PR24

NORTHUMBRIAN WATER *living water* | ESSEX&SUFFOLK WATER *living water*

A3-24 WASTEWATER WINEP – PHOSPHORUS

NES13

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1. INTRODUCTION

We are committed to improving the health of our rivers, lakes, and water bodies. This includes maintaining a balance of nutrients, such as phosphorus, so that the environment can thrive. One of the Government's key priorities in its strategic policy statement is to reduce nutrient pollution from sewage treatment works (STWs). Under the Environment Act's long-term environment targets (WISER guidance) we are required to reduce phosphorus loading from treated wastewater in our region to meet national targets.

The investment proposed in this business case will help our region's environment to thrive and make sure we play our part in delivering the Government's objectives. This business case sets out the enhancement investment required for us to meet our environmental obligations under the *Water Environment (Water Framework Directive) (England and Wales) Regulations 2017* (Water Framework Directive) and *Urban Waste Water Treatment Directive*, as captured against the following WINEP drivers:

- Investigations - WFD investigations (WFD_INV)
- No deterioration from current status - WFD no deterioration (WFD_ND)
- Improvements – including:
    - WFD improvements (WFD_IMP)
    - Environment Act improvements (EnvAct_IMP)
    - Urban Waste Water Treatment Directive improvements (U_IMP1 and U_IMP2)

The specific requirements for these drivers were initially agreed through discussions held in March and April 2022 between Northumbrian Water (NW), the Environment Agency (EA), and Natural England which were used for our January WINEP submission, then refined in May and June 2023 ahead of our final WINEP submission in July 2023. Where possible we have been efficient by combining needs, drivers and approaches to create the most streamlined plan (see Section 3.1).

The investments we are planning in AMP8, set out in this business case, will achieve the following benefits:

- Phosphorus removal load reduction against a 2020 baseline by the end of AMP8 of 62% towards meeting the Environment Act targets for the region - measured using the Environment Agency's methodology.[1]
- Further significant river phosphorus load reductions to meet good ecological status in partnership through catchment and nature-based solutions which are separate to these targets, and which will also drive integrated catchment management and help achieve wider environmental outcomes including biodiversity net gain, nature recovery, nutrient neutrality and climate mitigation in the region.

[1] The River Water Quality ODI phosphorus reductions calculated for NW by the end of AMP8 are much lower as these use measured regulatory sample data where the EA uses models and permits – the company had already made reductions by 2020 through overperformance against permits

- Improve 128km of rivers[2] within AMP8 through our phosphorus improvement plan, with an additional 426km to be improved following implementation of catchment nutrient balancing schemes by the end of the AMP – our biggest scale of water quality improvements for phosphorus delivered for the region as a result of a 5-year investment programme.

In addition to the programme of improvements summarised above, we have agreed a significant investigations programme under WFD, covering investigations at 27 STWs and the waterbodies they impact, to collect evidence and undertake modelling to identify where further improvements may be required in AMP9 and determine appropriate cost-effective schemes.

We recognise that catchment and nature-based solutions provide opportunities for us to use non-traditional, sustainable, multi-benefit approaches to deliver our PR24 obligations for nutrients including phosphorus. Consideration of these alternatives has featured heavily in our optioneering process. The comprehensive programme of improvements we have developed draws on our experience of using nature and catchment partnerships in AMP7 to deliver environmental improvements and was developed collaboratively through our work with the North East Catchments Hub. It includes:

- end-of-pipe phosphorus improvements at 19 STWs of which nine stand-alone where catchment and nature-based approaches were not found to be suitable options, and ten are key investments to support hybrid catchment solutions.
- a catchment permitting approach where this is appropriate for grouped STWs – this will apply to four of the nine end-of-pipe STW improvements for phosphorus and will also be used for two of the same STWs for ammonia, and will also play a key role in our catchment solutions.
- catchment solutions using a catchment nutrient balancing approach supported by in-river catchment permitting to address ‘fair share’ (each sector playing their part in addressing pollution under the Polluter Pays Principle), as an alternative to, or complimentary to, end-of-pipe investment across seven catchment areas (South Low, Embleton, Belford, Middle & Lower Wear, Clow Beck, Skerne, and Leven), covering 35 waterbodies.

To support the development of our PR24 Plan, including catchment and nature-based solutions (C&NBS), we created a strategic partnership with The Rivers Trust in April 2022. The Rivers Trust is the national organisation supporting coordination of Defra’s Catchment Based Approach (CaBA) and providing support for local rivers trust organisations, which host the Catchment Partnerships in the North East. The strategic partnership was used to establish the North East Catchments Hub, a new (currently informal) organisation which has brought catchment resources, expertise and partner engagement capacity into the region. The North East Catchments Hub has already helped to enhance and integrate the CaBA approach across the North East, through engaging all five local Catchment Partnerships in water company planning. The activities of the North East Catchments Hub have allowed us to fully explore C&NBS opportunities and support

[2] This measure of river improvements is the Environment Agency’s measure, and is separate to the river water quality PC which will be used for phosphorus load removals in AMP8

options development for the PR24 WINEP, by bringing the hub together with our internal teams and technical framework partners to form a PR24 Catchment Planning Team to develop WINEP schemes.

Through this approach, we have also worked closely with the Environment Agency, bringing Area team members into planning meetings collaborating on identifying needs, options and solutions.

Our approach to developing our WFD nutrients plan for PR24 reflects the guidance in the Government's Strategic Policy Statement for Ofwat which states that 'water companies should significantly increase their use of nature and catchment-based solutions to achieve multiple benefits for the environment and the public' as well as the Environment Agency's PR24 WISER document which states that water companies should 'use new and innovative approaches wherever possible to achieve wider environmental outcomes and provide best value to customers.'

Meeting our Water Framework Directive and related nutrient obligations through the WINEP drivers included in this enhancement case will require investment of c.£129 million capex over AMP8 for the IMP driver and c.£7.5 million in capex for the INV driver, in 2022/23 prices. This cost includes £40 million avoided investment in capex through including catchment solutions in our plan (see Section 3.4). The costs are summarised in Table 1 below. A translation of these costs by drivers to the Ofwat data table lines is included in Table 2.

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

Driver	Capex (£m)[3]	Opex (£m)	Totex (£m)
Investigations - WFD_INV	**7.454**	**-**	**7.454**
Improvements - WFD_IMP, WFD_ND, EnvAct_IMP1 including UWWTD[4] (Total)	**129.672**	**13.089**	**142.761**
Improvements – Phosphorus	121.457	12.898	134.355
Improvements – Sanitary determinands (Ammonia & BOD)	8.215	0.191	8.406
TOTAL	**137.4**	**13.8**	**150.215**

[3] Numbers may not add due to rounding.

[4] Urban Waste Water Treatment Directive (UWWTD)

TABLE 2: CWW3 AMP8 EXPENDITURE

Line Reference	Line description	Detail	Capex[1] (£m)	Opex (£m)	Totex (£m)	Transition Capex (£m)	Transition Opex (£m)	Transition Totex (£m)
CWW3.111	Investigations, other (WINEP/NEP) - multiple surveys, and/or monitoring locations, and/or complex modelling	Investigations	7.454	0.000	7.454	0.000	0.000	0.000
CWW3.81	Catchment management – nutrient balancing	7 Catchment solutions including 4 hybrid solutions including 10 end of pipe schemes	73.792	9.809	83.602	8.726	1.821	10.547
CWW3.72	Treatment for nutrients (N or P) and / or sanitary determinands, nature based solution	1 scheme for Percy Beck	4.989	0.175	5.164	1.200	0.000	1.200
CWW3.84	Catchment management - catchment permitting	6 end of pipe schemes for Team (P and Ammonia) and Wansbeck (P)	19.375	1.256	20.631	0.900	0.000	0.900
CWW3.66	Treatment for phosphorus removal (chemical)	4 end of pipe schemes where catchment and nature-based solutions are not appropriate	23.230	1.658	24.888	1.300	0.000	1.300
CWW3.75	Treatment for tightening of sanitary parameters	3 ammonia schemes (1 BOD no cost scheme)	8.215	0.191	8.406	0.500	0.000	0.500
CWW3.117	Contribution to third party schemes	1 scheme for Pallins Burn	0.071	0.000	0.071	0.071	0.000	0.071
Total			137.126	13.089	150.215	12.697	1.821	14.518

We request transition funding of £12.7m capex for Year 4 and Year 5 of AMP7 to allow us to start our phosphorus removal programme early and deliver best value catchment solutions for customers.

The following sections explain in greater detail the needs we must address in AMP8, how we have arrived at the best value solutions, and demonstrate our continued focus on maximising the role of nature and partnership opportunities to deliver more for customers and the environment in the long term.

2. NEED FOR ENHANCEMENT INVESTMENT

2.1. ALIGNMENT WITH STATUTORY PLANNING FRAMEWORKS

The Environment Agency and Natural England translate legislation and UK government priorities set out in the Water Industry Strategic Environmental Requirement (WISER). WISER describes the legal obligations, government targets and statutory (S or S+) requirements water companies must achieve during each five yearly price review. It also sets out the non-statutory (NS) (with or without government support) requirements a water company should consider provided there is customer support for this action. WISER therefore underpins the government's Strategic Policy Statement which specifies the government's priorities for the water industry and the framework and policy priorities within which Ofwat should operate.

The WINEP methodology enables water companies to develop, fund and implement sustainable solutions to address the problems. It does this by setting out the overarching process to design, develop, and deliver water company actions to protect and improve the environment.

Two main statutory drivers underpin the need for this enhancement case:

- the Water Framework Directive – ensuring 'no deterioration' to waterbodies as a consequence of our activities and achieving 'good ecological status'; and
- the Urban Waste Water Treatment Directive (UWWTD) – protecting our environment through potentially harmful wastewater discharges through designating rivers with high nutrient levels as 'sensitive' where any significant discharges require the implementation of more stringent discharge permits.

Implementation of both directives is managed by the Environment Agency (EA) on behalf of Defra. Delivery of all WINEP obligations is monitored by the EA and forms part of their annual Environmental Performance Assessment. Since PR19 there have been new nitrogen standards for ecological status of lakes and reservoirs and links to conservation drivers, the Environment Act 2021 target to reduce phosphorus loading from treated wastewater by 80% by 2037 against a 2020 baseline, and explicit inclusion of catchment and nature-based solutions (C&NBS) as options for achieving water body and catchment objectives.

All elements of this business case have been developed in accordance with the WINEP Framework. There is separate guidance for:

- nutrients and sanitary determinands (surface waters)[5];
- prevent deterioration[6]; and
- Urban Waste Water Treatment Regulations[7].

We examine each statutory driver in greater detail below.

2.2. WATER FRAMEWORK DIRECTIVE

The Water Framework Directive (WFD) includes drivers to reduce the levels of nutrients and sanitary determinands entering surface water, and to prevent deterioration of water quality elements within receiving water bodies due to STWs effluent discharges.

This enhancement case sets out the investment required for actions to be carried out in AMP8 to improve water quality to meet good WFD Regulations status, and to inform PR29 option development through the following:

- Catchment investigations into sources of nutrients (phosphorus) to river waterbodies.
- Investigations into the impacts of urban pollution on river water quality.
- Investigations into the water quality impacts from Washington STW and growth to the Wear Estuary.
- Actions to reduce loadings to surface waters of phosphorus, nitrogen, ammonia, or biochemical oxygen demand (BOD) through treatment at STWs or through catchment/nature-based alternatives to sewage treatment.
- Actions to prevent deterioration in water quality elements within receiving waterbodies in three catchments the Derwent, the River Skerne and the River Wear.
- Actions to improve discharges and reduce total phosphorus under UWWTD.

In addition to the WFD, we must also keep to the requirements presented in UWWTD to reduce phosphorus loads for STs that have crossed population thresholds.

The drivers and solutions to reduce nutrient and sanitary determinants in wastewater through improvements and prevent deterioration are included in our PR24 Plan through the WINEP. To justify action under the WINEP, PR24 guidance states that there must be a confirmed link between a water company asset and the observed effect for actions to improve biology, and sufficient robust evidence that there is a clear link between STW discharges and deterioration.

[5] Environment Agency 2022, PR24 WINEP driver guidance – Nutrients and sanitary determinands (surface waters) version 0.3
[6] Environment Agency 2022, PR24 WINEP driver guidance – Prevent deterioration version 0.3
[7] Environment Agency 2022, PR24 WINEP driver guidance – Urban Waste Water Treatment Regulations version 0.3

WINEP driver guidance sets the four statutory obligations as shown in Table 3. The guidance states there is a 'need to identify any extra actions (beyond those in PR19) required to meet WFD waterbody objectives and to account as far as possible for potential future changes to those objectives.' It also stipulates that there must be sufficient evidence and technical justification to confirm that the action is needed to achieve, or contribute to the achievement of, the relevant waterbody objective in the 2021 river basin management plans or improving the waterbody status towards good as part of the overarching goal of achieving good status.

TABLE 3: NUTRIENT AND SANITARY DETERMINANDS STATUTORY DRIVERS[8]

Driver Code	Description	Legal Obligation	Tier 1 outcome	Required by dates	PR24 data tables enhancement category
WFD_INV	Investigations of actions to improve water quality in terms of relevant WFD status objectives.	Statutory	Water company contribution to achieve improvement objectives for water quality or prevent deterioration	By 30 April 2027, to help inform PR29 planning	Investigations, other - multiple surveys, and/or monitoring locations, and/or complex modelling
WFD_IMP	Implementation of actions to improve water quality in terms of relevant WFD status objectives	Statutory plus		By 31 March 2030, to be delivered in AMP8.	Treatment for nutrients (nitrogen or phosphorus) and / or sanitary determinands, nature-based solution
EnvAct_IMP1	Actions to reduce phosphorus loading from treated wastewater by 80% by 2037 against a 2020 baseline	Statutory	Water company contribution to achieve improved water quality.	Identified as secondary driver delivered through WFD_IMP. By 31 December 2038.	
WFD_ND[9]	Actions to meet requirements to prevent deterioration	Statutory	Water company contribution to achieve improvement objectives for water quality or prevent deterioration	By 31 March 2030, to be delivered in AMP8.	Treatment for tightening of sanitary parameters

These drivers contribute to the following 25 Year Environment Plan goals/policies:

- improving at least three quarters of our waters to be close to their natural state as soon as is practicable.
- reaching or exceeding objectives for rivers, lakes, coastal waters and ground waters that are specially protected, whether for biodiversity or drinking water as per our river basin management plans.
- restoring 75% of our one million hectares of terrestrial and freshwater protected sites to favourable condition, securing their wildlife value for the long term.
- reducing the impact of wastewater.

[8] Source: Environment Agency

[9] This driver is a primary driver for one need and has been considered as a secondary driver for other needs being delivered under WFD_IMP.

- improving how we manage and incentivise land management.

There are two statutory plus WFD drivers in the WINEP framework guidance for Water Body Ecological Status[10] which have been identified as secondary drivers for our Needs, where applicable. These drivers contribute towards the Environment Agency Tier 1 outcome - Water company actions contributing to poor or bad ecological status.

2.3. URBAN WASTE WATER TREATMENT DIRECTIVE

There are two UWWTD statutory drivers as shown in Table 4. We've used these drivers to help prioritise our investment to upgrade the same sites for WFD. The WFD standards are based on 'river needs' quality status and so are more stringent than UWWTD, and therefore it is more efficient to select the same sites for upgrades where the UWWTD already applies as no catchment options are feasible for the UWWTD.

TABLE 4: URBAN WASTEWATER TREATMENT REGULATIONS STATUTORY DRIVERS

Driver Code	Description	Legal obligation	Required by date	PR24 data tables enhancement category
U_IMP 1	Actions to improve discharges from agglomerations that, through population growth, have crossed the population thresholds in the UWWTR and therefore must achieve more stringent UWWTR requirements. This includes newly qualifying discharges (from agglomerations >10,000 PE) within existing Sensitive Areas. This includes discharges of >2,000 PE to fresh waters and estuaries and discharges >10,000 PE to coastal waters, as well as discharges >10,000 PE and 100,000 PE to Sensitive Areas.	Statutory	By 13 May 2030	Treatment for phosphorus removal (chemical)
U_IMP 2	Actions to reduce total phosphorus and/or total nitrogen levels in qualifying discharges (from agglomerations >10,000 PE) associated with the next review of Sensitive Areas (Eutrophic).	Statutory	By 13 May 2030	

These drivers contribute towards the Environment Agency Tier 1 outcome - Water company actions to protect the environment from the effects of urban wastewater collection and discharges. There were no needs identified for U_IMP3 which cover actions to introduce more stringent treatment than UWWTD secondary treatment to optimise reduction of nitrogen in qualifying discharges (from agglomerations >10,000 PE) associated with the next review of freshwater Sensitive Areas (nitrate).

[10] Environment Agency 2022, PR24 WINEP driver guidance – Water Body Ecological Status (Poor and Bad Ecological Status Waterbodies) version 0.3

The WINEP drivers in this business case have links to other planning frameworks including:

- River Basin Management Plan (2019) which defines the waterbody status with the objective to meet Good Chemical status linking to these Drivers.
- Water Resources Management Plan from which growth scenarios are used for the ND assessment by the Environment Agency.
- DWMP which supports in defining the catchment characteristics discharging into the STW. Schemes shall contribute to the improved water quality (Total Phosphorus) in downstream surface waterbodies.
- Flood Risk Management Plan which sets out how organisations, stakeholders and communities will work together to manage flood risk.
- Drinking water quality standards that can impact domestic sewage chemical concentrations.

2.4. OUR PROGRESS DURING AMP 7

We are on-track to deliver our WINEP programme for AMP7. The WINEP is a key part of the overall programme of measures to meet the requirements of the Environment Agency (EA)'s Water Industry Strategic Environmental Requirements (WISER) document. This includes objectives to meet Water Framework Directive (WFD) 'Good' status in our rivers by 2027 and prevent deterioration in status, together with other international regulatory drivers, including the Urban Wastewater Treatment (UWWT) and Habitats Directives.

The EA sets an expectation in its WISER guidance that companies will deliver 100% of the environmental improvement schemes listed in WINEP. To date (by 31 March 2023) we have delivered over 70% (439 schemes) of our WINEP programme. We are confident that we will deliver 100% of the schemes by the end of the five-year period.

The EA monitor and report on our WINEP delivery performance as part of the Environmental Performance Assessment (EPA). Successful delivery of our WINEP programme has underpinned our achievement of a 4-star performance, the highest possible, in the Environment Agency's Environmental Performance Assessment (EPA) in two out of the last three years with last year seeing us achieve a 3-star rating. We have consistently delivered 100% of schemes since its introduction in 2011.

A significant part of our WINEP programme is focused on the impact of our STWs on the environment, which includes the level of nutrients discharged. Through previous AMPs and in AMP7 we have been part of the Chemical Investigations Programme (CIP) investigations and trials. The AMP6 CIP2 programme was a collaborative approach to trialling alternative technologies for phosphorus removal to understand the lowest technically achievable limit (TAL), and to understand the costs required to meet TAL which helps to inform permitting decisions to ensure the options are not cost prohibitive. These investigations and trials have informed the permit development for nutrient and chemicals in wastewater and the need to invest in removal of these as necessary. The CIP2 trials informed our programme for phosphorus removal in AMP7, which has been delivered through schemes included in our AMP7 WINEP programme.

In AMP7, we have expanded our range of solutions to meet the demands of tighter permit requirements for phosphorus towards TAL. We have also undertaken feasibility and development work for catchment solutions for phosphorus using catchment nutrient balancing approaches, and agreed with the EA that trials for catchment-based solutions will start in two catchments in 2027. These projects for the Browney and Skerne are in development as the foundation for our programme of catchment solutions in AMP8 and beyond and have allowed us to think differently about how we can deliver phosphorus improvements in PR24.

We have an **EPA 3 star rating** and are endorsed by the EA to use catchment based permitting approaches, which means we can be confident in exploring greener more sustainable and more innovative options which can be more cost-effective and deliver wider benefits for customers and the environment, alongside optioneering hard engineered end-of-pipe solutions.

We are confident that the skills and capabilities we have developed over the past AMPs, our technical understanding of the requirements for our region, our ability to work collaboratively and in partnership with others, and our continued focus on the environment provide a strong foundation from which to deliver our more stretching AMP8 programme.

2.5. OUR ASSUMPTIONS FOR BASE SPEND IN AMP8

The need for investment to reduce phosphorus loading to waterbodies in AMP8 is based on the performance improvement required and timescale in which it must be delivered, defined by the statutory drivers. All investment is new, related to changing permit and nutrient requirements and has not been funded in previous price reviews.

The assumptions we have made to allocate investment to base or enhancement are outlined in Table 5. We assume that continuing our now business-as-usual activities that deliver against nutrient improvement needs from previous AMPs will be covered by base investment as operational costs for running phosphorus and ammonia removal treatment plants. This includes meeting existing permit levels for phosphorus and sanitary determinands (ammonia and BOD). As our AMP8 WINEP improvement needs for nutrients set out within this business case (outlined in Section 2.6) align with our statutory obligations, they fall to enhancement expenditure.

TABLE 5: OUR ASSUMPTIONS AROUND BASE AND ENHANCEMENT INVESTMENT

Base	Enhancement
• Maintenance of ongoing wastewater treatment for nutrients and sanitary determinands following previous AMP enhancement investment • Items funded at previous price reviews • Business-as-usual activities that deliver against needs from previous AMP enhancement investment	• Needs aligned with new statutory obligations

We have not received investment funding from Ofwat to address our AMP8 WINEP needs in the past, these are all included as new schemes for PR24.

2.6. OUR AMP8 NEEDS

2.6.1 Our obligations for WFD nutrient improvements and investigations

Step 1 of the WINEP Options Development Guidance requires us to confirm the environmental risks and issues to address. We have followed the methodology set out in the WINEP driver guidance. We worked with the Environment Agency and Natural England to identify needs on a catchment basis.

To inform and establish our list of sites we reviewed the following:

- the Environment Agency's SAGIS-SIMCAT models.
- an initial long list of 40 STWs considered for phosphorus removal or investigation under WFD drivers in catchments identified for potential water company investment (note that this list subsequently increased with the introduction of new nutrient drivers, both ahead of January 23 WINEP submission and then again ahead of the final WINEP submission in July 2023).
- 27 extra STW candidates for improvement brought in to WINEP needs under extra drivers, including Environment Act_IMP1, following Environment Act Targets legislation.
- STWs considered for ammonia removal.
- waterbodies which may be impacted significantly by urban sources, including polluted surface water outfalls and misconnections.

A catchment-level assessment was carried out by the PR24 Catchment Planning Team for nutrient drivers, where the focus was on phosphorus, considering the impact of our assets on water quality and assessing the evidence at catchment scale.

As required by WINEP guidance, a weight of evidence approach was used to assess the robustness of the available information, and to understand the need for further evidence gathering through investigations or for improvements.

A simplification of the methodology used to identify the needs to keep to WFD investigations and improvement actions follows the PR24 WINEP driver guidance is illustrated in Figure 1. More detail is provided in the Options Development Reports on how the needs have been defined including detail on SAGIS outputs and the evidence gathered and assessed as required by WINEP.

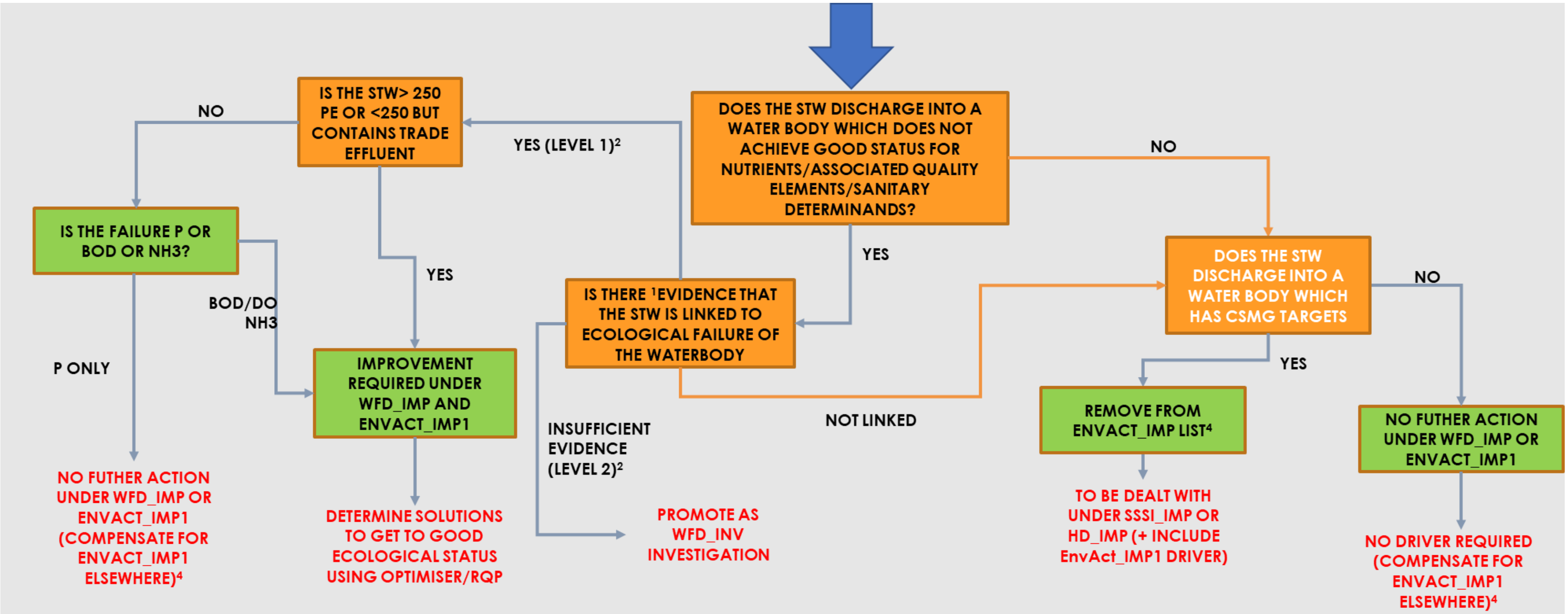
A clear link between the impact of our wastewater assets and an environmental issue was required to support the need and has been identified from the following sources:

- eutrophication weight of evidence (WoE);
- RNAGs status;
- the outcomes of SAGIS modelling;
- analysis of in-river water quality and final effluent data; and
- local knowledge from catchment partners suggests that our wastewater assets, together with other catchment sources, are impacting on water quality of the waterbody.

Current site performance and requirements to meet WFD good status informed our approach to options development. The performance improvements required under the WFD_IMP driver are shown in greater detail in Appendix B.

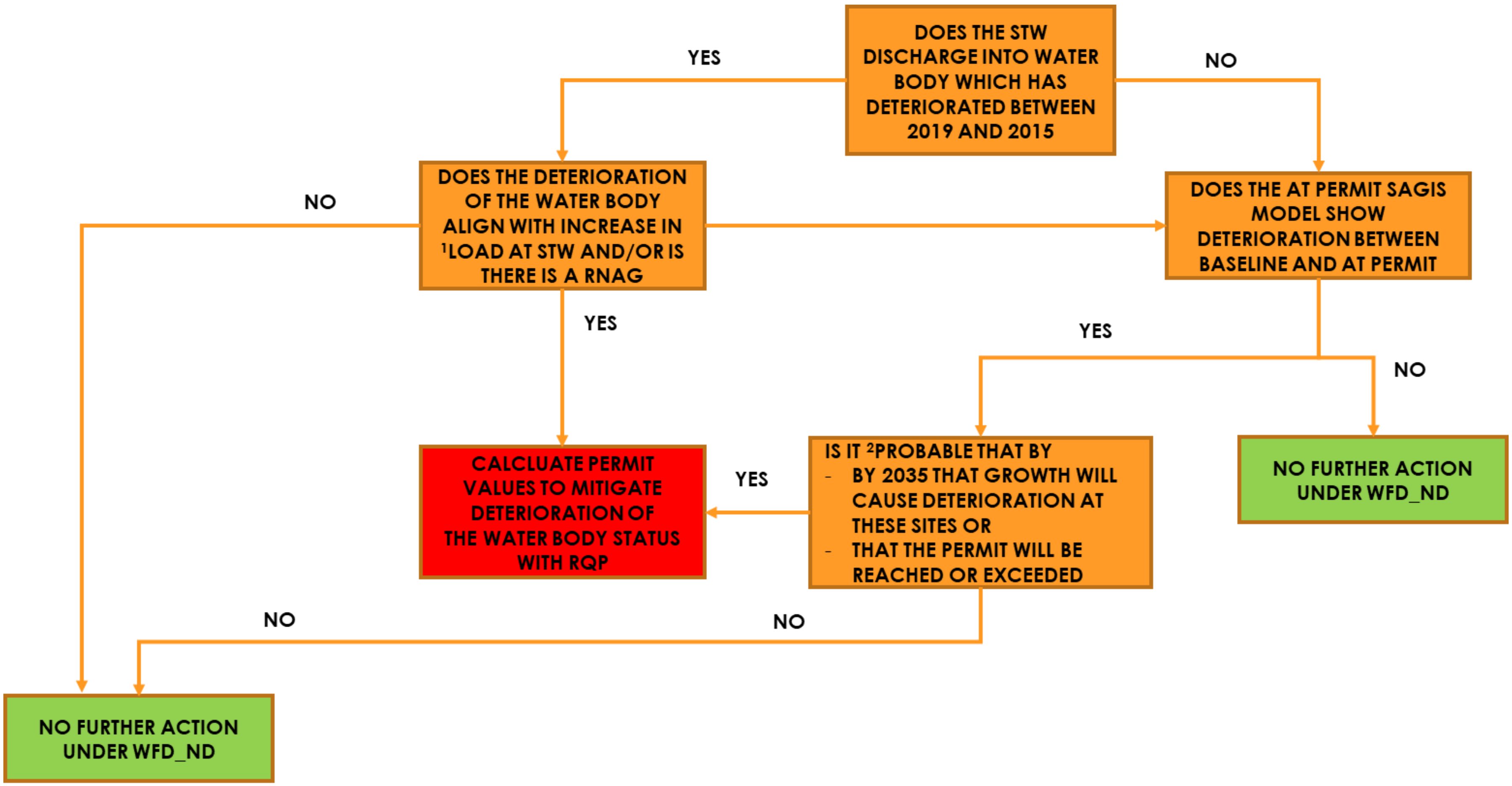
In addition to WFD improvements and future improvements covered by investigations, other sites may require investment to prevent deterioration in the quality of receiving waters where the quality of effluent discharged from STWs is impacted by growth and development. The methodology used to identify needs under the WFD_ND driver follows the PR24 WINEP driver guidance and is shown in Figure 1 and Figure 2.

FIGURE 1: METHODOLOGY FOR DETERMINING WFD IMPROVEMENTS AND INVESTIGATIONS



[1] EVIDENCE CONSIDERD TO BE RNAG, EUTROPHICATION WoE WITH *'VERY CERTAIN' OR 'QUITE CERTAIN' EUTROPHICATION PROBLEM*, NWG SAMPLING (JAN TO DEC)
[2] EVIDENCE AS PER THE DRIVER GUIDANCE CONFIDENCE LEVELS. LEVEL 1 = CONFIRMED LINK, LEVEL 2 = RISK OF PROBLEM CAUSED AND INV WILL RESOLVE EVIDENCE SHORTFALL.
[3] APPROPRIATE TREATMENT UNDER THE UWWTD IS BOD:SS OF 40:60
4 THE EnvAct DRIVER REQUIRED AN OPERATIONAL CATCHMENT LEVEL LOAD REMOVAL TARGET TO BE MET. Without a need from WFD_IMP it is assumed that the EnvAct load removal could be compensated for elsewhere

FIGURE 2: WFD_ND METHODOLOGY



[1]LOAD INCREASE EVALUATED BASED ON INCREASE IN CONCENTRATION AND/OR INCREASE IN FLOW
[2] PROBALE RISK OF DETERIORATION CALCULATED BASED ON GROWTH > 10% AT A SITE WITH HEADROOM <10%

Review of no deterioration requirements resulted in identification of the following needs (Table 6):

TABLE 6: NO DETERIORATION NEEDS

No.	ND Need	Root cause	Need Description
1	Lockhaugh STW (phosphorus)	~14% population growth in catchment feeding Lockhaugh STW causing increase in phosphorus load from STW	No deterioration would result in a change of the P removal from 2 mg/l to 0.95 mg/l at Lockhaugh STW to maintain the waterbody status as High in the Derwent from Burnhope Burn to River Tyne water body
2	Bishop Auckland STW (Ammonia)	~16% Population growth in catchment causing increase in ammonia load from STW	No deterioration would result in a change in the NH3 from 10mg/l to 2.8 mg/l at Bishops Auckland to maintain waterbody status as high within water body Wear from Gaunless to Browney. Current 95%ile performance is 4.2 mg/l
3	Windlestone STW (BOD)	~14% population growth in catchment feeding Lockhaugh STW causing increase in phosphorus load from STW	No deterioration would result in a change of the P removal from 2 mg/l to 0.95 mg/l at Lockhaugh STW to maintain the waterbody status as high in the Derwent from Burnhope Burn to River Tyne water body

Following review and assessment of drivers and needs with the EA ahead of our final WINEP submission in July 2023, we identified 29 needs for WFD nutrient investigations, 56 needs for improvements for WINEP nutrients at STW or waterbody level and 2 needs for UWWTD drivers for which WINEP solutions were developed (Table 7).

TABLE 7: NEED IDENTIFICATION FOR WFD_IMP

Need Type	No. Needs	Need Description
WFD INV (Phosphorus)	29[11]	Investigations required to understand future improvements towards achieving Good ecological status in receiving waterbodies. Includes 27 STW level needs (1 marine impact) and 2 urban waterbody needs

[11] An additional 4 STWs were also identified for WFD INV needs in the Coquet catchment which are included in our long-term phosphorus improvement plan, but these have SSSI INV as a primary driver and are not included in this business case (see NES-28 A3-14 Protected Areas and Bathing Waters case)

Need Type	No. Needs	Need Description
WFD IMP (Phosphorus)	45	P removal schemes required for STWs to achieve fair share towards achieving Good ecological status in receiving waterbodies
ENV ACT IMP1 (Phosphorus)	3	P removal schemes required for STWs where waterbodies are formally already at Good ecological status but evidence shows improvements are needed
WFD ND (Phosphorus)	2	Lockhaugh STW Embleton STW
WFD IMP (Ammonia)	4	Ammonia removal schemes required to achieve Good ecological status in receiving waterbodies
WFD ND (Ammonia)	1	Ammonia removal schemes required to ensure no deterioration in ecological status in receiving waterbodies
WFD ND (BOD)	1	Windlestone STW
UWWTD	2	Willington (U_IMP1) and Stressholme (U_IMP2)
Total	**87**	

Our approach through the PR24 catchment planning team was to address these needs at catchment level to develop appropriate and cost-effective solutions. Our catchment approach meant that the number of needs does not map directly to the number of solutions, as we developed options for catchment investigations, catchment solutions, and catchment permitting approaches to address these needs alongside traditional STW level solutions.

Our integrated approach to addressing needs also meant that we combined drivers, needs and solutions where we could, to make sure that we were efficient (see Section 3.4).

Review of requirements resulted in identification of the following WFD_IMP needs presented in Table 8:

TABLE 8: NEEDS FOR WFD_IMP

No.	Need name	Root cause	Need Description	Secondary WINEP driver
1	Belford burn catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in Belford Burn from Source to Ross Low (GB102021072990) from Moderate to Good waterbody status. The new WFD_IMPg (P) permit of 0.25mg/l will also address the catchment's secondary driver WFD_ND (P) which permit is 0.4mg/l.	EnvAct_IMP1 WFD_ND
2	Wansbeck catchment improvement	Failure against the WFD phosphate classification element. Waterbody at moderate status downstream of Morpeth, and at Pegswood is at poor status	WFD_IMPg (P). Improve water quality (P) in Bothal Burn (GB103022077030) from Poor to Moderate and Wansbeck from Font to Bothal Burn from Poor (based on Macrophytes class) to Good. The new WFD_IMPg (P) solution will also address the catchment's secondary driver WFD_ND (BOD) by changing the outfall location to River Wansbeck. Investment at Morpeth required.	EnvAct_IMP1 WFD_ND
3	Pallins burn catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in Pallins Burn Catchment (tributary of Till) (GB102021072990) from Moderate to Good.	None
4	Clow beck catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in Aldbrough Beck from Source to Clow Beck (GB103025072150); Aldbrough Beck from Forcett Park Catch to Clow Bk (GB103025072060) and Barton Beck from Source to Clow Beck (GB103025072040) from Poor/Moderate to Good..	WFD_IMP_MOD EnvAct_IMP1
5	Embleton burn catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in Embleton Burn from Source to North Sea (GB103022076370) from Poor to Good. The new WFD_IMPg (P) permit of 1mg/l will also address the catchment's secondary driver WFD_ND (Phosphorus) which permit is 2mg/l.	WFD_IMP_MOD EnvAct_IMP1 WFD_ND
6	Hawthorn burn catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in Hawthorn Burn from Source to North Sea (GB103025075950) from Poor to Moderate. Phosphorus he new WFD_IMPg (P) driver will also address the catchment's secondary driver WFD_MOD.	WFD_IMP_MOD EnvAct_IMP1
7	Percy Beck catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in Percy Beck Catchment (Tributary of Tees) (GB103025072220) from Poor to Moderate. Secondary driver EnvAct_IMP1.	EnvAct_IMP1
8	River Leven catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in Broughton Beck from Source to River Leven (GB103025071870) and Leven from Tame to River Tees (GB103025071880) from Poor to Moderate and three other Leven waterbodies from Moderate to Good. The new WFD_IMPg (P) driver will also address the catchment's secondary driver WFD_MOD.	WFD_IMP_MOD EnvAct_IMP1
9	River Skerne catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in multiple waterbodies of the Skerne from Poor/Moderate to Good. The new WFD_IMPg (P) driver will also address the catchment's secondary drivers: WFD_IMP_MOD, EnvAct_IMP1, WFD_ND (BOD) and WFD_CHEM.	WFD_IMP_MOD EnvAct_IMP1 WFD_ND WFD_CHEM

No.	Need name	Root cause	Need Description	Secondary WINEP driver
10	River Team catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in Team from Source to Tyne (GB103023075670) from Moderate to Good.	EnvAct_IMP1
11	River Team catchment improvement	Failure against the WFD ammonia classification element.	WFD_IMPg (NH3). Improve water quality (NH3) in Team from Source to Tyne (GB103023075670).	EnvAct_IMP1
12	River Tees catchment improvement	Failure against the WFD phosphate classification element. Waterbody at poor status.	WFD_IMPg (P). Improve water quality (P) in Tees from Skerne to Tidal Limit (GB103025072595) Poor to Good. The new WFD_IMPg (P) permit of 0.25mg/l at Stressholme STW will also address the catchment's secondary driver WFD_ND (P) which permit is 0.4mg/l and the UWWTD (P) which has a limit of 1mg/l.	WFD_IMP_MOD EnvAct_IMP1
13	River Tees catchment improvement	Failure against the WFD ammonia classification element.	WFD_IMPg (NH3) Improve water quality (P) in Tees from Skerne to Tidal Limit (GB103025072595) Poor to Good.	WFD_IMP_MOD EnvAct_IMP1
14	River Wear catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in multiple Wear Middle & Wear Lower and Estuary (improvement in WFD P status) The new WFD_IMPg (P) permit of 0.25mg/l will also address Bishop Auckland STW secondary driver WFD_ND (P) which permit is 0.5mg/l. See Investment Loader WINEP WFD_ND for NH3. The new WFD_IMPg (P) permit of 0.25mg/l will also address Sedgeletch STW secondary driver WFD_ND (P) which permit is 0.77mg/l	WFD_IMP_MOD EnvAct_IMP1 WFD_ND
15	South Low catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in South Low from Haggerston Bridge to North Sea (GB103021073222) from Moderate to Good. South Low from Source to Haggerston Bridge (GB103021073221) is already High. The WFD_IMPg (P) new permit at Lowick STW of 0.8mg/l will also address its secondary driver WFD_ND (P) which permit is 2.51mg/l.	EnvAct_IMP1
16	Tyne upper catchment improvement	Failure against the WFD phosphate classification element.	WFD_IMPg (P). Improve water quality (P) in March Burn Catchment (tributary of Tyne) (GB103023075650) from Moderate to Good.	None

2.6.2 Our obligations for UWWTD improvements

Drivers for UWWTD are UIMP1, UIMP2 and UIMP3. These impact nutrient removal requirements for phosphorus and nitrogen. We worked with the Environment Agency to understand these drivers for PR24. We were made aware that one new site (stretch of the River Tees) would be designated under UWWTD as a sensitive area – eutrophic. This impacts Stressholme STW which does not currently have a phosphorus permit.

We reviewed population growth at our works to assess any other new requirements under UWWTD. We used Edge analytics data to show the increase in dwellings from 2020 to 2060 for 159 numeric STWs. Using a factor of 2.4, the number of dwellings was converted to a Population Equivalent (PE). A population growth factor was established by calculating the percentage change in PE from 2020 to the design horizon of 2035. This growth factor was then applied to the current STW permits PE to achieve the PE for 2035. We agreed with the Environment Agency that population forecasts would be derived from the local plan forecast data for our PR24 planning (representing the high demand scenario).

After we reviewed growth and population, Willington STW was identified as requiring permits under UWWTD as it will breach the 10,000 population threshold requiring phosphorus treatment to 2mg/l (Table 9 and Table 10 respectively). The level of treatment[12] required to meet these permits is based upon the receiving water body and population equivalent.

TABLE 9: UWWTD IMPOSED PERMIT LIMITS[13]

Population Equivalent	Total Phosphorus permit limit (mg/l)	Total Nitrogen limit (mg/l)
10,000 to 100,000	2	15
>100,000	1	10

TABLE 10: POPULATION GROWTH AT WILLINGTON

Data Source	%Growth increase	PE 2021	PE in 2025	PE in 2035
DWMP	4.5%	10,944	10,078	10,910
Edge	3.6%	9,543	11,100	11,340

We reviewed the growth in population for Stressholme and concluded that owing to high infiltration at the works, there is headroom available for the predicted population growth within AMP8. Stressholme will thus not qualify for growth investment

[12] Environment Agency January 2019, Waste water treatment works: treatment monitoring and compliance limits

[13] Urban Waste Water Treatment Regulations

within AMP8. The infiltration will be reviewed within AMP7/8 with a likelihood of a reduction in infiltration and dry weather flow (DWF). Stressholme STW and Willington STW growth is summarised in Table 11.

TABLE 11: GROWTH DATA

Treatment Works	Current population equivalent at 2022	Population equivalent at 2030	Population equivalent at 2035	Current consent	Future Consent
Stressholme	145,986	156,729	164,849	No P limit	P limit of 1 mg/l Total nitrogen limit of 10 mg/l
Willington	9,222	9,441	9,570	No P limit	P limit of 2mg/l Total nitrogen limit of 15 mg/l

A summary of UWWTD sites is given in
Table 12.

TABLE 12: LIST OF UWWTD SITES

No.	Need name	Need Description	Root cause
1	U_IMP1 - Willington STW	Sites where the population growth is greater than 10,000 which means that it will fall into UIMP1 driver and receive a permit of 2mg/ for Phosphorus. There is no current phosphorus permit on this site. New P limit of 2 mg/l.	Current assets will not meet new permit of 2 mg/l.
2	U_IMP2 - Stressholme STW	Stressholme STW discharge is currently more than the 100,000PE threshold. The discharge point is in a newly designated a sensitive area. New P limit of 1mg/l.	Current assets will not meet new permit of 1 mg/l.

2.7. LINK TO LONG TERM STRATEGY

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

Our LTS sets out our long-term target to work with partners to eliminate all impediments to our rivers achieving good ecological status caused by our operations and to make sure that 75% of our rivers achieve good ecological status. To achieve this, we need to improve and restore biological quality elements and reduce the nutrients and pollution in rivers. This means investigating and tackling issues where our operations and physical infrastructure could cause deterioration, or where catchment and nature-based solutions or upgrades to existing infrastructure could help to achieve good ecological status.

We consider this is a low/no regret investment because it is needed to meet statutory requirements in the 2025-30 period. We have a legal obligation to deliver this investment by 2030 as this enhancement case includes only investment needed to meet the statutory requirements for 2025-30 under the WFD and UWWTD in the WINEP. We therefore consider this investment is necessary in 2025-30 to deliver our LTS.

As this enhancement case tackles complex environmental challenges around nutrients, we expect there will be a need for further investment in future periods. The investigations included in this enhancement case will support development of future options including those for PR29.

The timing of the improvement required, set by the Environment Agency, has challenged our ability to deploy catchment and nature-based solutions. We have worked collaboratively with the Environment Agency to incorporate, where possible, a nature-first approach as it supports our 2050 ambition to care for the long term needs of the environment and is aligned with the 25 Year Environment Plan goals.

2.8. FACTORS OUTSIDE OF OUR CONTROL

At a high level, the needs identified and included in this enhancement case are driven by a statutory obligation to be addressed by WINEP schemes agreed with the Environment Agency. The WFD and UWWTD commit us to achieving specific permit limits targeted to meet river needs for nutrients. We contribute directly to the nutrient load through our wastewater treatment process by discharging treated effluent. The quality of effluent discharged from our sites and assets (and the main driver for this enhancement) is within our control, subject to having available technologies to treat to the required limits.

Investments required to address nutrients are also driven by factors outside our control. Water bodies are impacted by nutrients from various sources, of which treated wastewater is one. There are, however, other stakeholders in our region who also contribute to the level of nutrient concentration in water bodies. The nutrients discharged from their sites and assets, for example farms and agricultural land, contribute to nutrient levels and are not within our direct control.

To address the factors outside our control that contribute to the needs identified in this case we have taken a catchment approach. This is because the models do not always reflect these external contributions, and in some cases improved evidence is needed to understand the apportionment and responsibility wastewater treatment needs to play in meeting river water quality outcomes. This has helped us to understand the various drivers of nutrients in our region, allowed us to consider 'fairshare' and catchment level nutrient management and enabled a broader range of options to be considered than simply end-of-pipe on our sites and assets.

We have experience in working at a catchment level, for example through the North East Catchments Hub, and are confident in our ability to address the statutory needs while also incorporating the wider needs of the local environment through a greater use of C&NBS. Additional information on our options appraisal is included in Section 3.2.

2.9. CUSTOMER SUPPORT FOR THE NEED

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

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

We also asked customers about their support for investment in nature-based solutions rather than engineering solutions. In our People Panels research, we discussed our options for tackling nutrient neutrality across Lindisfarne and Teesmouth. Customers did 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 considered this important (**line-of-sight**, NES45). We apply a similar approach to phosphorus.

In our **qualitative affordability and acceptability testing** (NES49), customers supported our “preferred” plan which included these phosphorus 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 phosphorus (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.

We have listened to our customers and included nature-based solutions and catchment-based solutions, with modifications made as agreed with the Environment Agency, in our enhancement case. We recognise our proposed approach requires some statutory requirements to not be applied by the Government (with green solutions used instead of grey to deliver more benefits).

Our process of optioneering, which included catchment-based solutions, is supported by our ongoing work in AMP7 with our North East Catchments Hub, which we established to bring the catchment-based approach into integrated water management at a regional level. We have tested all statutory environmental requirements as a single package.

Our catchment approach to developing our phosphorus plan has been endorsed by The Rivers Trust, in a letter copied to Defra, Ofwat and the EA, CEO Mark Lloyd notes *'This is an industry-leading approach, and follows Ofwat's guidance to 'produce a high quality, evidence based WINEP programme of best value options – allowing water companies to meet their regulatory obligations and customers' needs, whilst 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 environmental recovery in the North East of England.'*

We attach this letter as Appendix E to this enhancement case.

3. BEST OPTION FOR CUSTOMERS

3.1. PROCESS FOR IDENTIFYING THE BEST OPTION FOR CUSTOMERS

We have followed a robust process to identify the best option for customers. The process begins with identifying a broad range of options to address the needs identified in Section 2.6, progresses through screening and assessing the feasibility, and concludes by looking at the cost and benefits delivered by the options available.

Key to our appraisal of 'best options' has been our application of a catchment-based approach. This has introduced broader perspectives, additional benefits, and opportunities for increased efficiency into our options identification process. We understand the importance of meeting our statutory obligations and the certainty with which performance improvements must be delivered. In developing our programme to meet our obligations within the mandated WFD timescales, we have strived to balance the level of certainty in our investment with opportunities to deliver greater benefits for customers and the environment through C&NBS, as well as the corresponding bill impact.

Our commitment is to work with stakeholders and communities to deliver the best value options for customers and the environment. We believe that sustainable green solutions, including catchment and nature-based solutions, offer the best value for customers wherever appropriate. These options deliver better and wider improvements for the environment, can be co-funded, are typically more affordable for customers, and are strongly supported by customers, Defra, the Environment Agency and Ofwat.

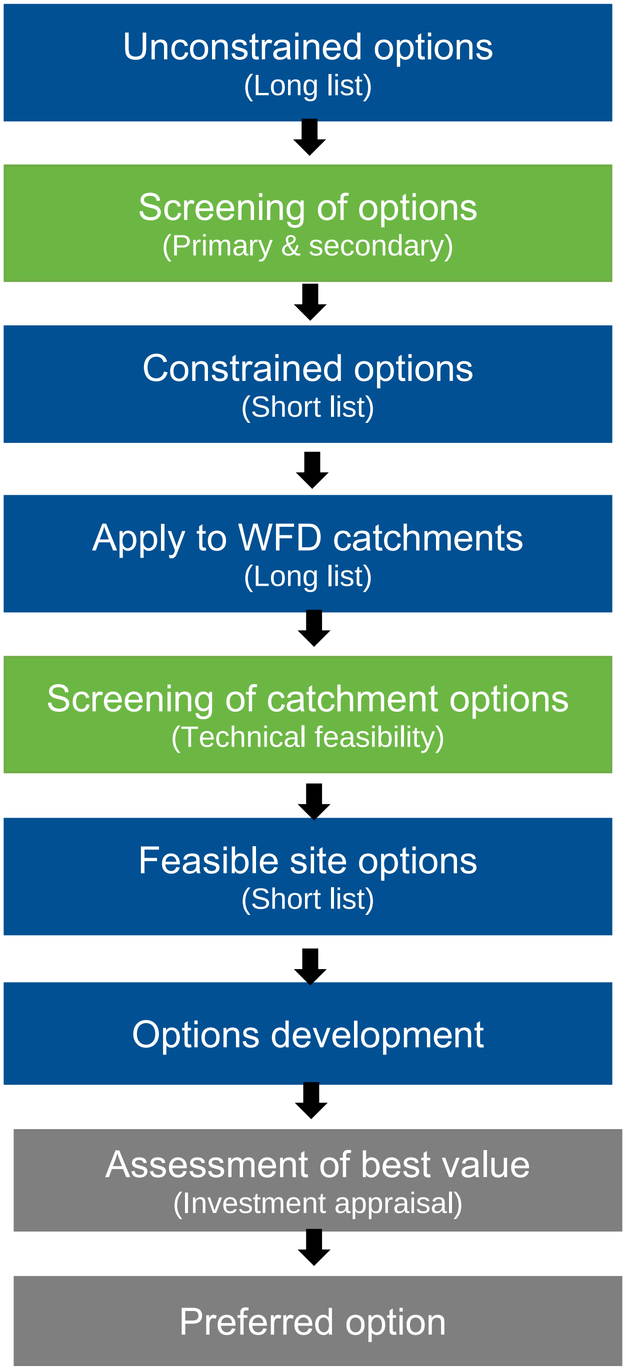
Our options identification process follows the WINEP Methodology for options development and appraisal, incorporating catchment options. To determine the best option for customers to address each need identified, we applied three different optioneering methodologies depending on the driver code.

- For the INV (investigation) driver code, where there is a clear need to investigate and address a knowledge gap, we worked with the Environment Agency, Mott MacDonald and Stantec to scope an appropriate means of investigation to satisfy the statutory requirement.
- For the ND (no deterioration) and IMP (improvement) driver code, we applied a methodology based on the principles of HM Treasury's *The Green Book: Central Government Guidance on Appraisal and Evaluation*[14] and the *WINEP Options Development Guidance*. A full description of each of the steps and the output from it is contained in the following sections.

Figure 3 summarises how our options development process aligns with the six WINEP options development principles and Table 13 summarises the principles we have applied in developing our options.

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

FIGURE 3: PROCESS FOR DEVELOPING AND FILTERING OPTIONS



Unconstrained list of options (section 3.2.2)

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 options (section 3)

To identify a constrained list of options capable of meeting the need, we have screened the unconstrained list of options against two criteria:

1) technically feasible, and
2) expected to meet statutory obligation.

This screening has been completed in accordance with Section 7.2.2 of the WINEP Options Development Guidance.

Options development (section 3)

For the constrained list of options, we developed the scope up to Level 1 for screening and 2 for preferred options where possible to enable more details cost estimates. With more detailed scope information, we have also measured the benefits, including carbon emissions, for each option.

Assessment of best value (section 3.4)

We have carried out an assessment of benefits and net present value for each option from the constrained list following Section 7.3 of the 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 the WINEP Options Development Guidance.

Preferred option (section 3.4.2)

We have selected the preferred option based on the outcomes of the best value assessment to maximise value for customers and environmental outcomes while achieving the regulatory requirement for each need.

TABLE 13: WINEP OPTIONS DEVELOPMENT PRINCIPLES

Expectation	How this has been met
Environmental net gain	The options developed for our WINEP programme will address risks to the environment from our wastewater operations, improving water quality with benefits for the aquatic environment. Through our options development process we have defined and selected options that result in the greatest wider environmental gains (such as for biodiversity, climate and catchment resilience), through assessment of Wider Environmental Outcomes and use of C&NBS where possible.
Natural capital	We have assessed each of our options against the full range of natural capital metrics and wider environmental outcomes as part of our WINEP assessment to the Environment Agency. The measures that apply to our options are shown in Table 21. These have been quantified through our benefits assessment which is describe in section 3.4.1.
Catchment and nature-based solutions	We have considered a range of nature-based solutions such as catchment nutrient balancing, 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 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 0.
Evidence	We present evidence on our reasoning to discard options within Section 0, and evidence how we developed option costs in Section 3.4.2. Extra evidence of our options development process including data used 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	Collaboration has been a fundamental component of our WINEP options development. We have worked closely with the North East Catchments Hub (NECH), a strategic partnership with the Rivers Trust, who have also engaged with wider stakeholders across our operational area through a series of workshops, to support the development of our WINEP plan.

3.2. BROAD RANGE OF OPTIONS

Consistent with Figure 4 above, we developed a long list of unconstrained options to address the needs included in this enhancement case. In accordance with the WINEP guidance, we have also considered sustainable low carbon solutions such as integrated wetlands, catchment nutrient balancing and other catchment and nature-based solutions. The options are presented in greater detail below, including our approach to screening options and selecting best value options for customers.

In assessing the options, we have also combined drivers, needs and approaches and used our integrated catchment approach to allow for efficient investment across the programme. For example, where we knew hard engineering investment was required at Willington STW for UWWTD, and at Bishop Auckland STW for ammonia, we selected these as key sites within our Wear catchment solution for WFD investment at end-of-pipe.

3.2.1 Options for WFD nutrient investigations

The needs identified under the WFD_INV driver require investigations. These have a distinct solution and so were not subject to further optioneering, but the PR24 Catchment Planning Team worked to group these into 15 catchment level investigations, which were scoped and costed in consultation with our consultants and the North East Catchments Hub. The option for each investigation is the investigation itself, and the alternative is the 'do nothing' option.

A summary of the options identified as solutions for the WFD_INV needs is shown in Table 14. These options are also the best value options. The Totex value of the investigations included in our AMP8 plan is £7.454m. Costs included in this enhancement case are in relation to the WFD_INV driver for phosphorus only, other WFD investigations are included in other WINEP business cases.

TABLE 14: THE OPTIONS TO ADDRESS WFD_INV NEEDS FOR PHOSPHORUS (P)

No.	Solution	Solution Description	Option (type of investigation)	30 Year NPV[15]
1	South Low Catchment Investigation	Investigation into the impacts of Lowick STWs water quality and WFD phosphate status of the South Low from Source to Haggerston Bridge waterbody.	Investigation into the impact of STW(s) on water quality in downstream waterbody (P)	-£261,735
2	River Aln Catchment Investigation	Investigate water quality (P) and/or reduce impacts of WHITTINGHAM, GLANTON and ALNWICK STWs on River Aln.	Investigation into the impact of STW(s) on water quality in downstream waterbody (P)	-£576,862
3	River Pont Catchment Investigation	Investigation into impacts of STAMFORDHAM, MATFEN and WHALTON STW on water quality in downstream waterbody	Investigation into the impact of STW(s) on water quality in downstream waterbody (P)	-£559,315
4	River Lyne Catchment Investigation	Investigation into impacts of ULGHAM STW on water quality in downstream waterbody	Investigation into the impact of STW(s) on water quality in downstream waterbody (P)	-£261,735
5	Hepscott Burn Catchment Investigation	Investigation into the impacts of Hepscott STWs water quality and WFD phosphate status of the Sleek Burn / Hepscott Burn Source to Tidal Limit waterbody in the River Blyth catchment.	Investigation into the impact of STW(s) on water quality in downstream waterbody (P)	-£261,735
6	South Tyne Catchment Investigation	Investigation into the impacts of Nenthead and Allendale STWs water quality and WFD phosphate status of the Nent from Source to South Tyne and Allen from Source to West Allen waterbodies.	Investigation into the impact of STW(s) on water quality in downstream waterbody (P)	-£419,298
7	Derwent Catchment Investigation	Investigation into the impacts of Consett and Dipton STWs water quality and WFD phosphate status of the Derwent from Burnhope Burn to River Tyne waterbody.	Investigation into the impact of STW(s) on water quality in downstream waterbody (P)	-£419,298
8	Wear Upper Catchment Investigation	Investigation into the impacts of the Wolsingham, Frosterley, Western Area, Stanhope and Rookhope STWs on water quality and WFD phosphate status of the Wear from Middlehope Burn to Houselop Beck and Rookhope Burn from Source to Wear waterbodies.	Investigation into the impact of STW(s) on water quality in downstream waterbody (P)	-£839,349

[15] Benefits – Costs: minimal benefits included in Copperleaf optimisation run, hence negative NPV

No.	Solution	Solution Description	Option (type of investigation)	30 Year NPV[15]
9	River Gaunless Catchment Investigation	Investigation into impacts of BUTTERKNOWLE, RAMSHAW, COCKFIELD and NEW MOORS STWs on water quality in downstream waterbody	Investigation into the impact of STW(s) on water quality in downstream waterbody (P)	-£681,785
10	Tees Middle Catchment Investigation	Investigation into the impacts of Barnard Castle and Staindrop STWs water quality and WFD phosphate status of the Tees from Percy Beck to River Greta waterbody.	Investigation into impact of STW(s) on water quality in downstream waterbody (P)	-£419,298
11	River Leven Catchment Investigation	Investigation into the impacts of Swainby sewage treatment works (STW) water quality and WFD phosphate status of the Potto Beck (tributary of Leven) water body.	Investigation into impact of STW(s) on water quality in downstream water body (P)	-£261,735
12	Billingham Beck Catchment Investigation	Investigation into the impacts of BISHOPTON STW on water quality in downstream waterbody.	Investigation into the impact of STW(s) on water quality in downstream waterbody (P)	-£261,735
13	Wear Estuary Marine Modelling Investigation	Marine modelling investigation to identify impact of ammonia, nitrogen, and phosphorus loads on the Wear estuary, including macroalgae growth, including investigation of the impact of Washington STW.	Marine modelling investigation to identify the impact of ammonia, nitrogen, and phosphorus loads on the Wear Estuary, including macroalgae growth	-£137,985
14	Ouseburn Urban Pollution Investigation	Investigate the impact of misconnections, storm overflows and other sources of urban pollution on water quality (P) in the Ouseburn waterbody.	Investigation into the impact of misconnections, storm overflows and other sources of urban pollution on water quality (P) in the Ouseburn waterbody	-£308,159
15	Urban Pollution Investigations	Investigate impact of misconnections, storm overflows and other sources of urban pollution on water quality (P) in five water bodies (to be specified).	Investigation into the impact of misconnections, storm overflows and other sources of urban pollution on water quality (P) in five water bodies (to be specified)	-£890,051

3.2.2 Options for WFD and UWWTD nutrient improvements

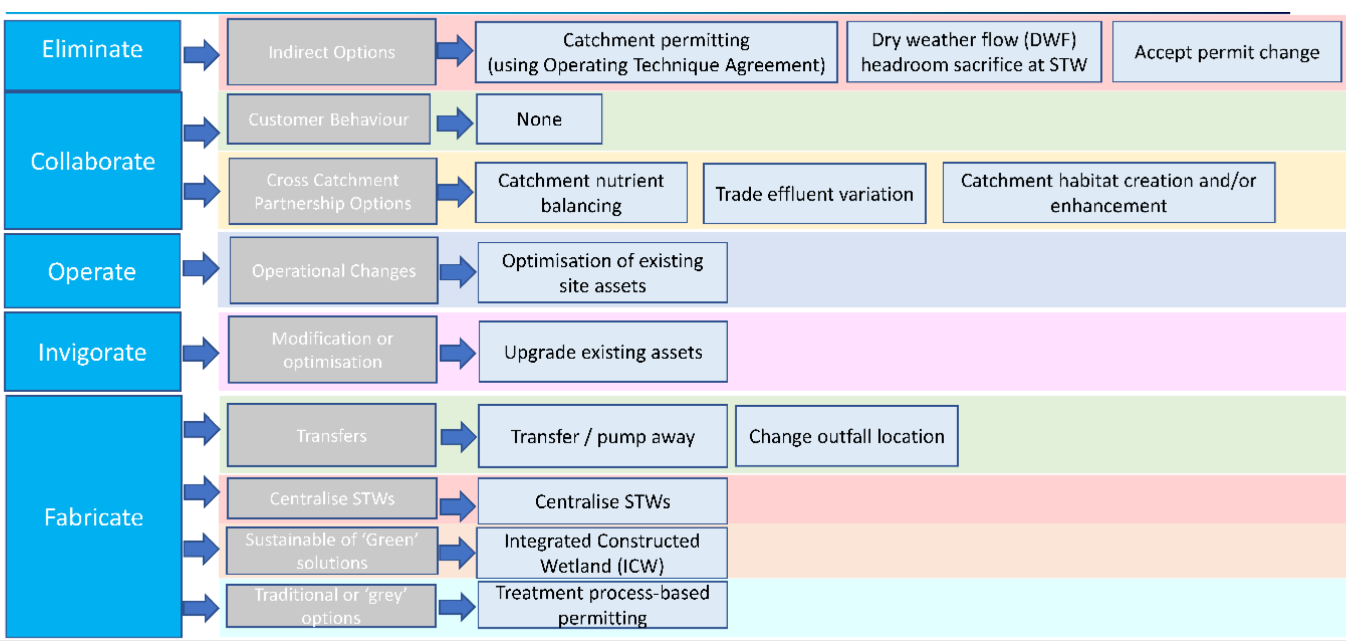
For the improvement drivers addressed by this enhancement case, a range of improvement options have been considered. As explained in Section 3, above, we have used a catchment approach to identify a broader range of options. Addressing needs at a catchment level also enabled us to group together STW to develop catchment solutions, while following an options identification and screening process for individual STWs alongside.

The unconstrained list of options was developed from the following sources:

- PR24 Guidance[16];
- consultant developed opportunity list;
- catchment level discussions; and
- internal discussions.

Once we had defined the need we followed the Totex Hierarchy to identify the best value solution that would address the need.

FIGURE 4: INTERVENTIONS FRAMEWORK CONSIDERING RANGE OF APPLICABLE INTERVENTIONS



[16] Environment Agency, 2022, PR24 WINEP driver guidance – Nutrients and sanitary determinands (surface waters)

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

- Eliminate - identification of processes and practices that can be stopped, possibly by stakeholder management or other, and by challenging the need for existence. Eliminate options are likely to have the lowest costs to deliver the benefit. They may be used in combination with other options.
- Collaborate - work with stakeholders to re-assign the issue or co-fund. Costs can be shared with third parties either to deliver the same or an extra level of social and environmental benefit. Our catchment solutions collaborate with multiple stakeholders.
- 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.
- 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.

The catchment approach developed to address our WFD phosphorus plan is set out in the Appendix to the ODRs (see Appendix A). At a high level, we have looked at the catchments outlined in Table 15 to develop our AMP8 options.

TABLE 15: SOLUTION OPTIONS AT CATCHMENT LEVEL

No.	Catchment Level for Developing Solutions	No. STWs	Driver	Determinand	No. Waterbodies
1	Pallins Burn	1	WFD IMP	Phosphorus	1
2	Belford Burn	1	WFD IMP	Phosphorus	1
3	South Low	1	WFD IMP	Phosphorus	1
4	Embleton Burn	1	WFD IMP	Phosphorus	1
5	Wansbeck	2		Phosphorus	2
6	Tyne Upper	1	WFD IMP	Phosphorus (1 STW) Ammonia (1 STW)	1
7	Derwent	1		Phosphorus	1
8	River Team	2		Phosphorus (2 STWs) Ammonia (2 STWs)	1
9	Middle And Lower WEAR	33		Phosphorus (33 STWs) Ammonia (1 STW)	16
10	Hawthorn Burn	1	WFD IMP P	Phosphorus	1
11	Clow Beck	3		Phosphorus	5
12	River Skerne	3		Phosphorus (3 STWs) BOD (1 STW)	6

13	River Leven	5		Phosphorus	5
14	River Tees	2	WFD IMP	Phosphorus (1 STW) Ammonia (1 STW)	2

Note: Some STWs have multiple needs so this does not align directly with Table 7.

The NECH has been working closely with our strategic leads and PR24 WINEP partners Mott MacDonald and Stantec and has connected with Catchment Partnerships and catchment partners to identify opportunities across multiple WINEP drivers. Identified opportunities have then been developed into feasible options to be included in the WINEP Options Development and Appraisal process[17]. A working group was established in October 2022 to enable catchment cross-organisational working – the PR24 Catchment Planning Team – which met weekly in the lead up to WINEP submission and engaged Environment Agency Area Water Quality specialists and Natural England stakeholders to share the approach and facilitate development of solutions.

We identified a broad list of options, as shown in Table 16, which provide improvements to reduce phosphorus and ammonia. These include sustainable nature-based and low carbon solutions such as integrated wetlands, catchment nutrient balancing and habitat creation following our approach to consider these solutions first as those which could be best value for customers, and in-line with the WINEP guidance. Our hierarchy focuses on these minimum and low carbon interventions first.

3.3. PRIMARY AND SECONDARY SCREENING OF OPTIONS

3.3.1 Primary and secondary screening of technologies at a programme level

Screening of the unconstrained list of options to produce the constrained list was carried out at a generic level across the whole programme rather than at a site or catchment specific level. In accordance with the WINEP options assessment guidance[18] section 6, we have carried out the screening of each of the options shown in Table 16 to make sure the option is:

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

If the option does not meet these criteria, then the option is discarded. The result of the primary screening is shown in Table 16. These options are applicable to all statutory drivers including WFD_IMP, WFD_ND, U_IMP1 and U_IMP2. The extent to which an option will support delivery of the regulatory target varies by need.

[17] Stantec and Mott MacDonald jointly developed a methodology for PR24 WINEP Options Development, outlined in 'WINEP Methodology – Wastewater Catchment Phosphorus Reduction Schemes' and issued as a separate Appendix to the relevant ODRs
[18] Environment Agency, March 2022, WINEP Options Assessment Guidance

TABLE 16: RESULTS OF PRIMARY SCREENING AT A PROGRAMME LEVEL (WFD_IMP)

Option title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
Treatment process-based permitting Installing new assets at the STW to meet the statutory requirement for a new single site permit (reed bed, electrocoagulation, tertiary cloth filter, submerged aerated filter, ferric dosing, deep bed filter, ballasted coagulation treatment systems, BioMag, biological nutrient removal).	Yes	Yes	**Carried forward**
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive watercourse).	Yes	Yes	**Carried forward**
Centralise STWs Combine two or more STWs into a new larger works to achieve efficiencies of scale.	Yes	Yes	**Carried forward**
Transfer / Pump away Transfer flow (raw) from one or more smaller STW(s) into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	**Carried forward**
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place. This may include extra assets on site to achieve tighter permit limit.	Yes	Depends on existing site assets	**Carried forward**
Integrated constructed wetland (ICW) Create ICW with multiple benefits as an alternative treatment solution (only applicable where less stringent permit limits or existing treatment solution needs to be tighter).	Yes	Yes	**Carried forward**

Option title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
Catchment permitting for nutrients 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 benefits from overperformance between sites (measured as kg load reduction at STWs).	Yes *No for U_IMP1 and U_IMP2*	Yes	**Carried forward**
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	Yes	Yes	**Carried forward**
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	Yes	Yes	**Carried forward**
Catchment nutrient balancing (not for U_IMP1 and 2) Catchment nutrient balancing i.e., targeting phosphorus or ammonia load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes *No for U_IMP1 and U_IMP2*	Yes	**Carried forward**
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus or ammonia loads to the watercourse via reduced runoff and sediment losses or increased filtration.	Yes *No for U_IMP1 and U_IMP2*	Yes	**Carried forward**
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	Yes	Yes	**Carried forward**

3.3.2 Application of options to individual catchments

All twelve options, identified at an overarching programme level as interventions capable of delivering the statutory requirements, were carried forward from primary screening and applied to each individual catchment. In accordance with the WINEP Options development guidance, each site was screened against the potential technology options to identify whether it was technically feasible to implement that technology on individual STWs within each catchment. For example, we took into consideration:

- Is it technically feasible to build or implement the solution?
- Can the technology achieve the required permit levels or is required to meet the required limit? In some cases, the technology options will not meet the permit, in other cases the technology option is not required as it will outperform the new permit.
- Can existing assets on site be expanded or upgraded to meet the new permit?
- Can existing assets on site be optimised to meet the new permit?
- For transfer options to another works, can we make sure that the receiving STW will have 10% headroom capacity and is within 5km to make the transfer route feasible? Note that for WFD_Chem sites where a transfer is required, it was agreed that the 5km screening rule was to be ignored.
- Is there sufficient green space available in the locality in which to construct a biological filter, a package STW, a wetland or a vertical flow reed bed?

Furthermore, we reviewed point source pollution and diffuse pollution to assess trade impact and farmer contribution to pollution loads as well as population growth and Dry Weather flow headroom at STW to establish capacity and site performance.

For the ICW option, feasibility screening involved the application of a Wetland Screening Tool, developed in previous work[19]. The wetland screening methodology used for the PR24 WINEP is described in full in the Wetland Screening technical note[3].

Catchment and Nature Based solutions (C&NBS) were screened by the PR24 Catchment Planning Team (with a focus on catchment nutrient balancing), with ideas and opportunities brought forward by the North East Catchments Hub (NECH). Improvement actions are summarised in Table 17. Detailed screening information for each improvement catchment (WFD_IMP), including discarding reasoning is documented in Appendix C.

[19] Mott MacDonald, December 2021, NWG AMP7 Wetlands Feasibility Study Screening and Concept Design Report

Screening for No Deterioration and actions under UWWTD are contained in Appendix D. In the River Skerne catchment, Windlestone STW is currently able to achieve the new permit value for BOD. Therefore, there was no screening carried out for this catchment.

TABLE 17: PRIMARY SCREENING FOR TECHNICAL FEASIBILITY WFD_IMP CATCHMENTS

Catchment name (WFD_IMP)	Treatment process-based permitting	Change outfall location	Centralise STWs	Transfer / Pump away	Replace/retrofit/expand existing primary/secondary treatment processes	Integrated constructed wetland (ICW)	Catchment permitting for nutrients	Trade effluent variation	DWF headroom sacrifice at STW	Catchment nutrient balancing	Catchment habitat creation	Operational solution
Belford Burn catchment improvement (P)	Yes	No	No	No	No	Yes	No	No	No	No	No	No
Bothal Burn Catchment improvement (P)	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No
Pallins Burn catchment (P)	Yes	Yes	No	Yes	No	No	No	No	No	No	Yes	No
Clow Beck catchment improvement (P)	Yes	Yes	No	Yes	No	Yes	Yes	No	No	Yes	No	No
Embleton Burn catchment improvement (P)	Yes	No	No	No	No	Yes	No	No	No	Yes	No	No
Hawthorn Burn catchment improvement (P)	Yes	Yes	No	Yes	No	Yes	No	No	No	No	No	No
Percy Beck catchment improvement (P)	Yes	No	No	Yes	No	Yes	No	No	No	No	No	No

Catchment name (WFD_IMP)	Treatment process-based permitting	Change outfall location	Centralise STWs	Transfer / Pump away	Replace/retrofit/expand existing primary/secondary treatment processes	Integrated constructed wetland (ICW)	Catchment permitting for nutrients	Trade effluent variation	DWF headroom sacrifice at STW	Catchment nutrient balancing	Catchment habitat creation	Operational solution
River Leven catchment improvement (P)	Yes	No	No	Yes	No	Yes	Yes	No	No	Yes	No	No
River Skerne catchment improvement (P)	Yes	No	No	No	Yes	No	Yes	No	No	Yes	No	No
River Team catchment improvement (P)	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No
River Team catchment improvement (NH3)	No	Yes	No	No	Yes	No	Yes	No	No	No	No	No
River Tees catchment improvement (P)	Yes	No	No	No	No	No	No	No	No	No	No	No
River Tees catchment improvement (NH3)	No	No	No	No	Yes	No	No	No	No	No	No	No
River Wear catchment improvement (P)	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	No	No
South Low catchment improvement (P)	Yes	No	No	No	No	Yes	Yes	No	No	Yes	No	No

3.3.3 Option development process

For each of the options with a “Yes” in Table 17, we developed a list of scopes from our desktop assessments. We also carried out a deliverability assessment in accordance with the WINEP. Detail of the risks to delivery are documented in the ODR’s submitted as part of our WINEP development. For example, delivery risks associated with the preferred option to address the need for the River Tees is document in Section 3.5 of the NW_Tees_WFD_ODR.

3.4. BEST VALUE

Our plan for investigations includes 15 catchment investigations to address the 29 needs identified for WFD INV for phosphorus (Table 14). Totex cost is **£7.45m.**

Where possible we have been efficient by combining needs, drivers and approaches to create the most streamlined plan.

Our best value plan for improvements includes 7 catchment solutions to avoid investment at 19 STWs (avoiding Capex investment of £40m for customers) and includes end-of-pipe investment at 19 STWs (which also incorporates catchment permitting and nature-based solutions through wetlands). Ten of these end-of-pipe investments are included alongside catchment nutrient balancing in our catchment solutions (Table 18). Totex cost for nutrient improvements is £143m.

TABLE 18: SUMMARY OF SOLUTIONS BY DRIVER

Driver	Number of needs addressed	Solutions Selected as Best Value Options
WFD_INV	29 (27 STWs and 2 waterbody-level needs)	15 Catchment Investigations to address these needs: 12 WFD investigations to identify the need for future AMP phosphorus schemes at 26 STWs 1 marine investigation into the impact of 1 STW on the Wear Estuary 2 investigations for phosphorus for 6 waterbodies not linked to STWs
WFD_IMP (P)	45	7 Catchment solutions using catchment nutrient balancing including 10 end of pipe solutions and avoiding investment at another 19 STWs (impacting 38 STWs) 2 Catchment solutions using catchment permitting for Wansbeck (Morpeth and Pegswood) and Team (Birtley and East Tanfiled) 4 end-of-pipe solutions for Lockhaugh, Hawthorn, Stressholme and Slaley Hall (P) STWs 1 nature based solutions wetland scheme for Stainton STW 1 3rd party co-funded habitats improvement scheme for Branxton STW
WFD IMP (Ammonia)	4	1 solution for River Tees Catchment Solution (ammonia) for Sedgefield 1 solution for Tyne Upper Catchment Solution (ammonia) for Slaley Hall 1 solution for Team Catchment Solution (ammonia) for Birtley & East Tanfield
EnvAct_IMP1	3	1 solution for Derwent catchment investigation (Lockhaugh STW)

Driver	Number of needs addressed	Solutions Selected as Best Value Options
		2 needs for Morpeth and Stressholme are addressed under WFD_IMP solutions as delivered through catchment-based approach (Morpeth included in Wansbeck need; Stressholme included in River Tees need)[20]
WFD_ND	3	River Wear catchment improvement for Bishop Auckland (ammonia) No cost scheme for Windlestone (BOD) Lockhaugh included in WFD IMP solution as WFD improvement also required
Total		

Table 19 shows a summary comparison of costs for the catchment solutions we selected as best value for customers against alternative traditional end-of-pipe solutions. Our catchment solutions for 7 catchments (South Low, Belford, Embleton, Wear, Clow Beck, Skerne and Leven) will use catchment nutrient balancing across 35 waterbodies to reduce nutrients towards achieving Good status. This approach allows us to avoid end-of-pipe investment in AMP8 at 19 STWs included in these catchments.

As part of our options development and appraisal process, we looked at end-of-pipe solutions for the STWs included in our plan alternatives for these sites under the catchment solutions review were:

- End of pipe phosphorus schemes at 10 STWs + CNB in 35 waterbodies through 7 catchment solutions (cost £73.8m Capex) - Our chosen option, or
- End of pipe phosphorus schemes at 10 STWs + additional schemes for end of pipe investment at 19 STWs = 29 STWs (cost £114.5m Capex) - Our avoided cost option

In addition to the Catchment Management - Nutrient Balancing cost line, we also have other investment in P schemes for chemical P, nature-based solutions and catchment permitting, which together make up our full phosphorus programme (and with sanitary determinands our full nutrient removal programme for P and ammonia) (as defined in Table 1).

[20] These schemes are included as lines in WINEP under Environment Act IMP1 drivers, but the solutions are included in the catchment solutions to address WFD needs so these schemes cover multiple drivers

TABLE 19: COST COMPARISON FOR CATCHMENT SOLUTIONS VERSUS TRADITONAL END OF PIPE SOLUTIONS

Solution Type	Description	Complete Scheme Totex	Complete Capex	5 Year Opex	EoP Scheme Element**	Annual Opex
Catchment Solutions	10 EoP and CNB to avoid investment at 19 STWs	£83,601,680	£73,792,229	£9,809,451	£54,881,097	£2,020,999
Alternative EoP Solutions	29 EoP (10 EoP we must do, plus the 19 at EoP not CNB)	£114,514,543	£114,514,543	0	£114,514,543	£2,830,345
Difference in solutions		**£30,912,864**	**£40,722,314**	**-£9,809,451**	**£59,633,447**	**£809,347**

TABLE 20: COSTINGS FOR STW END OF PIPE SCHEMES AVOIDED IN AMP8 THROUGH CATCHMENT SOLUTIONS

STW	Catchment	STW	Preferred Scheme if Required	Avoided Cost	
				Capex	Annual Opex
Branxton	Pallins Burn	BRANXTON	Transfer to River Till	£925,984	£968
Haggerston Castle	South Low	HAGGERSTON CASTLE	Ferric dose and 0.2ha Wetland	£1,238,211	£25,022
Embleton	Embleton Burn	EMBLETON	Ferric dose and Wetland	£1,850,569	£26,111
Hamsterley	Wear	HAMSTERLEY	Ferric dosing	£1,648,516	£13,599
Tudhoe Mill	Wear	TUDHOE MILL	Ferric dosing +TSR	£5,347,702	£75,594
Brancepeth	Wear	UNIVERSITY	Transfer to Barkers Haugh STW	£5,419,986	£1,912
Cassop	Wear	CASSOP	Transfer to Horden catchment	£2,632,234	£366
Belmont	Wear	BARKERS HAUGH	Ferric and Caustic dosing +TSR	£7,508,740	£148,093
Edmondsley	Wear	BELMONT	Ferric and Caustic dosing +TSR	£6,505,431	£118,189
Hustledown	Wear	EDMONDSLEY	Ferric and wetland	£1,332,265	£45,429
Chester le Street	Wear	CHESTER LE STREET	Ferric and Caustic dosing +TSR	£7,541,194	£119,242
Aldbrough	Clow Beck	ALDBROUGH	Ferric dosing	£2,207,654	£32,998
Melsonby	Clow Beck	MELSONBY	Ferric and wetland	£1,392,574	£44,735
Barton	Clow Beck	BARTON	Move final effluent to Clow Beck	£455,224	£366
Ingleby Greenhow	Leven	INGLEBY GREENHOW	Transfer to Great Ayton	£1,918,572	£148

STW	Catchment	STW	Preferred Scheme if Required	Avoided Cost	
				Capex	Annual Opex
Carlton in Cleveland	Leven	CARLTON IN CLEVELAND	PST+ Ferric Dosing+ TSR	£1,688,695	£11,940
Hutton Rudby	Leven	HUTTON RUDBY	Ferric and wetland	£1,674,891	£48,169
Windlestone	Skerne (Lower)	WINDLESTONE	Ferric and Caustic dosing +TSR	£3,722,931	£60,661
Sadberge	Skerne (Lower)	SADBERGE	PST, Ferric and Caustic dosing +TSR	£4,622,073	£35,806
19 STWs	**Total**			**£59,633,447**	**£809,347**

3.4.1 Benefit scoring

As presented in data tables CWW15 and CWW16, our assessment of benefits uses the Benefits Assessment Tool (BAT) to provide biodiversity, water supply and km river improved using EA methodology, and provides costed benefits for water quality, which can be used to show how schemes are cost beneficial.

No scoring has taken place for the WFD_INV options as investment of this nature improves knowledge of the need to inform PR29 requirements. WFD_ND schemes are a statutory must do and will not deliver environmental benefits to water quality. All WFD_IMP and ENVACT_IMP1 options have been scored against the following value measures:

- biodiversity (units uplift contributed by the scheme design).
- river water quality (VM72).
- embedded carbon emissions (VM03).
- operational carbon emissions (VM02).

The Wider Environmental Outcomes Metrics in our Value framework have been embedded into our portfolio optimisation tool, Copperleaf. Table 21 shows the range of benefits, the quantification and monetisation values we have used for the assessment of WFD_IMP options.

TABLE 21: RANGE OF BENEFITS IDENTIFIED FOR WFD_IMP AND WFD_ND OPTIONS

Value measures	Description	Unit	Value	WEO	Performance Commitment
Operational Carbon	t/CO2e /year	tCO2e	£256.2[21]	Net zero	Yes – GHG
Embedded Carbon	t/CO2e /year	tCO2e	£256.2[21]	Net zero	No
River Water Quality (phosphorus)	Kg /P /year	Kg	kg (P)		Yes – from AMP9
Biodiversity net gain[22]	Change in biodiversity units (BU).	BU	Not monetised in VM	Biodiversity	Not included because already inherent in WINEP baseline
Improved Water Environment[22]	Length of water environment improved	Km	Not monetised in VM	Km Improved	No

The whole life carbon estimation was based on embedded carbon plus 30-year operational carbon. Operational carbon is based on power and chemicals only. Changes to operation/maintenance activities were assumed to be negligible. The 30-year carbon forecast allows for projected grid decarbonisation. Note that due to the nature of some catchment and nature-

[21] £ value per tonne of CO2e in 2025/26, annual increase (varying rate) reaching £378.6/t CO2e in 2054/55

[22] Not included in Copperleaf optimisation

based solution options, which do not involve any construction work, the carbon emissions model used was not deemed to be applicable, and therefore no carbon emissions have been calculated.

Our value framework has been applied to our optimisation process and contains a mixture of benefits which reflect measures which relate benefits 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 horizon. This scoring takes into account the certainty of benefits being realised for different types of options.

TABLE 22: BENEFITS FROM WINEP WIDER ENVIRONMENTAL OUTCOMES AND NORTHUMBRIAN WATER'S VALUE FRAMEWORK FOR WATER FRAMEWORK DIRECTIVE INVESTMENTS

Options carried	NWG Value framework measures	WINEP Wider Environment Outcomes
WFD_IMP, WFD_ND, WFD_INV AND U_IMP		
Investigation	N/A	N/A
Catchment permitting for nutrients 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).	Operational carbon emissions River water quality Water quality (Improved Water Environment)	Natural environment Catchment resilience Net zero
Catchment nutrient balancing (not for U_IMP1 and 2) Catchment nutrient balancing - targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Embedded carbon emissions Operational carbon emissions River water quality Improved Water Environment	Natural environment Catchment resilience Net zero
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	Embedded carbon emissions Operational carbon emissions River water quality (requires scoring) Improved Water Environment (requires scoring) Water Purification by Habitats (no framework measure)	Natural environment Catchment resilience Net zero
Centralise STWs Combine two or more STWs into a new larger works to achieve efficiencies of scale.	Embedded carbon emissions Operational carbon emissions River water quality Water quality (Improved Water Environment	Natural environment Catchment resilience Net zero

Options carried	NWG Value framework measures	WINEP Wider Environment Outcomes
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive watercourse).	Embedded carbon emissions Operational carbon emissions River water quality Water quality (Improved Water Environment)	Natural environment Catchment resilience Net zero
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	Operational carbon emissions River water quality Water quality (Improved Water Environment	Natural environment Catchment resilience Net zero
Integrated Constructed Wetland (ICW) downstream of STW Create ICW with multiple benefits as treatment solution (only applicable where less stringent permit limits or existing treatment solution that needs to be tighter).	Embedded carbon emissions Operational carbon emissions Biodiversity Amenity (recreation) Water Purification by Habitats (no NWG framework measure) River water quality Water quality (Improved Water Environment)	Natural environment Catchment resilience Net zero Access, amenity, and engagement
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	Operational carbon emissions River water quality Water quality (Improved Water Environment)	Natural environment Catchment resilience Net zero
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place. This may include extra assets on site to achieve tighter permit limit.	Embedded carbon emissions Operational carbon emissions River water quality Water quality (Improved Water Environment)	Natural environment Catchment resilience Net zero
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	Operational carbon emissions River water quality Water quality (Improved Water Environment)	Natural environment Catchment resilience Net zero

Options carried	NWG Value framework measures	WINEP Wider Environment Outcomes
Transfer / pump away Transfer flow (raw) from one or more smaller STWs into an existing larger works with DWF headroom.	Embedded carbon emissions Operational carbon emissions River water quality Water quality (Improved Water Environment)	Natural environment Catchment resilience Net zero
Treatment process-based permitting Installing new assets at the treatment works to meet the statutory requirement for a new single site permit (electrocoagulation, tertiary cloth filter, optimised ferric dosing, deep bed filter, ballasted coagulation treatment systems, BioMag, biological nutrient removal).	Embedded carbon emissions Operational carbon emissions River water quality Water quality (Improved Water Environment)	Natural environment Catchment resilience Net zero
UWWTR (U_IMP1 & 2)		
Ferric dosing	Embedded carbon emissions Operational carbon emissions (carbon data not available to score against this value model) Water quality (Improved Water Environment) (km improved not available to score against this value model) River water quality	Natural environment Catchment resilience Net zero
Ferric dosing with TSR	Embedded carbon emissions Operational carbon emissions (carbon data not available to score against this value model) Water quality (Improved Water Environment) (km improved not available to score against this value model) River water quality	

Source: Northumbrian Water

3.4.2 Cost benefit appraisal to select preferred option

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

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

We have run optimisations to select the least cost options based on present values only and the best value using private and societal values. The output of this assessment has informed our preferred options, shown below.

Overall, we have included seven catchment nutrient balancing schemes, four of which are hybrid schemes containing grey or end-of-pipe interventions as part of the solution to make sure we can meet the statutory requirements. A summary of the options identified and their NPVs is included in Table 23. We have explained in greater detail below where there are differences between least cost and best value and justified our option selection.

TABLE 23: 30 YEAR NPV AND SELECTED WFD_IMP OPTIONS

Site	Option	Least cost alternative	Best value alternative	Preferred Option	30 Year NPV[23]
PR24 - WFD IMP - BELFORD BURN CATCHMENT IMPROVEMENT	End-of-Pipe Treatment: Belford (P)	No	No	No	-£5,603,759
PR24 - WFD IMP - BELFORD BURN CATCHMENT IMPROVEMENT	Hybrid solution - Catchment nutrient balancing and Integrated Constructed Wetland: Belford (P)	Yes	Yes	Yes	-£3,376,123
PR24 - WFD IMP - WANSBECK CATCHMENT IMPROVEMENT	End of Pipe Solution 1: Wansbeck (P) Tertiary Treatment: Morpeth Change Outfall Location: Pegswood	Yes	Yes	Yes	-£18,676,942
PR24 - WFD IMP - WANSBECK CATCHMENT IMPROVEMENT	End of Pipe Solution 2: Wansbeck (P) Tertiary Treatment: Morpeth and Pegswood	No	No	No	-£17,412,478
PR24 - WFD IMP - PALLINS BURN CATCHMENT IMPROVEMENT	Catchment Habitat Solution: Branxton (P)	Yes	Yes	Yes	-£68,412
PR24 - WFD IMP - PALLINS BURN CATCHMENT IMPROVEMENT	End of Pipe Solution: Branxton (P)	No	No	No	-£801,629
PR24 - WFD IMP - PALLINS BURN CATCHMENT IMPROVEMENT	End of Pipe Solution: Change Branxton Outfall Location to River Till	No	No	No	-£847,077
PR24 - WFD IMP - PALLINS BURN CATCHMENT IMPROVEMENT	End of Pipe Solution: Transfer Branxton	No	No	No	-£1,533,753
PR24 - WFD IMP - CLOW BECK CATCHMENT IMPROVEMENT	Catchment nutrient balancing: Clow Beck (P)	Yes	Yes	Yes	-£3,462,670
PR24 - WFD IMP - CLOW BECK CATCHMENT IMPROVEMENT	End of Pipe Solution: Tertiary Treatment: Aldbrough and Melsonby, Transfer: Barton	No	No	No	-£8,998,410
PR24 - WFD IMP - CLOW BECK CATCHMENT IMPROVEMENT	End of Pipe Solution: Tertiary Treatment: Aldbrough, Change Outfall Location: Barton, ICW: Melsonby	No	No	No	-£8,502,976

[23] Benefits – Costs: minimal benefits included in Copperleaf optimisation run, hence negative NPV

Site	Option	Least cost alternative	Best value alternative	Preferred Option	30 Year NPV[23]
PR24 - WFD IMP - EMBLETON BURN CATCHMENT IMPROVEMENT	Catchment nutrient balancing: Embleton (P)	Yes	Yes	Yes	-£778,198
PR24 - WFD IMP - EMBLETON BURN CATCHMENT IMPROVEMENT	End of Pipe Solution: Embleton (P) Tertiary Treatment and Integrated Constructed Wetland	No	No	No	-£5,651,820
PR24 - WFD IMP - EMBLETON BURN CATCHMENT IMPROVEMENT	End of Pipe Solution: Embleton (P) Tertiary Treatment Only	No	No	No	-£2,193,067
PR24 - WFD IMP - HAWTHORN BURN CATCHMENT IMPROVEMENT	Change outfall location: Hawthorn to North Sea via Seaham long sea outfall	No	Yes	Yes	-£5,665,131
PR24 - WFD IMP - HAWTHORN BURN CATCHMENT IMPROVEMENT	Tertiary treatment and ICW: Hawthorn ferric dosing and Integrated Constructed Wetland (P)	No	No	No	-£5,617,447
PR24 - WFD IMP - HAWTHORN BURN CATCHMENT IMPROVEMENT	Tertiary Treatment: Hawthorn Ferric, Caustic dosing and Tertiary Solids Removal (P)	Yes	No	No	-£4,022,870
PR24 - WFD IMP - PERCY BECK CATCHMENT IMPROVEMENT	Tertiary Treatment and Integrated Constructed Wetland: Stainton (P)	No	Yes	Yes	-£5,651,820
PR24 - WFD IMP - PERCY BECK CATCHMENT IMPROVEMENT	Tertiary Treatment: Ferric, Caustic dosing and Tertiary Solids Removal at Stainton (P)	Yes	No	No	-£3,926,597
PR24 - WFD IMP - PERCY BECK CATCHMENT IMPROVEMENT	Transfer / pump away: Stainton STW closure and transfer to Barnard Castle	No	No	No	-£3,397,161
PR24 - WFD IMP - RIVER LEVEN CATCHMENT IMPROVEMENT	End of Pipe Solution 1: Leven (P)	No	No	No	-£19,137,390
PR24 - WFD IMP - RIVER LEVEN CATCHMENT IMPROVEMENT	End of Pipe Solution 2: Leven (P)	No	No	No	-£10,066,802
PR24 - WFD IMP - RIVER LEVEN CATCHMENT IMPROVEMENT	Hybrid solution - Catchment nutrient balancing: Leven (P)	Yes	Yes	Yes	-£9,107,411
PR24 - WFD IMP - RIVER SKERNE CATCHMENT IMPROVEMENT	End of Pipe solution: Expand existing tertiary treatment and treatment process-based permitting	No	No	No	-£18,678,474
PR24 - WFD IMP - RIVER SKERNE CATCHMENT IMPROVEMENT	Hybrid solution - Catchment nutrient balancing: Skerne (P)	Yes	Yes	Yes	-£14,539,304
PR24 - WFD IMP - RIVER SKERNE CATCHMENT IMPROVEMENT	Tertiary Treatment: Aycliffe, Sadberge, and Integrated Constructed Wetland: Windlestone (P)	No	No	No	-£18,856,942

Site	Option	Least cost alternative	Best value alternative	Preferred Option	30 Year NPV[23]
PR24 - WFD IMP - RIVER TEAM CATCHMENT IMPROVEMENT	Change outfall location: Birtley STW, expand existing secondary treatment: East Tanfield (P)	No	No	No	-£13,728,470
PR24 - WFD IMP - RIVER TEAM CATCHMENT IMPROVEMENT	Expand existing tertiary treatment and operational solution: Team (P)	Yes	Yes	Yes	-£4,144,450
PR24 - WFD IMP (NH3) - RIVER TEAM CATCHMENT IMPROVEMENT	Operational solution: East Tanfield and retrofit secondary treatment processes: Birtley (NH3)	Yes	Yes	Yes	-£3,742,368
PR24 - WFD IMP (NH3) - RIVER TEAM CATCHMENT IMPROVEMENT	Operational solution: East Tanfield, ASP: Birtley (NH3)	No	No	No	-£19,903,200
PR24 - WFD IMP (NH3) - RIVER TEAM CATCHMENT IMPROVEMENT	Operational solution: East Tanfield, change outfall location: Birtley to River Wear (NH3)	No	No	No	-£11,518,997
PR24 - WFD IMP (NH3) - RIVER TEAM CATCHMENT IMPROVEMENT	Operational solution: East Tanfield, Plastic Media: Birtley (NH3)	No	No	No	-£22,916,197
PR24 - WFD IMP - RIVER TEES CATCHMENT IMPROVEMENT	Tertiary Treatment: Stressholme CoMag (P)	Yes	Yes	Yes	-£18,338,268
PR24 - WFD IMP - RIVER TEES CATCHMENT IMPROVEMENT	Tertiary Treatment: Stressholme Ferric (P)	No	No	No	-£28,089,261
PR24 - WFD IMP (NH3) - RIVER TEES CATCHMENT IMPROVEMENT	Change Sedgefield outfall location to Seaton Carew Long Sea Outfall	No	No	No	-£30,090,706
PR24 - WFD IMP (NH3) - RIVER TEES CATCHMENT IMPROVEMENT	Tertiary Treatment: Sedgefield (NH3)	Yes	Yes	Yes	-£3,481,762
PR24 - WFD IMP - RIVER WEAR CATCHMENT IMPROVEMENT	End of Pipe Solution: Wear (P)	No	No	No	-£94,873,639
PR24 - WFD IMP - RIVER WEAR CATCHMENT IMPROVEMENT	Hybrid solution - Catchment nutrient balancing for Wear plus engineering solutions at seven STWs (P)	Yes	Yes	Yes	-£65,725,364
PR24 - WFD IMP - SOUTH LOW CATCHMENT IMPROVEMENT	Catchment nutrient balancing: South Low (P)	Yes	Yes	Yes	-£749,555
PR24 - WFD IMP - SOUTH LOW CATCHMENT IMPROVEMENT	Tertiary Treatment: Haggerston (P)	No	No	No	-£2,402,090
PR24 - WFD IMP - TYNE UPPER CATCHMENT IMPROVEMENT	Tertiary Treatment: Slaley Hall (P and NH3)	Yes	Yes	Yes	-£11,993,978

Site	Option	Least cost alternative	Best value alternative	Preferred Option	30 Year NPV[23]
PR24 - WFD IMP - TYNE UPPER CATCHMENT IMPROVEMENT	Transfer / pump away: Slaley Hall	No	No	No	-£12,322,955

Source: Northumbrian Water

TABLE 24: 30 YEAR NPV AND SELECTED OPTIONS FOR WFD_ND AND ENVACT_IMP

Site	Option	Least cost alternative	Best value alternative	Preferred Option	30 Year NPV[23]
PR24 - WFD ND (NH3) - RIVER WEAR CATCHMENT IMPROVEMENT	End-of-Pipe Treatment: Bishop Auckland NSAF (NH3)	Yes	Yes	Yes	-£7,810,758
PR24 - WFD ND (NH3) - RIVER WEAR CATCHMENT IMPROVEMENT	Tertiary Treatment: Bishop Auckland ASP (NH3)	No	No	No	-£20,824,833
PR24 - EnvAct IMP - DERWENT CATCHMENT IMPROVEMENT	Tertiary Treatment: Lockhaugh (P)	Yes	Yes	Yes	-£3,065,520

TABLE 25: 30 YEAR NPV AND SELECTED OPTIONS FOR UWWTD

Site	Option	30 Year NPV[23]	Type of option	Justification
UWWTR Willington STW	Hybrid solution - Catchment nutrient balancing for Wear plus engineering solutions at seven STWs (P)	-£65,725,364	Preferred option	Willington is a hybrid solution required as part of our growth business case also (River Wear catchment). The UWWTD will be satisfied by the investment proposed to address WFD_IMP driver, above in Table 23.
UWWTR Stressholme STW	Tertiary Treatment: Stressholme CoMag (P)	-£18,338,268	Preferred option	The UWWTD will be satisfied by the investment proposed to address WFD_IMP driver, above in Table 23.

For the majority of options proposed, the least cost and best value alternatives were the same. For three options where there is a difference between the least cost and preferred option, we have explained our decision in greater detail in Table 26.

TABLE 26: SITES WITH DIFFERENT LEAST COST AND PREFERRED OPTIONS

Need	Least cost option	Preferred Option	30 Year NPV Variance £m (Costs only) (negative value = favourable)	Carbon societal value Variance £m (positive value = favourable)	Carbon variance t/CO2e (negative value = favourable)	Justification
Hawthorn Burn Catchment	Tertiary treatment: Hawthorn Ferric, Caustic dosing and Tertiary Solids Removal (P)	Change outfall location: Hawthorn to North Sea via Seaham long sea outfall	1.55	-0.09	113	At a high level, transferring avoids us having to return and reinvest in this site in the future. AMP8 is the right time to invest because there are drivers requiring improvement. This improvement could be delivered by a least cost end-of-pipe solution, however, for a small additional amount of Totex (£1.4m) greater environmental improvements for the longer term can be delivered. The proposed best value solution involves moving the discharge to Seaham which in turn discharges to the North Sea. There are extra benefits in terms of improved water quality of hawthorn burn and less stringent consents for ammonia, BODs and suspended solids at Seaham because the discharge will have more dilution in the North Sea hence giving overall less compliance risk. Better overall environmental outcome in receiving watercourse from the change in outfall location.
Percy Beck catchment improvement	Tertiary Treatment: Ferric, Caustic dosing and Tertiary Solids Removal at Stainton (Phosphorus)	Tertiary treatment and ICW: Stainton (P)	2.29	-0.05	121	We have prioritised wetlands and the biodiversity uplift (per WINEP methodology). Customers have fed back to us they also support the wetland and NBS options. This has the additional benefit of uplifting the biodiversity baseline, delivering more for customers and the environment.

Need	Least cost option	Preferred Option	30 Year NPV Variance £m (Costs only) (negative value = favourable)	Carbon societal value Variance £m (positive value = favourable)	Carbon variance t/CO2e (negative value = favourable)	Justification
						Percy Beck is a nutrient neutrality catchment. It is better value to include an ICW here because of the extra nitrogen benefits it will deliver.
Wansbeck	End of Pipe Solution 2: Wansbeck (P) Tertiary Treatment: Morpeth and Pegswood	End of Pipe Solution 1: Wansbeck (P) Tertiary Treatment: Morpeth	1.11	-0.15	344.48	We have selected the transfer of Pegswood rather than end-of-pipe treatment here as best value because it also removes the need for ammonia treatment.

The benefits and investment for our preferred option for WFD is included in Table 27. Profiling of benefits and expenditure will continue to be refined as we continue to work with our strategic delivery partner to carry out further design work and optimisation of the programme for delivery.

TABLE 27: EXTRACT FROM TABLE CWW15 – BENEFITS FOR PREFERRED OPTIONS

Investment Area	Benefit Description	Units of benefits created by projects starting in AMP8		Total benefit value generated by projects starting in AMP8 £m		Present value of benefits £m	PR24 BP reference
		AMP8	AMP9	AMP8	AMP9		
		2025-30	2030-35	2025-30	2030-35	2025-55	
Treatment for phosphorus removal (chemical) (CWW3.64)	Embedded Carbon (Tonnes)	4966.650	0.000	1.307	0.000	0	CWW15.232
	Operational Greenhouse Gas Emissions (Tonnes)	398.075	544.075	0.109	0.157	-1.600292122	CWW15.233
	Km River Improved (EA Measure)	63.533	0.000	2.860	7.150	23.882	CWW15.234
	Total					22.282	CWW15.242
Treatment for nutrients (N or P) and / or sanitary determinands, nature based solution* (CWW3.70)	Embedded Carbon (Tonnes)	1024.678	0.000	0.273	0.000	0	CWW15.254
	Operational Greenhouse Gas Emissions (Tonnes)	48.313	232.781	0.013	0.067	-0.295867636	CWW15.255
	Km River Improved (EA Measure)	11.310	0.000	0.260	0.650	2.171	CWW15.256
	Education (no. visits/year)	1800.000	1800.000	0.025	0.025	0.889	CWW15.257
	Biodiversity Units	8.810	10.080	0.000	0.000	0	CWW15.258
	Water Purification by Habitats (Hectares)	0.900	0.000	0.002	0.002	0	CWW15.259
	Total					2.764	CWW15.264
Treatment for tightening of sanitary parameters (CWW3.73)	Embedded Carbon (Tonnes)	1728.950	0.000	0.459	0.000	0	CWW15.265
	Operational Greenhouse Gas Emissions (Tonnes)	787.675	1124.625	0.215	0.323	-1.091	CWW15.266
	Km River Improved (EA Measure)	0.000	3.900	0.000	0.800	2.548	CWW15.267
	Total					1.457	CWW15.275
	Embedded Carbon (Tonnes)	5566.000	0.000	1.487	0.000	0	CWW15.287

Investment Area	Benefit Description	Units of benefits created by projects starting in AMP8		Total benefit value generated by projects starting in AMP8 £m		Present value of benefits £m	PR24 BP reference
		AMP8	AMP9	AMP8	AMP9		
		2025-30	2030-35	2025-30	2030-35	2025-55	
Catchment management - nutrient balancing (CWW3.79)	Operational Greenhouse Gas Emissions (Tonnes)	59.125	990.625	0.016	0.286	-2.01636575	CWW15.288
	Km River Improved (EA Measure)	0.000	425.790	0.000	50.350	160.356	CWW15.289
	Water Supply Benefit (m^3/year)	0.000	15330000	0.000	17.650	56.212	CWW15.290
	Other	0.000	14.380	0.000	0.000	0	CWW15.291
	Total					214.552	CWW15.297
Catchment management - catchment permitting (CWW3.82)	Embedded Carbon (Tonnes)	2432.700	0.000	0.640	0.000	0	CWW15.298
	Operational Greenhouse Gas Emissions (Tonnes)	208.675	285.325	0.057	0.082	-0.784	CWW15.299
	Km River Improved (EA Measure)	50.896	0.000	1.680	4.200	To be provided	CWW15.300
	Total			2.377	4.282	-0.784	CWW15.308
Contribution to third party schemes under WINEP/NEP only (CWW3.115)	Km River Improved (EA Measure)	2.32	0	0.205	0.205	0.729	CWW15.410
	Total						CWW15.411

In summary, we have proposed a broad package of investments to address the requirements included in the WFD and UWWTD. We have assessed the needs of our region, looking at catchments as well as sites and waterbodies. We have worked collaboratively with the Environment Agency and other stakeholders in our area to determine the best value solutions. We have had independent third party (Jacobs) assurance carry out on our AMP8 WINEP programme to make sure suitability and reliability of our programme, and to confirm that we have followed the WINEP Options Development Guidance.

3.4.3 Transition Spend

As noted in Section 1, we have included transition funding of £12.7m for Year 4 and Year 5 of AMP7 to allow us to start our phosphorus removal programme early and deliver best value catchment solutions for customers.

Table 48 justifies the expenditure for each investment area, our requests are linked to early delivery of schemes under no deterioration drivers (by March 2027), and complex scheme requirements for transfers or new technologies and early starts required for innovative catchment solutions, which should be classified as large non-routine investments.

TABLE 28: CWW3 AMP8 EXPENDITURE

Line Reference	Description	Transition Capex (£m)	Justification for early start
CWW3.111	Complex Investigations	-	Not Applicable for WFD phosphorus schemes
CWW3.79	Catchment Management – Nutrient Balancing	8.7	Catchment solutions in 7 catchments need to be launched in AMP7 to ensure success of innovative approaches, CNB and collaboration with partners and land managers (estimate £40m Capex avoided)
CWW3.70	Nature Based Solutions	1.2[24]	Integrated Wetland Schemes are innovative and complex and extra time is needed to ensure these are the correct solutions and can be developed for learning and ensure performance
CWW3.82	Catchment Management – Catchment Permitting	0.9	Wansbeck catchment scheme includes a complex transfer scheme for Pegswood and a growth scheme for Morpeth which will exceed its DWF early in AMP8, addressing the investments together provides efficiency for customers, this investment for catchment permitting needs to be started now; Team catchment scheme includes innovative mine water co-treatment reedbed and partnership approach with Coal Authority that needs to be reviewed, managed and agreed within the catchment permit

[24] Note that transition funding for Wooler and Greatham wetlands under HD IMP driver is also included in this investment line (Business case NES28 for Protected Areas)

CWW3.64	Chemical Treatment - Phosphorus	1.3	Scheme for Hawthorn includes a 4km transfer to a long sea outfall, a complex scheme which needs additional time for review and development to ensure delivery or if not feasible, substitute scheme delivery; Stressholme is a large works (147,000 PE) requiring complex treatment to meet tight permits, with CoMag technology that we have not previously utilised; Lockhaugh has a ND limit which needs to be in place by March 2027 (same scheme for IMP)
CWW3.73		0.5	Bishop Auckland has an ND driver for ammonia which needs to be in place for March 2027
CWW3.115	3rd Party Co-funded Schemes	0.1	Partner funding will be invested from 2023-2025 to get this waterbody to Good status, NW can invest very efficiently is aligning with this scheme (estimate £0.96m cost avoided)
Total		**12.7**	

We note that this meets Ofwat's criteria for transition funding because: we have provided sufficient and convincing evidence about our partnership and catchment management approach; these relate to schemes in WINEP where early delivery helps to reduce overall costs (for example, £40m for CWW3.79) and helps earlier delivery of customer and environmental benefits. In particular, we note that early start on C&NBS will help us to learn – and to share our learning – before planning begins for WINEP at PR29.

3.5. UNCERTAINTY

Our commitment is to work with stakeholders and communities to deliver the best value options for customers and the environment. We believe that sustainable green solutions including catchment solutions used as alternatives to end-of-pipe investment would offer the best value for customers. However, this does introduce factors outside of our control. Solutions harnessing nature and requiring environmental partnership activity and work with land managers cannot deliver the same level of certainty or deliver to the same timescales as hard engineering, though the trade-off for wider environmental benefits should be worth the challenge.

We are starting work early to mitigate risks and ensure the success of our solutions. We have launched our catchment solutions projects already with the North East Catchments Hub to support AMP8 delivery, and requested transitional spend activity for AMP8 catchment schemes to make sure that these schemes have the best foundation in terms of data, on the ground engagement and design of appropriate measures and interventions (see Section 3.4.3). We will work closely with the Environment Agency to assess new data and evidence, update the SAGIS model and agree targets and solutions that can be delivered in partnership.

Our preferred options include catchment and nature-based solutions including a large-scale programme of catchment nutrient balancing across 35 waterbodies, and a small number of integrated constructed wetlands (3 schemes proposed). There is more uncertainty with the realisation of nature-based solutions benefits than traditional engineered solutions, and the benefits, although they are expected to be much greater, are likely to take longer to realise.

To illustrate the difference in certainty between engineered versus nature-based options relevant to WFD_IMP needs, we have outlined and ranked (RAG) the risks identified with the ICW solution proposed for the Percy Beck catchment (Table 29 and Table 30).

TABLE 29: PERCY BECK RISK ASSESSMENT, ENGINEERING SOLUTION

Risk category	RAG rating	Comment
Driver compliance		Chosen option is conventional approach to comply with the standard.
Delivery		Conventional solution but complex delivery due to need to transfer/pump away and land access.
Outcome		Conventional solution for total phosphorus removal.
Cost		High cost uncertainty due to site closure and transfer to Barnard Castle.
Resources		No specialist resources required.
Technology		Most technology is standard.
Supply chain		Multiple framework suppliers for chosen option but uncertain supply chain for relocation of assets.
Public perception		High carbon cost for a solution.

TABLE 30: PERCY BECK RISK ASSESSMENT, CATCHMENT SOLUTION (NBS COMPONENT)

Risk category	RAG rating	Comment
Driver compliance	Amber	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 Stainton) this significantly lowers the risk of non-compliance.
Delivery	Amber	The delivery of these options is dependent on third parties. We have limited experience in delivering some of these options, however appropriate connections have been made with organisations / partners such as Rivers Trust, who are experienced in delivering these solutions and have already secured MMO and crown estate licensing.
Outcome	Green	The combined catchment option is likely to deliver the phosphorus reductions needed in addition to a number of wider environmental benefits such as enhanced biodiversity, climate resilience and water purification in addition to volunteering and educational opportunities.
Cost	Red	Implementing these options is more costly than transfer/pump away option.
Resources	Green	Implementing these options could require a higher input of resources at the start of the delivery programme (i.e. this AMP cycle) in terms of staff time, training, purchasing of the resources etc. However, once up and running, the majority of these options should require less resource to maintain and it is likely that third parties such as the Catchment Hub would oversee and manage this.
Technology	Green	These options are relatively low risk for technology.
Supply chain	Amber	Risk of disruption from extreme weather/ climate change, disease, parasites etc
Public perception	Green	Potential to increase our positive environmental impact and influence through this project, which would be a positive opportunity. This is an innovative approach and we could be seen as leaders in using this type of solution to address nutrient loading.

Source: Northumbrian Water

The main risks for the preferred catchment and nature-based options are delivery, cost, technology, supply chain and public perception and compliance. Compliance and delivery are inherent risks for nature-based solutions which are offset by the low risks associated with technology and resources. Working with the NECH to deliver the nature-based solutions will reduce the impact on delivery, costs and resources and improve the chances of realising the stated benefits.

To mitigate the risk for customers, we have included as part of our adaptive pathway approach, the ability to use (grey) solutions from AMP9 where C&NBS are shown not to deliver sufficient improvement within the required timeframe (in our long-term strategy, NES_LTDS).

3.6. THIRD PARTY FUNDING

We include one partnership scheme in our WINEP submission for nutrients, for Pallins Burn. This is a small project which will be co-funded by partners through the Tweed Forum and which will be delivered early. The WFD catchment solutions will be facilitated by innovative catchment permitting, to include all numeric STWs more than 250 PE in these six catchments.

Design, delivery, and management of the C&NBS solutions will be led by the NECH, supported by the Rivers Trust and our environmental experts, and other catchment partners. The NECH is learning and developing from its first year of activity in 2022 and will upskill and upscale within the AMP7 enabling stage to make sure it has the capacity and capability to manage this and other catchment projects across AMP8 and beyond.

Within AMP8, the NECH is also expected to assist in delivery of the schemes and WFD investigations included in this enhancement case. There are also opportunities for co-design and delivery of the treatment wetlands at Stainton and Belford STWs currently not identified as partner schemes but (elements of) which are nature-based solution schemes.

C&NBS offer the opportunity for water companies to draw in co-funding and co-finance which could make improvement schemes more cost-effective for customers, while also delivering greater value through multiple benefits. The development of these high-benefit schemes requires time and feasibility activities, and the tight WINEP timescales for PR24 have only allowed identification of potential schemes at a high level. Our approach has been to use the NECH to identify opportunities and provide a sufficient level of detail to include these as options in the ODRs, allowing high level assessment of the likely costs and benefits of C&NBS. As schemes develop through the enabling stages into detailed design, and co-benefits and partners are identified, matched funding and green finance opportunities will be explored. Schemes progressed in North West England have demonstrated how this can work in practice, and the Rivers Trust is sharing this learning to inform our North East projects.

We anticipate that our programme of catchment solutions could draw in at least £5m to drive integrated catchment management in the North East. In AMP 8, the North East Catchments Hub is expected to be co-funded linked to green finance and partner funded shared objectives. The Hub is currently worth £800k per year in core costs, and is expected to expand to support the wider AMP8 programme across other WINEP drivers, plus there is additional value in project delivery, outcomes monitoring etc. Confirmed funding for AMP7 Year 4 and 5 is £150,000 from the Mainstreaming nature based solutions Ofwat innovation project, and £50,000 from local partners to support delivery of integrated catchment approaches. These initial co-funding contributions are just the start of the likely leverage of our approach.

3.7. DIRECT PROCUREMENT FOR CUSTOMERS

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

3.8. CUSTOMER VIEWS INFORMING OPTION SELECTION

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

We also asked customers about their support for investment in nature-based solutions rather than engineering solutions. In our People Panels research, we discussed our options for tackling nutrient neutrality across Lindisfarne and Teesmouth. Customers did 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 considered this important (**line-of-sight**, NES45).

In our **qualitative affordability and acceptability testing** (NES49), customers supported our “preferred” plan which included these phosphorus 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 phosphorus (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 is strongly supported by customers and stakeholders.

4. COST EFFICIENCY

4.1. APPROACH TO COSTING

4.1.1 Cost methodology

A full description of our costing methodology is contained in Appendix A3 - Costs (NES04). In Figure 5, our project estimates have been costed to Level 2. 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. A level 3 estimate would require a level of detailed design to be carried out which would incur significantly more cost which is not appropriate until delivery is confirmed.

A sample of WFD driver project estimates produced as part of the PR24 costing process have been benchmarked against comparable water and wastewater companies. We have selected six projects within this enhancement case and in NES39-A3-25-WINEP Chemicals and Emerging Contaminants, at varying costs across the identified range of solution costs and technologies to compare against the industry position for these projects.

The sample projects that have been benchmarked can be seen in Table 31.

TABLE 31: BENCHMARKED NORTHUMBRIAN WASTEWATER PROJECTS

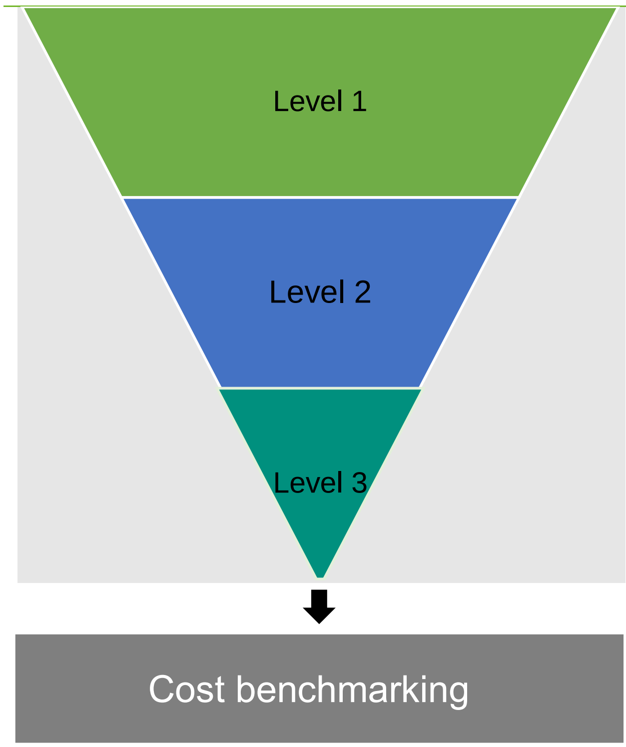
Project reference	Project name
7.1	Bishop Auckland STW NH3
7.2	East Tanfield STW
7.3	Aycliffe STW
7.4	Stokesley STW Cypher
7.5	Willington STW

The benchmarking exercise compares our estimated costs against six comparable water and wastewater companies from England and Wales. A mean average of these companies has been used as the benchmark with a 25% percentile and 75% percentile provided as a suitable range.

The costs comparisons have been calculated using each company's latest cost curve database. This should provide a suitable comparison as these cost curve databases have been used to build up each company's PR24 submission. The costs generated by each cost curve are based on the sizing information included in each WFD project estimate. The benchmarked costs have been adjusted for inflation using CPIH and have a price base of Q2 2022.

A summary of the benchmarking has been provided in the next section along with a more detailed breakdown for each project.

FIGURE 5: PROCESS COST ESTIMATION



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

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

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

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

Level – 3 (confidence: - 20% to +30%)
Detailed bottom-up cost of all items taking into consideration factors such as ground conditions.

Cost benchmarking
We have benchmarked our preferred options against the available cost curves from other companies.

4.1.2 Cost benchmarking

For WFD needs, we benchmarked several options against comparable water and wastewater companies for direct 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. The following table 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.

TABLE 32: BENCHMARK OF DIRECT COSTS

Investment Name	Option Type	Northumbrian £	Benchmark £	Delta[25] £	Delta %[26]
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%**

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 33 shows that our indirect costs are calculated as 63.40% of direct costs which is 10.46% below the industry benchmark.

TABLE 33: 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%

[25] Delta = Northumbrian – Benchmark
[26] Delta % = Delta ÷ Benchmark

The WFD programme is currently 5% below the industry benchmark when including indirect costs to the original direct costs as showed in Table 34 (below). With many items benchmarked, most of them across three other companies, there is confidence that the items identified have been analysed robustly.

TABLE 34: SUMMARY FOR WFD INCLUDING INDIRECT COSTS

Investment Name	Option	Northumbrian	Benchmark	Delta[25]	Delta %[26]
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%**

4.1.3 Factors affecting cost allowance

The costing was carried out in line with our PR24 Costing Methodology. Scopes were developed for the various solutions and issued to the costing team. The costing team used iMOD model cost curves to the scope to generate level 2 estimates of capex and opex, including risk, overheads and estimating contingency. A 30-year whole life cost NPV was calculated using the Spackman method, which considers annual opex, ICA capex every 10 years and M&E capex every 20 years with the social time preference rate as specified in The Green Book (HM Treasury, 2020). An allowance was included within each individual solution's cost for estimating uncertainty. The allowance will make provision for areas such as availability of cost data, assumptions, and time to deliver.

Ofwat is anticipating that a new enhancement model will be developed for growth at STWs which would impact WFD_ND, U_IMP 1 and U_IMP2. We await the new information that will be visible in that analysis at the Draft Determination.

5. CUSTOMER PROTECTION

5.1. PERFORMANCE COMMITMENT

The ability of the STWs 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 the calendar year and has an underperformance payment should the commitment not be achieved.

Compliance against dry weather flow permit measure is not currently covered by a performance commitment but these will become a statutory requirement which will form part of the Environment Agency's Environmental performance assessment during AMP8, leaving the companies open to prosecution should they fail to meet statutory requirements.

The reduction in phosphorus performance measure is the reduction in phosphorus emissions to river catchments relative to the base period as a result of the water company activities in delivering their functions. The base period is the annual average of 2020 to 2022 and the performance commitment is measured on a calendar year basis.

5.2. PRICE CONTROL DELIVERABLES

Our approach to determining Price Control Deliverables (PCD) is outlined in Section 12.3 of A3 – costs (NES04). In Table 35 below, we assess our WFD-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 35: ASSESSMENT OF BENEFITS AGAINST THE PCD CRITERIA

Enhancement scheme	Benefits linked to PC?	Materiality	Possible outcomes?
WINEP – Phosphorus (NES13)	Partial fail – benefits to river water quality through phosphorus reduction	Pass - >>1%	Outcome difficult to measure effectively and vary between schemes (particularly investigations). Customers could be protected through an output measure based on delivery of schemes.

Source: Environment Agency

Our WINEP programme is set out by the Environment Agency which determines the statutory and non-statutory investments we should make. The Environment Agency assures that WINEP actions are delivered to the agreed timeframe, and environmental obligations are met. We therefore propose a PCD that makes sure that costs are returned to customers either where the Environment Agency has decided that a project is no longer required, or where we have not delivered to the agreed timeframe and/or environmental obligations have not been met (according to the Environment Agency). A summary of our PCD for WINEP programme delivery is outlined in Table 36.

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TABLE 36: 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**.
Measurement and reporting	We will report on the delivery of WINEP projects at the next price review (PR29), including specifying the individual projects that have been delivered, not delivered, or that the Environment Agency has decided are no longer required (under the Environment Agency's WINEP alterations process). This is in addition to the WINEP guidance which specifies how we will need to report progress against delivery of the WINEP actions, and tracking and reporting WINEP delivery in a transparent and auditable manner.
Conditions on allowance	Projects must be delivered to the specification agreed with the Environment Agency under WINEP.
Assurances	The Environment Agency will confirm that WINEP actions have been delivered to the agreed timeframe, and that environmental obligations have been met. As set out in the WINEP guidance, there will be regular liaison between water companies and the Environment Agency to discuss progress, risks and issues associated with the delivery of the WINEP programme and to identify any alterations. The Environment Agency uses the WINEP measures sign-off, technical review and audit guidance for assurance that the environmental obligations as set out in the WINEP are completed as planned.
Price control deliverable payment rate	We will return funds back to customers for individual projects not delivered by the dates specified.
Impact on performance in relation to performance commitments	There may be some benefits to biodiversity for some schemes in NES13.

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 Environment Agency has decided these are no longer required, which should not lead to a penalty. If we did not deliver a project that is required (and where we had not agreed a change with the Environment Agency), we would not meet our statutory obligations and so this does not require an extra incentive to deliver.
- **Change according to the Environment Agency's WINEP alterations process**. In 2020-25, our ODI for WINEP delivery does not automatically take into account projects that are removed from WINEP by the Environment Agency – but this should be for the Environment Agency to determine. Costs should be returned to customers for projects that are not required, without further interventions needed from Ofwat.

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

APPENDIX A: ODR SUBMISSION INFORMATION

A.1 SUMMARY OF ODR DOCUMENTS SHARED WITH DEFRA, EA AND OFWAT

Ofwat have access to the following documents via SharePoint Defra/EA SharePoint site - WINEP Drafting - NWL - Water Quality - Stage 3. Following further development since submission with EA, some schemes and costs have been updated as part of our PR24 submission, but methodology and approach and the assessment of evidence is still valid.

TABLE 37: FILES SHARED VIA DEFRA SHAREPOINT SITE

ODR Title
Appendix A. WFD & HD IMP P ODRs – P reduction schemes methodology
Appendix B. WFD & HD IMP P ODRs – PR24 WFD Catchment approach paper
Appendix C. WFD & HD IMP P ODRs – Wetland screening technical note
Appendix E. WFD & HD IMP P ODRs – C&NBS Rivers Trust Endorsement
Appendix D. WFD & HD IMP P ODR – C&NBS evidence summary_Branxton
Appendix D. WFD & HD IMP P ODR – C&NBS evidence summary_Clow Beck
Appendix D. WFD & HD IMP P ODR – C&NBS evidence summary_Embleton
Appendix D. WFD & HD IMP P ODR – C&NBS evidence summary_Leven
Appendix D. WFD & HD IMP P ODR – C&NBS evidence summary_Skerne
Appendix D. WFD & HD IMP P ODR – C&NBS evidence summary_South Low
Appendix D. WFD & HD IMP P ODR – C&NBS evidence summary_Wear
NW_Bothal Burn_WFD_ODR
NW_Branxton_WFD_ODR
NW_Clow Beck_WFD_ODR
NW_Derwent_WFD_ODR
NW_Embleton Burn_WFD_ODR
NW_Hawthorn Burn_WFD_ODR
NW_Percy Beck_WFD_ODR
NW_River Leven_WFD_ODR
NW_River Skerne_WFD_ODR
NW_River Team_WFD_ODR
NW_River Wear_WFD_ODR
NW_Sedgefield_WFD_ODR
NW_South Low_WFD_ODR
NW_Tees_WFD_ODR

APPENDIX B: CURRENT AND FUTURE PERFORMANCE BY STW

B.1 CURRENT PERFORMANCE

TABLE 38: STW CURRENT TOTAL PHOSPHORUS (TP) PERMITS AND PERFORMANCE, AND NEW P PERMITS REQUIRED (OR EQUIVALENT FOR CNB) TO MEET WFD GOOD STATUS AND NW FAIR SHARE IN AMP8, AS AGREED WITH EA

Catchment	STW	Current WFD Water body status	Current TP Permit (mg/l)	SAGIS 2022 Baseline TP Assumption	Current TP Performance (mg/l)	TP Permit limit required for WFD IMP in AMP8[27] (mg/l)
Pallins Burn	Branxton	Moderate	None	N/A[28]	N/A	N/A (0.02 kg/day required for waterbody)
South Low	Haggerston Castle	Moderate	n/a	3.8	4.7	2.1
Belford Burn	Belford	Moderate	1.5	1.5	1.2	0.25
Embleton Burn	Embleton	Poor	n/a	1.0	4.0	0.8 (2.0 for ND)
Wansbeck	Pegswood	Poor	None	5.8	-	0.25
	Morpeth	Good	2	2.0	1	0.25
South Tyne	Slaley Hall	Moderate	n/a	5.0	-	0.25
Derwent	Lockhaugh	High	2	2.0	0.9	0.6 (0.9 for ND)
River Team (P)	East Tanfield	Moderate	1	2.0	0.6	0.25
	Birtley	Moderate	None	Not used	3.7[29]	0.25
Hawthorn Burn (P)	Hawthorn	Poor	None	5.0	3.9	0.25
Percy Beck (P)	Stainton	Poor	None	5.0	5.3	0.5
River Wear (P)	Hamsterley	Moderate	-	5.0	5	0.8
	Tow law	Poor	-	3.2	4.5	0.25
	Low Wadsworth	Moderate[30]	2	2	1.5	0.25

[27] Based on SAGIS Optimiser 2022b model
[28] Small descriptive works not covered in SAGIS model
[29] Birtley STW already has a mine water co-treatment reedbed in place which performs at 0.2 mg/l TP annual average, currently unpermitted for P
[30] Wear from Beechburn Beck to Gaunless that this STW discharges into, not the waterbody the STW is physically located in.

Catchment	STW	Current WFD Water body status	Current TP Permit (mg/l)	SAGIS 2022 Baseline TP Assumption	Current TP Performance (mg/l)	TP Permit limit required for WFD IMP in AMP8[27] (mg/l)
	Browney	Moderate	2	2	0.8	0.25
	Bishop Auckland	Good	2	2	0.25	0.25
	Willington	Good	-	5	4	0.25
	Brancepeth	High	-	5	5	0.6
	Tudhoe Mill	Good	2	2	1.5	0.3
	Kelloe	Moderate	0.3	3.94	0.25	0.25
	Bowburn	Moderate	0.25	2	0.25	0.25
	University	Moderate	-	6.87	5	5
	Cassop	Poor	-	5	5	0.3
	Sherburn	High	0.5	3.42	0.25	0.25
	Barkers Haugh	Moderate	2	2	1.0	1.1
	Belmont	Moderate	2	2	0.9	0.25
	Brasside	Moderate	-	1.9	5	0.25
	Sacriston	Poor	0.25	1.07	0.25	0.25
	Edmondsley	Good	-	5	5	0.3
	Hustledown	Moderate	0.9	2	0.25	0.25
	Sedgeletch	Poor	1	1	0.7	0.25
	Chester le street	Moderate	2	2	1	1.1
Clow Beck	Aldbrough	Moderate	None	5.0	2.7	1.1
	Melsonby	Moderate	None	5.0	3.9	0.4
	Barton	Moderate	None	5.0	3.0	0.4
River Skerne (P)	Windlestone STW	Moderate	2	2.0	1.4	0.25
	Aycliffe STW	Poor	2	2.0	1.3	0.25
	Sadberge STW	Poor	n/a	5.0	6.2	0.25
River Leven (P)	Ingleby Greenhow	Moderate	None	5.0	5.05	1.3

Catchment	STW	Current WFD Water body status	Current TP Permit (mg/l)	SAGIS 2022 Baseline TP Assumption	Current TP Performance (mg/l)	TP Permit limit required for WFD IMP in AMP8[27] (mg/l)
	Great Broughton	Moderate	None	5.0	3.98	0.25
	Great Ayton	Moderate	1.0	1.0	0.4	0.4
	Stokesley	Moderate	1.0	1.0	0.3	0.25
	Carlton in Cleveland	Moderate	None	5.0	4.28	1.8
	Hutton Rudby	Moderate	None	5.0	4.91	2.9
River Tees (P)	Stressholme	Poor	No permit	3.7	5.8	0.25

TABLE 39: STW CURRENT AMMONIA PERMITS AND PERFORMANCE, AND NEW NH3 PERMITS REQUIRED TO MEET WFD GOOD STATUS AND NW FAIR SHARE

Catchment	STW	Water body status for ammonia	Current NH3 Permit	NH3 performance 95%ile	Proposed NH3 permit[31] (mg/l) WFD_IMP
River Team catchment improvement (Ammonia)	East Tanfield	Moderate	2	0.2	Operating Technics Agreement
	Birtley	Moderate	40	4.7	
	Birtley reedbed	Moderate	No permit	0.621	
River Tees catchment improvement (Ammonia)	Sedgefield	High	5	3.2	1

[31] Based on SAGIS Optimiser 2022b model

APPENDIX C: WFD_IMP UNCONSTRAINED OPTIONS SCREENING: PHOSPHORUS & AMMONIA REDUCTION SCHEMES

C.1 BELFORD BURN (08NW100189)

TABLE 40: BELFORD BURN UNCONSTRAINED OPTION SCREENING

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 treats the incoming wastewater.	No	No	DISCARDED for Belford STW as technology will not achieve phosphorus permit.
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.	Unclear	Unclear	DISCARDED – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for Belford STW with ferric dosing expanded to second dose point.
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward **for Belford STW** DISCARDED at secondary screening as site has existing ferric dosing process, more cost effective to expand existing process than to install new asset
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward for Belford STW DISCARDED at secondary screening as other filter technologies are more cost effective for smaller sites
Treatment process-based permitting: CoMag 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 for Belford STW DISCARDED at secondary screening – Belford STW is too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Belford STW DISCARDED at secondary screening – Belford STW does not have an existing ASP. Installing BioMag would require a complete rebuild and would not be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites with ASPs is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Belford STW DISCARDED at secondary screening – Belford STW does not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASPs is the technology cost effective.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Belford STW DISCARDED at secondary screening No suitable water body which would provide sufficient dilution within 5 km to accept a transfer. Adjacent water bodies are at moderate status and no. Waren

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
			Burn is within 1.6km but discharges to Lindesfarn SSSI and does not provide sufficient dilution to accept more flow..
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Belford STW DISCARDED at secondary screening There is only Belford and Warren Mill STW (PE <50) within 5km of each other. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, two pipeline routes) compared to expanding tertiary assets at the existing works. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body, adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to expanding tertiary assets at the existing works. The benefits to water quality will be the same. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward for Belford STW DISCARDED at secondary screening No other STW within 5km with greater than 10% headroom capacity to receive flows.
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	Yes	Yes	Carried Forward for Belford STW existing ferric dosing shall be expanded for a second dose point.
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 for Belford STW in combination with use of the existing ferric dosing on site.
Catchment permitting for nutrients 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).	No	No	DISCARDED - not feasible as there is only one STW in the catchment
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED The proportion of trade effluent is <5% and removal of this trade effluent will not be sufficient a phosphorus permit of 0.25mg/l.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED Headroom required to support growth in Belford. Catchment has been identified as a site with growth >10%
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	No	No	DISCARDED Very high STW contribution to overall phosphorus loading (98%) means that a catchment solution will not achieve the required phosphorus load reductions
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	DISCARDED– will not achieve phosphorus load reductions required
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED - will not achieve the phosphorus permit.

C.2 BOTHAL BURN (08NW100195)

TABLE 41: BOTHAL BURN UNCONSTRAINED OPTION SCREENING

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 treats the incoming wastewater.	No	No	**DISCARDED** for Pegswood STW as technology will not achieve phosphorus permit.
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.	Unclear	Unclear	**DISCARDED** – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for Pegswood STW **DISCARDED** at secondary treatment as site already has a Deep Bed Filter, more cost effective to extend existing treatment than replace with new
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	**Carried forward for Pegswood STW with expansion of existing Deep Bed Filter**
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward for Pegswood STW **DISCARDED** at secondary treatment as site already has a Deep Bed Filter, more cost effective to extend existing treatment than replace with new
Treatment process-based permitting: CoMag 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 for Pegswood STW **DISCARDED** at secondary screening – Pegswood STW is too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Pegswood STW **DISCARDED** at secondary screening – Pegswood STW does not have an existing ASP. Installing BioMag would require a complete rebuild and would not be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites with ASPs is the technology cost effective.

Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Pegswood STW **DISCARDED** at secondary screening– Pegswood STW does not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASPs is the technology cost effective.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	**Carried forward.** Pegswood STW transfer to the River Wansbeck. This will need to be combined with ferric dosing to reduce phosphorus load in River Wansbeck
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Pegswood STW **DISCARDED** at secondary screening There is only Pegswood and Morpeth within 5km of each other. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, two pipeline routes) compared to construction of extra tertiary assets at the existing works or a single transfer pipeline. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body, adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works or a single transfer pipeline. The benefits to water quality will be the same. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	**Carried forward.** Pegswood STW transfer to Morpeth STW (which has a growth driver under AMP8)
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	Yes	Yes	**Carried forward** for Pegswood STW to Expand tertiary processes with addition of 2 point ferric dose point and expand existing deep bed filter.
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** for Pegswood STW with the requirement of ferric dosing to reduce phosphorus load on wetland.
Catchment permitting for nutrients 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).	No	No	**DISCARDED** for Pegswood STW **O**nly one STW within catchment, no opportunity to balance permits across several treatment plants.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	**DISCARDED** The trade effluent proportion of the flow is <10% of the overall flow and thus removing the trade flow would not be sufficient to provide the reduction in phosphorus loading required to hit the permit.

DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	**DISCARDED** for Pegswood STW. Not sufficient headroom in the STW to allow DWF sacrifice to achieve a phosphorus permit of 0.25mg/l.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	No	No	**DISCARDED** - Contingent on catchment solution which is not feasible due to it not achieving load reductions required to achieve good status
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	**DISCARDED** for Pegswood STW – will not achieve load reductions required to achieve good status
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	**DISCARDED** for Pegswood STW The site doesn't have existing phosphorus removal technology that could be optimised to meet the phosphorus permit

C.3 CLOW BECK (08NW100203)

TABLE 42: CLOW BECK UNCONSTRAINED OPTION SCREENING

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 treats the incoming wastewater.	Yes	Yes	Carried forward for Aldborough, Barton and Melsonby STW with ferric dosing DISCARDED at secondary screening for Barton and Melsonby STW as technology will not achieve phosphorus permits.
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.	Unclear	Unclear	DISCARDED – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for Aldborough, Barton and Melsonby STW with ferric dosing
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward for Aldborough, Barton and Melsonby STW with Mecana filters
Treatment process-based permitting: Deep **bed filter** Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward for Aldborough, Barton and Melsonby STW DISCARDED at secondary screening as other filter technologies are more cost effective for smaller sites. D**ISCARDED** at secondary screening for Aldborough STW because technology not required to achieve the permit value.
Treatment process-based permitting: CoMag 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 for Aldborough, Barton and Melsonby STW DISCARDED at secondary screening - Aldborough, Barton and Melsonby STW are too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Aldborough, Barton and Melsonby STW DISCARDED at secondary screening– Aldborough, Barton and Melsonby STW do not have an existing ASP. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites with ASPs is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Aldborough, Barton and Melsonby STW DISCARDED at secondary screening– Aldborough, Barton and Melsonby STW do not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASPs is the technology cost effective.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Aldborough, Barton and Melsonby STW (Barton STW to transfer to Clow beck)

			DISCARDED at secondary screening for Aldborough STW and Melsonby STW because no larger waterbody within 5km of the site to receive flows.
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Aldborough, Barton and Melsonby STW DISCARDED at secondary screening. The cost of transferring the flow from Aldborough, Melsonby and Barton and then building one new larger STW is expected to be more costly than other treatment options. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to other treatment options. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body, adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to other treatment options. The benefits to water quality will be the same as other treatment options. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward for Barton STW (Transfer to Stressholme STW) DISCARDED at secondary screening for Aldborough and Melsonby because no other STW with 5km with greater than 10% headroom capacity
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	No	No	DISCARDED No existing phosphorus removal technology to expand to meet the permit requirements.
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 for Aldborough STW, Barton STW and Melsonby STW
Catchment permitting for nutrients 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 (as part of catchment solution)
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED for Aldborough, Barton and Melsonby STW No trade effluent at any of the sites
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED for Aldborough, Barton and Melsonby STW Not sufficient headroom in the STW to allow DWF sacrifice to achieve a phosphorus permit of 0.25mg/l.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	Yes	Carried forward (as part of catchment solution)
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	DISCARDED for Aldborough, Barton and Melsonby STW – will not achieve load reductions required
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED for Aldborough, Barton and Melsonby STW The sites do not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit.

C.4 PALLINS BURN – BRANXTON (08NW100187)

TABLE 43: PALLINS BURN UNCONSTRAINED OPTION SCREENING

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 treats the incoming wastewater.	Yes	Yes	Carried forward for Branxton DISCARDED at secondary screening. Permit limit can be achieved without use of a reed bed
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.	Unclear	Unclear	DISCARDED – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for Branxton DISCARDED at secondary screening. Permit limit can be achieved without use of a Tertiary Cloth Filter.
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward for Branxton STW
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward for Branxton STW DISCARDED at secondary screening. Permit limit can be achieved without use of a Deep bed Filter.
Treatment process-based permitting: CoMag Ballasted coagulation is a tertiary treatment system and is an alternative to tertiary filtration processes. 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 for Branxton STW DISCARDED at secondary screening – Branxton STW is too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Branxton STW DISCARDED at secondary screening – Branxton STW does not have an existing ASP. Installing BioMag would require a complete rebuild and would not be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites with ASPs is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Branxton STW DISCARDED at secondary screening – Branxton STW is too small (PE<30,000) for this technology to be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs methanol dose). BNR would still require ferric dose which is carried forward above. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators/ mixers. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASPs is the technology cost effective.
Change outfall location: Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course)	Yes	Yes	Carried forward. Transfer Branxton final effluent to River Till

Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Branxton STW DISCARDED at secondary screening. There is only Branxton and Milfiled within 5km of each other. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, two pipeline routes) compared to a single transfer pipeline. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the waterbody, adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to a single transfer pipeline. The benefits to water quality will be the same as a single transfer pipeline. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of to a single transfer pipeline.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom	Yes	Yes	Carried forward. Transfer Branxton STW flow to Milfield STW
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	No	No	DISCARDED for Branxton STW No existing phosphorus removal technology to expand to meet the permit requirements.
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 for Branxton STW DISCARDED at secondary screening – Branxton is a small descriptive works, the small load reductions required mean that the site is more suited to a catchment wetland option, which was developed as part of the catchment solution (see below). This is a smaller scale and cheaper option than an ICW, with evidence suggesting this would be sufficient to achieve the required phosphorus load reduction for the catchment.
Catchment permitting for nutrients Flexible permit limits across all STWs discharging to a river. All STW s 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).	No	No	DISCARDED – Branxton is the only STW impacting the river status in Pallins Burn therefore there is no opportunity to balance loads across several treatment plants through catchment permitting.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED for Branxton STW – there is no trade effluent in this catchment.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED for Branxton STW – Site not currently permitted therefore would not be possible to accept a headroom sacrifice.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	Yes	Carried forward for Branxton STW DISCARDED from secondary screening as nutrient balancing for such a small phosphorus load reduction would not be cost beneficial compared to catchment habitat creation below.
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	Yes	Yes	Carried forward for Branxton STW
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED for Branxton STW. The site does not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit.

C.5 PERCY BECK (08NW100201)

TABLE 44: PERCY BECK UNCONSTRAINED OPTION SCREENING

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed 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 treats the incoming wastewater.	No	No	DISCARDED for Stainton STW as technology will not achieve phosphorus permit.
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.	Unclear	Unclear	DISCARDED for Stainton STW – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter (Tertiary Solids Removal) Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for Stainton STW with 2 point ferric dosing
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward for Stainton STW with Mecana filter
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward for Stainton STW **DISCARDED** at secondary screening as other filter technologies are more cost effective for smaller sites.
Treatment process-based permitting: CoMag Ballasted coagulation is a tertiary treatment system and is an alternative to tertiary filtration processes. 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 for Stainton STW DISCARDED at secondary screening – Stainton STW is too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Stainton STW DISCARDED at secondary screening – Stainton STW does not have an existing ASP. Installing Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites with ASPs is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Stainton STW DISCARDED at secondary screening – Stainton STW does not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASPs is the technology cost effective.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Stainton STW DISCARDED at secondary screening - No suitable larger water body within 5 km to receive flows.

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Stainton STW DISCARDED at secondary screening There is only Stainton and Barnard Castle within 5km of each other. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, two pipeline routes) compared to the transfer of Stainton to Barnard Castle STW. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to the transfer of Stainton to Barnard Castle STW. The benefits to water quality will be the same. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward for Stainton STW Transfer Stainton STW to Barnard Castle STW
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	No	No	DISCARDED No existing phosphorus removal technology to expand to meet the permit requirements.
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 for Stainton STW Wetland to be combined with single point dosing to achieve the permit
Catchment permitting for nutrients 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).	No	No	DISCARDED –Stainton is the only STW impacting the river status in Percy Beck therefore there is no opportunity to balance loads across several treatment plants through catchment permitting.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED for Stainton STW No trade effluent
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED for Stainton STW Not sufficient headroom in the STW to allow DWF sacrifice to achieve a phosphorus permit of 0.25mg/l.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	No	DISCARDED The high phosphorus load reductions required, and high STW contribution to phosphorus loading (80%), means that a catchment solution will not achieve required reductions
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	Yes	No	DISCARDED for Stainton STW – will not achieve load reductions required to reach good status
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED for Stainton STW The site does not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit.

C.6 RIVER LEVEN (08NW100207)

TABLE 45: RIVER LEVEN UNCONSTRAINED OPTION SCREENING

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 treats the incoming wastewater.	Yes	Yes	Carried forward for Carlton on Cleveland STW. DISCARDED at secondary screening for Ingleby Greenhow, Great Broughton and Hutton Rudby STW as technology will not achieve phosphorus permits.
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.	Unclear	Unclear	DISCARDED for Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs. – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward from primary screening for Ingleby Greenhow, Great Broughton and Hutton Rudby STWs with 2-point ferric dosing. DISCARDED at secondary screening for Carlton in Cleveland STW technology is not required to meet phosphorus limit.
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward for Ingleby Greenhow, Great Broughton and Hutton Rudby STWs with Mecana filters. Carried forward for Carlton in Cleveland STW.
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs DISCARDED at secondary screening as other filter technologies are more cost effective for smaller sites. DISCARDED at secondary screening at Carlton in Cleveland STW technology is not required to meet phosphorus limit.
Treatment process-based permitting: CoMag 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 Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs DISCARDED at secondary screening Ingleby Greenhow, Great Broughton and Hutton Rudby STW are too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective. DISCARDED at Carlton in Cleveland STW technology is not required to meet phosphorus limit.

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs DISCARDED at secondary screening based on the size of Ingleby Greenhow STW. The STW is too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective. DISCARDED at secondary screening at Carlton in Cleveland, Great Broughton and Hutton Rudby STWs do not have an existing ASP. Installing a Biomag would require a complete rebuild and would not be cost effective. Benefits to water quality and other natural capital measures are the same as traditional. Only at larger sites with ASPs is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward from primary screening for Ingleby Greenhow STW as it has an ASP. DISCARDED at secondary screening based on the size of Ingelby Greenhow STW. The STW is too small (PE<30,000) for this technology to be cost effective. BNR in all cases costs more to operate (due to higher energy costs) than other tertiary treatment technologies. DISCARDED at secondary screening at Carlton in Cleveland, Great Broughton and Hutton Rudby STW do not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. Benefits to water quality and other natural capital measures are the same as traditional. Only at larger sites with ASPs is the technology cost effective.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs DISCARDED at secondary screening effluent would require to be transferred out of the catchment as all water bodies in the catchment at poor/bad status.
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs DISCARDED at secondary screening Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to construction of extra tertiary assets at the existing works or transfer flows for one site. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping multiple flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works. The benefits to water quality will be the same as extra tertiary treatment. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward from primary screening for three STW (Ingleby Greenhow transfer to Great Ayton STW, Carlton in Cleveland transfer to Stokesley STW and Great Broughton to Stokesley STW) DISCARDED at secondary screening for Hutton Rugby because it is more than 5km from the nearest STW site.

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	No	No	DISCARDED for Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs.No existing phosphorus removal technology to expand to meet the permit requirements.
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 for Ingleby Greenhow, Great Ayton, Carlton in Cleveland and Hutton Rudby STW. Ingleby Greenhow, Great Ayton and Hutton Rudby STW would require ferric dosing upstream of the wetland. Carlton in Cleveland STW only requires a wetland.
Catchment permitting for nutrients 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 as part of catchment solution
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED for Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs.No trade effluent at any of the sites
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED for Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs. Not sufficient headroom in the STW to allow DWF sacrifice to achieve a phosphorus permit of 0.25mg/l.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	Yes	Carried forward
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	DISCARDED for Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs. – will not achieve load reductions required
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED for Ingleby Greenhow, Great Broughton, Carlton in Cleveland and Hutton Rudby STWs. The site does not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit.

C.7 RIVER SKERNE (08NW100204)

TABLE 46: RIVER SKERNE UNCONSTRAINED OPTION SCREENING

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 treats the incoming wastewater.	No	No	DISCARDED at Sadberge, Aycliffe and Windlestone STW as technology will not achieve phosphorus permits.
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.	Unclear	Unclear	DISCARDED at Sadberge, Aycliffe and Windlestone STW – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward at Sadberge STW with 2-point ferric dosing. DISCARDED at Aycliffe STW at secondary screening as other filter technologies are more cost effective for larger sites. DISCARDED at Windlestone STW at secondary screening as site has existing Deep bed filter process, more cost effective to expand existing process than to install new asset
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward at Sadberge STW with Mecana filter. DISCARDED at Aycliffe STW and Windlestone STW at secondary screening as site has existing ferric dosing process, more cost effective to expand existing process than to install new asset
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward at Aycliffe STW with 2-point ferric dosing. DISCARDED at secondary screening for Sadberge as other filter technologies are more cost effective for smaller sites. DISCARDED at Windlestone STW secondary screening as site has existing Deep bed filter process, more cost effective to expand existing process than to install new asset
Treatment process-based permitting: CoMag 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 for Aycliffe STW with 2-point ferric dosing DISCARDED at secondary screening at Sadberge and Windlestone. STWs are too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.

Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward at Sadberge, Aycliffe and Windlestone STW DISCARDED at secondary screening at Sadberge and Windlestone. STWs do not have an existing ASP. Installing Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective. DISCARDED from secondary screening at Aycliffe STW on advice of Biomag technology supplier. Risk to compliance of phosphorus permit. CoMag or other tertiary treatment would be required.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Aycliffe STW with 2-point ferric dosing. DISCARDED at secondary screening at Sadberge and Windlestone STWs do not have an existing ASP. Installing BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital, they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASPs is the technology cost effective.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Sadberge, Aycliffe and Windlestone STW DISCARDED at secondary screening No suitable larger water body within 5km to receive flows. All water bodies within the local area are at moderate status and moving the effluent discharge location would not remove a phosphorus permit limit.
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Sadberge, Aycliffe and Windlestone STW DISCARDED at secondary screening The cost of transferring the flow from Sadberge, Aycliffe and Windlestone STW and then building one new larger STW is expected to be more costly than other treatment options at each of the STW Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to construction of other treatment options . In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to other treatment options. The benefits to water quality will be the same as other treatment options. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of other treatment options.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	No	No	DISCARDED for Sadberge, Aycliffe and Windlestone STW No other STW within 5km with < 10% capacity
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	Yes	Yes	Carried forward for Windlestone STW and Aycliffe STW. Expand existing ferric dosing assets Both of these sites have ferric dosing which could be expanded for a second dose point. . Windlestone STW has an existing tertiary Deep bed filter asset that can be expanded
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 for Sadberge, Aycliffe and Windlestone STW DISCARDED through secondary screening. Not feasible at any of the three STW due to lack of land availability

Catchment permitting for nutrients 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 as part of catchment solution
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED for Sadberge, Aycliffe and Windlestone STW. The only site with trade effluent is Aycliffe STW and this is less than 1% of the flow. Removing the impact of the phosphorus loading from the trade effluent will not be sufficient to achieve the WFD good water body status
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED for Sadberge, Aycliffe and Windlestone STW Not sufficient headroom in the STW to allow DWF sacrifice to achieve a phosphorus permit of 0.25mg/l.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	Yes	Carried forward
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	DISCARDED for Sadberge, Aycliffe and Windlestone STW – will not achieve load reductions required
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED Aycliffe and Windleston STW have existing phosphorus removal technology, but optimisation of the assets will fail to meet the new phosphorus limit. New assets are required. DISCARDED Sadberge STW does not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit.

C.8 SOUTH LOW (08NW100188)

TABLE 47: SOUTH LOW UNCONSTRAINED OPTION SCREENING

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 treats the incoming wastewater.	No	No	DISCARDED for Haggerston Castle STW and Lowick STW as technology will not achieve phosphorus permits.
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.	Unclear	Unclear	DISCARDED for Haggerston Castle STW and Lowick STW – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for Haggerston Castle STW and Lowick STW with ferric dosing
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward for Haggerston Castle STW and Lowick STW with Mecana filter
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward for Haggerston Castle STW and Lowick STW DISCARDED at secondary screening for Haggerston Castle STW and Lowick STW as other filter technologies are more cost effective for smaller sites.
Treatment process-based permitting: CoMag 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 for Haggerston Castle STW and Lowick STW DISCARDED at secondary screening – Haggerston Castle STW and Lowick STW are too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Haggerston Castle STW and Lowick STW DISCARDED at secondary screening at Lowick STW does not have an existing ASP. Installing BNR would require a complete rebuild and would not be cost effective. DISCARDED at secondary screening at Haggerston Castle STW is too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites with ASPs is the technology cost effective
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Haggerston Castle STW and Lowick STW DISCARDED at secondary screening at Lowick STW does not have an existing ASP. Installing BNR would require a complete rebuild and would not be cost effective. DISCARDED at secondary screening at Haggerston Castle STW is too small (PE<30,000) for this technology to be cost effective BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASPs is the technology cost effective.
Change outfall location	Yes	Yes	Carried forward for Haggerston Castle STW and Lowick STW

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).			DISCARDED at secondary screening. No suitable water body within 5 km to receive flows.
Centralise STWs Combine two or more STWs into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Haggerston Castle STW and Lowick STW The cost of transferring the flow from Haggerston Castle STW and Lowick STW and then building one new larger STW is expected to be more costly than other treatment options at each of the STW Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to construction of extra tertiary assets at the existing works. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works. The benefits to water quality will be the same as other treatment options. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STWs into an existing larger works with dry weather flow (DWF) headroom.	No	No	DISCARDED for Haggerston Castle STW and Lowick STW No other STW within 5km with greater than 10% headroom capacity to receive flows
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	No	No	DISCARDED for Haggerston Castle STW and Lowick STW No existing phosphorus removal technology to expand to meet the permit requirements.
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 at Haggerston Castle STW and Lowick STW. Both sites would require ferric dosing upstream of the wetland.
Catchment permitting for nutrients 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 as part of catchment solution
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED for Haggerston Castle STW and Lowick STW No trade effluent at Lowick STW and the trade effluent at Haggerston is seasonal and linked to a caravan park which operates during the summer.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED for Haggerston Castle STW and Lowick STW Not sufficient headroom in the STW to allow DWF sacrifice to achieve a phosphorus permit of 0.25mg/l.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	Yes	Carried forward
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	DISCARDED for Haggerston Castle STW and Lowick STW – will not achieve load reductions required
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED for Haggerston Castle STW and Lowick STW. Neither site have any existing phosphorus removal technology which could be optimised to achieve the phosphorus permit.

C.9 RIVER TEAM (08NW100197)

TABLE 48: UNCONSTRAINED OPTION SCREENING FOR RIVER TEAM – PHOSPHORUS REMOVAL

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 treats the incoming wastewater.	No	No	DISCARDED for East Tanfield STW. Technology will not achieve permit at East Tanfield and Birtley STW.
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.	Unclear	Unclear	DISCARDED – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for East Tanfield and Birtley STW DISCARDED at secondary screening for East Tanfield STW as site already has a Deep Bed Filter, more cost effective to extend existing treatment than replace with new. DISCARDED at secondary screening for Birtley STW, effluent passes through a reedbed (jointly owned and operated with the coal authority). The effluent is blended with mine water downstream of the reedbed and is close to meeting the permit. A cloth filter is not required to meet permit. More cost effective to apply for OTA (Operating Technique Allowance) with East Tanfield performance than install new assets.
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward at East Tanfield and Birtley STW DISCARDED at secondary screening for Birtley STW, effluent passes through a reedbed (jointly owned and operated with the coal authority). The effluent is blended with mine water downstream of the reedbed and is close to meeting the permit. Ferric dosing is not required to meet permit. More cost effective to apply for OTA (Operating Technique Allowance) with East Tanfield performance than install new assets. DISCARDED at secondary screening for East Tanfield STW as site already has ferric dosing, more cost effective to extend existing treatment than replace with new.
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward at East Tanfield and Birtley STW DISCARDED at secondary screening for Birtley STW, effluent passes through a reedbed (jointly owned and operated with the coal authority). The effluent is blended with mine water downstream of the reedbed and is close to meeting the permit. A deep bed filter is not required. More cost effective to apply for OTA (Operating Technique Allowance) with East Tanfield performance than install new assets. DISCARDED at secondary screening for East Tanfield STW as site already has a Deep Bed Filter, more cost effective to extend existing treatment than replace with new.

Treatment process-based permitting: CoMag Ballasted coagulation is a tertiary treatment system and is an alternative to tertiary filtration processes. 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 at East Tanfield and Birtley STW DISCARDED at secondary screening for Birtley STW, effluent passes through a reedbed (jointly owned and operated with the coal authority). The effluent is blended with mine water downstream of the reedbed and is close to meeting the permit. CoMag tertiary treatment is not required. More cost effective to apply for OTA (Operating Technique Allowance) with East Tanfield performance than install new assets. DISCARDED. at secondary screening for East Tanfield STW as site already has a Deep Bed Filter, more cost effective to extend existing treatment than construct new tertiary treatment.
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward at East Tanfield and Birtley STW DISCARDED Birtley STW does not have an existing ASP. Installing BioMag would require a complete rebuild and would not be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective. Biomag tertiary treatment is not required. More cost effective to apply for OTA (Operating Technique Allowance) with East Tanfield performance than install new assets. DISC**ARDED**. at secondary screening for East Tanfield STW as site already has a Deep Bed Filter, more cost effective to extend existing treatment than construct new tertiary treatment.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward at East Tanfield and Birtley STW DISCARDED Birtley and East Tanfield STW do not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites is the technology cost effective. More cost effective to apply for OTA (Operating Technique Allowance) with East Tanfield performance than install new assets.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward at East Tanfield and Birtley STW. Birtley STW transfer to the Wear. DISCARDED at secondary screening for East Tanfield STW because no larger waterbody within 5km of the site.
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward at East Tanfield and Birtley STW The cost of transferring the flow from East Tanfield and Birtley STW and then building one new larger STW is expected to be more costly than extra ferric dosing and Deep bed filter at East Tanfield Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to construction of extra tertiary assets at the existing works. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if

			the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works. The benefits to water quality will be the same as extra tertiary treatment. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward at East Tanfield and Birtley STW DISCARDED at secondary screening for East Tanfield and Birtley STW because no other STW with 5km with greater than 10% headroom capacity
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	Yes	Yes	Carried forward for East Tanfield STW to Expand tertiary processes with addition of second ferric dose point and extra deep bed filter. DISCARDED at secondary screening for Birtley STW, no existing phosphorus removal technology to expand to meet the permit requirements.
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).	No	Yes	DISCARDED at East Tanfield and Birtley STW Insufficient land available at both sites for wetland.
Catchment permitting for nutrients 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). Operating Technique Agreement is the mechanism for catchment permitting	Yes	Yes	Carried forward for East Tanfield and Birtley STW. Operating Technique Agreement (OTA) to be used for catchment permitting between East Tanfield and Birtley STW.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED for East Tanfield and Birtley STW. The trade effluent proportion of the flow is <10% of the overall flow. Removing the impact of the phosphorus loading from the trade effluent will not be sufficient to achieve the WFD good water body status.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	Yes	Yes	Carried forward at East Tanfield and Birtley STW DISCARDED Not sufficient headroom in the STW to allow DWF sacrifice to achieve a phosphorus permit of 0.25mg/l.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting P load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	No	No	DISCARDED at East Tanfield and Birtley STW – High phosphorus load reductions required relative to the size of the catchment, high STW contribution, Load reduction not considered feasible via catchment measures due to low estimated agricultural contribution and no RNAGS for agricultural diffuse pollution.
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	DISCARDED at East Tanfield and Birtley STW – will not meet load reductions required
Operational solution **Optimisation of existing site assets to achieve new permit through operational activities**	No	No	DISCARDED for Birtley STW. The site does not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit. The effluent is blended with mine water downstream of the reedbed and is close to meeting the permit. DISCARDED for East Tanfield - Optimising of existing phosphorus removal assets are not sufficient to achieve phosphorus permit of 0.25mg/l.

TABLE 49: RIVER TEAM UNCONSTRAINED OPTION SCREENING – AMMONIA REMOVAL

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Nitrifying Submerged Aerated Filter Biological process where biomass grows on submerged media. The biomass consumes the nutrients within the wastewater. Air, provided by mechanical blowers is required to sustain the biomass.	Yes	Yes	Carried forward at Birtley STW DISCARDED at secondary screening at East Tanfield STW. Site currently meets permit, and no further investment is required.
Treatment process-based permitting: Nitrifying Trickling Filter Biological process where biomass grows on plastic media. Wastewater is distributed over the media and trickles down through the filter. The biomass consumes the nutrients within the wastewater Air naturally flows upwards through vents.	Yes	Yes	Carried forward at Birtley STW DISCARDED at secondary screening at East Tanfield STW. Site currently meets permit, and no further investment is required.
Treatment process-based permitting: Activated Sludge Plant Biological process where biomass grows within an aeration tank at a controlled concentration. Air, provided by mechanical blowers is required to sustain the biomass. Return activated sludge is recycled to maintain the biomass. Surplus activated sludge is removed from the process to control the concentration.	Yes	Yes	Carried forward at Birtley STW DISCARDED at secondary screening at East Tanfield STW. Site currently meets permit, and no further investment is required.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Birtley STW to transfer to Wear DISCARDED at secondary screening at East Tanfield STW. Site currently meets permit, and no further investment is required.
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for East Tanfield and Birtley STW DISCARDED at secondary screening. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to construction of extra tertiary assets at the existing works. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works. The benefits to water quality will be the same as extra tertiary treatment. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward for East Tanfield and Birtley STW DISCARDED for secondary screening for East Tanfield and Birtley STW because no other STW with 5km with greater than 10% headroom capacity
Replace/retrofit secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	Yes	Yes	Carried forward for Birtley STW Refurbishment/retrofit of the existing secondary treatment stone media filters to improve ammonia removal. DISCARDED at secondary screening at East Tanfield STW. Site currently meets permit, and no further investment is required.
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).	No	No	DISCARDED at East Tanfield and Birtley STW Insufficient land available at both sites for wetland.

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Catchment permitting for nutrients 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. Feasible between East Tanfield and Birtley STWs using an Operating Technique Agreement for the catchment permitting.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED for East Tanfield and Birtley STW. The trade effluent proportion of the flow is <10% of the overall flow.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	Yes	Yes	Carried forward at East Tanfield and Birtley STW DISCARDED Not sufficient headroom in the STW to allow DWF sacrifice to achieve an ammonia permit of 1mg/l.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting ammonia load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	No	No	DISCARDED Agricultural practice changes would not have significant impacts on ammonia loads to water bodies locally (ammonia emissions from agriculture are predominantly via volatilisation i.e., in gaseous form).
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce ammonia loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	DISCARDED – Catchment habitat creation/enhancement would not reduce ammonia loads to the water body Load reduction not considered feasible via catchment measures due to low estimated agricultural contribution and no RNAGS for agricultural diffuse pollution.
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	Carried forward- for East Tanfield. STW already achieves permit of 1mg/l ammonia. DISCARDED for Birtley STW. Extra investment will be required to achieve the permit value of 1mg/l

C.10 EMBLETON BURN (08NW100190):

TABLE 50: EMBLETON BURN UNCONSTRAINED OPTION SCREENING

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 treats the incoming wastewater.	No	No	DISCARDED for Embleton STW as technology will not achieve phosphorus permit.
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.	Unclear	Unclear	DISCARDED – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for Embleton STW DISCARDED from secondary screening technology not required to meet phosphorus permit. Furthermore, AMP 7 investment for Deep bed filter
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward for Embleton STW
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward for Embleton STW DISCARDED from secondary screening technology not required to meet phosphorus permit. Furthermore, AMP 7 investment for Deep bed filter
Treatment process-based permitting: CoMag Ballasted coagulation is a tertiary treatment system and is an alternative to tertiary filtration processes. 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 for Embleton STW DISCARDED at secondary screening –Embleton STW is too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Embleton STW DISCARDED at secondary screening – Embleton STW does not have an existing ASP. Installing BioMag would require a complete rebuild and would not be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites with ASPs is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Embleton STW DISCARDED at secondary screening – Embleton STW does not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASPs is the technology cost effective.

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Embleton STW Discarded at secondary screening no suitable larger water body within 5 km.
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Embleton STW DISCARDED at secondary screening for Embleton STW. There is Embleton, Rennington and Dunstan STW within 5km of each other. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to single point ferric dosing. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works. The benefits to water quality will be the same as extra tertiary treatment. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward for Embleton STW DISCARDED at secondary screening for Embleton STW because no other STW within 5km with greater than 10% headroom capacity
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	No	No	DISCARDED No existing phosphorus removal technology to expand to meet the permit requirements.
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 for Embleton STW
Catchment permitting for nutrients 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).	No	No	DISCARDED –Only one STW impacts the waterbody. No opportunity for catchment permit to balance permits across several treatment plants.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED No trade effluent at Embleton STW
DWF headroom sacrifice at STWs Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED Not sufficient headroom in the STW to allow DWF sacrifice to achieve a phosphorus permit of 0.25mg/l.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	Yes	Carried forward for Embleton STW
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	DISCARDED – will not achieve load reductions required

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED Embleton STW does not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit.

C.11 RIVER WEAR – 14 STWS (08NW100198):

TABLE 51: WEAR CATCHMENT UNCONSTRAINED OPTION SCREENING – PHOSPHORUS REMOVAL

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 for Barkers Haugh, Belmont, Bishop Auckland (Vinovium), Brasside, Cassop, Chester le Street, Edmonsley, Low Wadsworth, Sedgeletch, Tow Law, Tudhow Mill, University and Willington STW as technology will not achieve phosphorus permits. DISCARDED for Hamsterley STW technology is not required to meet phosphorus limit.
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 – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for Belmont, Brasside, Cassop, Chester le Street, Edmonsley, Low Wadsworth, Tow Law, Tudhow Mill, University and Willington STW with 2 point ferric dosing. DISCARDED for Hamsterley STW technology is not required to meet phosphorus limit. DISCARDED for Bishop Auckland, Barkers Haugh and Sedgeletch STW at secondary screening as other filter technologies are more cost effective for larger sites.
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward at Barkers Haugh, Belmont, Bishop Auckland (Vinovium), Brasside, Cassop, Chester le Street, Edmonsley, Hamsterley, Low Wadsworth, Sedgeletch, Tow Law, Tudhow Mill, University and Willington STW with Tertiary Solid Removal.
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward for Barkers Haugh, Bishop Auckland (Vinovium), and Sedgeletch,STW with 2 point ferric dosing. DISCARDED for Hamsterley STW technology is not required to meet phosphorus limit. DISCARDED for Tow Law, Low Wadsworth, Willington, Tudhoe Mill, University, Cassop, Belmont, Brasside, Edmonsley and Chester le Street STW at secondary screening as other filter technologies are more cost effective for smaller sites.
Treatment process-based permitting: CoMag 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 for Bishop Auckland (Vinovium), Sedgeletch and Barkers Haugh STW with 2 point ferric dosing.. DISCARDED for Tow Law, Low Wadsworth, Willington, Tudhoe Mill, University, Cassop, Belmont, Brasside, Edmonsley and Chester le Street STWs are too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective DISCARDED for Hamsterley STW technology is not required to meet phosphorus limit.

Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Sedgeletch STW with 2 point ferric dosing. DISCARDED for Tow Law, Hamsterley, Low Wadsworth, Bishop Auckland (Vinovium), Willington, Barkers Haugh, Tudhoe Mill, University, Cassop, Belmont, Brasside, Edmonsley and Chester le Street STWs do not have an existing ASP. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Sedgeletch STW with 2 point ferric dosing. DISCARDED for Tow Law, Hamsterley, Low Wadsworth, Bishop Auckland (Vinovium), Willington, Barkers Haugh, Tudhoe Mill, University, Cassop, Belmont, Brasside, Edmonsley and Chester le Street STWs do not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital, they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites is the technology cost effective.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Tow Law (Change to Houselop Beck), Sedgeletch (Change to Wear) and Cassop STW (Change to Horden catchment). DISCARDED for Hamsterley, Low Wadsworth, Bishop Auckland (Vinovium), Willington, Tudhoe Mill, University, Barkers Haugh, Belmont, Brasside, Edmondsley, Chester le Street STWs as no larger waterbody within 5km to receive flows.
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	No	DISCARDED at secondary screening Feasibility cannot be determined at this stage but potential future opportunity
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward for University STW (transfer to Barkers Haugh STW, Cassop STW (transfer to Bowburn STW), Hamsterley (transfer to Low Wadsworth STW), Edmondsley STW (transfer to Hustledown STW) DISCARDED at Sedgeletch, Tow Law, Low Wadsworth, Bishop Auckland (Vinovium), Willington, Barkers Haugh, Tudhoe Mill, Belmont, Brasside, and Chester le Street STWs, no other STW with 5km with greater than 10% headroom capacity
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	Yes	Yes	Carried forward to expand ferric dosing at Bishop Auckland STW (Vinovium), Low Wadsworth STW, Barkers Haugh STW, Sedgeletch STW, Chester Le Street STW, Tudhoe Mill STW. Belmont STW will have ferric and caustic retrofitted. DISCARDED for University, Cassop, Hamsterley, Edmondsley, Tow Law, Willington and Brasside STWs. No existing phosphorus removal technology to expand to meet the permit requirements.
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 for Edmondsley STW, Tow Law STW, Low Wadsworth STW, DISCARDED for Barkers Haugh, Belmont, Bishop Auckland (Vinovium), Brasside, Cassop, Chester le Street, Sedgeletch, Tudhow Mill, University Hamsterley and Willington STW as will not achieve load reductions required
Catchment permitting for nutrients 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 STW**)**	Yes	Yes	Carried forward as part of catchment solution
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED as removing the impact of the phosphorus loading from the trade effluent will not be sufficient to achieve the WFD good water body status

DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	Yes	No	DISCARDED Not sufficient headroom in the STWs to allow DWF sacrifice to achieve a phosphorus permits.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	Yes	Carried forward as SAGIS modelling, RNAGs, on-the-ground feasibility assessment and catchment characterisation indicate that catchment-based solution is both feasible and that when implemented alongside end-of-pipe solutions, has the potential to achieve overall (cross-sector) Good status across the Wear catchment.
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	DISCARDED as it will not achieve load reductions required
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED at University, Cassop, Hamsterley, Edmondsley, Tow Law, Willington and Brasside STWs. The works do not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit. DISCARDED at Bishop Auckland STW (Vinovium), Belmont Low Wadsworth STW, Barkers Haugh STW, Sedgeletch STW, Chester Le Street STW, Tudhoe Mill STW. Optimisation of existing ferric dosing assets would not meet the phosphorus permit.

TABLE 52: WEAR CATCHMENT UNCONSTRAINED OPTION SCREENING - AMMONIA REMOVAL

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Nitrifying Submerged Aerated Filter Biological process where biomass grows on submerged media. The biomass consumes the nutrients within the wastewater. Air, provided by mechanical blowers is required to sustain the biomass.	Yes	Yes	Carried Forward for Bishop Auckland (Vinovium) STW
Treatment process-based permitting: Trickling Filters Biological process where biomass grows on stone media. Wastewater is distributed over the media and trickles down through the filter. The biomass consumes the nutrients within the wastewater Air naturally flows upwards through vents.	Yes	Yes	Carried Forward for Bishop Auckland (Vinovium) STW DISCARDED at secondary treatment at Bishop Auckland (Vinovium) STW. Site already has trickling filters more cost effective to extend existing treatment than replace with new
Treatment process-based permitting: Activated Sludge Plant Biological process where biomass grows within an aeration tank at a controlled concentration. Air, provided by mechanical blowers is required to sustain the biomass. Return activated sludge is recycled to maintain the biomass. Surplus activated sludge is removed from the process to control the concentration.	Yes	Yes	Carried forward for Bishop Auckland (Vinovium) STW
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward at Bishop Auckland (Vinovium) STW DISCARDED at secondary screening for Bishop Auckland (Vinovium) STW because no larger waterbody within 5km of the site to receive flows.
Centralise STWs Combine two or more STWs into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Bishop Auckland (Vinovium) STW DISCARDED at secondary screening for Bishop Auckland (Vinovium) STW. There is Willington, Low Wadsworth and Newfield within 5km of each other. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to extending the existing trickling filters. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works. The benefits to water quality will be the same as extra tertiary treatment. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward for Bishop Auckland (Vinovium) STW DISCARDED at secondary screening for Bishop Auckland (Vinovium) STW because no other STW within 5km with greater than 10% headroom capacity to receive flows
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	Yes	Yes	Carried forward for Bishop Auckland (Vinovium) STW. Existing trickling filters can be expanded to increase nitrification.
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).	No	No	DISCARDED Insufficient land available at Bishop Auckland (Vinovium) STW for wetland.
Catchment permitting for nutrients 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).	No	No	DISCARDED –Only one STW impacts the waterbody. No opportunity for catchment permit to balance permits across several treatment plants.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	Yes	No	DISCARDED for Bishop Auckland (Vinovium) STW No trade flow in the catchment
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	Yes	No	DISCARDED for Bishop Auckland (Vinovium) STW Not sufficient headroom in the STW to allow DWF sacrifice to achieve an ammonia permit of 2.8mg/l

Catchment nutrient balancing Catchment nutrient balancing i.e., targeting ammonia load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	No	No	DISCARDED for Bishop Auckland (Vinovium) STW Agricultural practice changes would not have significant impacts on ammonia loads to water bodies locally (ammonia emissions from agriculture are predominantly via volatilisation i.e., in gaseous form).
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce ammonia loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	DISCARDED for Bishop Auckland (Vinovium) STW as it will not achieve load reductions required
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED for Bishop Auckland (Vinovium) STW. Optimisation of existing ammonia removal assets would not meet the ammonia permit.

C.12 HAWTHORN BURN (08NW100200)

TABLE 53: HAWTHORN BURN UNCONSTRAINED OPTION SCREENING

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed 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 for Hawthorn STW as technology will not achieve phosphorus permit.
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.	Unclear	Unclear	DISCARDED – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for Hawthorn STW with 2 point ferric dosing
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Ca**rried forward** for Hawthorn STW with Mecana Filter
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward for Hawthorn STW **DISCARDED** at secondary screening as other filter technologies are more cost effective for smaller sites.
Treatment process-based permitting: CoMag Ballasted coagulation is a tertiary treatment system and is an alternative to tertiary filtration processes. 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 for Hawthorn STW DISCARDED at secondary screening – Hawthorn STW is too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Hawthorn STW DIS**CARDED** at secondary screening – Hawthorn STW does not have an existing ASP. Installing BioMag would require a complete rebuild and would not be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Hawthorn STW DISCARDED at secondary screening – Hawthorn STW does not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
			other traditional treatment technologies. Only at larger sites is the technology cost effective.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Hawthorn STW (Change outfall to North Sea)
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Hawthorn STW DISCARDED through secondary screening Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to the transfer of Hawthorn STW to Seaham or the north sea. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works. The benefits to water quality will be the same as extra tertiary treatment. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward. for Hawthorn STW (Transfer to Seaham or Horden STW)
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	No	No	DISCARDED for Hawthorn STW. No existing phosphorus removal technology to expand to meet the permit requirements
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 for Hawthorn STW
Catchment permitting for nutrients 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).	No	No	DISCARDED for Hawthorn STW. Not possible, only one treatment plant being considered in this catchment for phosphorus removal.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED for Hawthorn STW. No trade effluent
DWF headroom sacrifice at STWs Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED Not sufficient headroom in the STW to allow DWF sacrifice to achieve a phosphorus permit of 0.25mg/l.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	No	DISCARDED Estimated load reductions achievable via agricultural mitigations fall short of reductions required. Evidence suggests that without end-of-pipe removal, the waterbody will fail to meet the requirements for Good or even Moderate status.
Catchment habitat creation and/or enhancement	Yes	No	DISCARDED for Hawthorn STW will not achieve load reductions required

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.			
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED Hawthorn STW. does not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit.

C.13 RIVER TEES (08NW100205)

TABLE 54: RIVER TEES CATCHMENT UNCONSTRAINED OPTION SCREENING - PHOSPHORUS REMOVAL

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Reedbed (constructed wetland) 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 treats the incoming wastewater.	No	No	DISCARDED for Stressholme STW as technology will not achieve phosphorus permit.
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.	Unclear	Unclear	DISCARDED – technology unproven within the water industry to guarantee permit value can be achieved.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	Carried forward for Stressholme STW DISCARDED at secondary screening as other filter technologies are more cost effective for larger sites.
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	Carried forward for Stressholme STW with Tertiary Solids Removal
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	Carried forward for Stressholme STW with 2 point ferric dosing

Treatment process-based permitting: CoMag 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 for Stressholme STW with 2 point ferric dosing
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Stressholme STW DISCARDED – Stressholme STW does not have an existing ASP. Installing BioMag would require a complete rebuild and would not be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites with ASPs is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from waste waters. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.	Yes	Yes	Carried forward for Stressholme STW DISCARDED – Stressholme STW does not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASPs is the technology cost effective.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Stressholme STW DISCARDED at secondary screening - No waterbody less than 5 km from the STW with capacity to receive large flow. In addition, removing large base flow from the existing river is likely to have significant environmental impacts and would require storm storage/treatment to be include as part of the transfer.
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Stressholme STW DISCARDED through secondary screening Stressholme is a large STW>150,000PE with no other STW within 5km of the site. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to construction of extra tertiary assets at the existing works. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works. The benefits to water quality will be the same as extra tertiary treatment. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward for Stressholme STW DISCARDED at secondary screening for Stressholme because no other STW within 5km with greater than 10% headroom capacity to receive flows.
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	No	No	DISCARDED No existing phosphorus removal technology to expand to meet the permit requirements.
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).	No	No	DISCARDED Insufficient land available at Stressholme STW for wetland. Area of wetland for a large works would be unfeasible to operate and would not be cost effective.

Catchment permitting for nutrients 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).	No	No	DISCARDED for Stressholme STW. Not possible, only one treatment plant being considered in this catchment for phosphorus removal.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED The trade effluent proportion of the flow is <5% of the overall flow and thus removing the trade flow would not be sufficient to provide the reduction in phosphorus loading required to meet the permit.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED No existing phosphorus removal technology to expand to meet the permit requirements.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	No	DISCARDED The estimated load reductions achievable via agricultural mitigations fall short of reductions required, due to high STW contribution of 70%. Evidence suggests that without end-of-pipe removal, the waterbody will fail to meet the requirements for Good.
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	Yes	No	DISCARDED – will not achieve phosphorus load reductions required to achieve good status
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED The site does not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit.

TABLE 55: RIVER TEES CATCHMENT UNCONSTRAINED OPTION SCREENING - AMMONIA REMOVAL

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Treatment process-based permitting: Submerged Aerated Filter Biological process where biomass grows on submerged media. The biomass consumes the nutrients within the waste water. Air, provided by mechanical blowers is required to sustain the biomass.	Yes	Yes	Carried Forward for Sedgefield STW DISCARDED at secondary screening as site has existing NSAF process, more cost effective to expand existing process than to install new asset.
Treatment process-based permitting: Trickling filters Biological process where biomass grows on stone media. Wastewater is distributed over the media and trickles down through the filter. The biomass consumes the nutrients within the wastewater Air naturally flows upwards through vents.	Yes	Yes	Carried forward for Sedgefield STW DISCARDED at secondary screening based on site having existing SAF assets. It is more cost effective to install extra capacity compared to replaced entire secondary treatment with trickling filters
Treatment process-based permitting: Activated Sludge Plant Biological process where biomass grows within an aeration tank at a controlled concentration. Air, provided by mechanical blowers is required to sustain the biomass. Return activated sludge is recycled to maintain the biomass. Surplus activated sludge is removed from the process to control the concentration.	Yes	Yes	Carried forward for Sedgefield STW DISCARDED at secondary screening based on site having existing SAF assets. It is more cost effective to install extra capacity compared to replaced entire secondary treatment with ASP
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive water course).	Yes	Yes	Carried forward for Sedgefield STW DISCARDED at secondary screening the nearest water body with a suitable dilution capacity is around 20km away. Transporting effluent this far will not be more cost effective compared than expansion of the works. Furthermore, we would require extra storm storage/treatment if the base effluent flow was removed from the existing water
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Sedgefield STW DISCARDED at secondary screening The nearest STWs are Fishburn and Bradbury. The cost of transferring the flow from Fishburn, Bradbury and Sedgefield STW and then building one new larger STW is expected to be more costly than extra NSAF at Sedgefield STW Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to construction of extra tertiary assets at the existing works. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works. The benefits to water quality will be the same as extra tertiary treatment. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward for Sedgefield STW DISCARDED at secondary screening for Sedgefield STW because no other STW with 5km with greater than 10% headroom capacity

Unconstrained options	Technically feasible?	Meets statutory obligation?	Reason for discarding
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit.	Yes	Yes	Carried forward for Sedgefield STW expand existing NSAF to increase nitrification
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).	No	No	DISCARDED Insufficient land available at Sedgefield STW for wetland.
Catchment permitting for nutrients 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).	No	No	DISCARDED Only one works for ammonia. Catchment permitting is unfeasible
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	No	DISCARDED for Sedgefield STW the trade effluent proportion of the flow is <5% of the overall flow and thus removing the trade flow would not be sufficient to provide the reduction in phosphorus loading required to achieve the permit.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	DISCARDED at Sedgefield STW Not sufficient headroom in the STW to allow DWF sacrifice to achieve an ammonia permit of 1mg/l. Population growth predicted at site.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	No	DISCARDED at Sedgefield STW Agricultural practice changes would not have significant impacts on ammonia loads to water bodies locally (ammonia emissions from agriculture are predominantly via volatilisation i.e., in gaseous form).
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce ammonia loads to the watercourse via reduced runoff and sediment losses or increased filtration.	Yes	No	DISCARDED at Sedgefield STW as it will not achieve load reductions required
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	DISCARDED at Sedgefield STW . Optimisation of existing ammonia removal assets would not meet the ammonia permit.

APPENDIX D PRIMARY SCREENING FOR TECHNICAL FEASIBILITY NO DETERIORATION (ND) AND UWWTD

D.1 DERWENT CATCHMENT: LOCKHAUGH STW (ND FOR P)

TABLE 56: PRIMARY SCREENING FOR TECHNICAL FEASIBILITY NO DETERIORATION IN DERWENT CATCHMENT (LOCKHAUGH STW – PHOSPHORUS)

Option Title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
Accept Permit change	No	No	**Discarded** – site cannot meet new permit without capital intervention.
Treatment process-based permitting: Reedbed (constructed wetland) 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 that treat the incoming wastewater.	Yes	Yes	**Carried forward** for Lockhaugh STW with existing two point ferric dosing.
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.	Unclear	Unclear	**DISCARDED** – the technology is not required to meet phosphorus permit. The site has already got ferric dosing for phosphorus removal.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	**Carried forward** for Lockhaugh STW with existing two point ferric dosing.
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	**Carried forward** **DISCARDED** at secondary screening for Lockhaugh STW as site has existing two point ferric dosing.
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	**Carried forward** **DISCARDED** at secondary screening as other filter technologies are more cost effective for smaller sites.
Treatment process-based permitting: CoMag Ballasted coagulation is a tertiary treatment system and is an alternative to tertiary filtration processes. 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 for Lockhaugh STW **DISCARDED** at secondary screening **–** Lockhaugh STW is too small (PE<30,000) for this technology to be cost effective. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites is the technology cost effective.
Treatment process-based permitting: BioMag 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**.**	Yes	Yes	Carried forward for Lockhaugh STW **DISCARDED** at secondary screening–Lockhaugh STW does not have an existing ASP. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites with ASPs is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal (BNR) BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulate the organisms to accumulate nutrients from wastewater. Following the anaerobic stage, the organisms are exposed to aerobic conditions. Due to their stressed state, they overreact and accumulate more	Yes	Yes	Carried forward for Lockhaugh STW **DISCARDED** at secondary screening–Lockhaugh STW does not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more

Option Title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.			concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASPs is the technology cost effective.
Change outfall location	Yes	Yes	Carried forward for Lockhaugh STW **DISCARDED** at secondary screening for Lockhaugh STW because no larger waterbody within 5km of the site.
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale,	Yes	Yes	Carried forward from primary screening. **DISCARDED** at secondary screening. There is only Lockhaugh and East Tanfield STW within 5km of each other. The cost of transferring the flow from Lockhaugh and East Tanfield and then building one new larger STW is expected to be more costly than adding tertiary filters. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to extra tertiary filters. In addition, centralising the sites will require storm treatment/network storage to protect the existing watercourse if the treated effluent baseflow was removed from the waterbody, adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to tertiary filters. The benefits to water quality will be the same as other treatment options. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary filters.
Transfer / Pumpaway Transfer flow (raw) from one or more smaller STW into an existing larger works with dry weather flow (DWF) headroom.	Yes	Yes	Carried forward for Lockhaugh STW **DISCARDED** at secondary screening because no other STW within 5km with greater than 10% headroom capacity
Replace / retrofit / expand existing primary/secondary/tertiary treatment processes Use existing process types or more intensive processes where treatment is already in place. This may include extra assets on site to achieve tighter permit limit.	No	No	**DISCARDED** for Lockhaugh STW. Existing two point ferric dosing does not require to be expanded to meet phosphorus permit. The site requires a tertiary filter to meet the associated iron permit.
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).	No	No	**DISCARDED - i**nsufficient land available at Lockhaugh STW for a wetland.
Catchment permitting for nutrients 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).	No	No	**DISCARDED** –Only one STW impacts the waterbody. No opportunity for catchment permit to balance permits across several treatment plants.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions	No	No	**DISCARDED** - The trade effluent proportion of the flow is <5% of the overall flow. Removing the trade flow would not be sufficient to provide the reduction in phosphorus loading required to meet the permit.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	**DISCARDED** for Lockhaugh STW. Not sufficient headroom in the STW to allow DWF sacrifice to achieve a phosphorus permit.
Catchment nutrient balancing Catchment nutrient balancing i.e., targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	No	No	**DISCARDED** for Lockhaugh STW. Catchment nutrient balancing will not meet load reductions required for phosphorus or address the cause of future deterioration.
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	**DISCARDED** for Lockhaugh STW. Habitat creation and/or enhancement will not meet load reductions required for phosphorus or address cause of future deterioration.
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	**DISCARDED**– There is a risk that the increase in ferric dose to meet the phosphorus permit would result in failures to the iron permit. Optimising the existing ferric dose is not technically feasible.

Source: Northumbrian Water

D.2 RIVER WEAR CATCHMENT (ND NH3)

TABLE 57: PRIMARY SCREENING FOR TECHNICAL FEASIBILITY NO DETERIORATION IN RIVER WEAR (BISHOP AUCKLAND – NH3)

Option Title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
Accept Permit change	No	No	**DISCARDED** – the site cannot meet new permit without capital intervention. Existing performance is around 5mg/l for NH3
Treatment process-based permitting: Nitrifying Submerged Aerated Filter Biological process where biomass grows on submerged media. The biomass consumes the nutrients within the wastewater. Air provided by mechanical blowers is required to sustain the biomass.	Yes	Yes	**Carried Forward** for Bishop Auckland (Vinovium) STW
Treatment process-based permitting: Trickling Filters Biological process where biomass grows on stone media. Wastewater is distributed over the media and trickles down through the filter. The biomass consumes the nutrients within the wastewater Air naturally flows upwards through vents.	Yes	Yes	**Carried Forward** for Bishop Auckland (Vinovium) STW **DISCARDED** at secondary treatment at Bishop Auckland (Vinovium) STW. Site already has trickling filters more cost effective to extend existing treatment than replace with new.
Treatment process-based permitting: Activated Sludge Plant Biological process where biomass grows within an aeration tank at a controlled concentration. Air provided by mechanical blowers is required to sustain the biomass. Return activated sludge is recycled to maintain the biomass. Surplus activated sludge is removed from the process to control the concentration.	Yes	Yes	**Carried forward** for Bishop Auckland (Vinovium) STW
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive watercourse).	Yes	Yes	Carried forward at Bishop Auckland (Vinovium) STW **DISCARDED** at secondary screening for Bishop Auckland (Vinovium) STW because no larger waterbody within 5km of the site to receive flows.
Centralise STWs Combine two or more STWs into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward for Bishop Auckland (Vinovium) STW **DISCARDED** at secondary screening for Bishop Auckland (Vinovium) STW. There is Willington, Low Wadsworth and Newfield within 5km of each other. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to extending the existing trickling filters. In addition, centralising the sites will require storm treatment/network storage to protect the existing water course if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of extra tertiary assets at the existing works. The benefits to water quality will be the same as extra tertiary treatment. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of extra tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with DWF headroom.	Yes	Yes	Carried forward for Bishop Auckland (Vinovium) STW **DISCARDED** at secondary screening for Bishop Auckland (Vinovium) STW because no other STW within 5km with greater than 10% headroom capacity to receive flows.
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place. This may include extra assets on site to achieve tighter permit limit.	Yes	Yes	**Carried forward** for Bishop Auckland (Vinovium) STW. Existing trickling filters can be expanded to increase nitrification.
Integrated constructed wetland (ICW)	No	No	**DISCARDED** Insufficient land available at Bishop Auckland (Vinovium) STW for wetland.

Option Title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
Create ICW with multiple benefits as treatment solution (only applicable where less stringent permit limits or existing treatment solution that needs to be tighter).			
Catchment permitting for nutrients 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).	No	No	**DISCARDED** –Only one STW impacts the waterbody. No opportunity for catchment permit to balance permits across several treatment plants.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	Yes	No	**DISCARDED** for Bishop Auckland (Vinovium) STW. No trade flow in the catchment.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	Yes	No	**DISCARDED** for Bishop Auckland (Vinovium). STW Not sufficient headroom in the STW to allow DWF sacrifice to achieve an ammonia permit of 2.8mg/l.
Catchment nutrient balancing Catchment nutrient balancing such as targeting ammonia load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	No	No	**DISCARDED** for Bishop Auckland (Vinovium). STW Agricultural practice changes would not have significant impacts on ammonia loads to waterbodies locally (ammonia emissions from agriculture are predominantly via volatilisation i.e., in gaseous form).
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce ammonia loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	**DISCARDED** for Bishop Auckland (Vinovium) STW as it will not achieve load reductions required.
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	**DISCARDED** for Bishop Auckland (Vinovium) STW. Optimisation of existing ammonia removal assets would not meet the ammonia permit.

D.3 WINDLESTONE STW (ND)

TABLE 58: PRIMARY SCREENING FOR TECHNICAL FEASIBILITY NO DETERIORATION (WINDLESTONE – BOD)

Option Title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
Accept Permit change	Yes	Yes	Carried forward for Windlestone STW. Site already meets new permit.
Treatment process-based permitting Install new assets to treat pollutant to meet new permit.	Yes	Yes	Carried forward **DISCARDED** for Windlestone STW. No extra investment is required to meet new permit.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive watercourse).	Yes	Yes	Carried forward **DISCARDED** for Windlestone STW. No extra investment is required to meet new permit.
Centralise STWs Combine two or more STWs into a new larger works to achieve efficiencies of scale.	Yes	Yes	Carried forward **DISCARDED** for Windlestone STW. No extra investment is required to meet new permit.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW into an existing larger works with DWF headroom.	Yes	Yes	Carried forward **DISCARDED** for Windlestone STW. No extra investment is required to meet new permit.
Replace / retrofit / expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place. This may include extra assets on site to achieve tighter permit limit.	Yes	Yes	Carried forward **DISCARDED** for Windlestone STW. No extra investment is required to meet new permit.
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 **DISCARDED** at secondary screening for Windlestone STW. No extra investment is required to meet new permit.
Catchment permitting for nutrients 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 **DISCARDED** at secondary screening for Windlestone STW. No extra investment is required to meet new permit.
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions	Yes	Yes	Carried forward **DISCARDED** at secondary screening or Windlestone STW. No extra investment is required to meet new permit.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	Yes	Yes	Carried forward

Option Title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
			DISCARDED at secondary screening for Windlestone STW. No extra investment is required to meet new permit.
Catchment nutrient balancing Catchment nutrient balancing such as targeting BOD load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	Yes	Yes	Carried forward **DISCARDED** at secondary screening for Windlestone STW. No extra investment is required to meet new permit.
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce BOD loads to the watercourse via reduced runoff and sediment losses or increased filtration.	Yes	Yes	Carried forward **DISCARDED** at secondary screening for Windlestone STW. No extra investment is required to meet new permit.
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	Yes	Yes	Carried forward for Windleston STW to optimise and maintain existing assets to meet the new permit.

Source: Northumbrian Water

D.4 WILLINGTON AND STRESSHOLME (UWWTD)

TABLE 59: PRIMARY SCREENING TECHNICAL FEASIBILITY PHOSPHORUS REDUCTION SCHEMES - U_IMP1 AND U_IMP2

Option title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
Accept Permit change	No	Yes	**DISCARDED** for Stressholme and Willington STWs. The sites cannot meet new permit without capital intervention.
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.	Unclear	Unclear	**DISCARDED** – technology unproven within the water industry to guarantee permit value can be achieved. Technology is too small and not commercially viable for large works like Stressholme and Willington STWs.
Treatment process-based permitting: Mecana Cloth filter Physical separation process, where solids are captured on a series of cloth discs. Solids are removed by backwashing cloth discs.	Yes	Yes	**Carried forward** for Stressholme and Willington STWs with single point ferric dosing. **DISCARDED** for Stressholme STW at secondary screening as other filter technologies are more cost effective for larger sites. **DISCARDED** at secondary screening for Willington STW because technology not required to achieve the permit value.
Treatment process-based permitting: Reedbed (constructed wetland) 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 that treats the incoming wastewater.	Yes	Yes	**Carried forward** for Willington STW with single point ferric dosing. **Discarded** at secondary screening for Stressholme STW based on the size of the reed bed required to treat effluent, land mass required (~23ha).
Treatment process-based permitting: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Yes	Yes	**Carried forward** for Stressholme and Willington STWs with Deep bed filter for Stressholme STW.
Treatment process-based permitting: Deep bed filter Physical separation process, where solids are captured within a volume of sand media. Solids are removed by backwashing the sand. Dirty back wash water is returned to the inlet works.	Yes	Yes	**Carried forward** for Stressholme and Willington STWs with single point ferric dosing. **DISCARDED** at secondary screening for Willington STW because technology not required to achieve the permit value.
Treatment process-based permitting: CoMag 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** for Stressholme and Willington STWs with single point ferric dosing. **DISCARDED** at secondary screening because technology not required to achieve the permit value. This technology is usually only required to meet tighter phosphorus limits <0.5 mg/l. Refer to WFD_IMP driver.
Treatment process-based permitting: BioMag 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.	Yes	Yes	Carried forward for Stressholme and Willington STWs with single point ferric dosing. **DISCARDED** at secondary screening–Stressholme and Willington STWs do not have an existing ASP. Ballasted coagulation in all cases costs more to construct (requires more assets) and operate (due to higher energy costs) than other tertiary treatment technologies and would deliver the same benefit to the water quality. Only at larger sites with ASPs is the technology cost effective.
Treatment process-based permitting: Biological Nutrient Removal (BNR)	Yes	Yes	Carried forward for Stressholme and Willington STWs with single point ferric dosing.

Option title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
BNR consists of anaerobic/anoxic and aerobic chambers in succession within an activated sludge plant. The change in conditions manipulates the organisms to accumulate nutrients from wastewater. Following the anaerobic stage, the organisms are exposed to aerobic conditions, due to their stressed state, they overreact and accumulate more phosphorus than originally expelled in the anaerobic stage resulting in a net removal of phosphorus from the wastewater. In addition to BNR, sites will require ferric addition to guarantee phosphorus removal.			**DISCARDED** at secondary screening. Stressholme and Willington STWs do not have an existing ASP. Installing a BNR would require a complete rebuild and would not be cost effective. BNR in all cases cost more to construct (more concrete) and operate (due to higher energy costs) than other packaged treatment technologies. In terms of natural capital, they have more embedded carbon due to more concrete and more operational carbon due to high energy use aerators. Benefits to water quality and other natural capital measures are the same as other traditional treatment technologies. Only at larger sites with ASP is the technology cost effective.
Change outfall location Move final effluent outfall so more relaxed permit is acceptable (discharge into less sensitive watercourse).	Yes	Yes	Carried forward for Stressholme and Willington STWs. **DISCARDED** at secondary screening for Stressholme and Willington STWs because no larger waterbody within 5km of the site to receive flows.
Centralise STWs Combine two or more STWs into a new larger works to achieve efficiencies of scale	Yes	Yes	Carried forward for Stressholme and Willington STWs. **DISCARDED** at secondary screening. Centralising the sites to a new larger works will cost significantly more to construct (more concrete, multiple pipeline routes) compared to construction of tertiary assets at the existing works. In addition, centralising the sites will require storm treatment/network storage to protect the existing watercourse if the treated effluent baseflow was removed from the water body adding cost and carbon. Centralising the sites will have a higher operating cost due to pumping flows to the new location plus operation of the new works compared to construction of tertiary assets at the existing works. The benefits to water quality will be the same as extra tertiary treatment. Furthermore, the release of embedded carbon from demolished assets will be significantly higher than the embedded carbon of tertiary assets.
Transfer / Pump away Transfer flow (raw) from one or more smaller STW(s) into an existing larger works with DWF headroom	Yes	Yes	Carried forward for Stressholme and Willington STWs. **DISCARDED** at secondary screening for Stressholme and Willington STWs because no other STW with 5km with greater than 10% headroom capacity.
Replace/retrofit/expand existing primary/secondary treatment processes Use existing process types or more intensive processes where treatment is already in place, may include extra assets on site to achieve tighter permit limit	No	No	**DISCARDED** - No existing phosphorus removal technology to expand to meet the permit requirements.
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).	No	No	**DISCARDED** at Stressholme and Willington STWs. Insufficient land available at both sites for a wetland.
Catchment permitting for nutrients 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).	No	No	**DISCARDED** - Offsetting through catchment permitting is not allowed under the UWWTD driver. PR24 guidance states that '*it is not appropriate to find catchment solutions that result in a less stringent or different permit at these locations'*.

Option title	Meets Statutory Obligation?	Technically feasible?	Reason for discarding
Trade effluent variation Varying trade effluent permits at sites or removing trader high flow contributions.	No	Yes	**DISCARDED** - It is not possible to deliver a sufficient reduction to catchment phosphorus loads to achieve permits.
DWF headroom sacrifice at STW Accept a reduced DWF permit so that a more relaxed final effluent permit is imposed.	No	No	**DISCARDED -** UWWTD permits are based on population served. There is no opportunity to relax the permit based on DWF headroom.
Catchment nutrient balancing Catchment nutrient balancing such as targeting phosphorus load reductions from agriculture (working with farmers to reduce source pollution) and other non-water company sectors.	No	No	**DISCARDED** - Offsetting through catchment permitting is not allowed under the UWWTD driver. PR24 guidance states that '*it is not appropriate to find catchment solutions that result in a less stringent or different permit at these locations'*.
Catchment habitat creation and/or enhancement Creation of new or enhancement of existing habitats such as woodland, wetlands, and vegetated riparian margins in the wider catchment aiming to reduce phosphorus loads to the watercourse via reduced runoff and sediment losses or increased filtration.	No	No	**DISCARDED** - Offsetting through catchment permitting is not allowed under the UWWTD driver. PR24 guidance states that '*it is not appropriate to find catchment solutions that result in a less stringent or different permit at these locations'*.
Operational solution Optimisation of existing site assets to achieve new permit through operational activities.	No	No	**DISCARDED** for Stressholme and Willington STWs. The sites do not have existing phosphorus removal technology that could be optimised to meet the phosphorus permit.

6. APPENDIX E: LETTER IN SUPPORT FROM THE RIVERS TRUST

The Rivers Trust

Northumbrian Water PR24 WINEP:
Supporting statement from The Rivers Trust

The Rivers Trust are proud to be working in partnership with Northumbrian Water through the North East Catchments Hub to co-develop catchment and nature based schemes for submission into Northumbrian Water's PR24 WINEP. This is an industry leading approach following the Ofwat guidance (May, 2022) to 'produce a high quality, evidence based WINEP programme of best value options – allowing water companies to meet their regulatory obligations and customers' needs, whilst restoring and increasing natural assets to realise environmental net gains'. It has our full support we believe it could provide a step change for water quality improvements and wider environment recovery in the northeast.

- **It is the right thing to do.** This innovative approach takes a holistic look at what the catchment and the local environment needs. Traditional improvements at STW are end of pipe solutions. This programme will address water quality issues at source and for the long-term. Not only is this the right thing to do, but it will also save Northumbrian Water customers money now and well into the future.
- **It will achieve multiple benefits at landscape scale.** Whilst driven by water quality improvements, catchment and nature based schemes deliver multiple benefits across flood and drought resilience, biodiversity net gain, carbon sequestration, clean air, amenity value and more.
- **It will catalyse more investment.** This ground breaking programme for catchment and nature based solutions is an industry first for WINEP and we have not seen investment in catchments at this scale in the north east before. We will assess the multiple benefits and stimulate further investment through market led approaches to build bigger and more encompassing programmes.
- **It will deliver locally.** Partners within the existing Catchment Based Approach partnerships, who are already on the ground delivering impact with long-standing relationships with land managers and farmers, will deliver the schemes within this programme, supporting the regional Green Recovery and levelling up agendas.
- **The time is now.** The need is clear and there is a hive of activity and commitment to improve our rivers and wider environment. Investment through Northumbrian Water's WINEP will support and catalyse the governments suite of strategies to promote landscape recovery, including Local Nature Recovery Strategies, Environmental Land Management Schemes, nutrient neutrality, biodiversity net gain and net zero and will provide the catalyst for further private sector investment into the North East.

This programme will have far reaching impacts for the water industry and beyond. It is the approach that Ofwat and Defra have advocated for and will have significant impact for water quality and landscape scale recovery in the northeast, while reducing costs to customers and supporting a local green recovery.

"Solving the climate, biodiversity and water quality emergencies is going to be too expensive unless we invest in solutions that address them all at once. We must make limited funding go further by working intelligently and collaboratively to achieve the best outcome for the environment. Communities don't care about the phosphate concentrations in sewage effluent – they just want healthy rivers teeming with wildlife."
Mark Lloyd, CEO