PR24

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A3-14 WINEP PROTECTED AREAS AND BATHING WATERS

NES28

TABLE OF CONTENTS

1. INTRODUCTION

Our long-term goals include "caring for the long-term needs of our environment". Our ambition as set out in our Long Term Delivery Strategy (LTDS) is to “restore and enhance our local and global environment”. Our plan shows how we meet Water Industry National Environment Plan (WINEP)[1] needs and is endorsed by the Environment Agency (EA).

This WINEP – Protected Areas and Bathing Waters business case of £58m details how we will deliver on our commitment to maintain bathing water quality, maintain and improve our natural habitats, and restore our marine conservation zones. Our plans are aligned to WINEP statutory guidelines. We are confident that our plans will address these areas and enable us to maintain an exceptional level of performance by delivering environmental and local community benefits.

As presented in our Drainage and Wastewater Management Plan (DWMP)[2], our ambitious long-term environmental goals are to demonstrate leadership in catchment management to enhance natural capital and deliver net gain for biodiversity, and to have the best rivers and beaches in the country. In previously funded plans, we have invested in maintaining our bathing waters and are proud that already 95% of the North East England population lives within a one-hour drive from a beach with Good or Excellent bathing waters. We have pledged that we will work with partners to achieve 100% of coastal bathing waters at Good or Excellent by 2030[3].

When building our plan, we have taken a holistic approach to viewing our catchments, understanding our commitments and requirements within each area. We have worked through a robust options development and selection process, where we have been able to demonstrate the wider value of our potential solutions. We have selected options based on the value they present. In some cases, this value is presented through a blended approach incorporating green and grey solutions.

This business case describes our proposed approach to meeting the statutory obligations as part of WINEP. The European Habitats legislation requires us to contribute to maintaining or restoring habitats and species at sites at favourable conservation status across their natural range which applies to special areas for conservation (SAC) and special protection areas (SPA), among others. The Wildlife and Countryside Act places a statutory requirement on us to protect sites of special scientific interest (SSSI), as designated by Natural England.

It also sets out our approach to the requirement to contribute towards improving or maintaining the quality of Bathing Waters (BW) and maintaining Marine Conservation Zones (MCZ) in favourable condition. The Water Framework Directive and Regulations (WFD) includes a requirement to make sure there is no deterioration of designated bathing waters and shellfish waters.

This business case details five areas of enhancement investment need, as set out in Table 1.

[1] PR24 WINEP driver guidance – Bathing Waters, Environment Agency
[2] NWL Drainage and Wastewater Management Plan, Northumbrian Water
[3] A vision for our coasts and rivers, Northumbrian Water

TABLE 1: SUMMARY OF COSTS TO ACHIEVE OUR WFD OBLIGATIONS OVER AMP8

Investment need	WINEP drivers	Capex (£m)	Opex (£m)	Totex (£m)
Reduction of phosphorus in the Wooler Water (River Till SAC)	HD_IMP	3.225	0.000	3.225
Reduction of nitrogen at Seal Sands	HD_IMP			Included in NN
Achieving nutrient neutrality requirements in Teesmouth & Cleveland coast SPA	HD_IMP_NN	45.479	2.216	47.695
Investigations to understand the impact of our activities on the environment	HD_INV, SSSI_INV	2.180	0.000	2.180
Restore bathing waters, shellfish waters and marine conservation zones	BW_ND, BW_NDINV, BW_INV BW_IMP3, MCZ_INV, SW_INV	4.781	0.152	4.932
TOTAL				**58.033**

This business case explains the need for this investment, our approach to developing our solutions and why we believe they demonstrate the best outcomes for our customers, society and the environment.

2. NEED FOR ENHANCEMENT INVESTMENT

2.1. ALIGNMENT WITH STATUTORY PLANNING FRAMEWORKS

Our plan to meet our long-term goals means aligning to all statutory planning frameworks. Our WINEP Protected Areas and Bathing Waters investment of **£58m** has been developed to meet the WINEP framework guidance. Our investment is for activities which have not been funded in previous price reviews.

The scale of our PR24 proposals is fully justified by this business case. It addresses known issues and contributes towards our statutory obligations under the Habitats Directive and has target completion dates of 30 March 2030. It also includes further investigations to assess the impact of our current activities for completion by 30 April 2027 which will help to identify future needs.

The timing is determined by the EA and Natural England.

The legislation requires us to make sure that discharges from sewage treatment works (STW) meet the protective standard in watercourses and waterbodies, and to consider any operational activities that could also impact on water quality or otherwise impact on the condition of protected sites including bathing water and marine conservation zones.

The Department of Environment, Food and Rural Affairs (Defra) has proposed new legislation requiring a set treatment permit limit is met at STWs at 2,000 population equivalent (PE) or over. This applies to the Tees catchment only in PR24 by meeting the technically achievable limit (TAL) for nitrogen. The Levelling Up and Regeneration Bill which covers a wide range of environmental issues is currently going through the legislative process in Parliament. The impact of any new

legislative requirements on the business case will be assessed as and when required but our preferred option appears to us to be supported by recent amendments.

TABLE 2: REQUIREMENTS FOR PROTECTED AREAS AND BATHING WATERS DURING AMP8

Requirement	Legislation
The statutory requirement to reduce the level of phosphorus discharged from Wooler STW into the Wooler Water and allows the Till SAC to meet its new Common Standards Monitoring Guidance (CSMG) target for phosphorus leading to achieving favourable status.	**European Habitats Directive** enacted through the Conservation of Habitats and Species Regulations 2017 – maintain or restore favourable conservation status for the habitats and species listed under the Directive.
This is not yet a legal requirement but expected to pass a Defra approved requirement to achieve the Technically Achievable Limit for nitrogen in the Tees catchment (HD_IMP_NN).	The **Levelling Up and Regeneration Bill** has been introduced to Parliament and is currently going through the legislative process. The bill includes measures to amend the Water industry Act to require water companies to treat wastewater to the technically achievable limit in nutrient neutrality catchments, where the PE exceeds 2,000. The bill is subject to change during the legislative process, so it is not yet possible to say for certain what will be included in the final version.
The statutory requirement to investigate the impact of phosphorus and nitrogen discharges into the Tweed, Lindisfarne, Coquet and Tees Estuaries on protected sites and the wider coastal system (HD_INV).	**European Habitats Directive** enacted through the **Conservation of Habitats and Species Regulations 2017** – maintain or restore favourable conservation status for the habitats and species listed under the Directive.
The statutory requirement to investigate the impact of Thropton and Snitter, Rothbury, Felton, Longhorsley, Shilbottle and Amble STWs on phosphorus and nitrate loads and the condition of the River Coquet SSSI (SSSI_INV).	**European Habitats Directive** enacted through the Conservation of Habitats and Species Regulations 2017 – maintain or restore favourable conservation status for the habitats and species listed under the Directive. **Wildlife and Countryside Act 1981**
The statutory requirement to achieve standards for designated bathing waters for the protection of public health and the environment (BW_ND, BW_NDINV).	**European Bathing Water Directive 2006/7/EC** implemented through the **Bathing Water Regulations 2013** which provide a framework for managing bathing water quality including the designation of bathing water sites and standards for water quality. Tighter standards were introduced in 2015. **Water Framework Directive** and Regulations includes a requirement to make sure there is no deterioration of designated bathing waters.
This is a non-statutory requirement where we are seeking to improve designated bathing waters in the Spittal catchment to good or excellent to protect public health and the environment and to support the seaside economy (BW_IMP3, BW_INV3).	**European Bathing Water Directive 2006/7/EC** implemented through the **Bathing Water Regulations 2013** which provide a framework for managing bathing water quality including designation of bathing water sites and standards for water quality. Tighter standards were introduced in 2015.
This is a non-statutory requirement where we are seeking to improve our non-designated bathing waters to good or excellent to protect public health and the environment (BW_INV5).	**European Bathing Water Directive 2006/7/EC** implemented through the **Bathing Water Regulations 2013** which provide a framework for managing bathing water quality including designation of bathing water sites and standards for water quality. Tighter standards were introduced in 2015.
The statutory requirement is to assess the technical feasibility and costs of meeting a standard for a designated Marine Conservation Zone (MCZ_INV).	**Marine and Coastal Access Act 2009** gives competent authorities (including water companies) a duty to exercise their functions in a manner that best supports the conservation objectives for designated marine conservation zones. Work under this driver supports the goals and objectives of the 25 Year Environment Plan, the UK Marine Strategy and the Environment Act.

Requirement	Legislation
The statutory requirement to achieve standards for designated bathing waters for the protection of public health and the environment (BW_ND, BW_NDINV).	**European Bathing Water Directive 2006/7/EC** implemented through the **Bathing Water Regulations 2013** which provide a framework for managing bathing water quality including the designation of bathing water sites and standards for water quality. Tighter standards were introduced in 2015. **Water Framework Directive and Regulations** includes a requirement to make sure there is no deterioration of designated bathing waters.
The statutory requirement to carry out a study to understand the microbial impact on shellfish waters at one shellfish water location. (SW_INV)	**Shellfish Waters Directive (2006/113/EC)** stated that all Member States should establish programmes to reduce pollution in designated shellfish waters. Existing shellfish waters have now become **Water Framework Directive** Protected Areas, for the protection of economically significant aquatic species.

2.2. OUR PROGRESS UP TO 2025

We are committed to building on our strong environmental performance. In the North East of England, 32 out of 34 bathing waters are classed as excellent or good and we have overseen dramatic reductions in pollution in the past decade with zero serious pollutions in 2022. This performance has underpinned our achievement of a 4-star performance, the highest possible, in the EA's Environmental Performance Assessment (EPA) in two out of the last three years with last year seeing us achieve a 3-star rating.

The North East of England already has some of the cleanest rivers and bathing waters in the country, but we recognise that we need to go much further in comparison to other countries. In 2022, we published *A Vision for our Coasts and Rivers*[4], containing nine ambitious pledges to contribute to further improvement of our water environment to benefit local communities. In April 2023, we published an update on progress demonstrating that we are on track to meet these pledges. Nutrient Neutrality and the other legal requirements set out above provide a new focus for AMP8.

Our wastewater WINEP for AMP7 includes 626 schemes, all of which we are on track to deliver on time or early. The delivery of these schemes makes sure that we are able to focus on planning and early start delivery of our AMP8 schemes.

2.3. NEED FOR INVESTMENT IN AMP8

2.3.1 WINEP guidance and AMP8

The scale and timing of the activities in our plan are aligned to the WINEP statutory guidance and supported by the EA.

Our plan for contributing to the restoration of favourable conditions at Habitats Directive sites, SSSIs, Bathing Waters and MCZs has been developed as part of the WINEP framework and a wider coastal management strategy. This work will meet

[4] A vision for our coasts and rivers, Northumbrian Water, 2023

the statutory requirements and provide extra environmental benefits which can only be realised when we plan at catchment level, considering the wider environmental and community needs. The requirements are set out in the PR24 WINEP framework driver guidance which are shown in Table 3. The completion dates are either statutory or approved by Defra.

TABLE 3: DRIVERS RELATING TO PROTECTED SITES

Driver Code	Description	Legal Obligation	Tier 1 outcome	Regulatory date
HD_IMP Phosphorus	Action to contribute to restoration of a European site or Ramsar site to move towards meeting the conservation objectives.	Statutory	Maintain or restore favourable conservation status at European sites	31 March 2030
HD_IMP Nitrogen	Action to contribute to restoration of a European site or Ramsar site to move towards meeting the conservation objectives.	Statutory		31 March 2030
HD_IMP_NN Nutrient Neutrality	Defra requirement to include in PR24. Action to reduce total phosphorus and/or total nitrogen levels to the Technically Achievable Limit (TAL) from discharges which drain to catchments, where nutrient neutrality is advised.	Non-statutory (to become statutory subject to Royal assent)		31 March 2030 (if it becomes a statutory requirement)
HD_INV Nitrogen and Phosphorus	Investigation and/or options appraisal to determine impacts of water company activities, or permit/licence conditions/standards on a European site or Ramsar site or to determine the costs and technical feasibility of meeting targets.	Statutory		30 April 2027
SSSI_INV	Investigation and/or options appraisal to determine impacts of water company activities or permit or licence conditions/standards on a SSSI or to determine the costs and technical feasibility of meeting targets.	Statutory	Maintain or restore SSSIs to favourable condition	30 April 2027
BW_NDINV	Investigations for waters failing their Baseline class.	Statutory	Water company contribution to improve and maintain the bathing water quality class	30 April 2027
BW_IMP3	Actions to improve water to Good or Excellent where there is evidence of customer support.	Non statutory		31 March 2030
BW_INV3	Investigations to lead to improving waters to Good or Excellent where there is evidence of customer support.	Non statutory		30 April 2027

Driver Code	Description	Legal Obligation	Tier 1 outcome	Regulatory date
BW_INV5	Investigations at non-designated waters where there is evidence of customer support.	Non statutory		30 April 2027
SW_INV	Investigation to understand why the microbial standards are not being met consistently and what actions are needed to improve the shellfish waters where they have deteriorated.	Statutory	Water company contribution to improve and maintain shellfish water quality.	30 April 2027
MCZ_INV	Investigation and or options appraisal to determine impacts of water company activities, or permit / licence conditions/standards on an MCZ or to determine the costs and technical feasibility of meeting targets.	Statutory	Maintain MCZ at favourable condition for all features based on a whole site approach to marine protected areas; or restore appropriate habitats in MCZ to favourable condition where possible, within the context of a whole site approach.	30 April 2027

These drivers contribute towards the EA Tier 1 outcomes – water company actions and investigations to improve and maintain water quality for bathing, improve and maintain shellfish water quality, and to maintain MCZs at favourable condition for all features based on a whole site approach to marine protected areas. They also contribute to the provision of clean and plentiful water in bathing waters as required by the 25 Year Environment Plan[5].

2.3.2 Need for phosphorus reduction in Wooler Water

The European Habitats Directive enacted through the Conservation of Habitats and Species Regulations 2017 defines the need to maintain or restore favourable conservation status for the habitats and species listed under the Directive. Based on this, we have assessed our catchments and areas where we need to improve to make sure we are meeting the requirements.

Our WFD overall condition assessments found that the there is a need for improvements in the River Till catchment, a SAC. The specific need relates to phosphorus concentrations in the Wooler Water, a part of the River Till SAC. There is a statutory requirement to reduce the level of phosphorus discharged from the Wooler STW into the Wooler Water to reduce the total phosphorus concentration in the river to 13 µg/l. This reduction will help the Till SAC meet its favourable condition standard set by Natural England.

[5] 25 Year Environment Plan, Defra

FIGURE 1: WOOLER WATER WATERBODY

Two assets are located in the Wooler catchment, Wooler STW and the new Wooler Water Treatment Works (WTW). Both of these will have discharges which impact on the quality of the Wooler Water. Catchment information is showed in Figure 1. Both assets have HD_IMP drivers for PR24 WINEP.

The entire Till catchment is a SAC and is SSSI designated due to the presence of Atlantic salmon, otter, lamprey, Ranunculion fluitantis (Water Crowfoot) and Callitricho-Batrachion vegetation.

A new CSMG target for the SAC unit downstream of Wooler STW and Wooler WTW, was set by Natural England in March 2022 (13 µg/l). This target is more stringent than the previous target set in 2014 (40 µg/l), which established the level of phosphorus removal required at Wooler STW. The improvement to Wooler STW was completed in March 2020 as part of AMP6.

Outputs from SAGIS modelling suggest that to meet the 13 µg/l requirement in the Wooler Water downstream of our assets, a load reduction of 931 kg/yr needs to be achieved without the impact of any new load to the receiving water from the Wooler WTW once operational. When an estimate is included for phosphorus load from the WTW, this increases to 1,119 kg/yr (see Table 4).

TABLE 4: SAGIS MODELLING OUTPUT FOR WOOLER WATER

Scenario	Location	Load reduction in optimiser to meet 0.013 mg/l CSMG target (kg/day)				Total load reduction required (kg/yr)
		STW	Intermittent	Diffuse	Total	
Values (without growth and WTW)	At Wooler STW	1.31	1.24	0.00	2.55	931
	At WQ DW41000125	1.31	1.24	0.00	2.55	931
Values + growth (without WTW)	At Wooler STW	1.62	1.24	0.00	2.86	1,044
	At WQ DW41000125	1.31	1.24	0.00	2.55	931
Values + WTW estimates + growth	At Wooler STW	2.13	1.24	0.00	3.37	1,232
	At WQ DW41000125	1.82	1.24	0.00	3.06	1,119
Values +WTW estimate + growth (1 mg/l @STW)	At WQ DW41000125	1.03	1.24	0.00	2.27	830

This evidences the need to invest in the Wooler Water catchment. The investment of **£3.2m** is sought for improvements to reduce the phosphorus discharge from Wooler STW.

2.3.3 Need to achieve nutrient neutrality in the Tees Estuary

THE HABITATS DIRECTIVE LEVELLING UP REGENERATION BILL (LURB)

In 2022, Natural England issued advice that 31 habitat sites are in unfavourable condition due to excess nutrient pollution. Because of this, the advice says that development plans or projects in these areas can only go ahead if the additional wastewater produced by the development will not add to nutrient pollution – in other words they must be 'nutrient neutral'.

Following this advice from Natural England, the EA issued guidance in December 2022 to say that water companies should upgrade all STWs in these areas that serve a PE of more than 2,000 people. The objective of this would be to remove nitrogen from final effluent to meet the 'Technically Achievable Limit' (TAL), which is currently 10 mg/l of total nitrogen. In our region, this only applies for nitrogen limits for Teesmouth and Cleveland Coast SPA and Lindisfarne SPA together with the river catchments that drain to these areas. As all STWs discharging to Lindisfarne SPA have less than 2,000 population, only the Teesmouth and Cleveland Coast Tees SPA is subject to TAL requirements.

The LURB was amended (see Appendix A) and communicated on 7 September 2023 stating:

"The Levelling Up and Regeneration Bill sets a requirement on water companies to upgrade wastewater treatment works, in designated areas, to the Technically Achievable Limit (TAL) for nitrogen or phosphorus by 1 April 2030. The government has now tabled further supplementary amendments which seek to provide a greater level of flexibility in how water

companies reduce nutrient pollution across affected catchments, with the aim of maximising benefits for the environment while minimising costs on water bill payers."

Our investment of **£47.7m** is sought to carry out the improvements required to restore Seal Sands SSSI and achieve nutrient neutrality for the Tees Estuary with a flexible approach. Seal Sands improvement needs are part of our Tees Estuary nutrient neutrality wider needs. This is covered in section 2.3.4. These two needs are intertwined and hence we look to address them with a combined approach.

2.3.4 Need to restore Teesmouth Cleveland Coast SPA Seal Sands SSSI

The Teesmouth and Cleveland Coast SPA is in North East England and comprises significant areas of intertidal sand and mudflat, saltmarsh and freshwater grazing marsh, saline lagoon, sand dune, shingle, rocky shore, and shallow coastal waters which support a number of nationally and internationally important bird species. Seal Sands is the largest area of intertidal mudflat on the east coast of England located in the Tees Estuary between Lindisfarne and the Humber Estuary.

The Seal Sands SSSI gained its name through having many seals that sit on the banks, it supports high densities of invertebrate prey important for a range of overwintering waterbirds, particularly redshank and shelduck. Smaller areas of intertidal mudflat occur elsewhere within the estuary, notably at Greatham Creek and North Tees mudflat. Maps showing these areas are shown in Figure 2 and Figure 3. The NEPIC state "Seal Sands is a blend of heavy industry and wildlife living together in harmony[6]".

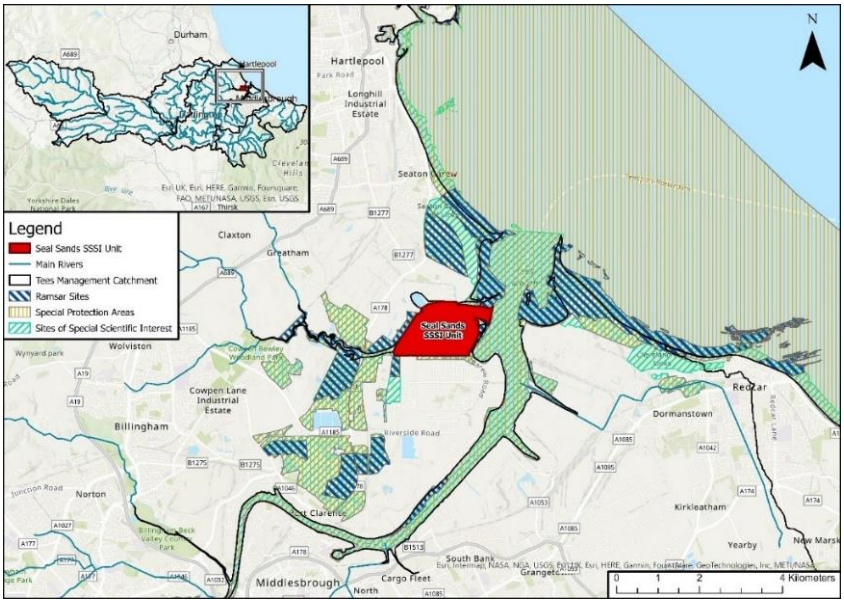
The industrial impacts on this area come from large scale industry such as:

- Billingham Complex[7]: a chemical production company situated slightly further up the estuary. The outflow pipe of Billingham is cited[8] as discharging 80bn litres of industrial effluent every year into the Tees estuary. These chemicals include arsenic, cyanide, toluene, xylene, substituted benzenes and organochlorines. The nitrate impact comes from 1,000 mg/l of ammonia per day discharging[9] directly into the estuary.
- Teesworks[10]: a site under development that is next door to Bran Sands STW, this is on the UK's largest brownfield site that will be developed into the UK's largest freeport. The development declares to achieve a 'net zero Teesside', however it is unknown what the impact will be on the estuary nutrient levels once the development is complete and active.

[6] 1,000 years of industry living alongside nature; Seal Sands is a blend of heavy industry and wildlife living together in harmony, NEPIC
[7] Billingham Complex, CF Industries
[8] Outflow Pipe RT01 from ICI Billingham in Teeside, Greenpeace
[9] Environment Agency data
[10] The UK's Largest Freeport, Teesworks

FIGURE 2: MAP OF SEAL SANDS SSSI AND BRAN SANDS

FIGURE 3: PROTECTED AREAS IN THE TEESMOUTH ESTUARY INCLUDING SEAL SANDS SSSI



Since 1998, Seal Sands SSSI has been classed as unfavourable declining due to the growth of macroalgae on the mudflats which limits the availability of food for key wader species. Coverage has reduced over time, due to the redirection of

Billingham STW final effluent in 2008 and the closing of some larger industrial sites, which resulted in the removal of nitrogen loads from these sources. Cowpen Bewley landfill site, which discharges directly onto Seal Sands, was capped around 2008 which reduced the permitted effluent discharge but could not remove the load completely.

Figure 4 and Table 5 show the increasing levels of macroalgae coverage in the last five years at Seal Sands SSSI.

FIGURE 4: CHANGE IN MACROALGAE COVERAGE AT SEAL SANDS SSSI[11]

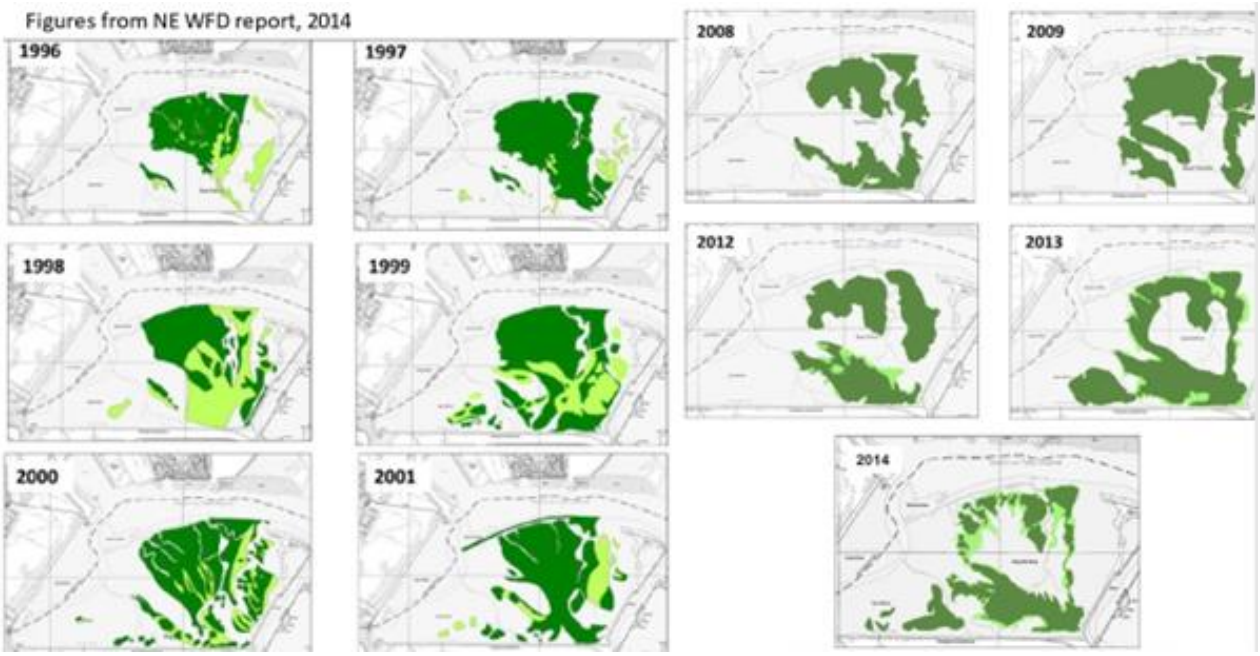


TABLE 5: INCREASES IN MACROALGAE COVERAGE AT SEAL SANDS 2017 TO 2022

Date	19 September 2017	27 September 2018	14 September 2019	18 September 2020	8 September 2021	27 August 2022
Area of algae present (hectares)	19.06	15.17	15.26	27.31	36.92	18.81
As a percentage of intertidal area	9.38%	7.47%	7.51%	13.45%	18.19%	9.26%

The nitrogen loads at Seal Sands SSSI were subject to the development of two models. One was developed by Hull University (2008) on our behalf and as part of an AMP4 investigation. A second one was developed by the EA in 2018. The Hull University study developed a hydrodynamic 2D model which had accurate source apportionment information but was limited in that it was not able to calculate the load reduction required to reduce macroalgae below 500 g/m^2 in weight to be classed as good WFD status. The EA's dCPM model was a simple box model and has some source apportionment capability

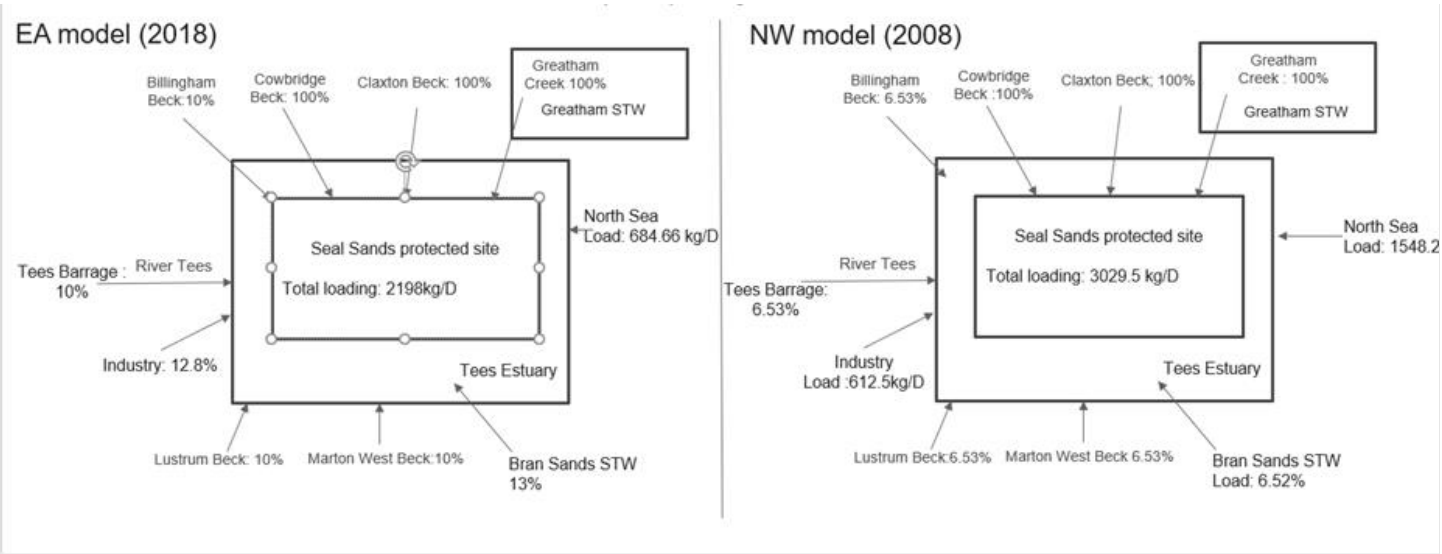
[11] WFD Report, Natural England, 2014

but is not as accurate in this regard. However, it does have the capability to predict the level of nitrogen reduction required to get the site to WFD "good" status.

Conceptual site models were produced to demonstrate the hydrodynamics of the marine environment and the relative contributions of nutrients at Seal Sands SSSI. The models were updated with the latest SAGIS outputs and current performance data for our assets. The EA has not updated the discharge information for regulated industries, so these have been assumed to have remained unchanged since 2018.

Figure 5 shows the relative contribution of nitrogen from different sources at Seal Sands for both models.

FIGURE 5: SOURCE OF NITROGEN CONTRIBUTIONS TO SEAL SANDS SSSI



At the time, the Hull University study concluded that there was no requirement to upgrade Bran Sands STW and that the redirection of Billingham STW outfall would be sufficient to remove our contribution from the protected habitat. Ten years later in 2018, the EA study concluded that an 80% reduction in load would be required at Seal Sands SSSI to achieve favourable condition status at the site. The EA and Natural England supported both sets of results.

The two models were updated with the latest freshwater inputs from SAGIS SIMCAT and flow and concentration data updated for direct estuary discharges. Extra growth up to 2035 was also included in these figures. The sum of nitrate and ammoniacal nitrogen was used for the SAGIS SIMCAT outputs and the sum of nitrate, nitrite and ammoniacal nitrogen were used for the load from Bran Sands STW. Intermittent discharges were excluded from the analysis and will be addressed separately through the Storm Overflow Reduction Plan (SORP). Table 6 shows the loads reaching Seal Sands SSSI from each source.

TABLE 6: NITROGEN LOADS REACHING SEAL SANDS SSSI INCLUDING GROWTH TO 2035

Input name	Load at 2035 kg/d	Load at 2035 from STW kg/d	% load from STW source
Greatham Creek	30.99	6.11	19.7
Claxton Beck	38.76	0	0
Cowbridge Beck	7.49	0	0
Billingham Beck	300.50	65.53	21.8
Lustrum Beck	373.19	0	0
Marton West Beck	64.52	0	0
Acklam Beck	65.69	0	0
Bran Sands STW	5784.79	NA	NA
Tees Barrage	5535.00	1,847	33
North Sea	684.66	0	0
Industry load	4180.00	0	0

The need is to reduce the discharging nitrogen loads to restore Seal Sands SSSI to favourable status. This need is addressed within the wider Nutrient Neutrality approach.

Our PR24 submission includes the investment for a new marine model (included in HD_INV) to make sure that the options are based on current information including biomass weight which has changed significantly over time. We plan to start creating a detailed up-to-date model in 2023.

2.3.5 Need to investigate impacts on Habitats Directive sites

The Habitats Directive investigation needs are driven by the Tier 1 outcome 'maintain or restore favourable conservation status at European sites'. These look at Marine Habitats Directive sites. We discussed with both the EA and Natural England which protected areas had the potential to be impacted by our assets. Through this assessment, four sites have been identified with a need for investigations.

The investigations are a statutory requirement to understand more about the impact of our wastewater discharges on the wider coastal environment and protected sites. The purpose of the **£1.9m** expenditure is to determine the impact of our activities, or permit/licence conditions/standards on 12 STWs across the following designated habitats:

- Teesmouth and Cleveland Coast Special Protected Area (SPA) – five STWs;
- Berwickshire and North Northumberland Coast SAC – six STWs; and
- Northumberland Marine SPA – one STW.
- Lindisfarne SPA – five STWs

We will base our options on Natural England's requirements for the following investigations and modelling:

- nutrients (nitrogen as the lead determinant for investigation, followed by phosphorous) with a focus on the features that are water dependent and sensitive to eutrophication, such as seagrass, saltmarsh and mudflats; and
- chemicals for which will include all parameters previously tested and screened for the Tees catchment.

The need is to conduct surveys, monitoring, modelling and data collection to establish the links between our activities and the coastal environment as well as their impact.

2.3.6 Need to investigate impacts on the Coquet catchment

We have a statutory requirement through the Wildlife and Countryside act 1981, a UK designated legislation. For any SSSI, we are required to investigate or do an options appraisal to determine the impacts of our activities, or permit, or license conditions on the site, or to determine the costs and technical feasibility of meeting the required targets.

In March 2022, new CSMG standards were set by Natural England, for phosphorus standards in each SSSI unit of the Coquet SSSI.

SAGIS SIMCAT modelling identified the at permit concentrations in the SSSI units had the potential to be exceeded but only marginally. Other sources of pollution impacting the phosphorus concentration are highly likely therefore we agreed with both regulators to investigate the impact of our assets as well as looking for other wider impacts where feasible.

The investment of **£0.3m** in our plan is for investigations for the River Coquet SSSI.

2.3.7 Need to restore Bathing Waters

Our bathing water investment of **£4.4m** includes both statutory (£1.6m) and non-statutory (£2.8m) drivers.

Statutory

Our statutory required bathing water investment of **£1.6m** (BW_NDINV) is to carry out investigations for waters failing their baseline class. This is defined by the EA for sites which are designated as European bathing water sites.

For bathing waters which fail to meet their baseline class (in 2021 or 2022), and where the cause is not yet fully understood, we are required to invest in the appropriate investigations. These investigations are to understand our contribution to the baseline class failure and to identify our assets impacting on them and any improvements required at those assets.

Our investment is for investigations at five bathing waters that we have identified as falling in the above category. These five sites are Newbiggin South, South Shields, Crimdon, Beadnell and Seaton Sluice. Improvements that we identify through these investigations will then be taken forward for investment in future planning periods.

Non-Statutory

Our non-statutory bathing water investment of **£2.8m** (BW_IMP3, BW_INV3 and BW_INV5) is for bathing water improvements, investigations leading to improvements and investigations leading to the designation of new bathing waters. Our customers have indicated that they support bathing water improvements and wider improvements to the coastal environment as shown in section 2.6.

We have assessed all our bathing waters and have identified:

- one site where we aim to improve the class from Good or Excellent (Spittal);
- one site where we will investigate the need to go to Good or Excellent (Seaton Carew North); and
- three sites where we will undergo investigations leading to the designation of new bathing waters (Wylam – inland, Fish sands – coastal, Fishermans Haven – coastal).

The investment sought will allow for improving one bathing water to excellent and investigations into a further four. These investigations will inform investment in future planning periods, in line with our long-term plan.

2.3.8 Need to restore MCZs

Our non-statutory MCZ investment of **£0.2m** (MCZ_INV) is for investigations to maintain MCZs at favourable condition for all features based on a whole site approach to marine protected areas.

We have seven MCZs within our operational area. We have identified three of these seven as requiring investigations to maintain favourable condition. Investing in investigations at Aln Estuary, Coquet to St Marys and Berwick to St. Mary's will allow a greater understanding of our investment needs in future planning periods.

2.3.9 Need to investigate impacts on the coastal environment

Shellfish water protected areas are areas designated for the protection of shellfish growth and production. Good water quality is important for the production of high-quality shellfish.

The Shellfish Waters Directive (2006/113/EC) states that all Member States should establish programmes to reduce pollution in designated shellfish waters. DAERA works closely with the Food Standards Agency in managing shellfisheries from both an environmental and public health perspective. The WFD originally established a legal framework for the protection, improvement and sustainable use of Europe's water environment. This has been taken forward through the introduction of River Basin Management Plans. Within the River Basin Management Plan Structure, existing shellfish waters have now become WFD Protected Areas for the protection of economically significant aquatic species.

In our region, the area of Holy Island is defined as a shellfish water catchment. Our statutory shellfish water investment of **£0.3m** (SW_INV) is for investigations in this area. The EA requires us to carry out a shellfish waters investigation at Holy Island shellfishery by April 2027 to understand the reasons for a deterioration in the levels of bacteria in the mussel flesh. The requirement is to conduct a study to understand why the microbial standards are not being met consistently and what actions are needed to improve the shellfish waters.

2.4. NEED FOR ENHANCEMENT EXPENDITURE IN AMP8

2.4.1 Base vs enhancement expenditure

The proposal to restore Habitats Directive sites to favourable condition results from new and emerging issues identified through monitoring and modelling to meet legal obligations. Some investigations are also required to understand the impact of phosphorus and nitrates on the marine environment. There is no overlap with base investment. Table 7 sets out our assumptions for base and enhancement cases.

TABLE 7: ASSUMPTIONS FOR BASE AND ENHANCED INVESTMENT

Base	Enhancement
Protected Areas	
• Work to effectively manage our impact on protected areas as designated by the relevant legislation.	• A new statutory obligation as defined by the WINEP driver guidance. • A new Defra approved activity as defined by the WINEP driver guidance.
Bathing Waters and MCZ	
• Ensuring bathing and shellfish water maintain their current status. • Items funded at previous price reviews. • Upgrades required to improve bathing water & shellfish water status in AMP7.	• Investigations and actions to improve bathing water, shellfish waters & marine conservation zones that are at risk of deterioration in AMP8. We have clearly linked all actions back to the driver requirements.

There is no base expenditure proposed for AMP8 that will contribute to addressing the needs related to these drivers. Base expenditure will be targeted to bathing water quality and marine conservation zones. We have not received enhancement funding from Ofwat to address the needs related to these drivers in previous price reviews.

2.5. ALIGNMENT TO THE LONG-TERM STRATEGY

Our long-term strategy (LTS) sets out our long-term target to achieve leading levels of river water quality; working with partners to eliminate all impediments to our rivers achieving good ecological status caused by our operations. In England, the water sector accounts for around 24% of the reasons why rivers do not currently meet good ecological status. In our area, wastewater accounts for around 13% of the problem with more than half of the issues coming from physical changes made to rivers and lakes over many years, pollution from farming (10%), and pollution from abandoned mines (9%). Removing our impact is not enough to restore our rivers. While working with others, we aim to make sure that 75% of our rivers achieve good ecological status, regardless of the causes. This long-term target is not new and one of our nine

ambitious pledges for our coasts and rivers is to work with the EA, Natural England, The Rivers Trust, and Catchment Partnerships to identify, and have plans in place to eliminate, all impediments to our rivers achieving good ecological status caused by our operations. This builds on our ambitious goal to have the best rivers and beaches in the country, as set out in our business plan for 2020-2025.

We will achieve these long-term targets through five key elements, as described in our business plan. This enhancement case addresses parts of two of these elements being 'reducing our impact on the environment' and 'enjoying the environment'. Although this enhancement case does not look at how we can work with others to reduce their impact on the environment, and how we can protect and enhance the environment, we have included these as principles throughout all our design work and we take these potential benefits into account when assessing the options. In particular, our enhancement case for WINEP – protected areas and biodiversity enhanced business case (NES18) sets out our activities to restore river health. Within our AMP8 business plan, we are proposing the trial of catchment and nature based solutions. We see these solutions as delivering a wide societal and environmental value and ensuring a sustainable low cost approach for our customers in the long term.

2.5.1 Reducing our impact on the environment

Achieving good ecological status includes improvements to physico-chemical elements – that is, reducing the amount of nutrients (nitrogen and phosphorus) in river water, as well as reducing storm overflows.

Our business plan for 2025-2030 includes six schemes for catchment and nature-based solutions across 30 waterbodies, and upgrades to seven treatment works, to support our long-term target to reduce phosphorus loading from treated wastewater by 50% by 2028, and 80% by 2038 (compared to 2020). We describe most of these schemes in our WINEP Phosphorus enhanced business case (NES13), we have included one scheme at Wooler Water within this business case, with its primary driver coming from the Habitats Directive, rather than restoring good ecological health.

Our business plan for 2025-2030 also includes hybrid catchment and nature-based solutions for removing nitrogen in the Teesmouth and Cleveland protected area, combined with an upgrade at Bran Sands STW, to support the reduction of nitrogen to achieve good ecological status. In assessing the options, we looked at where there could be wider benefits in improved water environments, impacts on habitats and biodiversity, and other factors that support our long-term strategy targets. These benefits can support improved ecological health by providing improvement to the environment for fish, invertebrates and other animals and plants (which in turn, can support improved biological quality).

In addition to reducing nutrients, our storm overflows programme set out in our Storm overflows enhanced business case (NES27) will reduce the number of spills to the lowest any company has ever achieved. Our reductions in abstractions under the long term environmental destination will further help to support improved resilience to drought, climate change, and the longer-term water needs of the environment, including investigations to support our understanding of long-term environmental health. We are also investigating on improving the hydrological regime, modified waterbodies, groundwater

pressures, and physical impacts on habitats to support good ecological status through improvements of the hydromorphological quality elements.

We have introduced monitoring on all our storm overflows, with this due to be published as open data by December 2023 to support transparency and citizen science. We will introduce river water quality monitoring by 2030, with this data also planned to be made open to all.

Finally, we include investigations to understand the impact of phosphorus and nitrogen discharges into estuaries, rivers, and protected sites across our areas and the work that is needed in the future. In our long-term strategy, we have assumed that WINEP expenditure to reduce our impact on the environment will remain at historic high levels to tackle new issues. These investigations will help us to understand this in more detail.

2.5.2 Enjoying the environment

Our vision for coasts and rivers sets out our ambition to achieve 100% of coastal bathing waters at Good or Excellent status by 2030. In addition to this, we will work in partnership to improve 500km of bluespaces (such as river banks and accessible water environments) for the public to enjoy in our regions by 2030 as described in our DWMP[12]. We are already doubling the number of our Water Rangers – our citizen volunteers who are trained to help us monitor environmental conditions around rivers and take action to address wider river issues such as littering, fly tipping, or signs of pollution.

2.5.3 Adaptive pathways – and the future of WINEP

WINEP has historically been a short-term process focused on the next five years, with limited long-term thinking. Our DWMP is a strategic long-term plan which defines how we will manage the risks to our wastewater network and treatment works from a range of future pressures and uncertainties, and this includes WINEP. This will become statutory for the first time from 2024.

Decisions about protecting the local environment should be made for the long-term and should focus on the right outcomes. These decisions should be made by people and organisations working together locally to protect individual catchments, so that local needs and specific catchment needs can be considered.

Our WINEP for 2025-2030, as submitted to the EA, included our nutrient neutrality ambitions to include catchment and nature based solutions. These support the reduction of nitrogen and phosphorus in our rivers and other water bodies – rather than short term, prescriptive solutions. Although this was not accepted by the EA, we are proposing our preferred option as we estimate that this will save customers around £270m and will create more than £208m of environmental and wider benefits. These schemes have been developed in partnership with others across the catchments.

[12], DWMP, Northumbrian Water, 2023

These schemes are just the beginning of more long-term planning for the environment. The 25 Year Environment Plan sets out longer term goals, with responsibilities for delivering these shared between the government, regulators, water companies, farmers, and other land users. We believe this could be the start of a long-term, outcome focused approach – and we will continue to develop these partnerships and share our data and insights. We have committed to introduce final effluent and river monitoring to get a greater understand of our environmental impacts by 2030, and to work with the EA, Natural England, The Rivers Trust, and Catchment Partnerships to remove the impact of our operations on rivers not achieving good ecological status.

All the elements in this enhancement case form part of the core pathway in our long-term delivery strategy. Most are statutory requirements, and so are "no regrets." For the elements which are currently non-statutory, including nutrient neutrality, we expect that they will be required before 2030.

We do have an adaptive approach for nutrient neutrality. However, there is still some uncertainty in this area. We are proposing our preferred option, which we will monitor, and may adapt our approach of move to our alternative option if we are not achieving the outcomes we require for nutrient neutrality. We cover more detail on our preferred and alternative options in Appendix F.

There are no trigger points or adaptive pathways in our long-term delivery strategy which are specific to bathing water quality. However, we expect environmental challenges around anti-microbial resistance, persistent organic pollutants and microplastics in the future – which will make some contribution to improving river health, such as removing chemicals. The investment that is needed will depend on the results of current and future investigations, and whether alternative solutions can be implemented such as banning certain chemical products or making behavioural or other product changes to avoid pollutants entering wastewater. We expect that these investments are only needed under some of the scenarios in our long-term delivery strategy – and we have set this trigger point for investment for 2027, with investment beginning from 2032, so that we can understand the impact of technology or social changes.

In addition to this, we will need to review the impacts of climate change, legal changes, and technology on the need for further investment in these areas before the price reviews in 2029 and 2034.

2.6. CUSTOMERS SUPPORT FOR THE NEED

Our customers tell us that the environment is important to them. However, when we explore individual environmental outcomes and measures those relating to river water quality are considered to matter less, and require less investment, compared to other environmental measures (**common PCs insight summaries**, NES42). Customers do not prioritise this as highly as investment in reliable supplies of water.

Customers supported our ambition but are not willing to pay for improved performance (**common PCs insight summaries**, NES42).

In our People Panels research, we discussed our options for tackling nutrient neutrality across Lindisfarne and Teesmouth (at the time, Lindisfarne is within scope of these. Customers do not support an engineering-based approach to removing nitrogen from wastewater, because of the high cost for a relatively low impact. Customers indicated that they would support a less expensive, nature-based approach. Customers did consider this important (**enhancements and other service area summaries**, NES43).

In our pre-acceptability research, most customers preferred to invest now to remove nitrogen using nature-based approaches. There was substantial support for nature-based solutions rather than engineering solutions. Customers noted the benefits of the cheaper option and preferred to take the risk of a later bill increase if nature-based solutions were not successful, rather than an immediate large increase (**enhancements and other service area summaries**, NES43).

Our Advanced WINEP plan for nitrogen and phosphorus provides better value at a lower cost than traditional solutions and is strongly supported by customers and stakeholders. Our Board decided that they wanted to change the conversation about WINEP, and so we have challenged the EA by providing advocacy and evidence to support our Advanced WINEP proposals – which are now included in our business plan. We discussed these proposals with the Water Forum throughout the process, and they asked us to continue to push for this.

Our business plan includes our Advanced WINEP, with some modifications as agreed with the EA as we developed these plans further. This is supported by our customer research and by our stakeholders.

Customers also identified “pollution leading to dead fish in rivers” and “algae choking plants and wildlife” as medium priorities in our **DWMP research in 2020**, similar to storm overflows. Chemicals and microplastics in wastewater are seen as higher priorities which one participant described as “the next pandemic”. In our **research on long-term priorities**, customers said that they wanted us to be more ambitious on improvements to the water environment. They wanted to see a target in line with the current commitment for improving the quality of coastal bathing waters for the best beaches.

Customers rank bathing water quality as a “low” priority. This includes ranking “having the best rivers and beaches in the country” as the least important environment measure (**common PC insight summaries**, NES42). However, we have seen the importance of “cleaner beaches” improve compared to other business plan areas in our Domestic Tracking survey, and customers supported our long-term target to have 100% of our bathing waters meeting “excellent” standards by 2030. Our WINEP investments for improving bathing waters (and investigations for future improvements) are needed to meet this long-term target. These investments are cost-beneficial, when we use customer valuations for benefits.

2.7. FACTORS OUTSIDE MANAGEMENT CONTROL

We understand the factors that are outside of our control and have got mitigations in place where possible. We are aware of the current position of the LURB amendments and the timing of any new legislative requirements arising from this which will need to be reflected in our plan. We are monitoring the updates and have plans in place if we are no longer able to go ahead with our planned NTAL approach.

We have undertaken considerable cost benchmarking for the alternative approach and have a clear understanding of the additional funding that would be needed in the event that our approach is not accepted.

3. BEST OPTION FOR CUSTOMERS

3.1. PROCESS FOR IDENTIFYING THE BEST OPTION FOR CUSTOMERS

We can demonstrate our process and how it gives the best option for our customers. Our value framework means that we are assessing value in the round. We can show how our selected options will give the best value to our customers.

3.1.1 WINEP options development principles

We have followed the WINEP options development guidance[13], the principles of which are summarised in Table 8.

TABLE 8: WINEP OPTIONS DEVELOPMENT PRINCIPLES

Expectation	How this has been met
Environmental net gain	We have carried out an assessment of environmental net gain options by assessing the potential environmental impacts including the natural environment, net zero, catchment resilience, access, amenity, and engagement of each option and monetised alongside the whole life cost, choosing the one that provides the greatest overall environmental benefit/cost ratio.
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 EA. These have been quantified through our benefits assessment which is described in section 3.2.3, 3.3.5 and 3.5.3.
Catchment and nature-based solutions	We have considered a range of nature-based solutions such as integrated constructed wetlands, reed beds, evaporation, facultative lagoons and infiltration fields.
Proportionality	We have taken a proportional approach to options development based on The Green Book[14] principles. Where there are more than three traditional treatment options, we have screened out those which have obviously less natural capital benefits, higher costs and higher carbon without undertaking a full benefits and cost assessment, which would require a level 2 optioneering scope. Further information is contained in the remainder of section 3.
Evidence	The evidence to our options 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 EA to define the list of sites. We used the North East Catchment Hub (NECH) to help develop options and raise risks. Further collaboration with local stakeholders and planning authorities will occur as part of the delivery process.

[13] WINEP options development guidance, Environment Agency
[14] The Green Book, HM Treasury, 2022

3.1.2 Hierarchy for identifying unconstrained options

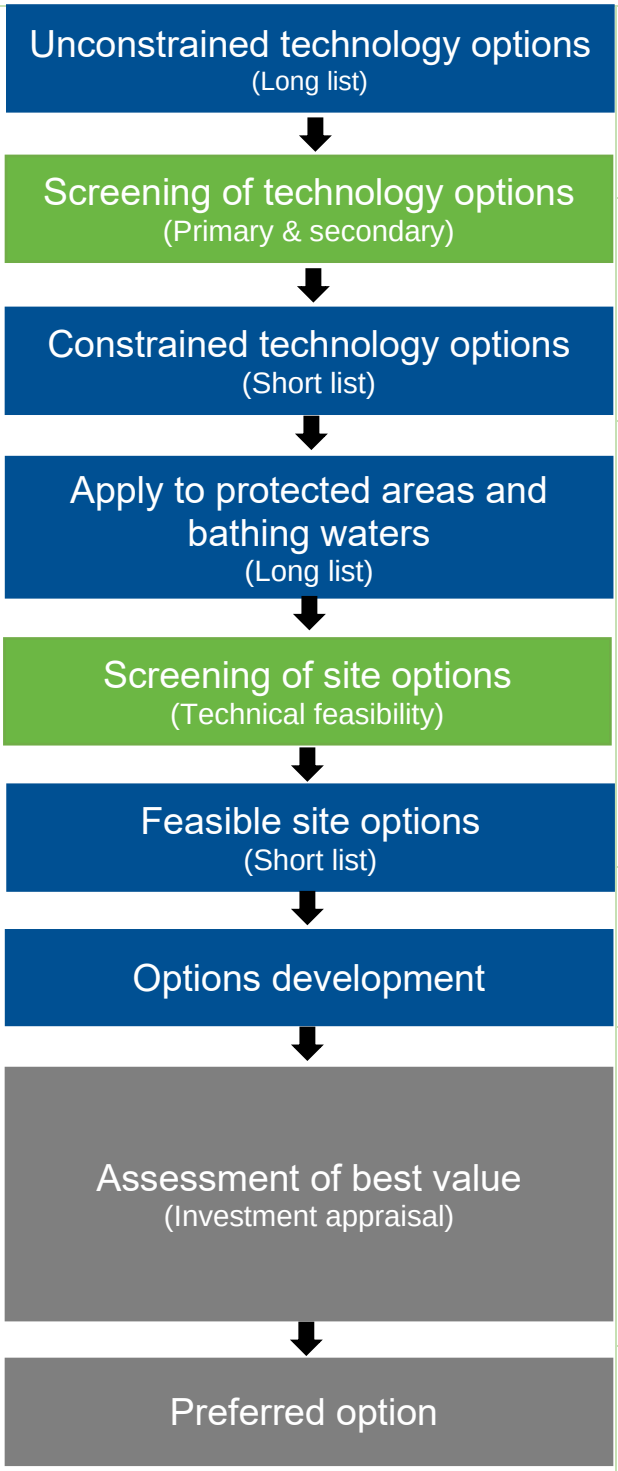
We have built our plan by considering a broad range of options. All options are real, deliverable and meet the needs defined in the WINEP guidance.

We have a structured approach for categorising and assessing options to meet our need and make sure a consistent approach is followed across all our investment needs, regardless of the driver.

- 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. In this case options include changes to permits.
- 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.
- Operate – improved operational management practices to enhance existing capacity.
- 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. In this case, new infrastructure would be required to meet the standard for secondary treatment, so there are no options for invigorate.
- 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. 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.

Figure 6 shows our process for identifying the best option for a single site which is based on the principles of the HM Treasury's The Green Book and the WINEP Options Development Guidance. A full description of how this has been applied is contained in the following sections.

FIGURE 6: PROCESS FOR DEVELOPING AND FILTERING OPTIONS



Unconstrained list of technology options (Appendix A)

We have developed a broad range of potential technology options in accordance with section 7.2.1 of the WINEP Options development guidance.

Constrained list of technology options (sections 3.2.2, 3.3.2 and 3.5.2)

We have screened the unconstrained list of technology option against:
1) expected to meet statutory obligation, and
2) technically feasible in accordance with section 7.2.2 of the WINEP Options development guidance.

Constrained list of technology options for site options

We have applied the constrained list of technology options to each of the catchments and then screened this to make sure the technology is technically feasible to implement on a specific STW site within each catchment.

For example, it is not possible to implement transfer solution where there are no alternative STWs nearby.

Options development

We have developed options based on the technology options available and their ability to meet the requirements as described in the need.

Assessment of best value (sections 3.2.3, 3.3.5 and 3.5.3)

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 in section 7.3 of WINEP options development guidance.
We have also assessed each option against the Wider Environmental Outcomes Metrics and a deliverability assessment as part of our benefits assessment in accordance with section 7.2 of WINEP Options Development guidance.

Preferred option (sections 0, 0 and 0)

The preferred option selected has bene described with reasoning where the best value is an alternative to the lowest cost.

3.1.3 Approach to screening

In accordance with the WINEP options assessment guidance, we have carried out screening of each of the technology options to make sure the option is:

- expected to meet the statutory obligation; and
- technically feasible (to implement the option).

If the option does not meet these criteria, the option is then discarded. We undertook secondary screening to see if the proposed options were likely to have significantly higher monetary and/or carbon costs or would deliver fewer benefits in comparison to other options in which case they were also discarded.

The results were also tested against the CSMG targets for protected areas (equivalent to WFD limits). SAGIS modelling indicated that a reduction of 830kgP/year would be needed to meet the CSMG standard of 0.013mg/l for Wooler Water. This is considered not to be achievable via a catchment solution (catchment nutrient balancing) given that 75% of the phosphorus loading comes from Wooler STW and there are few other sources of phosphorus in the catchment.

We collaborated with the NECH to develop and assess the feasibility of catchment and nature-based options across WINEP. The NECH was established in 2022 and brings together local, regional and national expertise in a regional hub to develop improvements for water quality and the wider environment in the North East. It brings together stakeholders from more than 20 organisations including the Rivers Trusts, the EA and Natural England and is facilitated by a strategic partnership with The Rivers Trust.

The NECH brings a catchment based approach for water management, facilitating cross-catchment working and knowledge sharing with the support of Catchment Partnerships. The Hub is a focal point for our planning activities and partnership working which seeks to improve the environment through catchment and nature-base solutions and plays an important part in the creation of our business plan for 2025-2030.

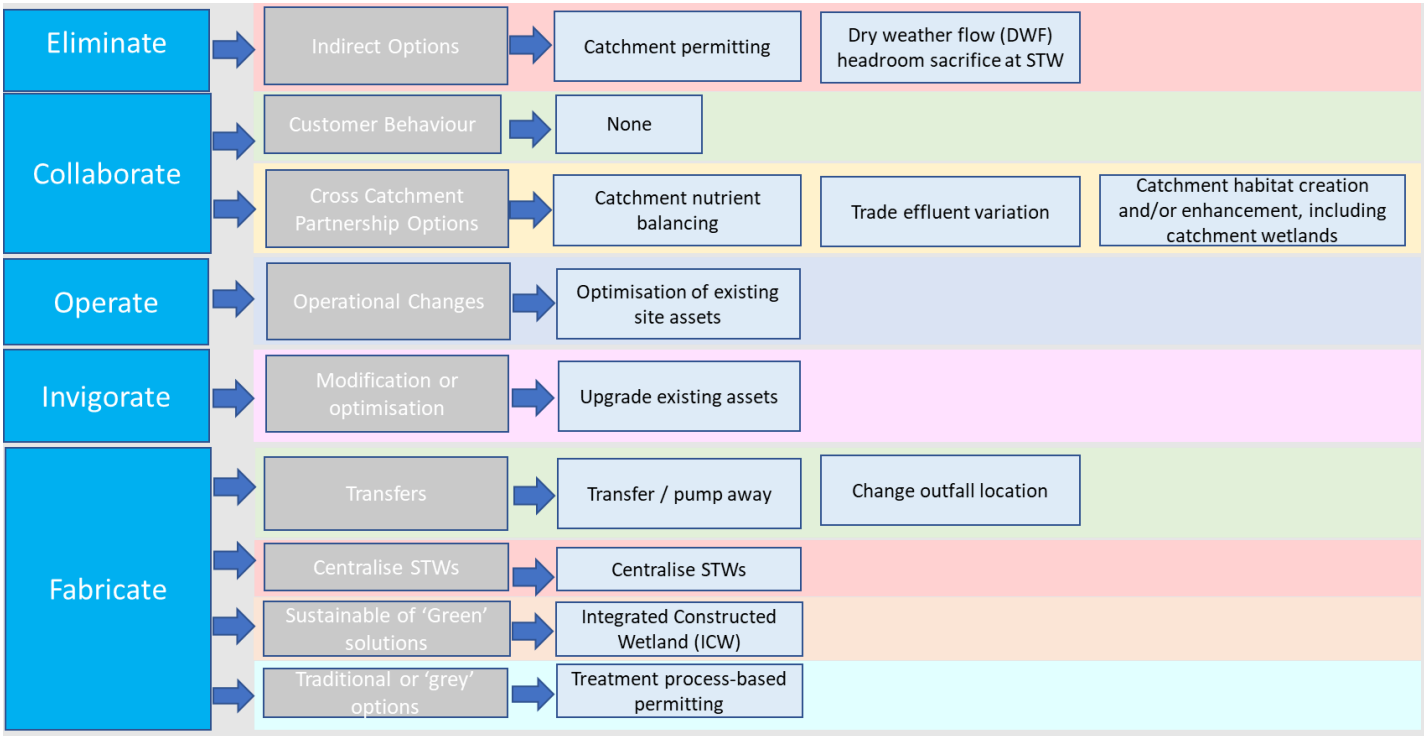
Our approach to screening has been used across our WINEP programme, the detail for each need is shown in the following sections 3.2 to 3.5.

3.2. OPTIONS FOR WOOLER WATER

3.2.1 Broad range of unconstrained options – Wooler

The framework described in section 3.1 and its application to Wooler Water is shown in Figure 7 below.

FIGURE 7: WOOLER WATER UNCONSTRAINED OPTIONS



3.2.2 Primary and secondary screening of options – Wooler

We have also worked with the Tweed Forum, a local stakeholder group promoting sustainable land and water management for the Tweed, to develop nature-based solutions specifically for the Wooler Water catchment. Our constrained list of options for Wooler Water is shown in Table 9.

TABLE 9: WOOLER WATER SCREENING TO IDENTIFY THE CONSTRAINED OPTIONS

Option	Meets Statutory Obligation?	Technically Feasible?	Reason for discarding
Catchment permitting Flexible permit limits across all STWs discharging to a river. All STWs within a specified catchment are included in an innovative catchment permit which provides flexibility and offsetting and allows benefit from overperformance between sites (measured as kg load reduction at STWs).	Yes	Yes	**Carried forward**– used between Wooler WTW and Wooler STW both of which have pre-existing P consents.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	Yes	Yes	**Carried forward** from primary screening. **Discarded** from secondary screening. There is no opportunity to relax the permit to any other value. The waterbody must have a phosphorus load removed to achieve good status.
Catchment nutrient balancing Working with landowners and catchment partners.	No	Yes	**Discarded –** The load reduction achievable from the catchment is insufficient to meet the statutory obligation. Only one WwTW within the catchment
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	**Discarded –** Removing the impact of the P loading from the trade effluent will not be sufficient to achieve the CSMG targets
Catchment habitat creation	No	Yes	**Discarded –** The load reduction achievable from the catchment is insufficient to meet the statutory obligation.
Optimise existing site assets Optimised Ferric dosing (P monitor control).	No	No	**Carried forward** from primary screening. **Discarded** from secondary screening Existing P removal assets currently achieve a P limit of 2 mg/l and are not sufficient to get to new P permit
Transfer flow to another WwTW or catchment Transfer flow (raw) from one or more smaller WWTW into an existing larger works with dry weather flow (DWF) headroom.	No	No	**Discarded –** Does not meet the screening criteria requiring WWTW with 10% headroom to be within 5km of the site.
Change in outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	No	No	**Discarded –** Does not meet the screening criteria requiring appropriate waterbody within 5km.

Option	Meets Statutory Obligation?	Technically Feasible?	Reason for discarding
Centralise WwTWs Combine two or more WwTW into a new larger works to achieve efficiencies of scale.	No	No	**Discarded –** There is only one WwTW discharging to this watercourse to therefore there is no opportunity to combine with other WwTWs
Integrated constructed wetland (ICW) Create ICW with multiple benefits as treatment solution (only applicable where less stringent permit limits or existing treatment solution that needs to be tighter).	Yes	Yes	**Carried forward**
Treatment process based permitting – Reed beds A reed bed system wastewater flows continuously through the support medium, made up of a gravel base planted with the common reed. The area around the reeds becomes populated with both aerobic and anaerobic bacteria. It is these bacteria that treat the incoming wastewater.	No	No	**Discarded –** Unable to treat effluent to below 1mg/l
Treatment process-based permitting – **Electrocoagulation** As an innovative process, electrocoagulation uses electrodes and electricity to dose a chemical for phosphorus removal using a sacrificial anode rather than chemical delivery and dosing a liquid chemical.	No	No	**Discarded –** Electrocoagulation unable to treat effluent to below 1mg/l. Will not meet required permit. Technology aimed at smaller works where it is advantageous to deliver and store liquid chemical; untested at size/flows.
Treatment process-based permitting – Tertiary filtration Install tertiary cloth filtration or sand filtration and chemical dosing to remove phosphorus and iron. Physical separation process, where solids are captured on a series of cloth discs or within a volume of sand. Solids are removed by backwashing cloth discs or sand media.	Yes	Yes	**Carried forward**
Treatment process-based permitting – Ballasted tertiary coagulation Install ballasted coagulation (an alternative to tertiary filtration) Ballasted coagulation is a high-rate, physical-chemical clarification process involving the fixing of flocs, or suspended solids, onto ballast (sand) with the aid of a polymer. The resulting sludge, which contains the ballast, is collected for treatment where the sludge is -separated from the ballast. The residual solids are sent through a sludge processing system and the recovered ballast is recycled.	Yes	Yes	**Carried forward** from primary screening. **Discarded** from secondary screening Ballasted coagulation in all cases cost more to construct (require more assets) and operate (due to higher energy costs) than other tertiary treatment technologies. Benefits to water quality and other natural capital measures are the same as traditional treatment technologies.
Treatment process-based permitting – Ballasted secondary treatment Ballasted secondary treatment processes incorporate a ballast into the mixed liquor of an activated sludge plant. The ballast binds to the floc in the activated sludge and improves the settlement rate and associated solids removal. For phosphorus removal ferric sulphate is dosed into the wastewater entering the aeration basin prior to ballast addition.	No	No	**Discarded –** Technology only works in combination with an activated sludge plant which Wooler does not have.

The following two options were carried forward to the benefits scoring and investment appraisal:

- A new integrated constructed wetland at Wooler STW with catchment permitting utilising overperformance at Wooler WTW; and
- Treatment process based permitting – installation of tertiary cloth filtration or sand filtration and chemical dosing.

The Tweed Forum had previously (in 2020) identified an Integrated Constructed Wetland (ICW) as a means of 'polishing' water quality and improving phosphorus removal capability as part of the chemical dosing system implemented at Wooler WwTW designed to achieve a permit limit of 2 mg/l. A feasibility study was carried out to assess the land area needed to remove an extra 25%, 50% or 75% of phosphorus loading to the river assuming the 2 mg/l permit was achieved. The results are shown in Table 10.

TABLE 10: WOOLER WATER LAND AREA REQUIRED FOR AN ICW SOLUTION

ICW Option ID	ICW Outflow concentration (mg/l)	% P removed	Water volume treated (m^3/d)	P removed annually (kg/yr)	Land take (ha)	Estimated Cost (2018)
1	1.5	25	300	54.8	0.35	£18k-£53K
2	1.0	50	300	109.5	0.95	£48k-£140k
3	0.5	75	300	164.3	2.40	£120k-£355k
4	1.5	25	656	119.7	0.80	£41-£121
5	1.0	50	656	239.4	2.17	£110-£320
6	0.5	75	656	359.2	5.50	£275k-£810k
7	1.5	25	2293	418.5	2.74	£137k-£405k

Based on Wooler STW achieving a final effluent of 2 mg/l total phosphorus and assuming costs of £92k to £148k per hectare (2018 estimates) a land area of 2.74 ha is required with an indicative cost in the range £137k to £405k.

A second study was carried out as part of PR24 planning (covering all sites considering an ICW solution) using an in-house Wetland Screening Tool. The tool used removal rates derived from academic literature, monitored effluent quality and considered the current evidence available for chemically dosed and non-dosed wetlands, and calculated the size of wetland required. The outcomes of the wetland screening exercise confirm that an ICW solution located at Wooler STW is a viable option.

3.2.3 Best value – Wooler

We understand the value of all our options and have carried out a value assessment of each of the technology options considered. Our plan includes the options that deliver the most value for the money we are spending.

Benefit scoring

For each of the technology options carried forward to this stage we carried out a benefits assessment using the remaining two criteria in the WINEP options assessment guidance[15] section 6:

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

We have assessed each of the technology options against the Wider Environmental Outcome Metrics[16] as shown in Table 11. Firstly, we have mapped each of the appliable ecosystem service/goods category to our value framework metrics in column 2 and listed the relevant WINEP outcome in column 3.

[15] WINEP Options Assessment Guidance, Environment Agency, March 2022
[16] WINEP Wider Environmental Outcome Metrics V2.1, Environment Agency, April 2022

TABLE 11: BENEFITS FROM WINEP WIDER ENVIRONMENTAL OUTCOMES AND NORTHUMBRIAN WATER'S VALUE FRAMEWORK FOR HD_IMP PHOSPHORUS

Options carried forward	NWG Value framework measures	WINEP Wider Environmental Outcomes	Certainty that benefits will be realised (Deliverability assessment)
Continue business as usual As is position	Phosphorus (River Water Quality)		No benefits delivered
Integrated Constructed Wetland (ICW) Install 2.74 ha ICW at Wooler WWTW alongside chemical dosing (already in place) to 2mg/l	Phosphorus (River Water Quality) – 418 kg/yr Embedded carbon emissions Operational carbon emissions	Natural environment Catchment resilience Net zero Access, amenity and engagement	High likelihood of delivering benefits. Best practice will be used for all project management activities (scoping, budgeting, work planning, skills and knowledge). The North East Coastal Hub will support the development and implementation of a detailed technical solution capable of delivering the stated benefits.
Treatment process-based permitting: Additional Ferric dosing point and cloth filter or sand filter	Phosphorus (River Water Quality) – 624 kg/yr Embedded carbon emissions Operational carbon emissions	Natural environment Catchment resilience Net zero	Very high likelihood of delivering benefits. Best practice will be used for all project management activities (scoping, budgeting, work planning, skills and knowledge). The project proposes an industry standard technical solution that is well understood by us and our suppliers.

Extra water quality benefits will be secured from a reduction in phosphorus loads where end-of-pipe solutions are proposed which we were unable to quantify as the water body is already at High status for phosphate. One extra disbenefit from an end-of-pipe solution would be increased carbon emissions arising from extra treatment processes at Wooler STW. This is included in the value assessments for the different options.

The ICW option would deliver a range of benefits:

- Water quality: ICWs are designed to reduce phosphorus loads to watercourses and have the potential to remove other pollutants such as nitrogen. Water quality benefits were not able to be quantified as the water body is already at high status for phosphate.
- Biodiversity: habitat creation (including wetland planting) and the improvement of water quality downstream will have benefits for biodiversity. This has been quantified using the Biodiversity Net Gains (BNG) metric.
- Minor benefits have also been identified for air quality, climate regulation, water purification (filtration by habitats), recreation, volunteering and education. These minor benefits have not been quantified/monetised, in line with the benefits assessment methodology.

Table 12 describes the type of benefit and the source of monetisation that we have used where applicable.

TABLE 12: RANGE OF BENEFITS IDENTIFIED FOR WOOLER (HD_IMP_PHOSPHORUS)

Value measures or Benefit	Description	Unit	Value	Value source
Operational Carbon	t/CO2e /year	tCO2e	£256.2*	NWL Value Framework
Embedded Carbon	t/CO2e /year	tCO2e	£256.2*	NWL Value Framework

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

Note that a single dummy value measure for each option type to include the summation of the monetised benefits from the WINEP Wider Environmental Outcomes Assessment could be used for simplicity.

Investment appraisal

A robust cost benefit appraisal has been carried out within our portfolio optimisation tool. This calculates a Net Present Value (NPV) for each option. The present value is calculated by combining the profile of the present value of benefits and the profile of present value of costs over the appraisal period. The results of this assessment and the chosen option are shown in Table 13. The table shows the NPV for the options to meet the HD_IMP WINEP driver.

Costs and benefits have been adjusted to 2022/23 prices using the CPIH Index[17] financial year average. The impact of financing is included in the NPV calculation. Capital expenditure has been converted to a stream of annual costs, where the

[17] Consumer Price Index including owner occupiers' housing costs, Office for National Statistics

annual cost is made up of depreciation/regulatory capital value (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 HM Treasury's *The Green Book*[18].

We have used our Copperleaf asset management system to optimise our plan and select a best value plan. Our best value and least cost selection process has been assured by our third-party assurer, through the price review process.

TABLE 13: NPV AND PREFERRED OPTION

Option	NPV	Type of option
Integrated constructed wetland	-£2.825m	Preferred option (least cost)
Engineered end of pipe solution at Wooler STW	-£4.095m	

TABLE 14: EVALUATION OF PREFERRED OPTION

	Least cost and preferred option
Capex in AMP8	£3.225m
Opex in AMP8	£0
Totex in AMP8	£3.225m
Totex (30 yr NPV)	-£2.825m
Carbon societal value	-£0.108m

Section 4 shows how this investment is included in the CWW3 and CWW15 data tables.

3.2.4 Impact – Wooler

An ICW is the preferred option, as it is the least cost (£3.2m) and best value option that will meet the regulatory obligation (required phosphorus load reduction), while maximising wider environmental benefits. Unquantified benefits for the preferred option of an ICW include improved water quality, climate regulation, water purification, volunteering, angling and minor benefits for flood regulation, air quality, recreation and education. Figure 8 shows an outline layout for the preferred option, but this could change with detailed design and further project development.

[18] The Green Book, HM Treasury, 2022

FIGURE 8: OUTLINE LAYOUT FOR THE PREFERRED OPTION

3.2.5 Uncertainty – Wooler

We understand that our preferred option of an ICW is a nature-based solution (NBS) and there is more uncertainty with the realisation of NBS benefits than traditional engineered solutions. Compliance with the new standard will be implemented by an Operating Techniques Agreement and will be balanced against the performance of Wooler WTW. Wetlands are modular and they are built in cells, this means we can add extra cells as required to improve treatment. This helps with maintenance and taking assets out of service. We have outlined and ranked (RAG) the risks for each option, as shown in Table 15.

TABLE 15: WOOLER WATER FINAL OPTIONS RISK ASSESSMENT

Risk category	Option 5 – Replace/retrofit/expand existing primary or secondary treatment processes using existing process types or more intensive processes		Option 6 - ICW	
	RAG rating	Comment	RAG rating	Comment
Driver compliance • Define any risks that will impact the driver compliance.		**LOW RISK** – Chosen option is well tested industry standard method of removing phosphorus. Some risk due to reliance on performance of existing assets		**MEDIUM RISK** – Higher uncertainty associated with nature-based solutions compared to traditional end-of-pipe solutions. Risk lowered by combining with chemical dosing (ICW acting as tertiary treatment stage) or using where permit level is not significantly less than current performance
Delivery • Define any risks to delivery of the option (resources, technology)		**LOW RISK** - The required expansion of assets for tighter nutrient removal is fairly standard with good experience in the industry.		**MEDIUM RISK** – There is some inherent uncertainty in ability of catchment and nature-based solutions to deliver. Risk lowered by combining with chemical dosing (ICW acting as tertiary treatment stage) Uncertainty around availability of appropriate land and cost of land purchase/lease.
Cost • Define any risks that might impact cost certainty		**MEDIUM RISK** – until a detailed site assessment has been complete it is difficult to have cost certainty on any site restrictions.		**MEDIUM RISK** – Costs are subject to detailed site surveys and detailed design
Resources • Define any risks to resourcing the successful operation of the option		**LOW RISK** No specialist resources required		**LOW RISK** No specific risks identified
Technology • Define any risks related to the use of technology to meet the driver compliance		**LOW RISK** Technology is standard with NWL and wider water industry		**LOW RISK** No specific risks identified
Supply chain • Define any risks in the supply chain		**MEDIUM RISK** likely to be significant demand in the water industry for this technology, however there are several suppliers for this option		**LOW RISK** No specific risks identified
Public perception • Define any risks that will impact NWG perception with the public		**MEDIUM RISK –** some disruption will be caused by construction works on site		**VERY LOW RISK** Partnership project and investment in NBS solution gives the opportunity to positively increase NW's environmental impact and influence through this project

The preferred options show a similar overall level of risk with the Wooler WWTW upgrade medium risk for costs, resources and the supply chain, and the ICW option medium risk for compliance, delivery and costs. Compliance and delivery are inherent risks for NBS which are offset by the low risks associated with technology and resources.

3.3. OPTIONS FOR NUTRIENT NEUTRALITY (NN) AND SEAL SANDS

3.3.1 Broad range of unconstrained options – NN and Seal Sands

Through the risk and issues stages of WINEP, the EA flagged the need for at least an investigation, for Teesmouth and Cleveland Coast SPA. In March 2022, we were notified by Defra that nutrient neutrality would be rolled out to the Tees and Lindisfarne catchments. In summer 2022 we held workshops with the NECH which brought together stakeholders and regulators to develop plans for improvement. Options for both Lindisfarne and Teesmouth were developed with the objective of restoring the site to favourable status. At that time there was no additional requirement for Northumbrian Water to undertake anything other than an investigation.

Following the workshop plans were further developed with consultants and academics on the feasibility of marine nature-based solutions, as well as those on land.

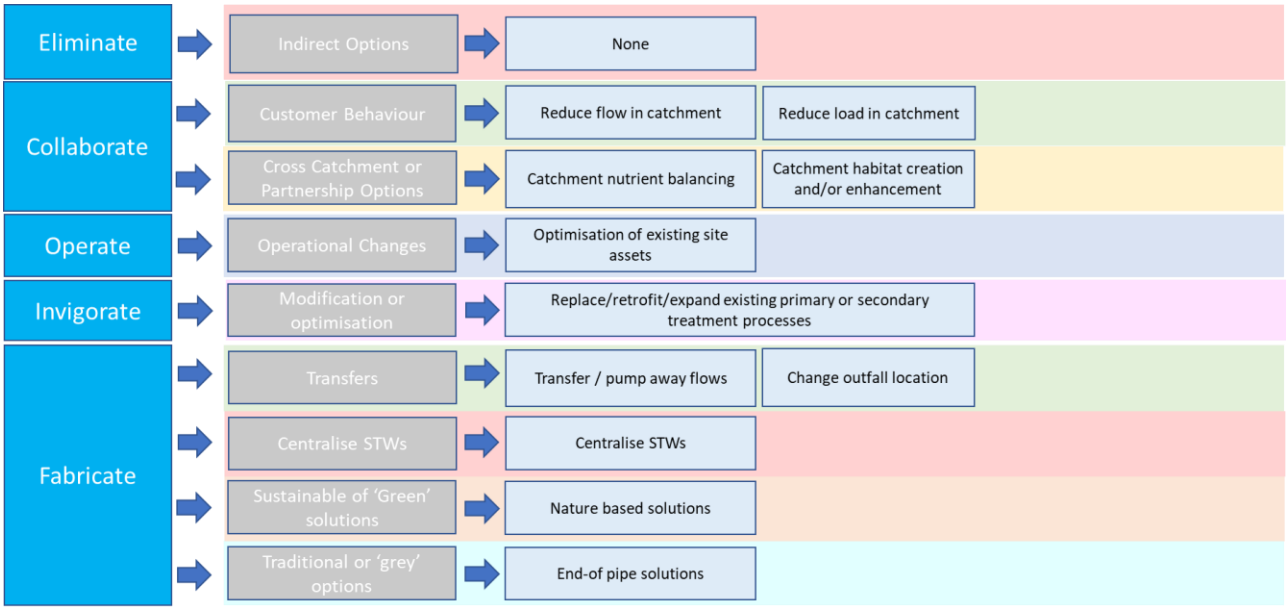
The solutions developed identified the main sources of nutrients originated from point source discharges directly into the Tees estuary with further significant loads entering from the North Sea. Due to the nature of the sources of nutrients, we identified that addressing nutrients within the freshwater river inputs would have limited improvement potential to seal sands SSSI which is the only eutrophic part of the estuary. It was clear that only marine based interventions, and some freshwater interventions located in Greatham beck would be viable options to improve the protected area of Seal sands SSSI.

In July 2022, we were asked by DEFRA to asess the cost of upgrading all numeric STWs within both nutrient neutrality areas to the technically achievable limit for total nitrogen this identified 49STW's. The approach below was used to develop options for the new legislative requirements alongside the nature-based solution options.

We have adopted a structured approach to identify and categorise the unconstrained options for nutrient neutrality. This means that we identify a full range of options and ensure consistency.

The framework described in section 3.1 and its application to nutrient neutrality is shown in Figure 9. A full list of unconstrained options was used for the screening process is shown in Appendix D.

FIGURE 9: NUTRIENT NEUTRALITY UNCONSTRAINED OPTIONS



3.3.2 Primary and secondary screening of options – NN and Seal Sands

Our constrained options for nutrient neutrality and Seal Sands are shown in Table 16.

TABLE 16: SEAL SANDS AND NUTRIENT NEUTRALITY SCREENING TO IDENTIFY THE CONSTRAINED OPTIONS

Option	Meets Statutory Obligation? (Seal Sands)	Meets Statutory Obligation? (Nutrient Neutrality)	Technically Feasible?	Reason for discarding
Influence policy Modify HD_IMP_NN driver	N/A	Yes	Yes	**Discarded** – Not an option for PR24. Ongoing discussions with Defra/Ofwat/EA
Reduce flow Demand management	No	No	Yes	**Discarded** – would increase concentration of nutrient therefore not reducing load in receiving environment
Catchment nutrient balancing The catchment area which drains directly onto Seal Sands will be targeted for catchment management activities to achieve nitrogen reductions Combined with; **End-of-pipe solution – upgrade Bran Sands WwTW** To achieve nitrogen reductions	Yes	Part	Yes	**Carried forward** Note – approach not allowed under Defra/EA Nutrient Neutrality guidance Note – Bran Sands WwTW has the single largest discharge into the Tees Estuary and is therefore the biggest opportunity for achieving further reductions.
Catchment habitat creation and/or enhancement A range of catchment solutions to achieve the required nitrogen reduction at Seal Sands including an ICW, saltmarsh restoration at Greatham, seagrass restoration, native oyster bed restoration, seaweed and shellfish farming and intertidal restoration measures	Yes	Part	Yes	**Carried forward** – Insufficient reduction in load at Seal Sands Note – approach not allowed under Defra/EA Nutrient Neutrality guidance
Optimise existing assets Use of existing WwTW assets for total nitrogen removal	Yes	No	Yes	**Discard** – Not viable for Nutrient Neutrality as no existing sites are able to meet the nitrogen Technically Achievable Limit.

Option	Meets Statutory Obligation? (Seal Sands)	Meets Statutory Obligation? (Nutrient Neutrality)	Technically Feasible?	Reason for discarding
Expand existing treatment processes Expand existing assets to include ammonia removal	N/A	Part	Yes	**Discard** – Upgrade may be required as enabling works to allow site to meet nitrogen Technically Achievable Limit. Does not achieve total nitrogen reduction on its own.
Expand existing treatment processes Upgrade activated sludge plant for total nitrogen removal. Augment existing assets at activated sludge plants to increase removal of nitrogen (with and without methanol dosing)	Yes	~~Yes~~ Part	Yes	**Carried forward**
Transfer / pump away flows. Transfer of existing flows to a different receiving site	No	No	Yes	**Discarded** – No improvement generated if flows continue to be discharged within the same catchment
Change outfall location Transfer of location of outfall to remove eliminate impact of discharges on Seal Sands SSSI	Yes	Yes	Yes	**Carried forward**
Centralise WWTWs Consolidate treatment works to create a centralised larger works	No	No	No	**Discarded** – No improvement generated if works are centralised within catchment as discharge would continue to contribute the same total nitrogen load to the sensitive areas
Integrated Constructed Wetlands Create new wetlands at WwTW to improve quality of effluent	Yes	No	Yes	**Carried forward** – Will not deliver sufficient nitrogen removal to meet Nutrient Neutrality driver in isolation
Nature based solution – algae treatment Implementation of algae treatment at WwTW to polish effluent	Yes	TBC	No	**Discarded** – Technology not yet proven to meet new limits, but considered to be viable long-term option, with further testing and scaling.
End-of-pipe solution – add treatment at filter works Add assets to remove nitrogen in a tertiary treatment step (with and without methanol dosing)	Yes	Part	Yes	**Carried forward**

Option	Meets Statutory Obligation? (Seal Sands)	Meets Statutory Obligation? (Nutrient Neutrality)	Technically Feasible?	Reason for discarding
End-of-pipe solution – replace filter works with activated sludge plant configured for nitrogen removal Full works replacement	Yes	Part	Yes	**Carried forward**
End-of-pipe solution – use sludge fermentation Partial solution to provide an alternative to dosing methanol at activated sludge plant sites.	N/A	Yes - enabling	No	**Discarded** – Technology not yet proven
End-of-pipe solution – use digestion liquors treatment technologies To provide partial nitrogen removal at sites with sludge digestion.	N/A	Part	Yes	**Carried forward**

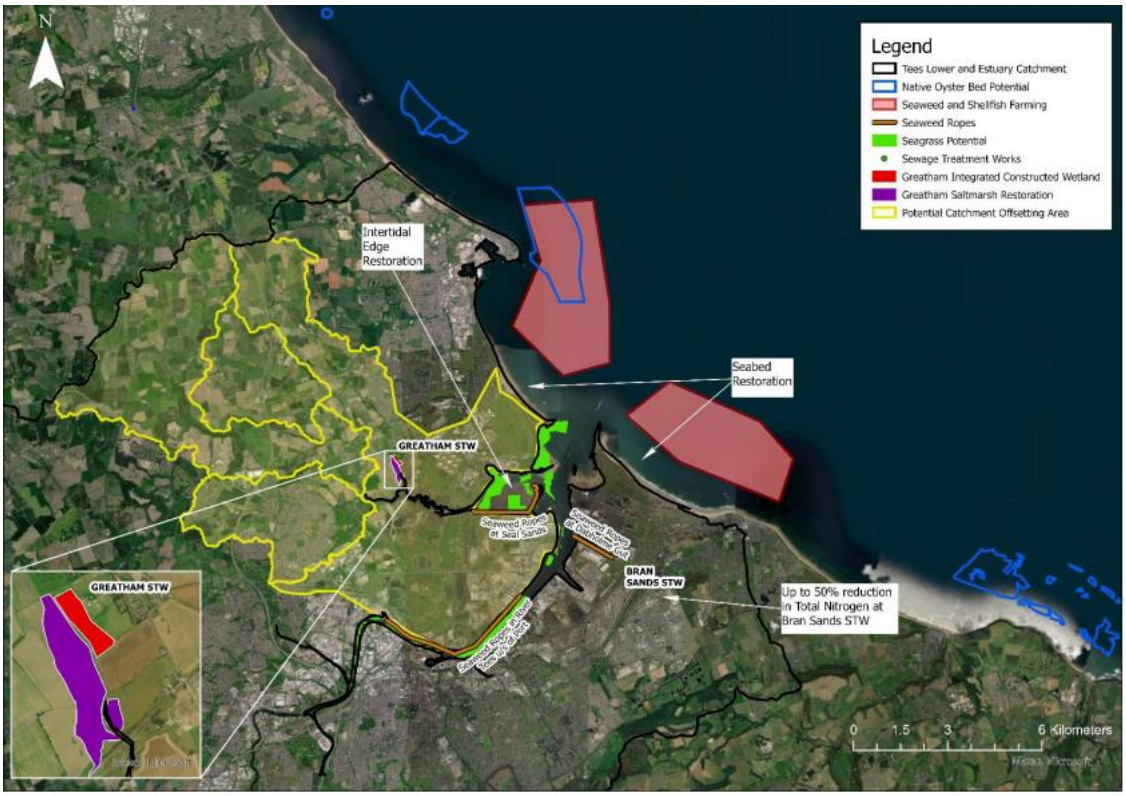
The combined screening of nutrient neutrality and Seal Sands options results in the following being carried forward for benefits scoring and investment appraisal;

- Catchment nutrient balancing
- Catchment habitat creation and/or enhancement
- Optimise use of existing assets
- Expand existing treatment processes to include ammonia removal
- Expand existing treatment processes by upgrading activated sludge plants
- Change outfall location to remove impact of discharges
- Integrated constructed wetlands at WwTW to improve quality of effluent
- End-of-pipe solution, add tertiary treatment at filter works
- End-of-pipe solution, replace filter works with activated sludge plant configured for nitrogen removal
- End-of-pipe solution, add treatment of digestion liquors treatment

3.3.3 Application of catchment options at individual sites

The following map shows the different locations in the Tees catchment for different types of NBS taking account of tidal currents, depth and light availability, among others. This is shown in Figure 10. We used this as a starting point for identifying feasible options for the alternative catchment offsetting solution.

FIGURE 10: NWG MAP OF THE TEES CATCHMENT SHOWING POTENTIAL LOCATIONS FOR NATURE BASED SOLUTIONS



We worked closely with the NECH who were already exploring the use of NBS in the Tees Estuary and have Marine Management Organisation (MMO) licences for sea grass and oyster beds in place. They are developing detailed options for review by planning authorities and are planning to explore the use of seaweed and shellfish for nutrient removal in the near future. NECH does not yet have the funding to implement their proposals. Our alternative catchment solution presents a major opportunity for joint working to deliver more NBS in the Tees Estuary.

The following sources of expertise and knowledge were used to identify an initial list of NBS that could contribute to the overall solution;

- existing work carried out with NECH;
- our understanding of the issues and opportunities in the Tees Estuary;
- latest findings from UK and international research;
- findings from project Ran trans, and trials in Poole harbour; and
- experience of commercial partners (Stantec, Mott MacDonald, Jacobs).

We have carried out a significant review into each of the NBS components to derive a list of possible options. The review looked at recent research (UK and international), and ongoing projects for example, Interreg RaNTrans (Rapid Removal of Nutrients in Transitional Waters project), different on/offshore locations to identify favourable conditions,

environmental variables, evidence about the likely reductions in nitrogen and phosphorus levels, design parameters (for example, nutrient removal rates per hectare) and existing land use among others. In carrying out this analysis we consulted a number of professional partners including MMO, Rivers Trust and The Crown estate.

Our review identified the following NBS as possible components for the Tees Estuary;

- NBS skills hub facility;
- seaweed farming;
- shellfish farming;
- native oyster bed restoration;
- saltmarsh restoration;
- sea grass restoration;
- integrated catchment wetlands;
- storm overflow reductions;
- agricultural catchment management;
- intertidal restoration measures;
- upgrade to Bran Sands WwTW; and
- seabed restoration.

More details of the reviews including evidence and benefits are included in Appendix B.

The establishment of a NBS hub at the estuary is a primary requirement to securing the skills base and resources needed to deliver the catchment solutions and to provide long-term support. The hub will help reduce deliverability risk by providing the project team with access to a specialist technical guidance and know-how during design, implementation and benefits monitoring. We have limited experience in delivering some of these options, however we have established connections with potential organisations/partners, for example, Rivers Trust, who have experience in designing and delivering NBS and securing funds and licences from third parties including the MMO and the Crown Estate.

The hub would also help to bring in match funding from private finances who are actively looking to become carbon neutral. This includes businesses with strong local interests such as BP, Shell, and Abel, and universities who are also interested in supporting the proposals and to use the hub as part of an innovative research facility. The proposal includes a 20% investment from NWG to help establish the hub with the balance to come from third parties. A hub would also have a long-term role by supporting the development of other catchment measures in the Tees Estuary, for example, the agricultural interventions in the upper part of the catchment proposed to meet WFD needs.

This business case considers combined options for both mitigation and improvement since individual NBS alone are unlikely to deliver favourable condition status of the protected area. Although there is less certainty associated with the outcomes of NBS, the potential to realise wider benefits and secure cost savings are significant and represent an exciting opportunity to address the specific issue of nitrogen loading and to build a more resilient habitat capable of supporting a wide variety of wildlife over the long-term.

Our proposals for an alternative solution will make use of the best scientific evidence and will require a new marine model to assess the impacts before detailed design. The expenditure associated with the modelling is included in HD_INV.

3.3.4 Application of Technically Achievable Limits (TAL) at individual sites

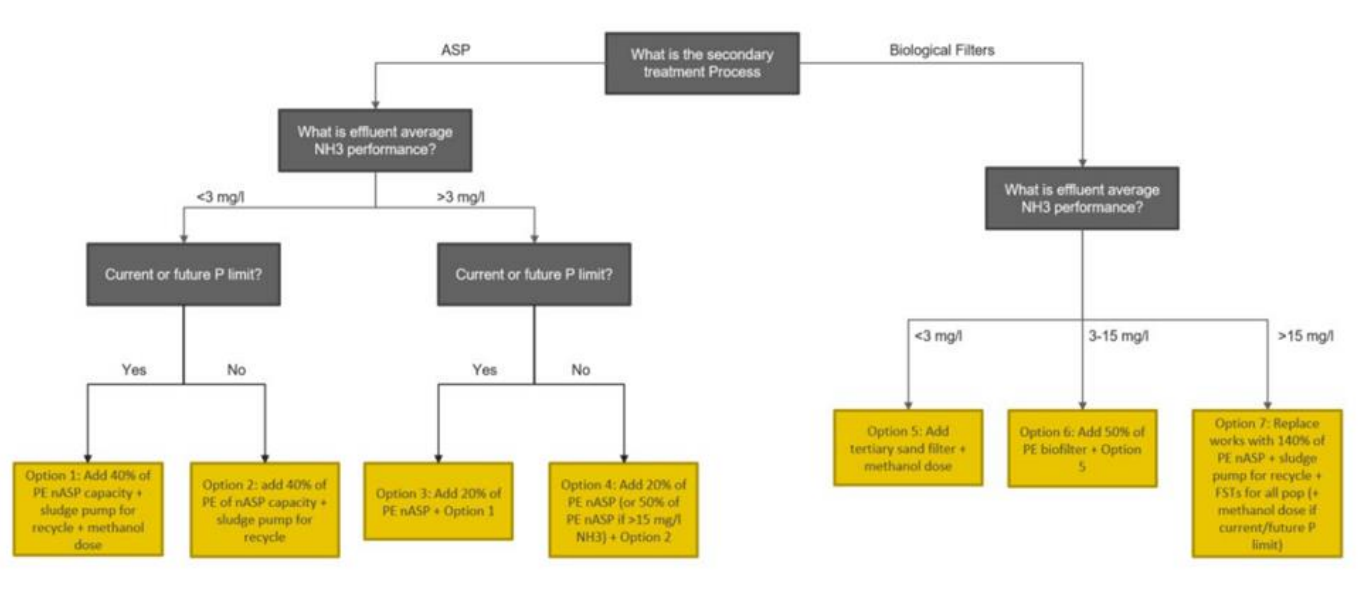
Defra requires our PR24 business plan to include the investment needed to achieve the nitrogen TAL for the Tess Catchment. The conditions imposed by Defra limits our choice of options to those that are engineering based since catchment offsetting options are specifically excluded. After reviewing all available evidence, the EA states that the protected area will not be restored to favourable status based on our actions alone, using a TAL solution. Following the legislation, we have undergone our screening process for TAL.

Based on the information in the screening table the following options are engineering based and are available to meet the nitrogen TAL;

- replace, retrofit or expand existing primary or secondary treatment processes;
- change outfall location to remove impact of discharges; or
- end-of-pipe solutions, replace and/or add assets to achieve nitrogen TAL.

Engineering solutions are required for all 16 STWs with a PE>2,000 since none of our STWs were originally designed to meet nitrogen standards. The following decision tree sets out the options for achieving nitrogen TAL based on the existing treatment process and the quality of the effluent discharge produced.

FIGURE 11: ENGINEERING OPTIONS FOR ACHIEVING NITROGEN TAL



The engineering options shown on the decision tree were assessed against the following criteria for each 16 STWs.

- Optimisation of existing site assets
  - Yes – if existing assets and treatment process includes nitrogen removal
  - No – if existing assets are not capable of performing nitrogen removal
- Expand existing secondary treatment (ammonia removal)
  - Yes – if the average ammonia removal is >3 mg/l (at biological filter works or activated sludge plants) and <15 mg/l (at biological filter works only) then additional nitrification capacity is included as part of the solution to enable total nitrogen removal
  - No – if the average ammonia removal is <3 mg/l (at biological filter works or activated sludge plants) then no expansion is necessary. If ammonia removal is >15 mg/l (at biological filter works only) then a full replacement is included (see option “Replace filter works with activated sludge plant configured for nitrogen removal”)
- Upgrade ASP for total nitrogen removal
  - Yes – if works is currently an activated sludge plant an upgrade is included.
  - N/A – if works is currently a biological filter works.
- Change outfall location
  - Yes – if existing outfall is <5km to the sea
  - No – if existing outfall is >5km to the sea
- Add tertiary treatment to filter works
  - Yes – if works is currently a biological filter works an upgrade is included.
  - N/A – if works is currently an activated sludge plant.

- Replace filter works with activated sludge plant configured for nitrogen removal
  - Yes – if biological filter works average ammonia effluent performance is >15 mg/l then a complete works replacement with an activated sludge plant is required
  - No – if biological filter works average ammonia effluent performance is <15 mg/l then works replacement is not required
  - N/A – if works is currently an activated sludge plant.
- Use of digestion liquors treatment technologies
  - Yes – if site has digestion facilities
  - No – if site does not have digestion facilities

The outcome of applying the criteria to the 16 sites is shown in Table 17. The option number applicable from the decision tree is shown by each site name. A bespoke solution is needed at Bran Sands STW since it discharges about 65% of total flow into the Tees Estuary and comprises 3 different treatment trains (A, B, C) receiving domestic and industrial wastewater and liquors from sewage sludge treatment. The “Upgrade ASP for total nitrogen removal” solution was adapted from an earlier study (2003) which included the following process upgrades:

- addition of activated sludge anoxic tanks for train C with mixing;
- new methanol dosing rig; and
- addition of recycle pump stations, pumps and pipework for trains C and B.

The 2003 study takes account of the complexities of the site and in particular the enabling works needed to increase the footprint of the site by 60% as part of the upgrade.

TABLE 17: SEAL SANDS AND NUTRIENT NEUTRALITY CONSTRAINED ENGINEERING OPTIONS

Wastewater Treatment Works	Optimise existing assets	Expand existing secondary treatment 4	Upgrade ASP 2	Change outfall location	Add tertiary treatment to filter works 5, 6	Replace filter works with activated sludge plant	Use digestion liquors treatment
AYCLIFFE	No	No	Yes	No	N/A	N/A	No
BARNARD CASTLE	No	Yes	N/A	No	Yes	No	No
BILLINGHAM	No	Yes	Yes	No	N/A	N/A	No
BRAN SANDS bespoke	Yes	No	Yes	Yes	N/A	N/A	Yes
CARLTON & REDMARSHALL	No	No	N/A	No	Yes	No	No
CHILTON LANE	No	No	N/A	No	Yes	No	No
FISHBURN	No	No	N/A	No	Yes	No	No
GREAT AYTON	No	No	N/A	No	Yes	No	No
HUTTON RUDBY	No	No	N/A	No	Yes	No	No
MARSKE	No	Yes	Yes	No	N/A	N/A	No
SEATON CAREW	No	Yes	Yes	No	N/A	N/A	No
SEDGEFIELD	No	No	N/A	No	Yes	No	No
STOKESLEY	No	No	N/A	No	Yes	No	No
STRESSHOLME	No	No	N/A	No	Yes	No	No
TRIMDON VILLAGE	No	No	N/A	No	Yes	No	No
WINDLESTONE	No	No	N/A	No	Yes	No	No

3.3.5 Best value – NN and Seal Sands

Benefit scoring

For each of the technology options carried forward to this stage we carried out a benefits assessment using the remaining two criteria in the WINEP options assessment guidance[19] section 6:

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

We have assessed each of the technology options against the Wider Environmental Outcome Metrics[20] as shown in Table 18. Firstly, we have mapped each of the appliable ecosystem service/goods category to the NWL value framework metrics in column 2 and listed the relevant WINEP outcome in column 3.

TABLE 18: BENEFITS FROM WINEP WIDER ENVIRONMENTAL OUTCOMES AND NORTHUMBRIAN WATER'S VALUE FRAMEWORK

Options carried forward	NWG Value framework measures	WINEP Wider Environmental Outcomes
Continue business as usual As is position		
Catchment Nutrient Balancing	Amenity (Recreation) Water quality – river (Improved Water Environment model) Biodiversity	Natural environment Catchment resilience Access, amenity and engagement
Catchment habitat creation and/or enhancement	Biodiversity Water Purification by Habitats (no Value Model) Climate regulation (no Value Model) Amenity (Recreation) Education (no Value Model) Water quality – river (Improved Water Environment model) Water quality – lake (no Value Model)	Natural environment Catchment resilience Access, amenity and engagement Net zero
Optimise use of existing assets	Operational emissions	Net zero
Expand existing treatment processes to include ammonia removal	Embedded carbon emissions Operational emissions Water quality (Improved Water Environment model)	Natural environment Catchment resilience Net zero
Expand existing treatment processes by upgrading activated sludge plants	Embedded carbon emissions Operational emissions Water quality (Improved Water Environment model)	Natural environment Catchment resilience Net zero
Change outfall location to remove impact of discharges	Embedded carbon emissions	Net zero
Integrated constructed wetlands at WwTW to improve quality of effluent	Biodiversity	Natural environment Catchment resilience

[19] WINEP Options Assessment Guidance, Environment Agency, March 2022
[20] WINEP Wider Environmental Outcome Metrics V2.1, Environment Agency, April 2022

Options carried forward	NWG Value framework measures	WINEP Wider Environmental Outcomes
	Water Purification by Habitats (no Value Model) Education (no Value Model) Embedded carbon emissions Operational carbon emissions	Access, amenity and engagement Net zero
End-of-pipe solution, add tertiary treatment at filter works	Embedded carbon emissions Operational emissions Water quality (Improved Water Environment model)	Natural environment Catchment resilience Net zero
End-of-pipe solution, replace filter works with activated sludge plant configured for nitrogen removal	Embedded carbon emissions Operational emissions Water quality (Improved Water Environment model)	Natural environment Catchment resilience Net zero
End-of-pipe solution, add treatment of digestion liquors treatment	Embedded carbon emissions Operational emissions Water quality (Improved Water Environment model)	Natural environment Catchment resilience Net zero

Our value framework is embedded into our portfolio optimisation tool and contains a mixture of benefits which reflect to performance commitments or other social and environmental benefits. First, we score the impact of continuing business as usual and then we score each of the 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. Table 19 describes the type of benefit and the source of monetisation that we have used where applicable.

TABLE 19: RANGE OF BENEFITS IDENTIFIED FOR TEESMOUTH CATCHMENT OFFSETTING (HD_IMP_NN)

Value measures or Benefit	Description	Unit	Value	Value source
Improved water environment	Length of water environment improved	Km	Not monetised in VM	NWL Value Framework
Biodiversity net gain	Change in biodiversity units (BU)	BU	Not monetised in VM	NWL Value Framework
Amenity (Recreation)	Number of visitors on England Coast path passing through saltmarsh site (10,000 average visits for all English coastal and beach sites)	Visits/day (Coastal)	£23*	NWL Value Framework
Operational Carbon	t/CO_2e /year	tCO_2e	£256.2**	NWL Value Framework
Embedded Carbon	t/CO_2e /year	tCO_2e	£256.2**	NWL Value Framework
Cost Savings	Mechanism for including monetisation of Improved water environment	£	£16,869***	WINEP Wider Environmental Outcomes Assessment
Education	Mechanism for including monetisation of Education	£	£2,272*[v] £4,543[v]	WINEP Wider Environmental Outcomes Assessment
Recreation	Mechanism for including monetisation of Recreation	£	£37,200	WINEP Wider Environmental Outcomes Assessment

Value measures or Benefit	Description	Unit	Value	Value source
Habitat Water Purification	Mechanism for including monetisation of Water Purification by Habitat	£	£10,410,025	WINEP Wider Environmental Outcomes Assessment
Climate Regulation	Mechanism for including monetisation of Climate regulation	£	£18,260[v**]	WINEP Wider Environmental Outcomes Assessment
Water Quality (lakes)	Mechanism for including monetisation of water quality (lakes)	£	£30,157[v***]	WINEP Wider Environmental Outcomes Assessment

* Value of coastal visit if 'Slight benefit' (values with Moderate and Major benefit are £115 and £230 respectively)

**£ value per tonne of CO_2e in 2025/26, annual increase (varying rate) reaching £378.6/t CO_2e in 2024/55

*** Annual value of £22,493 multiplied by an assumed confidence level of 0.75

*[v] Native Oyster Recreation: 180 pupils (6 school visits per year with classes of 30 pupils) with a benefit of £25.74 per pupil multiplied by an assumed confidence level of 0.5

[v] ICW at Greatham ICW: 360 pupils (1 school visit per month with classes of 30 pupils) with a benefit of £25.74 per pupil multiplied by an assumed confidence level of 0.5

[v]* Saltmarsh restoration + restoring oysters + shellfish farming + seaweed farming: 6449.6ha with a benefit of £2,152/ha/year multiplied by an assumed confidence level of 0.75; Greatham ICW: 1.41ha @ £350/ha/year @ 0.75 confidence

[v]** Saltmarsh restoration: 14.55ha with a carbon sequestration of 5.133 tCO_2e/ha/yr with a benefit of £326 per tCO_2e/ha/yr ('Central' estimate) multiplied by an assumed confidence level of 0.75

[v]*** Bran Sands – reduction by 50%: 2.25km^2 improved from Poor to Good status with a benefit of £8,238/km^2 for Poor to Moderate improvement and £9.633/km^2 for Moderate to Good improvement with a confidence level of 0.75

Note that a single dummy value measure for each option type to include the summation of the monetised benefits from the WINEP Wider Environmental Outcomes Assessment could be used for simplicity.

A detailed analysis of all the available nature-based solutions is shown in Appendix B.

Investment appraisal

We assessed all the constrained options and have identified three high level options for restoring Seal Sands SSSI to favourable condition and achieving nutrient neutrality which are set out in detail in the following sections.

- **Catchment offsetting** – a combination of catchment nature-based solutions and an upgrade to Bran Sands STW which as well as restoring Seal Sands SSSI will bring wider environmental benefits.
- **Long sea outfall –** moving the outfall of Bran Sands STW to a long sea outfall, removing the impact of the nitrates from the treatment works on the Tees catchment.
- **NTAL at 16 STWs** – a fully engineered solution to upgrade 16 STWs with a PE>2,000 which will restore Seal Sands SSSI to favourable condition and achieve nutrient neutrality in the Tees catchment. (Bran Sands, Stressholme, Seaton Carew, Marske, Aycliffe, Billingham, Windlestone, Barnard Castle, Stokesley, Sedgefield, Great Ayton, Trimdon Village, Fishburn, Chilton Lane, Carlton and Redmarshall and Hutton Rudby).

A robust cost benefit appraisal has been carried out within our portfolio optimisation tool. This calculates a Net Present Value (NPV) for each option. The present value is calculated by combining the profile of the present value of benefits and the profile of present value of costs over the appraisal period. For the options we assessed, we included wider benefits in the WINEP options assessment reviews. The results of this assessment and the chosen option are shown in Table 20. The table shows the net cost/benefit for the options to meet the HD_IMP_NN WINEP driver.

Costs and benefits have been adjusted to 2022/23 prices using the CPIH[21] Index financial year average. The impact of financing is included in NPV 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*[22].

Our best value and least cost selection process has been assured by our third-party assurer, through the WINEP and price review processes.

The costs of the full NTAL option of upgrading 16 STW or the long sea outfall option are prohibitive in comparison to the alternative catchment offsetting option combining NBS with an upgrade to Bran Sands STW. Table 20 shows the costs and benefits of the three options. Within this table, the benefit figures shown are those calculated for the WINEP submission, this includes benefits additional to those included in our copperleaf system. These benefits such as catchment resilience, natural environment (river length improvement) and access, amenity and engagement. Section 4 shows how this investment is included in the CWW3 and CWW15 data tables.

The costs of the alternative catchment offsetting option will be lower than the full NTAL solution and offers the potential of cost savings with matched funding from partner organisations. The alternative option of NBS and upgrade to Bran Sands STW represents an investment in natural capital and the wider environment and is a more cost effective and affordable solution for customers.

[21] Consumer Price Index including owner occupiers' housing costs, Office for National Statistics
[22] The Green Book, HM Treasury, 2022

TABLE 20: EVALUATION OF PREFERRED OPTION

	NBS + upgrade to Bran Sands STW	NBS + long sea outfall	NTAL at 16 WwTW
Capex in AMP8	£45.479m	£257.125m	£319.907m
Opex in AMP8	£2.216m	£2.216m	£0
Totex in AMP8	**£47.695m**	**£259.342m**	**£319.907m**
Total benefit (WINEP)	£208.869m	£208.869m	£4.758m
Net cost benefit	£161.174m	-£50.473m	-£315.149m
Carbon societal value	£4.126m	£6.065m	£34.589m
Type of option	Preferred option (least cost)		

3.3.6 Impact – NN and Seal Sands

The preferred option is a combination of a NBS in the Tees Estuary and an upgrade to Bran Sands STW. This is the least cost (£47.7m) and the best value option.

The NBS will absorb the extra nitrogen within the SPA and improve the habitat quality. This option generates more than 3 times the nitrogen removal than delivering TAL at each of the 16 SWs. This proposal restores the protected area to favourable status whilst removing the obligation for developers to offset their growth. This is our preferred plan in the DWMP[23] and represents a cost saving of £211m compared to the next lowest cost alternative of a NBS and a long sea outfall. Due to the high value of the alternative, we have undergone rigorous benchmarking, this is covered in section 8.1.3.

The Tees catchment option will enable delivery of a range of wider benefits not monetised, summarised below:

- **Water quality**: the ICW and arable land conversion will have significant benefits to water quality. The primary target for water quality improvement under this driver is nitrogen but there will be extra benefits for phosphorus, sediment, pesticides, and other water quality determinants. These improvements should be seen catchment wide due to the variety of the different measures covering the Tees catchment area. A 50% reduction at Bran Sands STW would have significant water quality benefits for the Seal Sands SSSI and the estuary.
- **Biodiversity, water purification, climate and hazard regulation**: measures included in the catchment option including native oyster restoration, saltmarsh restoration and seagrass restoration will all lead to significant benefits in biodiversity, with saltmarsh and seagrass restoration also delivering significant benefits to climate regulation. This is due to habitat improvements leading to increased resilience and higher rates of carbon sequestration, as well as reducing need for more carbon intensive treatment measures. Other measures like seaweed farming and

[23] DWMP, Northumbrian Water, 2023

shellfish farming will also deliver significant benefits through filtration by newly established habitats. In addition to this, the ICW will deliver benefits in hazard regulation through flow regulation and increased water infiltration rates. Biodiversity, water purification, climate and hazard regulation have been quantified / monetised based on an increase in habitat units and ecosystem service under the WEO methodology.

- **Carbon:** NBS within the habitat such as saltmarsh and seagrass restoration will have a positive impact on atmospheric carbon. Seagrass beds hold significant amounts of carbon that would otherwise be in the atmosphere. The WWF[24] state that carbon sequestration benefits in the long term.
- **Food – shellfish**: shellfish and seaweed farming would directly increase and create new shellfish and seaweed stocks for consumption for the food industry and others, alongside native oyster restoration and sea grass restoration measures.

Minor benefits have also been identified for air quality, recreation (and angling), volunteering and education. The England Coast Path will directly run through the restored saltmarsh, meaning that the site will have a high amenity value. The ICW is located next to the saltmarsh and a primary school and so it is predicted that there will be significant opportunities for educational visits. The combined measures are likely to improve biodiversity, attracting more wildlife to the area, providing recreational opportunities for bird watching and enjoying nature. These benefits have not been quantified / monetised, in line with assessment methodology.

Our approach to determining Price Control Deliverables (PCD) is outlined in Section 12.3 of **A3 – costs (NES04)**. In Table 21 below, we assess our protected areas and bathing water related enhancements to test if the benefits are linked to PCs, against Ofwat's materiality of 1%, and to understand if there are outcome measures that can be used. Our assessment has highlighted that the benefits we expect to deliver through our AMP8 WINEP programme will not be measured through PCs. Therefore, we propose a PCD to make sure protection for customers through delivery of our WINEP programme.

TABLE 21: ASSESSMENT OF BENEFITS AGAINST THE PCD CRITERIA

Enhancement scheme	Benefits linked to PC?	Materiality	Possible outcomes?
Wastewater WINEP – protected areas and bathing waters (NES28)	Pass – benefits are environmental or investigations	Pass–2%	Outcome difficult to measure effectively and vary between schemes (particularly investigations). Customers could be protected through an output measure based on delivery of schemes.

Our WINEP programme is set by the EA, which determines the statutory and non-statutory investments we should make. The EA 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 EA has decided that a project is no longer required, or where we have not delivered to the agreed timeframe and/or

[24] How seagrass can tackle climate change, WWF

environmental obligations have not been met (according to the EA). A summary of our PCD for WINEP programme delivery is outlined in Table 22.

TABLE 22: 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 EA has decided are no longer required (under the EA'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 EA under WINEP.
Assurances	The EA 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 EA to discuss progress, risks and issues associated with delivery of the WINEP programme and to identify any alterations. The EA 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.
Impact on performance in relation to performance commitments	There are some benefits to greenhouse gas emissions NES28.

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).
- Not include an automatic penalty for non-delivery (beyond returning the costs to customers). This is because this PCD includes projects where the EA 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 EA), we would not meet our statutory obligations and so this does not require an extra incentive to deliver.
- Change according to the EA's WINEP alterations process. In 2020-2025, our ODI for WINEP delivery does not automatically take into account projects that are removed from WINEP by the EA – but this should be for the EA 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.

We continue to work closely with Defra, the EA and Natural England to progress these opportunities. We held a very useful workshop with the EA and Natural England on 31 August to go through our plans again. While we all understood the benefits that our alternative proposals could potentially bring, we also all understood that the current legislation required NTAL; following the workshop there was a commitment to review our proposals further in the coming weeks.

The proposed amendments arrived after this workshop and the additional guidance provided by Defra is very encouraging. We believe the proposed amendments would allow a route towards the acceptance of our Advanced WINEP proposals submitted at the beginning of this year and we are also hopeful that ultimately we will be able to do so with the support of the EA and Natural England. We are keen to ask the Secretary of State to allow our alternative approaches, as per our Advanced WINEP, and we are continuing to work positively in collaboration with all other parties on our ambitious and innovative plan to make the improvements required in the short, medium, and long term.

Our business plan submission includes our preferred option of catchment and nature-based solutions as included in our Advanced WINEP. This would appear to align with proposed amendment 247YV. Following the recently announced amendments to the LURB, our preferred option is now in line with the amended regulation. We also have a range of fall-back options such as a long sea outfall at Bran Sands, should additional nutrient removal be required at a later date. We give an overview of our options and our approach to these in Appendix F.

We look forward to further guidance from regulators following business plan submission on 2 October and to working closely with Defra, the EA, and Natural England to deliver the desired improvements to the environment.

3.3.7 Uncertainty – NN and Seal Sands

We understand that our preferred option of marine NBS and an ICW carries more uncertainty than grey traditional methods, and will take longer to deliver, therefore we have used base funds in AMP7 to fund trials for denitrification at Bran Sands and have included transition funding (as described below in Table 26) to ensure we are mitigating risks relating to our preferred option.

We have outlined and ranked (RAG) the risks for each option, as shown in Table 23, Table 24, and Table 25 below.

TABLE 23: TEES ESTUARY RISK ASSESSMENT, ENGINEERING SOLUTION

Risk category	RAG rating	Comment
Driver compliance	G	Chosen option is conventional approach to keep to the standard
Delivery	A	Conventional solution but complex delivery due to site location (Bran Sands) and available land for upgrades.
Environmental outcome	A	Conventional solution for total nitrogen removal is not the beneficial as an environmental solution
Cost	R	High-cost uncertainty due to site complexity (Bran Sands) and use of tertiary nitrification and methanol dosing, which is non-standard.
Resources	G	No specialist resources required
Technology	A	Most technology is standard in industry but not used anywhere within NWG and methanol poses a significant health and safety risk
Supply chain	A	Multiple framework suppliers for chosen option but uncertain supply chain for tertiary nitrogen removal assets and methanol dosing rigs.
Public perception	R	High financial and carbon cost for a solution which is unlikely to deliver real improvements to the Seal Sands SSSI.

The risk assessment flags the high risks associated with the cost of a full NTAL solution and public perception of an option that may not deliver full benefit to Seal Sands SSSI.

TABLE 24: TEES ESTUARY RISK ASSESSMENT, CATCHMENT SOLUTION (NBS COMPONENT)

Risk category	RAG rating	Comment
Driver compliance	A	Catchment solutions tend to have greater uncertainty associated with meeting target loads reductions in comparison to conventional treatment solutions. As these options are intended to be used in combination (including treatment at Bran Sands WWTW) this significantly lowers the risk of non-compliance. See section 2 for greater detail on regulatory discussions.
Delivery	A	The delivery of these options is dependent on third parties. NWG has limited experience in delivering some of these options, however appropriate connections have been made with organisations / partners (for example, Rivers Trust) who are experienced in delivering these solutions, and have already secured MMO and crown estate licensing
Environmental outcome	G	The combined catchment option is likely to deliver the N reductions needed in addition to number of wider environmental benefits such as enhanced biodiversity, climate resilience and water purification in addition to volunteering and educational opportunities
Cost	G	Implementing these options in combination would be considerably cheaper than the alternative N TAL treatment solution
Resources	G	Implementing these options could require a higher input of resources at the start of the delivery programme (for example, this AMP cycle) in terms of staff time, training, purchasing of the resources etc, but once up and running the majority of these options should require less resource to maintain and it is likely third parties (for example, the catchment hub) would oversee and manage this. This is particularly the case for the marine-based activities. Greater resource maybe required to maintain the ICW at Greatham and potentially the agri-interventions
Technology	G	These options are relatively low risk for technology
Supply chain	A	Potential for there to be supply chain issues associated with obtaining sufficient quantities for example, of oyster spats, blue mussel seed, kelp for establishment. Risk of disruption from extreme weather/ climate change, disease, parasites.

Risk category	RAG rating	Comment
Public perception	G	Potential to increase NWG's positive environmental impact and influence through this project, which would be a positive opportunity. This is an innovative approach and NWG could be seen as leaders in using this type of solution to address nutrient loading

TABLE 25: TEES ESTUARY RISK ASSESSMENT, CATCHMENT SOLUTION (BRAN SANDS STW COMPONENT)

Risk category	RAG rating	Comment
Driver compliance	G	Chosen option is conventional approach to keep to the standard
Delivery	A	Conventional solution but complex delivery due to site location and available land for upgrades and contamination risks of available land
Environmental outcome	G	Conventional solution for total nitrogen removal
Cost	A	Cost uncertainty due to site complexity and use of tertiary nitrification and methanol dosing, which is non-standard
Resources	G	No specialist resources required
Technology	A	Most technology is standard with NWG but tertiary nitrogen removal and methanol dosing are not widely deployed, and methanol poses a significant health and safety risk
Supply chain	A	Multiple framework suppliers for chosen option but uncertain supply chain for tertiary nitrogen removal assets and methanol dosing rigs
Public perception	A	Reduced financial and carbon cost for a solution (compared to TAL engineered solutions) which helps to deliver improvements to the Seal Sands SSSI

The main risks for the alternative solution are delivery, cost, technology, supply chain and public perception (Bran Sands WWTW) and compliance, delivery and supply chain (catchment options). Compliance and delivery are inherent risks for NBS which are offset by the low risks associated with technology and resources. Working with the NECH to deliver the NBS will reduce the impact on delivery, costs and resources and improve the chances of realising the stated benefits.

To mitigate the performance risk of the green solutions, we have asked for transitional funding as shown in Table 26 below. This table shows both nutrient neutrality expenditure (£6.436m) and the habitats directive investigations (£1.113m) as described in section 3.4. Both of these areas of investment fulfil the criteria for transition funding as the outcome is not possible within the timeframes without commencing the schemes within AMP7.

TABLE 26: CWW12 TRANSITION EXPENDITURE FOR PROTECTED AREAS £M

PR24 BP reference	EA/NRW environmental programme	2023-24	2024-25	Total
CWW12.21	Increase storm system attenuation / treatment on a STW - green solution; (WINEP/NEP) wastewater totex	0.748	0.748	1.496
CWW12.57	Treatment for total nitrogen removal (chemical) (WINEP/NEP) wastewater totex	0.200	0.800	1.000
CWW12.72	Treatment for nutrients (N or P) and / or sanitary determinands, nature based solution (WINEP/NEP) wastewater totex	0.948	1.548	2.496
CWW12.87	Catchment management - habitat restoration; (WINEP/NEP) wastewater totex	0.179	0.179	0.358
CWW12.123	Restoration management (marine conservation zones etc) (WINEP/NEP) wastewater totex	1.043	1.043	2.086
CWW12.111	Investigations, other (WINEP/NEP) - multiple surveys, and/or monitoring locations, and/or complex modelling wastewater	0.371	0.742	1.113
	Total CWW12	**3.489**	**5.060**	**8.549**

3.4. OPTIONS FOR INVESTIGATIONS TEES ESTUARY AND COQUET CATCHMENT

3.4.1 Description of options – Tees Estuary and Coquet Catchment

Our approach to options for investigations has been to consider an investigation or a do-nothing option. Our investigation sites and issues within the Tees Estuary and Coquet Catchment are all statutory needs and therefore the 'do nothing' alternative is not a tenable option for us.

The need is to carry out surveys, monitoring, modelling and data collection to establish the links between and impact of our activities and the coastal environment.

Investigation for HD_INV driver – £1.9m

We will do investigations to determine the impact of our activities on habitats directive sites and to assess potential options to meet future condition targets. Our investigations will be based on Natural England and EA requirements.

The sites and impacts included are:

- Teesmouth – impact of nutrients and chemicals
- Lindisfarne (Holy Island and Budle Bay) – impact of nutrients
- Tweed estuary – impact of nutrients
- Coquet estuary – impact of nutrients

Investigation for Coquet Catchment SSSI_INV driver – £0.3m

We will do an investigation to determine the impacts of water company activities on the River Coquet SSSI and assess potential options to meet condition targets. This will involve the identification and appraisal of options to meet condition targets. This will include: water quality (phosphorus and nitrogen) and flow monitoring; catchment walkovers; engagement with catchment partners to identify opportunities for co-delivery and co-funding of interventions

The sites included in the investigation and their impact on River Coquet SSSI are:

- Thropton & Snitter STW – impact of phosphorus and nitrogen loads
- Rothbury STW – impact of phosphorus and nitrogen loads
- Felton STW – impact of phosphorus and nitrogen loads
- Longhorsley STW – impact of phosphorus and nitrogen loads
- Shilbottle STW – impact of phosphorus and nitrogen loads
- Amble STW – impact of phosphorus and nitrogen loads

Our investigations represent a minimal cost approach to addressing the needs outlined.

Section 4 shows how this investment is included in the CWW3 and CWW15 data tables.

3.5. OPTIONS FOR BATHING WATER, SHELLFISH WATERS AND MCZ

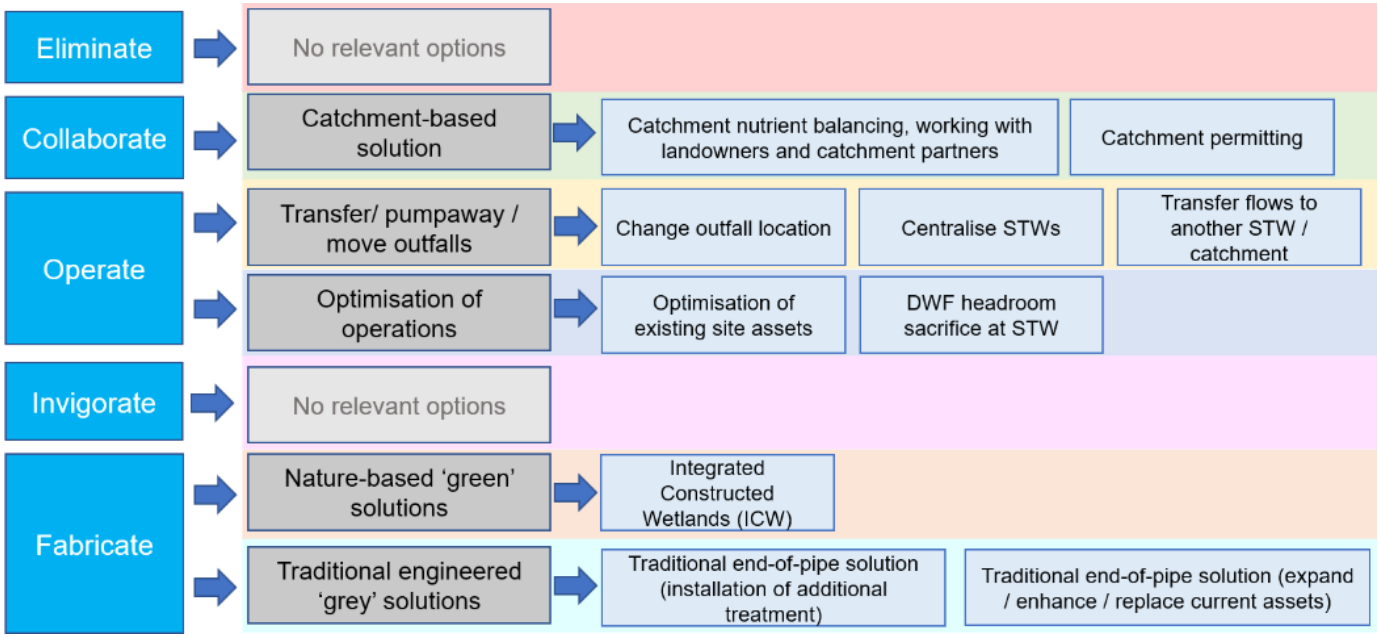
3.5.1 Broad range of unconstrained options – Bathing Waters and MCZ

Non-statutory required improvements for bathing waters BW_IMP - £1.8m

We have adopted a structured approach to identify and categorise the unconstrained options for bathing water improvement needs. This means that we identify a full range of options and make sure of consistency.

The framework described in section 3.1 and its application to bathing waters improvements is shown in Figure 12 below. See Appendix E for a full list of unconstrained options considered for bathing water, shellfish waters and MCZ.

FIGURE 12: BATHING WATER IMPROVEMENTS UNCONSTRAINED OPTIONS



Investigation drivers

For the investigation drivers, a standard set of modules was identified which could be implemented in varying degrees of complexity. Each module has three costs representing the three levels of complexity. This allowed the preferred option to be tailored for each location depending on the nature of the investigation and site characteristics. Expert judgement based on technical knowledge (Our team, EA, Mott MacDonald and Stantec) and experience gained through delivery of PR19 was used to identify the combination of modules, for example, the preferred option for each location. The costs of the preferred options were assured by consultants and incorporated into the business plan.

The key assumptions are that the format of the investigations follows that set out in PR19 measure specification forms. The objectives are to assess if our assets contribute to failing water quality and to identify and apportion contributing sources. Where quality impacts at marine habitats and MCZs are assumed to be nutrient related except at Tees Estuary where chemical investigation is a stated requirement of Natural England.

The investigations will include a combination of desk assessments, monitoring, modelling and other field activities as required.

Statutory required investigations for bathing waters BW_NDINV, MCZ_INV and SW_INV - £2.1m

The bathing waters in this category which will have investigations are:

- Newbiggin South Bathing Water
- South Shields bathing water
- Crimdon Bathing Water

- Beadnell Bathing Water
- Seaton Sluice Bathing Water

The areas of MCZ are:

- Aln Estuary MCZ
- Berwick to St. Mary's MCZ
- Coquet to St. Mary's MCZ

The area of shellfish waters is:

- Holy Island Shellfish Water

Non-statutory investigations for bathing waters BW_INV3 and BW_INV5 drivers – £1m

We will do statutory investigations for bathing waters failing their baseline class of 'Excellent.' Our investigations will be based on these regulatory requirements.

The bathing waters in this category which will have investigations are:

- Newbiggin South Bathing Water
- South Shields bathing water
- Crimdon Bathing Water
- Beadnell Bathing Water
- Seaton Sluice Bathing Water

Our investigations represent a minimal cost approach to addressing the needs outlined.

3.5.2 Primary and secondary screening of options – Bathing Waters, shellfish waters and MCZ

Our constrained options for bathing waters improvements are shown in Table 27.

TABLE 27: BATHING WATER SCREENING TO IDENTIFY THE CONSTRAINED OPTIONS

Option	Meets Statutory Obligation?	Technically Feasible?	Reason for discarding
1 Final effluent improvement	Yes	Yes	**Carried forward**
2 Change outfall location	Yes	Yes	**Carried forward**

The bathing water improvement options results in both the options above being carried forward for benefits scoring and investment appraisal.

Investigations investments did not undergo the same approach to development of wider options, due to the size and low-cost nature of the expenditure. All investigations required to meet the needs are included in our plan.

3.5.3 Best value – Bathing Waters, shellfish waters and MCZ

Benefit scoring

For each of the technology options carried forward to this stage we carried out a benefits assessment using the remaining two criteria in the WINEP options assessment guidance section 6:

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

We have assessed each of the technology options against the Wider Environmental Outcome Metrics as shown in Table 28. Firstly, we have mapped each of the appliable ecosystem service/goods category to the NWL value framework metrics in column 2 and listed the relevant WINEP outcome in column 3.

TABLE 28: BENEFITS FROM WINEP WIDER ENVIRONMENTAL OUTCOMES AND NORTHUMBRIAN WATER'S VALUE FRAMEWORK FOR BW_IMP3

Options carried forward	NWG Value framework measures	WINEP Wider Environmental Outcomes	Certainty that benefits will be realised (Deliverability assessment)
Enhanced FE treatment (UV disinfection)	Embedded Emissions Operational Emissions Bathing Water Compliance	Natural Environment Catchment resilience Net Zero	Certainty that the technology and treatment will be accepted by the EA and the correct doses being given to meet the need.
Change of outfall location	Embedded Emissions Operational Emissions Bathing Water Compliance	Natural Environment	Certainty that the change in outfall with disburse the final effluent outside the BW area. However, the delivery of the scheme would involve disturbance to the local community and likely to have resistance and uncertain timescales, hence a level of uncertainty over the timing of the benefits.

Our value framework is embedded into our portfolio optimisation tool and contains a mixture of benefits which reflect to performance commitments or other social and environmental benefits. First, we score the impact of continuing business as usual and then we score each of the 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. Table 29 describes the type of benefit and the source of monetisation that we have used where applicable.

TABLE 29: RANGE OF BENEFITS IDENTIFIED FOR BATHING WATERS (BW_IMP3)

Value measures or Benefit	Description	Unit	Value	Value source
Embedded Carbon	t/CO_2e /year	tCO_2e	£256.2*	NWL Value Framework
Improved Bathing Water Compliance	Monetised value capturing private and societal impact of bathing water compliance	£	£590,424	NWL Value Framework

*£ value per tonne of CO_2e in 2025/26, annual increase (varying rate) reaching £378.6/t CO_2e in 2024/55

Note that a single dummy value measure for each option type to include the summation of the monetised benefits from the WINEP Wider Environmental Outcomes Assessment could be used for simplicity.

Investment appraisal

A robust cost benefit appraisal has been carried out within our portfolio optimisation tool. This calculates a NPV for each option. The present value is calculated by combining the profile of the present value of benefits and the profile of present value of costs over the appraisal period. The results of this assessment and the chosen option are shown in Table 30. The table shows the NPV for the options to meet the HD_IMP_NN WINEP driver.

Costs and benefits have been adjusted to 2022/23 prices using the CPIH[25] Index financial year average. The impact of financing is included in NPV 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*[26].

We have used our Copperleaf asset management system to optimise our plan and select a best value plan. Our best value and least cost selection process has been assured by our third-party assurer, through the price review process.

TABLE 30: NPV AND SELECTED OPTIONS

Option	NPV	Type of option
Upgrade final effluent at Berwick STW	£7.708m	Preferred option (least cost)
Change outfall location	-£3.925m	

[25] Consumer Price Index including owner occupiers' housing costs, Office for National Statistics
[26] The Green Book, HM Treasury, 2022

The costs of changing the outfall location outweigh the benefits, whereas upgrading the final effluent at Berwick STW is both a lower cost and delivers a gain in value over the assessed period.

TABLE 31: EVALUATION OF PREFERRED OPTION

	Upgrade final effluent at Berwick STW	Change outfall location
Capex in AMP8	£1.695m	£47.521m
Opex in AMP8	£0.152m	£0
Totex in AMP8	£1.847m	£47.521m
Totex (30 yr NPV)	£7.708m	-£3.925m
Carbon societal value	-£0.025m	£0

Section 4 shows how this investment is included in the CWW3 and CWW15 data tables.

3.5.4 Impact – Bathing Waters, shellfish waters and MCZ

The preferred option to meet the bathing water improvement needs at Spittal bathing water is to improve final effluent quality at Berwick STW. This is the least cost (£1.85m) and the best value option.

The value of the improvements at Spittal bathing waters is given as a monetised value of the societal impact of bathing water compliance. This represents the value our customers, stakeholders and the wider community hold for having bathing waters categorised as 'excellent.'

To meet the needs of the bathing water and MCZ drivers, the investigations outlined in section 3.5.2 represent the lowest cost and best value options.

4. COST AND BENEFIT SUMMARY

Our preferred options within the protected areas and bathing water enhancement case are shown within cost (CWW3 – Table 32) and benefit (CWW15 – Table 33) data tables.

4.1. ENHANACEMENT INVESTMENT: CWW3

TABLE 32: EXTRACT FROM TABLE CWW3 - ENHANCED EXPENDITURE WASTEWATER NETWORK+ TOTEX £M (2022/23 PRICES)

PR24 BP reference	EA/NRW environmental programme	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	AMP8
CWW3.21	Increase storm system attenuation / treatment on a STW - green solution; (WINEP/NEP) wastewater	0.748	0.748	0.003	0.003	0.003	0.003	0.003	**1.512**
CWW3.57	Treatment for total nitrogen removal (chemical) (WINEP/NEP) wastewater	0.200	0.800	6.541	6.541	6.541	6.541	6.541	**33.704**
CWW3.72	Treatment for nutrients (N or P) and / or sanitary determinands, nature based solution (WINEP/NEP) wastewater	0.948	1.548	0.448	0.448	0.448	0.448	0.448	**4.737**
CWW3.87	Catchment management - habitat restoration; (WINEP/NEP) wastewater	0.179	0.179	1.376	0.563	0.563	0.563	0.563	**3.985**
CWW3.90	Microbiological treatment - bathing waters, coastal and inland (WINEP/NEP) wastewater	0.000	0.000	0.321	1.281	0.184	0.030	0.030	**1.847**
CWW3.111	Investigations, other (WINEP/NEP) - multiple surveys, and/or monitoring locations, and/or complex modelling wastewater	0.371	0.742	2.482	1.551	0.120	0.000	0.000	**5.266**
CWW3.123	Restoration management (marine conservation zones etc) (WINEP/NEP) wastewater	1.043	1.043	0.979	0.979	0.979	0.979	0.979	**6.982**
	TOTAL	**3.489**	**5.060**	**12.150**	**11.367**	**8.838**	**8.564**	**8.564**	**58.033**

As described in section 3.3.7 we have included expenditure for 2023-2025 of £7.549m in CWW12 as early start work.

4.2. ENHANCEMENT BENEFITS: CWW15

TABLE 33: CWW15 PROTECTED AREAS AND BATHING WATERS BENEFITS

Line Description	PR24 BP reference	Benefit	Units	DPs	2025-26	2026-27	2027-28	2028-29	2029-30	AMP8
Treatment for nutrients (N or P) and / or sanitary determinants, NBS	CWW15.254	Embedded GHG emissions	Tonnes	3	213.52	153.756	153.756	153.756	115.317	790.103
	CWW15.255	Operational GHG emissions	Tonnes	2	0	0	0	0	10.588	10.588
	CWW15.257	Education	Nr/visits/ year	0	360	360	360	360	360	1800
	CWW15.258	Biodiversity	Bio-diversity metric	2	2.73	0	0	1.52	0	4.25
	CWW15.259	Water purification by habitats	ha	1	0.9	0	0	0	0	0.9
Catchment management - habitat restoration	CWW15.309	Embedded GHG emissions	Tonnes	3	123.425	98.74	98.74	98.74	74.055	493.699
	CWW15.310	Operational GHG emissions	Tonnes	2					7.008	7.008
Treatment for total nitrogen removal (chemical)	CWW15.199	Embedded GHG emissions	Tonnes	3	1489.741	1191.793	1191.793	1191.793	893.844	5958.963
	CWW15.200	Operational GHG emissions	Tonnes	2					84.591	84.591

5. THIRD PARTY FUNDING

5.1.1 Third party funding – Wooler

The Tweed Forum have a positive relationship with the landowner, and at the time of the study the landowner was receptive to discussions around letting the land for an ICW under long-term agreements. Like all catchment schemes delivering multiple benefits and aligning with partner interests, co-funding is likely but not yet confirmed.

5.1.2 Third party funding – NN and Seal Sands

In AMP 8, the NECH is expected to be co-funded linked to green finance to drive integrated catchment management in the North East.

We have allowed for:

- 20% contribution from NWG for the skills hub Establish an NBS skills hub

We expect to gain:

- significant support from industry around Tees Estuary who are looking for carbon offsetting opportunities. This includes organisation with a local interest such as BP, Shell, and Abel, and development planned on the **Teesworks** site.
- Universities support for the schemes for use as innovative research facility
- In kind contributions of land use, time, resource, materials, equipment
- The salt marsh restoration is an EA scheme originally, but we have worked with them to modify the design to expand the area of saltmarsh restoration and we are likely to receive 50% match funding from them, but this is not yet agreed.
- The intertidal restoration, native oyster restoration, Seagrass restoration, Seabed restoration, and catchment management activities could also attract match funding from wider projects, but the amounts have yet to be determined

Long sea outfall opportunities:

The long sea outfall should this option be required, has capacity to accept other effluent streams from other significant independent operators (independent industry currently being the largest impacting sector). It has been designed to accommodate at least 30 years of Growth at Bran sands plus additional flow, so could accept 3rd party contributions towards its construction and operation from other industrial users on Teesside. This would be dependent on the EA, and Natural England, calling for a review of consents on Teesside, to upgrade the current quality of effluent, discharged from these 3rd party assets.

The agreements for this funding will be clarified as we progress with our preferred option.

6. DIRECT PROCUREMENT FOR CUSTOMERS

We assessed this programme against the DPC guidance (see our **assessment report**, NES38). This report concludes there are no opportunities for direct procurement for customers relevant to nitrogen because the projects are small value and less than <£200m of whole life totex. This may need to be revisited if we need to switch to N-TAL options in the future.

7. CUSTOMER VIEWS INFORMING SELECTION

In our People Panels research, we discussed our options for tackling nutrient neutrality across Lindisfarne and Teesmouth. Customers do not support an engineering-based approach to removing nitrogen from wastewater, because of the high cost for a relatively low impact. Customers indicated that they would support a less expensive, nature-based approach. Customers did consider this important (**enhancements and other service area summaries**, NES43).

In our pre-acceptability research, most customers preferred to invest now to remove nitrogen using nature-based approaches. There was substantial support for nature-based solutions rather than engineering solutions. Customers noted the benefits of the cheaper option and preferred to take the risk of a later bill increase if nature-based solutions were not successful, rather than an immediate large increase (**enhancements and other service area summaries**, NES43).

Customers also said that they would support us in pushing back on the engineering approach, and instead working with partners to invest in nature-based solutions at Teesmouth.

In our **qualitative affordability and acceptability testing** (NES49), customers supported our "preferred" plan which included these improvements. 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 these items (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.

Our customers also said that they would sometimes support nature-based solutions even when they were more expensive – for example, they were willing to pay more for additional green solutions for storm overflows where this could significantly reduce the amount of embedded carbon and deliver wider environmental benefits (see our **storm overflows enhancement case**, NES27).

We have strong stakeholder support for our balanced approach to delivering WFD and UWWTD requirements. The Rivers Trust (our partners in the North East Catchments Hub) say that they are "*proud to be working in partnership with Northumbrian Water to co-develop catchment and nature-based schemes… this is an industry leading approach following the Ofwat guidance… allowing water companies to meet their regulatory obligations and customers' needs, while restoring and increasing natural assets to realise environmental net gains. It has our full support and we believe it could provide a step-change for water quality improvements and wider environment recovery in the North East.*" (Letter in support of our WINEP programme).

Our enhancement cases for nitrogen and phosphorus removal provide better value at a lower cost than traditional solutions and are strongly supported by customers and stakeholders.

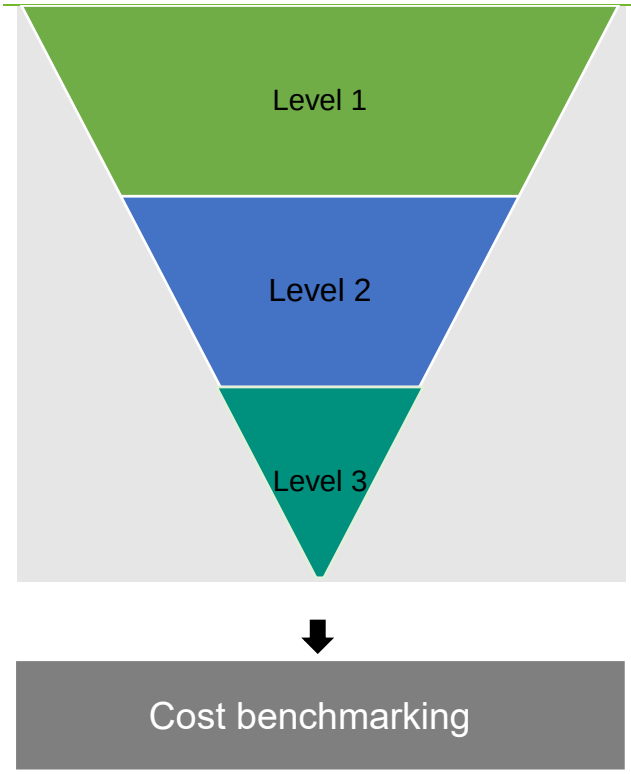
8. COST EFFICIENCY

8.1. APPROACH TO COSTING

8.1.1 Cost methodology

A full description of our costing methodology is contained in A3 Costs Appendix. Based on the costing methodology shown in Figure 13, all options for protected areas and bathing waters have been costed at Level 2 with the exclusion of costs for treatment at Bran Sands STW which are Level 3. This level is appropriate for a Price Review submission as it is sufficient to understand that the interventions can be delivered within the cost at a programme level. Where we have taken a Level 2 cost estimation only, we understand that a level 3 estimate would require a level of detailed design to be conducted which would incur significantly more cost which is not appropriate until delivery is confirmed.

FIGURE 13: PROCESS COST ESTIMATION



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

Costing is carried out using Northumbrian Water's 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 Northumbrian Water's 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 cost of all items taking into consideration factors such as ground conditions.

Cost benchmarking

We have benchmarked 9% of the preferred options against the available cost curves from other companies. Further detail is provided in section 8.1.3.

8.1.2 Options providing cost efficiencies

We have identified three types of delivery efficiencies:

- We are choosing our options where we have more control over the cost certainty or opportunity for shared resources to deliver.
- The opportunity to deliver one intervention to meet two drivers. This is the case for Greatham Wetland where storm overflows will be treated alongside final effluent through the wetland design. The catchment work within the Tees for

Phosphorus removal under the WFD driver will deliver significant benefits for nitrogen. A wetland has been chosen under the WFD driver for Stainton STW (Phosphorus) which should also lower nitrogen concentrations as well as phosphorus. Here we are planning the option that delivers the most value across these two drivers.

- Packaging of work for delivery

8.1.3 Cost benchmarking

We have benchmarked direct costs for each of the key asset types and indirect costs against the cost curves for other companies in our costing partner's database. As there is no standard asset hierarchy used for costing across all companies, there are differences in what each company includes and excludes.

Therefore, our costing partner has benchmarked where it is possible to carry out an equitable comparison and this ranges between two and five other companies depending on the asset type. Table 34 summarises the benchmarking of direct costs. Direct costs are defined as those incurred on plant, labour, material, and equipment i.e., costs that are directly accountable to the project. This represents costs for site based engineered options, for our NBS, we have not been able to compare our costs with the industry specifically due to their extremely bespoke nature. Although there are many costings available through the development of the industry DWMPs, this is not yet at a detailed enough level to enable cost comparison models to be developed. The comparisons shown in the following tables are benchmarks for options for the WINEP Phosphorus and WINEP Chemicals drivers, these options are similar in nature to the end of pipe solution at Bran Sands STW (part of our preferred option), therefore we would expect a similar level of benchmark.

TABLE 34: BENCHMARK OF DIRECT COSTS

Investment Name	Option Type	Northumbrian £k	Benchmark £k	Delta* £k	Delta %**
Bishop Auckland STW (Vinovium NH3)	End-of-pipe	£1,776,715	£1,694,605	£82,109	5%
East Tanfield STW	End-of-pipe	£1,557,535	£1,585,085	-£27,550	-2%
Aycliffe STW	End-of-pipe	£3,607,556	£4,557,297	-£949,741	-21%
Stokesley STW Cyper	End-of-pipe	£920,579	£1,174,379	-£253,799	-22%
Willington STW_Rev1 P02	End-of-pipe	£2,616,237	£2,455,278	£160,959	7%
Stressholme STW WFD UWWTR	End-of-pipe	£10,477,481	£9,370,611	£1,106,870	12%
Total		**£20,956,103**	**£20,837,254**	**£118,848**	**1%**

Note: * Delta = Northumbrian – Benchmark
** Delta % = Delta ÷ Benchmark

In addition to benchmarking of direct asset costs, we conducted an analysis of client and contractor indirect costs, comparing our own project and contract overheads to data provided by six comparator water companies. A larger number of comparator companies is available for indirect costs than for direct costs. Table 35 shows that our indirect costs are calculated as 63.40% of direct costs which is 10.46% below the industry benchmark.

TABLE 35: BENCHMARK OF INDIRECT COSTS

Indirect cost type	Northumbrian cost	Benchmark cost	Delta
Total Contractor Indirect	36.88%	48.01%	-11.14%
Total Client Indirect	26.52%	25.84%	0.68%
Total Project Indirect	63.4%	73.86%	-10.46%

The WFD programme is currently 5% below the industry benchmark when including indirect costs to the original direct costs as showed in Table 36. With many items benchmarked, most of them across three other companies, there is confidence that the items identified have been analysed robustly.

TABLE 36: SUMMARY FOR WFD INCLUDING INDIRECT COSTS

Investment Name	Option	Northumbrian	Benchmark	Delta*	Delta %**
Bishop Auckland STW (Vinovium NH3)	End-of-pipe	£2,903,152	£2,946,241	-£43,089	-1%
East Tanfield STW	End-of-pipe	£2,545,012	£2,755,829	-£210,816	-8%
Aycliffe STW	End-of-pipe	£5,894,746	£7,923,316	-£2,028,570	-26%
Stokesley STW Cyper	End-of-pipe	£1,504,227	£2,041,774	-£537,548	-26%
Willington STW_Rev1 P02	End-of-pipe	£4,274,931	£4,268,746	£6,185	0%
Stressholme STW WFD UWWTR	End-of-pipe	£17,120,204	£16,291,744	£828,460	5%
Total		**£34,242,272**	**£36,227,650**	**-£1,985,379**	**-5%**

Note: * Delta = Northumbrian – Benchmark

** Delta % = Delta ÷ Benchmark

Alternative option benchmarking for nutrient neutrality

In addition to our benchmarking described above, we have undertaken a thorough benchmarking exercise for the long sea outfall (LSO), alternative option for nutrient neutrality. We saw this as essential, due to the uncertainty around the agreement and delivery of our preferred option, and the high cost of the alternative.

Our benchmarking involved a third-party assessment, using four comparators. The summary of this can be seen in Table 37.

TABLE 37: LONG SEA OUTFALL BENCHMARKING £M

Items	Northumbrian Bran Sands LSO	Low	Medium	High
Scope	**109.222**	**100.312**	**114.182**	**122.024**
Pumping station	10.485	5.094	8.156	9.865
Onshore pipeline	28.725	26.335	34.423	39.323
Offshore pipeline	67.193	65.688	67.193	68.196
Other (power upgrade etc)	2.819	3.196	4.409	4.639
Contract overhead	**29.772**	**30.539**	**33.986**	**42.911**
Project overhead	**36.256**	**23.758**	**28.940**	**30.533**
Capex excl. risk	**175.250**	**154.609**	**117.108**	**195.467**
Risk	70.100	21.232	23.705	25.073
Capex Incl. risk	**245.350**	**175.841**	**200.813**	**220.540**
Annual Opex	1.564	1.910	1.910	1.910

We then assured these findings via a review by a specialist (Gardiner & Theobald) who provided cost assurance for the proposed long sea outfall at Bran Sands as part of their PR24 cost assurance PMO activities. They produced a report highlighting their findings and recommendations.

Overall, their assessment was that the estimate at £245m was a robust figure for the proposed scope of works. They also stated that the cost per metre rate of the onshore and offshore pipelines benchmarked favourably against other more recent schemes in the North East and North West.

8.1.4 Factors affecting cost allowances

We are not currently submitting any evidence to support that our costs for areas covered in this enhancement case would be different than other companies.

9. CUSTOMER PROTECTION

9.1. PERFORMANCE COMMITMENTS

This enhanced investment does not deliver a specific improvement in pollution or treatment works compliance as it relates to improvements in specific areas of our operation. However, should we fail to deliver secondary treatment by 2028, the EA may consider this as a pollution incident or as a permit breach and this would increase the number of pollution incidents and discharge compliance we would have to address under base expenditure.

The ability of the wastewater treatment works to treat an increased load will be covered under the discharge permit compliance (numeric) metric which is a common performance commitment. This measure is based on a calendar year and has an underperformance payment should the commitment not be achieved.

Compliance against dry weather flow permit measures is not currently covered by a performance commitment but these will become a statutory requirement which will form part of the EA's EPA during AMP8 leaving us open to prosecution in the event we fail to meet statutory requirements.

Our bathing water enhancement investment does impact our bathing water quality performance commitment taking one bathing water (Spittal) from good to excellent, the investment in AMP8 drives the performance improvement in AMP9 (2030-31). This is reflected in **NES05 Appendix 4 – outcomes** and in our outcome tables (OUT5).

9.2. PRICE CONTROL DELIVERABLES

Our approach to determining Price Control Deliverables (PCD) is outlined in Section 12.3 of A3 – costs (NES04). In Table 38 below, we assess our protected areas and bathing water related enhancements to test if the benefits are linked to PCs, against Ofwat's materiality of 1%, and to understand if there are outcome measures that can be used. Our assessment has highlighted that the benefits we expect to deliver through our AMP8 WINEP programme will not be measured through PCs. Therefore, we propose a PCD to make sure protection for customers through delivery of our WINEP programme.

TABLE 38: ASSESSMENT OF BENEFITS AGAINST THE PCD CRITERIA

Enhancement scheme	Benefits linked to PC?	Materiality	Possible outcomes?
Wastewater WINEP – protected areas and bathing waters (NES28)	Pass – benefits are environmental or investigations	Pass – 2%	Outcome difficult to measure effectively and vary between schemes (particularly investigations). Customers could be protected through an output measure based on delivery of schemes.

Our WINEP programme is set by the EA, which determines the statutory and non-statutory investments we should make. The EA 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 EA 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 EA). A summary of our PCD for WINEP programme delivery is outlined in Table 39.

TABLE 39: 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 EA has decided are no longer required (under the EA'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 EA under WINEP.
Assurances	The EA 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 EA to discuss progress, risks and issues associated with delivery of the WINEP programme and to identify any alterations. The EA 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.
Impact on performance in relation to performance commitments	There are some benefits to greenhouse gas emissions and biodiversity net gain in NES28.

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).
- Not include an automatic penalty for non-delivery (beyond returning the costs to customers). This is because this PCD includes projects where the EA 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 EA), we would not meet our statutory obligations and so this does not require an extra incentive to deliver.
- Change according to the EA's WINEP alterations process. In 2020-2025, our ODI for WINEP delivery does not automatically take into account projects that are removed from WINEP by the EA – but this should be for the EA 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.

10. APPENDIX A – ADVANCED WINEP (A_WINEP) SOLUTION FOR TEESMOUTH

To achieve success, the combined catchment solution for the HD_IMP_NN driver requires more flexibility than the standard WINEP methodology allows. We therefore propose that this scheme is delivered within the Advanced WINEP programme for the following reasons:

- This alternative solution requires an outcomes-based approach which needs time to be developed and prove its success. The aim would be to set-up and deliver all the catchment schemes by 2030, complete with modelled and measured load reductions. However, the macro-algae coverage at Seal Sands SSSI is likely to take longer than 5 years to respond to the improvements, as it would do with any end of pipe reductions. As a result, we request that the timescales for proving success should be multi-AMP and lengthened to 2037 to match the Environment Act targets timescale (linked to the government's 25 Year Environment Plan and contributing to the Environment Plan goal for 'Clean and plentiful water' at regional level). The improvement measures which are linked to the WFD P Improvements also require up to 2035 to demonstrate success.

- Catchment schemes are innovations, and an adaptive planning approach should be used to make sure that the best interventions and mitigations are being used to achieve the right targets. If NW and partners conclude in PR29 that the catchment options proposed in AMP8 are not able to deliver the improvements and roadmap to success expected in PR24 (see Section 6.2), a case would be made for further funding under the HD_IMP driver, which could include end-of-pipe options for WWTWs. These could involve the level of costs specified for the grey solutions identified as feasible options in Section 3.4 of this document and costed. This is not currently allowable for the same WWTW or waterbody/catchment under the WINEP methodology.

- We have an ambition to achieve Good status overall and cross-sector through investment in waterbodies impacted by continuous discharges. For the Tees Catchment that would mean moving multiple waterbodies to Good status for phosphate, and potential overall ecological improvement as a result, with numerous wider environmental enhancements delivered as secondary benefits. This also applies to nitrogen and we are keen to work with developers, regulators, eNGOs, and industry on Teesside to enable the restoration of the protected area. This is a better value, more affordable alternative to addressing fair share only and implementing proposed Nutrient neutrality (HD_IMP_NN) and Environment Act (EnvAct_IMP1) permits (which require high investment, are carbon-heavy, and have few environmental benefits). Both drivers are currently statutory requirements to be achieved through the WINEP by 2030 and 2037 respectively, but implementation would not be enough to drive any improvements in waterbody or protected area status or allow full fair share to be achieved.

This proposal has been discussed with the EA and Ofwat and was well received. A number of questions from regulators on scheme development and justification, plans, timescales, deliverability, and alternatives are addressed in ODR.

We propose that the combined catchment solution and Bran Sands upgrade is implemented as an Advanced WINEP scheme in the following way:

- We request that the combined catchment solution be included in the Advanced WINEP instead of the proposed N TAL solution, as we believe the option is better for the environment, and better for customers. Our customers have already supported this option and wanted us to challenge the implementation of N TAL options, via customer research carried out to date.

- Although we have provided data to show the load reduction potential, we request that the final load reduction is based on an up-to-date marine hydrodynamic model with an updated eutrophication model, so that the solutions, are appropriate and located in the optimum location, with appropriate load reduction targets.

- We request that the timescales for proving success should be multi-AMP and lengthened to 2037 to show the ecological response only (response to biomass reduction in opportunistic macroalgae), to match the Environment Act targets timescale (linked to the government's 25 Year Environment Plan and contributing to the Environment Plan goal for 'Clean and plentiful water' at regional level).

If this approach is acceptable, we would like to discuss how growth can be facilitated via measured improvement in N loading, some of these schemes will be used as part of a transitional funding and early start package, and some are linked to improvements underway in AMP7 for P removal which will also generate a nitrogen benefit.

Should this A-WINEP approach not be allowable, the alternative would be to invest in the preferred traditional solution at 16 WwTW in the Tees Catchment at a much higher costs to customers and would fail to achieve the same environmental improvements.

11. APPENDIX B – ANALYSIS OF NATURE BASED SOLUTIONS

The following sets out the analysis is carried out for each potential component of the nature based, or catchment solution.

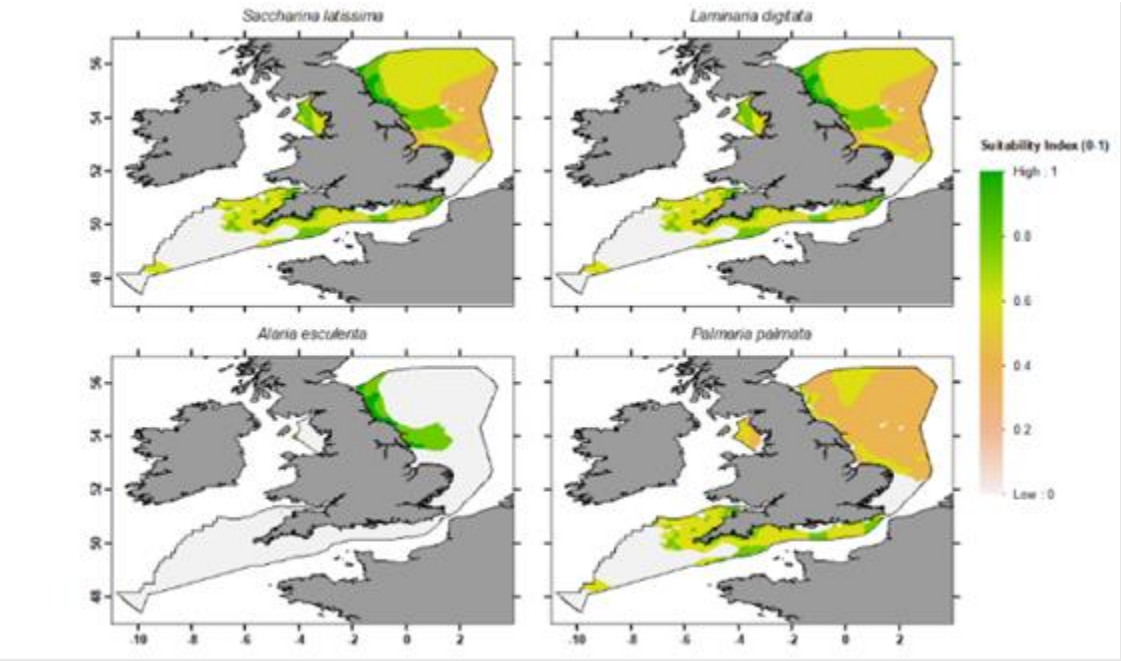
Nature Based Solution Skills Hub Facility

The establishment of a nature-based solutions hub at the estuary would be key to securing the skills base and resources required to deliver the catchment solutions outlined in the following sections, in addition to managing the supply chain. Having an established hub would also help with rolling out further catchment measures, for example the agricultural interventions in the upper part of the catchment which are being proposed as part of the WFD catchment schemes. This would also help to bring in match funding from private finances who are looking to become carbon neutral. This includes businesses such as BP, Shell, and Abel. Universities may also want to support the scheme and use it as an innovative research facility. The construction of the hub would be part-funded by NWG (20% contribution).

Seaweed farming

An opportunity for seaweed farming was identified for two locations offshore of the Teesmouth and Cleveland coast covering an area of approximately 2500ha (see Figure 14). By cultivating seaweed at this location, this would help to address the nitrogen loading from the North Sea impacting Seal Sands protected site.

FIGURE 14: SUITABLE AREAS (OPTIMAL AND SUBOPTIMAL) FOR SEAWEED SPECIES GROWTH OFF THE ENGLISH COAST

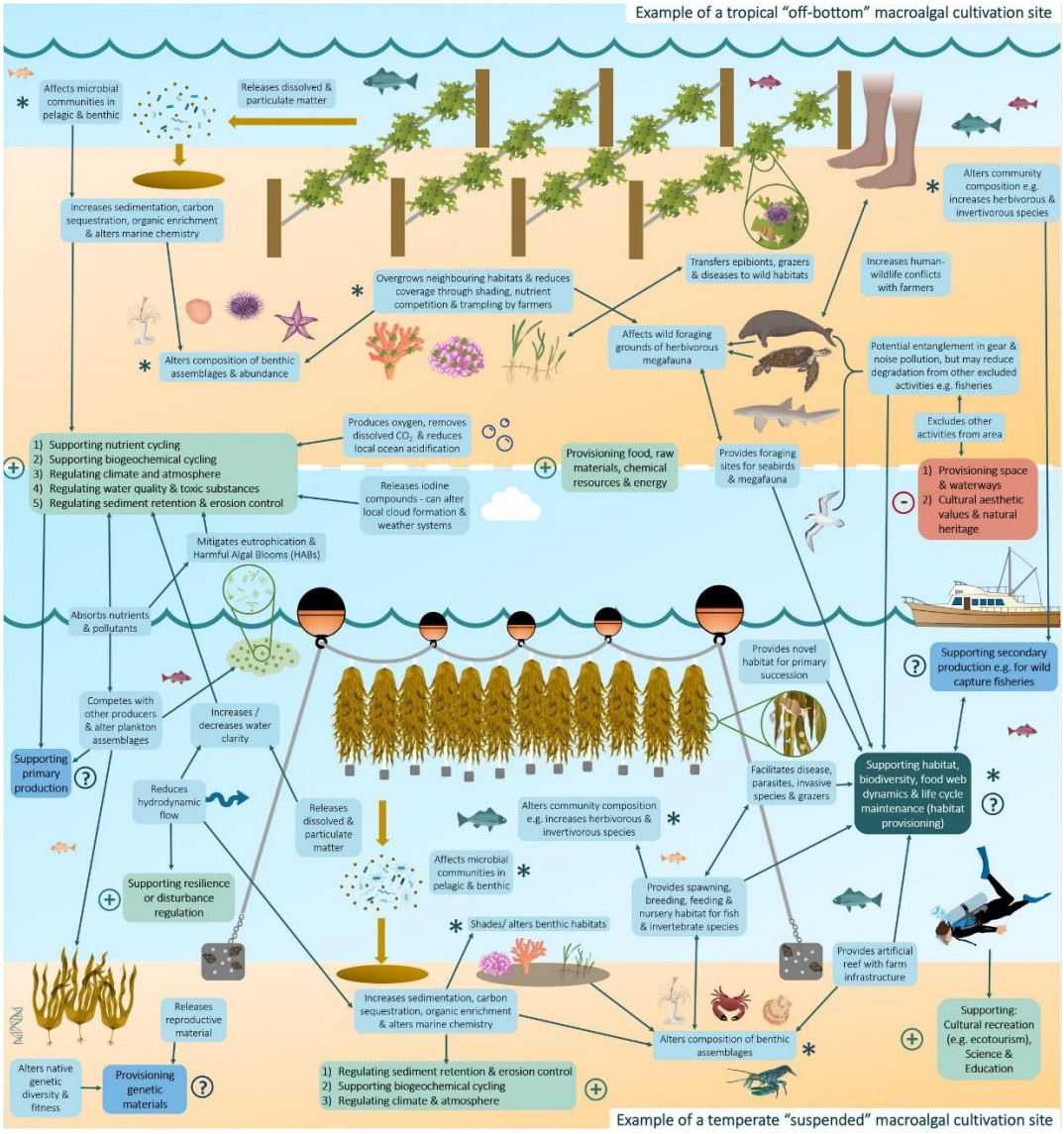


It is possible to use seaweed as a natural bio-extractant for pollutants. Seaweed has the potential to remove inorganic nutrients in water (including N, P and carbon) and when the seaweed is harvested, this removes the nutrients from the

system. Seaweed also oxygenates the water column, reducing the likelihood of hypoxic conditions. In addition, it has the potential to partially displace algae blooms. The North East coastline has very favourable conditions for seaweed aquaculture, as shown from the Marine Management Organisation (MMO) study outputs in Figure 15. This part of the coastline has the largest area of high suitability conditions for three out of four seaweed species investigated.

Seaweed farming has also been shown to aid in habitat restoration of the seabed when carried out in a sustainable way, as demonstrated by research carried out by Exeter University.

FIGURE 15: EXAMPLES OF MACROALGAL CULTIVATION SITES



Seaweed farming can reduce nitrogen and phosphorus loads in a marine environment, when sustainably farmed. The seaweed must be harvested to remove the nitrogen from the system, this can then be used in the retail industry (for example,

food, beauty products) or in agriculture as a form of fertiliser (liquid or pellets). Evidence from literature indicates that a reduction of 90kg/ha is possible; consequently, this value will be used in the optioneering.

Shellfish farming

Shellfish naturally remove plankton and detritus from the water through suspension-feeding activities and incorporate nutrients from ingested food into tissues, shell proteins, and other organic particles during growth. When shellfish are harvested, nitrogen contained within the tissue and shell is removed from the local environment. It is proposed that shellfish farming is carried out within the same area as the seaweed cultivation, outlined in section 3.3.1.1. A figure of 90kg/ha has been used in optioneering.

Native oyster restoration

Potential sites for native oyster bed restoration have been identified by the River Trust off the coast to the north and south of Tees Bay and are shown in Figure 16, covering an area of 1,435ha. The Native Oyster Bed Potential areas are derived from seabed sediment and current energy criteria and the map layer provides a 'high level' indication of where native oyster reefs could potentially be restored based on key environmental variables.

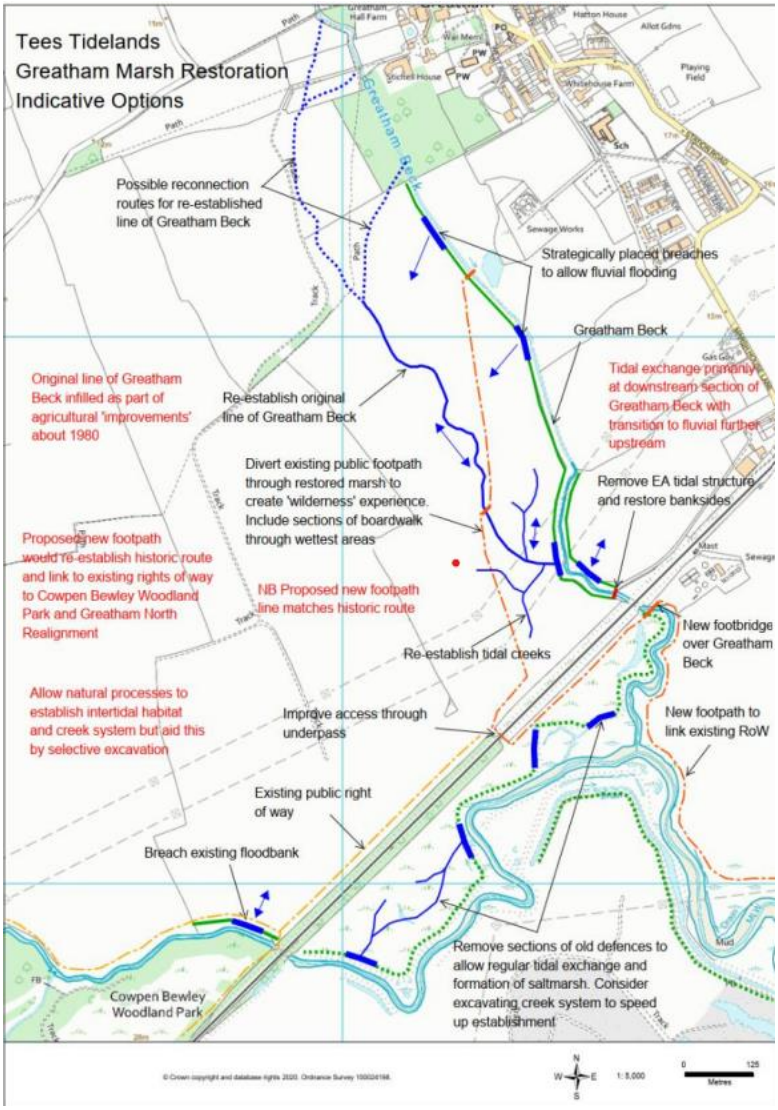
Restoring native oyster populations could enable nitrogen reductions via water filtration. Native oysters are known as 'ecosystem engineers' due to their ability to create conditions for other species to thrive, in addition to filtering and improving water quality. An adult oyster can filter more than 140 litres of water per day and are able to sequester carbon in the seabed. They also have the capability to remove nitrogen from the water by recycling it in their shell. Projects are already underway in the UK which are using native oyster beds as a method to reduce nutrients. This includes the Interreg RaNTrans (Rapid Removal of Nutrients in Transitional Waters) project2F3 which is piloting innovative techniques for rapidly reducing algal mat coverage and contributing to reductions in nutrient levels in the Solent and Channel Manche in France. It is estimated that, collectively the oyster beds in the Solent have the potential to remove 200,000kg of Nitrogen each year. A figure of 90kg/ha will be used in optioneering.

Saltmarsh restoration

Saltmarsh restoration is proposed at Greatham Marsh. The area is currently under intensive arable agriculture, managed by tenant farmers but owned by a charitable organisation. Landowner agreement is in place for the saltmarsh restoration, and it is likely that further agricultural interventions to improve water quality could be agreed upon. The restoration will allow the natural channel of the watercourse to be realigned connecting the groundwater baseflow with the surface water flow (see Figure 16). Up to 83% reduction in nitrogen of the flow going through the area can be reduced. The highlighted area in Figure 16 will also have the effluent from the integrated constructed wetland at Greatham WWTW flowing into it, further reducing the nitrogen loading. The 83% reduction figure has been applied to Greatham Creek, but it is proposed that monitoring will run alongside to allow for a baseline and subsequent reduction to be calculated. This project is part of the EA's Flood and Coastal Erosion Risk Management, Medium Term Plan (FCERM MTP) projects to remove their tidal structure at the bottom of Greatham Creek. The outline business case is included in Appendix D. NWG would like to pick

up the main part of the restoration project leaving the asset removal to the EA. The EA team are keen to allow match funding for this project to minimise the cost to taxpayers while maximising the environmental improvements possible.

FIGURE 16: TEES TIDELANDS, GREATHAM MARSH RESTORATION INDICATIVE OPTIONS



Sea grass restoration

Seagrass meadows play an integral role as filter mechanisms for incoming nutrients, especially nitrogen. Potential areas for seagrass meadow restoration have been identified by the Rivers Trust within the Tees. These locations were primarily derived from the EMODnet 2016 wave and current energy models. This data was combined with seabed digital elevation models (DEMs, sourced from Defra Marine DEM and EMODnet Composite 2018 DTM) to determine potential seagrass habitat areas. Areas of low salinity were also screened out based on EA salinity monitoring and modelling data3F4. They have the potential to improve water quality via processes including N burial in sediments and denitrification. The retention

of N in seagrass reduces the availability of N to ephemeral algae species; an important factor to consider in improving the status of the Teesmouth and Cleveland Coast protected site. A load reduction of 35kg/ha has been used for optioneering.

Integrated constructed wetland at Greatham

Greatham is a village with a WWTW serving 931PE and has a growth potential for the population to reach 1134PE by 2035. The existing WWTW comprises of a primary settlement tank, a trickling filter, and a humus tank (settling). The discharge permit requires the site to treat a dry weather flow of up to 249m3/d, and/or a maximum flow of 7 l/s, to concentrations of 30, 60, 10 mg/l for BOD, TSS, NH4-N, respectively.

An upgrade to this WWTW is proposed to include nitrogen removal, aiming to achieve 50% removal of the current N load discharged. The current final effluent nitrogen concentrations are shown in Table 40.

TABLE 40: EFFLUENT NITROGEN LEVELS FROM CURRENT TREATMENT

Average NH_4-N (mg/L)	Average NO_3-N (mg/L)	Average NO_2-N (mg/L)	Average DAIN (mg/L)
1.8	28.8	0.6	31.2

A tertiary Nature based Solution (NBS) is the preferred solution to achieve the 50% TN reduction rather than upgrading the WWTW. The Integrated Constructed Wetland (ICW) is to be situated after the existing tertiary and polishing treatment plant and the resulting design has a land requirement of 15000m2 including embankments (or ≈1.5 hectares).

For adequate denitrification (total N reduction) a carbon source is required. The latter is often available in the wastewater but as the ICW is to be used as post-treatment, insufficient residual carbon is expected. Carbon can be provided in the form of woodchips (although there are alternatives to this). Woodchip is widely available and cost competitive to other options. Due to the level of denitrification required, there will be an ongoing need to replenish the woodchip on an annual basis; however, such substrates may last for up to 15-30 years. Further ongoing general maintenance will be required to prevent wetland from clogging, to keep the ICW operating as intended.

Storm overflow reductions

Greatham Village will be used as a trial to incentivise customers to carry out their own surface water separation. 1 FTE staff member will be split between Greatham and the other trial village (covered under the A-WINEP storm overflow scheme, Hawthorn), to work with the residents to implement their own surface water separation. A grant scheme of £100k will be available to residents to apply for water butts, drainage pipes and wide scale community improvements (installation of ponds, SuDS and larger scale drainage) to manage surface water in the village more effectively, reducing pressure on the combined sewer system. The reduction in nitrogen has not been calculated but will improve nitrogen loads if the trial reduces spill volumes from storm overflows and increases the surface water dilution available within the watercourse. A separate Advanced WINEP option has been developed for this. If this trial is not successful a storage or treatment option will be implemented within AMP 9.

Agricultural catchment management

The catchment area of freshwater which directly drains onto Seal Sands, will be targeted for catchment management activities (see proposed catchment offsetting area in Figure 17). The Skerne, Clow Beck, and Leven operational catchments upstream of the barrage are also the target of phosphorus reduction trials in AMP7 & 8, which will also deliver nitrogen reduction.

The potential nitrogen load reductions achieved by the catchment options have been calculated using Farmscoper and SAGIS SIMCAT and are shown in Table 41 for the upstream catchments. Mitigation measures would include:

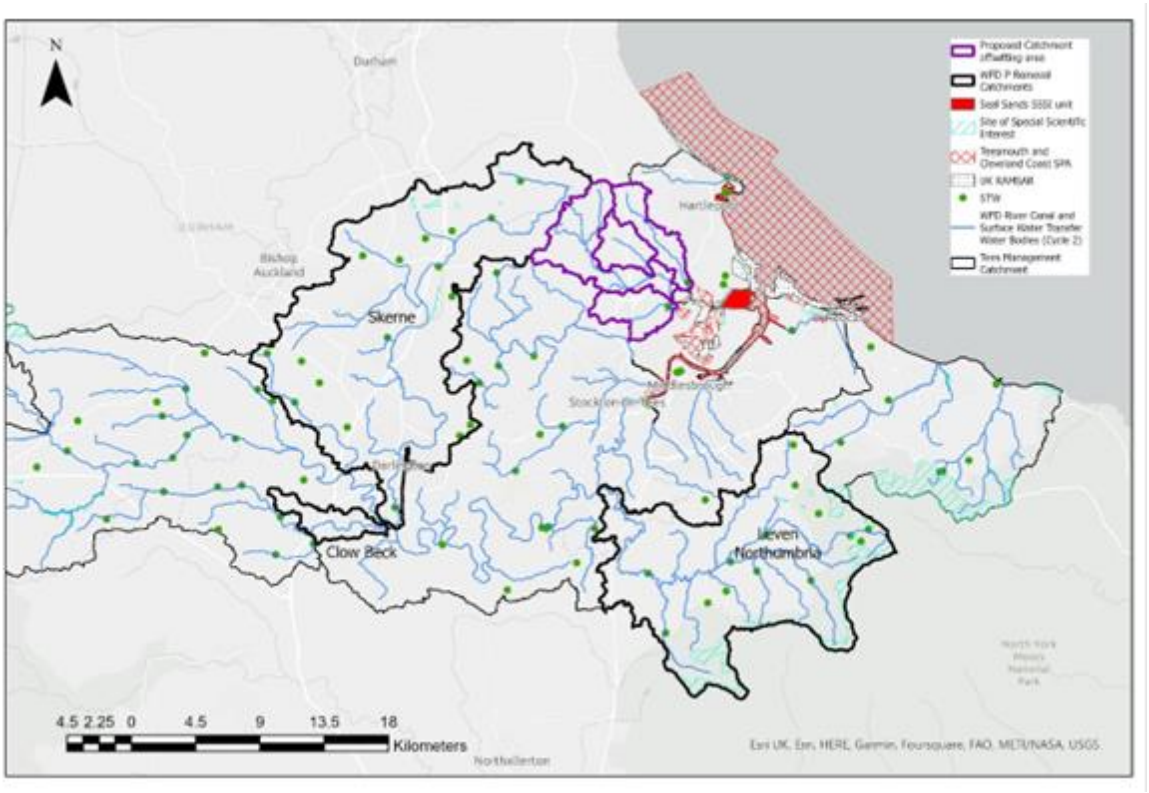
- Changing from ploughed cultivation to seed drills, or minimum till
- Ceasing use of inorganic fertiliser application
- Only applying fertiliser if critical based on routine soil testing
- Use of nitrogen absorbing crops like bird seed mixes without use of supplementary fertiliser to lower N concentration within soils
- The use of 3D buffer strips
- Cover and co cropping
- Drainage ditch/river restoration
- Use of ponds and wetlands
- Regenerative agriculture methods targeted towards soil health
- Agro-forestry integration
- Changing crop type towards wildflower meadows in the lower reaches.

A potential N load reduction of 2950kg/D would be achieved by carrying out agricultural interventions proposed as part of the WFD phosphorus removal schemes in the Skerne, Clow Beck and Leven catchments upstream of the estuary, as shown in Table 41. A wetland targeting P removal at Stainton WWTW will also provide some load reduction to the estuary. The wetland will have a 40% load reduction in N, but is quite far upstream, therefore there is likely to be a smaller impact at the estuary and protected site.

TABLE 41: POTENTIAL N OFFSETTING FROM AGRICULTURAL INTERVENTIONS IN THE UPSTREAM CATCHMENT

Operational catchment	Nitrate load	Ammonia load	Total N load (kg/D)
Skerne	731.88	415.59	1147.47
Clow Beck	314.43	188.56	502.99
Leven	813.00	486.19	1299.19
Potential N offsetting			**2949.65**

FIGURE 17: PROPOSED AGRICULTURAL OFFSETTING IN THE TEES



Intertidal restoration and bank side naturalisation

Intertidal edge restoration in and around Seal Sands would provide significant water quality and biodiversity benefits at the protected site. To restore the saltmarsh adjacent to Seal Sands, this would require removing part of the sea wall. The use of seaweed ropes within the estuary would also increase uptake of nitrogen. A number of locations have been identified for potential rope placement including Seal Sands, Dabholme Gut (downstream of Bran Sands WWTW) and within the Tees upstream of the port. Load reductions have been calculated based on evidence from other seaweed rope operations in the UK4F5. A load reduction of 270kg/d has been used in optioneering.

12. APPENDIX C – UNCONTSTRAINED LIST OF OPTIONS - WOOLER

Investment Name	Alternative Name	Recommended	Least cost	Best value	Approved
PR24 - HD_IMP - Wooler Water Catchment Improvement	Do Nothing	No	No	No	No
PR24 - HD_IMP - Wooler Water Catchment Improvement	Engineered end of pipe solution at Wooler STW	No	No	No	No
PR24 - HD_IMP - Wooler Water Catchment Improvement	Integrated Constructed Wetland Solution	Yes	Yes	Yes	Yes

13. APPENDIX D – UNCONTSTRAINED LIST OF OPTIONS – NUTRIENT NUETRALITY AND SEAL SANDS

Investment Name	Alternative Name	Recommended	Least cost	Best value	Approved
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Agricultural Measures	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Bran Sands 50% upgrade	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Bran Sands long sea outfall	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Catchment offsetting + 50% removal at Bran Sands	Yes	Yes	Yes	Yes
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Catchment offsetting + Bran Sands long sea outfall	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Do Nothing	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	End-of-pipe solution at 16 STWs	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Estuary HQ	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Greatham integrated constructed wetland	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Greatham saltmarsh restoration	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Intertidal edge restoration	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Native Oyster Restoration	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Seabed restoration	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Seagrass restoration and mariculture facility	No	No	No	No
PR24 - HD_IMP_NN- Teesmouth nutrient neutrality	Seaweed and Shellfish farming	No	No	No	No

14. APPENDIX E – UNCONTSTRAINED LIST OF OPTIONS – SPITTAL BATHING WATER

Investment Name	Alternative Name	Recommended	Least cost	Best value	Approved
PR24 - Spittal Bathing Water	Change outfall location	No	No	No	No
PR24 - Spittal Bathing Water	Do nothing	No	No	No	No
PR24 - Spittal Bathing Water	Enhanced FE treatment	Yes	Yes	Yes	Yes

15. APPENDIX F – OUR APPROACH TO NUTRIENT NEUTRALITY ALTERNATIVE OPTIONS

Our proposals for the nutrient neutrality driver are predicated on solutions which will drive an improvement to favourable status for the protected area. They also offset all growth up to 2060. We have focused all our options in the coastal and estuary area because the sources of nitrogen impacting the protected area come from these locations. Improving sites in the freshwater catchments will have limited impact on the protected area and are why we feel that TAL at these STW's is the wrong outcome for the environment and customers.

Our preferred approach – Option A

The preferred package of improvements include:

2500 hectares of seaweed & shellfish farm in the coastal area

- Saltmarsh restoration
- Wetland at Greatham STW
- Intertidal restoration throughout the estuary
- Working within freshwater catchments to improve nitrogen concentrations (directly flowing onto protected area)
- Seagrass restoration
- Native oyster restoration
- seabed restoration
- 50% reduction at Bran sands STW (28% reduction could be achieved within 5 months equivalent to 250,000 houses)

Most of these options will be started from 2023 increasing the timescales to demonstrate whether they are working or not. The load reductions generated by these options are based on the best available data we have; however, a new marine model needs to be undertaken to get an exact load target for the protected area, with up-to-date source apportionment. We currently predict that the load reduction is at least 4 times greater than the TAL option. Once this modelling work is complete, we will be able to reduce the uncertainty of the load reductions required. This is due at the end of 2025.

Where further improvement is needed – Option B

If this modelling work shows that the amount coming from the Offshore loading is less than the current predicted 25-50% the best option to still achieve the favourable status objective would be for Bran sands outfall to be relocated to a long sea outfall, removing it's load from the estuary. Work would commence on this option at the start of 2026 with any feasibility and design work happening from 2023 (as part of the transition funding bid). This work would be comfortably complete by the end of 2028.

And additional activity if needed – Option C

In the unlikely event that both the relocation of Bran sands and all the nature-based solutions are unsuccessful there are other mitigation measures (currently costed but not included in the submission) that could alternatively be put in place to increase the nitrogen reduction to the protected area. These could be commissioned from the start of 2027 once a review of the success of nature-based solutions is complete. These mitigation measures are listed in their ability to reduce nitrogen loading to the protected area with the top options having the largest nitrogen reduction potential to the protected area:

- Relocation of Greatham and Graythorpe STW's to long sea outfall via Seaton Carew STW
- Expansion of catchment measures in Billingham and Lustrum beck waterbodies
- Relocation of Sedgefield STW to long sea outfall via Seaton Carew STW
- Installation of Wetland treatment at Sedgefield, Carlton & Redmarshall
- Installation of wetland at Stressholme STW

If any of these options were also to fail to achieve the desired load reduction (which is extremely unlikely) we would then revert to TAL at each of or those designated of the 16 designated STW's. We are proposing that we put the nutrient neutrality options in our business plan as a notified item so that we can reopen the price review process to access the additional funds should this be required.