			Not monetised	Yes	No
Operational Carbon		tCO2e	£256.2*	Net zero	
Embedded Carbon		tCO2e	£256.2*	Net zero	

Note: *£ value per tonne of CO2e in 2025/26, annual increase (varying rate) reaching £378.6/t CO2e in 2024/55

Source: Northumbrian Water

TABLE 11: EXTRA BENEFIT FOR AMP9 INCINERATION AND CAKE STORAGE OPTIONS

Value measures	Description	Unit	Value	WEO	Performance Commitment
Biodiversity	Arable Fields	£/ha	2.52**	Net zero	
	Low calc grassland	£/ha	24.84**	Net zero	

Note: **2016. Values from CIRIA B£ST (susdrain.org)
Source: Northumbrian Water

For each option we scored the impact of continuing business as usual and then we scored each of the relevant options. Benefits are scored over time for a 30-year time horizon. This scoring takes into account the certainty of benefits being realised for different types of options. For the cake storage the pollution risk and the utilisation of bioresources is the same for all investment options. The options which include odour control will have more air quality benefits although we cannot monetise these. A fewer number of sites is also likely to mean less carbon and less disruption to customers, although actual volumes will depend on knowing the final locations of sites which will continue to be defined during the delivery process. The main differentiator will be cost and carbon.

High solids dewatering will provide air quality benefits and carbon benefits. Disposal to land will be better for the environment than disposal to landfill. The main differentiator on options is cost.

We have not applied a benefit to improved EPR reporting.

3.4.2 Cost benefit appraisal to select preferred option

For each of the options taken forward from primary screening we have carried out a robust cost benefit appraisal within our portfolio optimisation tool to select the preferred option. This calculates a net present value (NPV) over 30 years in accordance with the PR24 Guidance and cost to benefit ratio for each option. The ratio is calculated by dividing the present value of the profile of benefits by the present value of the profile of costs over the appraisal period of 30 years.

Costs and benefits have been adjusted to 2022-23 prices using the CPIH Index financial year average. The impact of financing is included in the benefit to cost ratio calculation. Capital expenditure has been converted to a stream of annual costs, where the annual cost is made up of depreciation/RCV run-off costs and allowed returns over the life of the assets. Depreciation (or run-off) costs are calculated using the straight-line depreciation over the appraisal period. To discount the benefits and costs over time, we have used the social time preference rate as set out in 'The Green Book'.

We have run optimisations to select the least cost based on private values only and the best value using private and societal values. The output of this assessment and the cost benefit ratios are included in Table 12.

TABLE 12: BENEFIT TO COST RATIO AND SELECTED OPTIONS

Option	NPV £m	Type of option
Single cake storage at a location (s) to be confirmed with odour control	-59.474	Preferred – best value
Single cake storage at a location (s) to be confirmed without odour control	-38.881	Alternative
Cake storage at six sites with odour control.	-86.090	Alternative
High solids dewatering land disposal.	-20.408	Preferred – least cost
High solids dewatering partial disposal to landfill.	-119.540	Alternative
Extra driers and pelletising at Howdon and Bran Sands STC.	-68.935	Alternative
Info management for compliance with landbank EPR.	-323.301	Preferred

Source: Northumbrian Water

For all sites except the cake barn, the least cost and best value alternatives were the same. Table 13 shows a comparison between our least cost and the best value option which we are now proposing in terms of additional storage. The Cake Barn with odour control has a higher carbon cost of £0.533m (2158 t/CO2e) over a 30 year period; however the requirement for odour control is driven by regulatory uncertainty and planning permission requirements, being deemed as fundamental to a compliant delivery in a strategic location.

TABLE 13: SITES WITH DIFFERENT LEAST COST AND BEST VALUE OPTIONS

Site	Least cost option	Best value option	30 Year totex variance £m	Carbon societal value variance £M	Carbon variance t/CO2e (30 yr)
Cake Barn at single location	Without odour control	With odour control	20.356	0.533	2,158.37

Source: Northumbrian Water

Table 14 shows an evaluation of key comparisons between the least cost and best value option. The inclusion of odour control within the cake barns design will ensure a compliant asset and satisfy planning permission criteria.

TABLE 14: EVALUATION OF PREFERRED OPTION

Totals for 7 sites	Least cost option	Best value option	Variance (£m)
Capex in AMP8	47.689	63.885	-16.196
Opex in AMP8	0.142	0.704	-0.562
Totex (30 yr NPV)	39.749	60.105	-20.356
Private value	-39.732	-60.086	20.354
Private and societal value	-38.881	-59.474	20.593
Societal carbon cost	1.491	2.024	-0.533

Source: Northumbrian Water

We have included odour control within our chosen option as opposed to no odour control as we know it is likely to lead to a failure in planning permission associated with potential odour complaints and an increase in air emissions.

We are not able to quantify the benefits from these until we have determined the final location of the sludge cake barn. This will be in located in the optimum strategic location considering it will service the deployment of Biosolids across the entire region from our two northern and southern Sludge Treatment Centres at Howdon and Bran Sands.

The benefits and investment for our preferred option for sewage sludge are included in Table 15 and Table 16. Profiling of benefits and expenditure will continue to be refined as we continue to work with our strategic delivery partner to carry out further design work and optimisation of the programme for delivery.

TABLE 15: INPUTS FOR TABLE CWW15 – BENEFITS BEST VALUE OPTION

EA/NRW environmental programme	Benefit	Units	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	Total
Sludge storage - Cake pads / bays	Operational carbon	t/CO2e		0.0	0.0	3.7	13.8	10.7	28.2
	Embedded carbon	t/CO2e		3542.9	2834.3	2125.8	0.0	0.0	8503.0
Sludge treatment - Thickening and/or dewatering	Operational carbon	t/CO2e		0.0	0.0	0.0	4.0	9.6	13.5
	Embedded carbon	t/CO2e		30.0	123.8	495.0	371.3	0	1020.1

Source: Northumbrian Water

TABLE 16: INPUTS FOR TABLE CWW3 - ENHANCED EXPENDITURE £M

EA/NRW environmental programme		Line	2024-2025	2025-26	2026-27	2027-28	2028-29	2029-30	AMP8 Total
Sludge storage - Cake pads / bays	Capex	CWW3.137	-	21.295	21.295	21.295	-	-	63.885
	Opex	CWW3.138	-	-	-		0.352	0.352	0.704
	Totex	CWW3.139		21.295	21.295	21.295	0.352	0.352	1.760
Sludge treatment - Thickening and/or dewatering	Capex	CWW3.143		-	-	8.250	8.250	-	16.500
	Opex	CWW3.144		0.718	0.718	0.634[11]	0.550	0.550	3.170
	Totex	CWW3.145		0.718	0.718	8.884	8.880	0.550	19.750
Sludge treatment other	Capex	CWW3.146		0.361	-	-	-	-	0.361
	Opex	CWW3.147	-	-	-	-	-	-	
	Totex	CWW3.148		0.361					0.361
Totals	Capex			21.656	21.295	29.545	8.250	-	80.746
	Opex			0.718	0.718	0.634	0.902	0.902	3.875
	Totex								84.621

Source: Northumbrian Water

[11] The increase in opex is due to the increase in tankering as a result of moving to Scenario 4. The Tables were locked for financial modelling in September, and we have identified that the opex saving should be one year later.

3.5. THIRD PARTY FUNDING

No opportunities for third party funding have been identified so far for the chosen interventions because these are all assets within our own sites or related to software upgrades on our existing systems. Proposed options for collaborating with other companies to form a National Dashboard for Environmental Permitting Regulations reporting were rejected by the Environment Agency in our original WINEP submission, however we will continue to look for opportunities to collaborate on this if it reduces costs. We have started engagement in Ofwat's newly launched Bid Assessment Framework (BAF) and recently approached both United Utilities and Yorkshire Water around future collaboration on landbank availability. Collaborative funding is however expected to be fully developed as part of the PR29 process.

3.6. DIRECT PROCUREMENT FOR CUSTOMERS

We assessed the septic tanks programme against the DPC guidance (see our **assessment report**, NES38). This report concludes there are no opportunities for direct procurement for customers relevant to septic tanks because the projects are small value and less than <£200m of whole life totex.

3.7. DELIVERABILITY ASSESSMENT

We have carried out a deliverability assessment and are confident that we can deliver the statutory requirements by 2030. We have programmed software and data changes for Environmental Permitting at the beginning of the AMP so we can meet the changes to the regulatory requirement which are expected to be included within the pending Environment Agency Sludge Strategy. We also intend to start the cake storage early in the AMP to make sure we have sufficient time to determine a final location and address and engage with any relevant stakeholders.

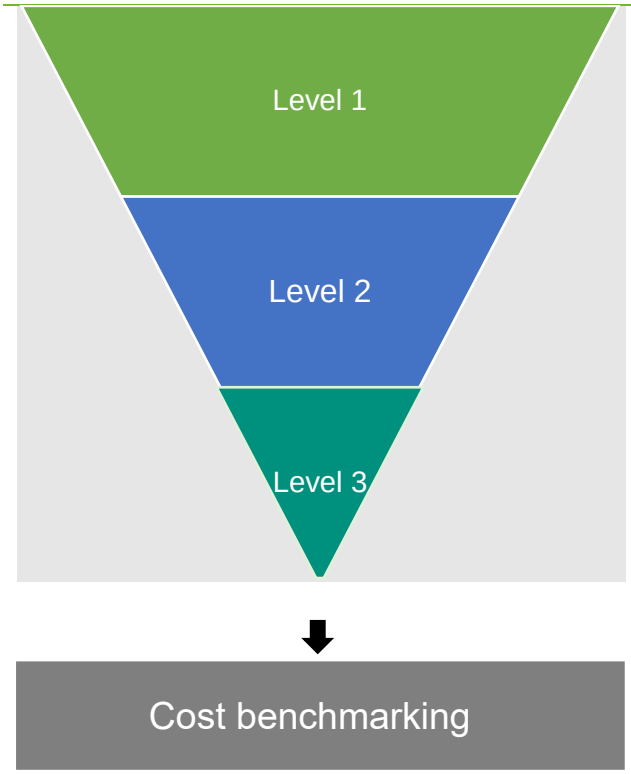
4. COST EFFICIENCY

4.1. APPROACH TO COSTING

4.1.1 Cost methodology

A full description of our costing methodology is contained in our A3 Costs Appendix. In Figure 5, our Environmental Permitting Regulations systems and extra high solids dewatering have been costed to Level 2. For the sludge cake barn we have not used our IMOD costing system as it does not have sufficient data points. We have therefore estimated it bottom up as we would with a Level 3 estimate but as we have not determined the location, the cost confidence will be +/- 50% as per a level 2 estimate.

FIGURE 5: PROCESS COST ESTIMATION



Level – 1 (confidence: – 50% to +100%)

Costing is carried out using our costing curves. Costing occurs at an overall asset level. For example, package plant or a pumping for a certain population.

Level – 2 (confidence: - 50% to + 50%) – Chosen approach

Costing is carried out using our costing curves. Costing occurs for each of the main items of scope. For example, the length of rising main and the size of the pumps.

Level – 3 (confidence: - 20% to +30%)

Detailed bottom-up costs of all items taking into consideration factors such as ground conditions.

Cost benchmarking

We have benchmarked the sludge cake storage option against the available cost curves from other companies. Further detail is provided in section 4.1.2.

Source: Northumbrian Water

Our costing has been carried out by our costing partners using our cost models. They have then been benchmarked against our costing partner's cost database and independently assured by PwC as they have been loaded into data tables.

4.1.2 Our position relative to other companies

We started an innovative step change to our bioresource strategy in 2007 by transitioning from thermal drying and lime stabilisation to advanced anaerobic digestion processing delivering the ability for us to become the frontier company as shown in section 4.1.2. We continue to review our sludge management strategy to further develop processing efficiencies in sludge treatment supply chain to enhance our position as the most efficient bioresource Water and Sewage Company.

TABLE 17: INDUSTRY COST EFFICIENCY

Company	Bioresources		Efficiency	Rank
	Actual	Modelled		
Anglian	427	369	1.157	7
Northumbrian	85	151	0.563	1
Severn Trent	449	535	0.839	2
Southern	237	239	0.992	4
South West	123	111	1.108	6
Thames	680	639	1.064	5
United Utilities	354	410	0.863	3
Welsh	258	191	1.351	10
Wessex	174	144	1.208	9
Yorkshire	370	319	1.160	8

Source: Northumbrian Water

4.1.3 Cost benchmarking

Our original estimate for the sludge cake barn of £118.044m has been reduced by 45% to £63.885m through our cost benchmarking. Our estimate is made up of the following elements:

- A direct cost which is directly attributable to the project such as plant, labour material and equipment.
- An indirect cost which is related to design, site setup, professional support and other costs not directly related to the construction aspect of a project.
- A risk and uncertainty element related to the level of costing, which is excluded from cost benchmarking.

We have compared our costs to estimates of three companies within our costing partner's database. It is however difficult to make any meaningful conclusions on overall costs because we are only able to benchmark the sludge pad that only covers 43% of the project cost (**Error! Reference source not found.**). When benchmarking a single cake barn direct c omparisons are difficult because:

- Single sites will have differences in physical location (urban vs rural) and linear volumetric capacity of the barns will be difficult to use as a linear comparison.
- Our estimate includes more detailed scope than some of the estimates particularly in the areas of odour control, power and lighting as we have costed bottom up – compared with benchmark costs. This means we will have a lower uncertainty factor due to scope.

As our location has not been finalised, our cost estimate will have a higher uncertainty factor than those companies who have determined a final location.

TABLE 18: SUMMARY FOR SEWAGE SLUDGE INCLUDING INDIRECT COSTS & REMOVED SCOPE FROM DIRECT COSTS

Investment Name	Option Type	Northumbrian	Benchmark	Delta*	Delta %**
3 months storage	26,800m3 Cake Barn	£27,438,345	£20,691,614	£6,746,731	33%
Total		**£27,438,345**	**£20,691,614**	**£6,746,731**	**33%**

Notes: * Delta = Northumbrian – Benchmark

** Delta % = Delta ÷ Benchmark

Source: Northumbrian Water

4.1.4 Factors affecting cost allowances

There are no specific factors which are unique to Northumbrian Water.

5. CUSTOMER PROTECTION

5.1. PERFORMANCE COMMITMENT

It is a statutory requirement to dispose of sludge to land and to be compliant with EPR. If sludge cake capacity is exceeded, a pollution incident may arise as a result of runoff from sludge storage areas either into site drainage or into the waterbody. The inability to dispose of sludge may also cause the treatment process to not work correctly and for a compliance failure to occur against the permit. Both of these instances are covered by performance commitments (that is, for pollution incidents and compliance).

However, these performance commitments are not significant compared to the cost of delivering these schemes, particularly for sludge cake storage. Therefore, in section 5.2 we propose a Price Control Deliverable to make sure customers are protected.

5.2. PRICE CONTROL DELIVERABLES

OUR APPROACH TO PRICE CONTROL DELIVERABLES IS SET OUT IN SECTION 12.3 OF OUR APPENDIX A3 - COSTS **(NES04).**
Table 19 shows our assessment against the Price Control Deliverable criteria. This assessment shows that the benefits will not be fully measured through PCs and ODIs, so we propose a PCD to make sure customers are protected through delivery of our WINEP programme.

TABLE 19: ASSESSMENT AGAINST PCD CRITERIA

Enhancement scheme	Benefits linked to PC?	Materiality	Possible outcomes?
WINEP – sewage sludge (NES34)	Pass – legal requirement not covered by performance commitments.	Pass – 3.1%	Provision of 90 days storage for cake storage. Provision of 36 days storage from high solids dewatering. Provision of reporting facilities for EPR compliance.

Source: Northumbrian Water

We propose that investment would be returned to customers if these statutory obligations are not delivered. There is no funding from third parties associated with these obligations.

Our WINEP programme is set by the Environment Agency, which determines the statutory and non-statutory investments we should make. The Environment Agency assures that WINEP actions are delivered to the agreed timeframe, and environmental obligations are met. We therefore propose a PCD that makes sure that costs are returned to customers either where the Environment Agency has decided that a project is no longer required, or where we have not delivered to the agreed timeframe and/or environmental obligations have not been met (according to the Environment Agency). A summary of our PCD for WINEP programme delivery is outlined in Table 20.

TABLE 20: SUMMARY OF THE PRICE CONTROL DELIVERABLE FOR OUR WINEP PROGRAMME DELIVERY TO PROTECT CUSTOMERS

Description of price control deliverable	**Delivery of WINEP projects as specified in our WINEP enhancement cases** (NES17, NES18, NES19, NES28, NES29, NES30, NES31, NES34).
Measurement and reporting	We will report on the delivery of WINEP projects at the next price review (PR29), including specifying the individual projects that have been delivered, not delivered, or that the Environment Agency has decided are no longer required (under the Environment Agency's WINEP alterations process). This is in addition to the WINEP guidance which specifies how we will need to report progress against delivery of the WINEP actions, and tracking and reporting WINEP delivery in a transparent and auditable manner.
Conditions on allowance	Projects must be delivered to the specification agreed with the Environment Agency under WINEP.
Assurances	The Environment Agency will confirm that WINEP actions have been delivered to the agreed timeframe, and that environmental obligations have been met. As set out in the **WINEP guidance**, there will be regular liaison between water companies and the Environment Agency to discuss progress, risks and issues associated with delivery of the WINEP programme and to identify any alterations. The Environment Agency uses the WINEP measures sign-off, technical review and audit guidance for assurance that the environmental obligations as set out in the WINEP are completed as planned.
Price control deliverable payment rate	We will return funds back to customers for individual projects, as specified in Table 16 above (for NES34) – 3 individual schemes to be delivered by the dates specified.
Impact on performance in relation to performance commitments	There are some impacts on performance commitments for carbon emissions, pollution incidents, and compliance. However, these are small compared to the costs of the schemes.

Source: Northumbrian Water

We propose a single PCD for most of our WINEP programme delivery (with the exception of storm overflows). This should:

- Be set according to **individual project costs**, rather than a "per project" unit cost. This is because these costs vary considerably, and a single rate would create an incentive to deliver more of the cheapest projects (at the expense of more expensive projects). Ofwat's guidance in IN23/05 identifies this incentive and expects us to set out scheme level deliverables where costs vary significantly across schemes (so our approach here is consistent with the guidance). If we did not aggregate WINEP schemes, there would be no PCD covering some of the other WINEP schemes because this would not be material on its own. However, some projects in NES34 are large compared to other WINEP projects.
- **Not include an automatic penalty for non-delivery** (beyond returning the costs to customers). This is because this PCD includes projects where the Environment Agency has decided these are no longer required, which should not lead to a penalty. If we did not deliver a project that is required (and where we had not agreed a change with the Environment

Agency), we would not meet our statutory obligations and so this does not require an extra incentive to deliver. This is a particular risk for NES34 where there may be uncertainty about requirements in 2025-30 (and customers should not be at risk from requirements that are no longer needed).

- **Change according to the Environment Agency's WINEP alterations process**. In 2020-25, our ODI for WINEP delivery does not automatically take into account projects that are removed from WINEP by the Environment Agency – but this should be for the Environment Agency to determine. Costs should be returned to customers for projects that are not required, without further interventions needed from Ofwat.

This is an aggregated PCD across all our WINEP schemes except for storm overflows. We chose to aggregate these PCDs because most of our WINEP enhancement cases or projects would not be individually material, and these share the same reporting, assurance, and conditions.