UUW65

Wastewater (Quality - Additional Requirements) Enhancement Case

October 2023

Chapter 8 supplementary document

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

This case includes:

- Case 15: Rainwater management for climate resilience
- Case 16: Wastewater supply and demand
- Case 17: Coastal and river erosion
- Case 18: Reducing risk of sewer flooding for properties
- Case 19: Wastewater reservoirs
- Case 20: Green recovery
- Case 21: First time sewerage

United Utilities

Water for the North West

1. Wastewater (Quality - Additional Requirements)

1.1 Structure

1.1.1 This document contains our Wastewater (Quality – Additional requirements) enhancement cases and is structured as below:

- Case 15: Rainwater management for climate resilience
- Case 16: Wastewater supply and demand
- Case 17: Coastal and river erosion
- Case 18: Reducing risk of sewer flooding for properties
- Case 19: Wastewater reservoirs
- Case 20: Green recovery
- Case 21: First time sewerage

UUW65

Rainwater Management for Climate Resilience

October 2023

Enhancement Case 15

United Utilities

Water for the North West

Contents

1. Enhancement submission

<table>
<tr><th colspan="2">Enhancement submission</th></tr>
<tr><td>Title:</td><td>Rainwater Management for Climate Resilience</td></tr>
<tr><td>Price Control:</td><td>100% Wastewater Network Plus</td></tr>
<tr><td>Enhancement headline:</td><td>By delivering rainwater management, we will reduce the amount of rainwater entering our combined sewer network through sustainable attenuation and disconnection. This will provide resilience against the forecast increased risk of sewer flooding because of more frequent and intense rainfall, primarily driven by climate change.</td></tr>
<tr><td>Enhancement expenditure
(FY23 prices)</td><td>
<table>
<tr><th></th><th>AMP8 Capex inc TI (£m)</th><th>AMP8 Opex (£m)</th><th>AMP8 Totex (£m)</th></tr>
<tr><td>Pre RPE and Frontier Shift</td><td>132.169</td><td>3.710</td><td>135.879</td></tr>
<tr><td>Post RPE and Frontier Shift</td><td>128.660</td><td>3.595</td><td>132.255</td></tr>
</table>

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

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

2. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	The North West has a unique set of operating circumstances, which make customers, assets and communities more vulnerable to the impacts of climate change related flooding. Climate change is forecast to bring increased rainfall, both in frequency and intensity, and the North West is predicted to be particularly affected by this shift. This increases the risk of sewer flooding as the drainage system can become overwhelmed.	*4.1.2*
	Risks identified through BRAVA as part of our DWMP highlighted a significant increase in the percentage at properties at risk of internal flooding. BRAVA assessed the risk arising from both hydraulic overload (accounting for climate change uplifts) and 'Flooding Other Causes'. The additional surface water resulting from climate change primarily drives the increase in risk modelled.	*4.2*
	There is a critical need to provide a step change in service provision now to secure resilience against the effects of climate change and protect against the risk of future deterioration in flooding performance. If we do not deliver this, we risk leaving communities with larger problems requiring ever-larger more complex solutions for future generations to resolve.	*4.3.1*
	We need to take a step change away from traditional grey storage solutions, towards more sustainable rainwater management solutions, as supported by Ofwat, Defra and customers. Managing the input of rainwater through attenuation and disconnection is seen as the most sustainable approach to starting our long-term adaptive plans, reducing the likelihood for carbon intensive conventional solutions for future generations.	*4.3.2*
	UUW considers this to require enhancement investment since PR24 base cost models have not historically allowed for rainwater management. The implicit allowance for 'reducing flood risk for properties' within the PR24 base cost models will therefore be complementary to, but separate from, this enhancement case.	*4.4*
	This programme is distinct from rainwater management solutions proposed through our Advanced WINEP since these schemes are primarily driving down storm overflow spill frequency alongside secondary benefits such as flood risk reduction.	*0*
Best option for customers	The interventions proposed in this enhancement case have been informed by the outputs of our DWMP. The approach to options development and selection followed in the DWMP is robust, and has considered over 65,000 options. These were iteratively screened and selected based on assessment of cost, performance, wider benefits and customer preference, to form a best value plan.	*5.2*
	An innovative decision support tool was utilised to optimise the options in each drainage area, to enable a flexible and adaptive approach, which prioritises least regret solutions first. The proposal consists primarily of	*5.3*

	SuDS schemes and schemes to 'increase the capacity of the existing network', supported by further implementation of our Dynamic Network Management programme. We have considered for delivery of the programme through third party partnerships, informed by the success of experience in our Green Recovery Programme. Building sustainable partnerships is key to delivering stretching long-term targets and this takes time and requires flexibility in the approach. The use of option blends enable programme flexibility as these allow lowest regret options to be prioritised ahead of more expensive solutions, while risks materialise and understanding improves.	*5.4* *5.5*
Cost efficiency	The unit costs for our interventions have been derived from multiple sources, and in alignment with our WINEP methodologies. Where detailed cost data is not available, estimates have been informed by previous projects and existing installations. Benchmarking for SuDS schemes is difficult given the limited wide-scale roll out of these schemes, and availability of external data. Unit costs have been benchmarked against available data where possible, and this analysis has indicated that UUW is efficient.	*6.2* *6.3*
Customer protection	Customers will be protected via a Price Control Deliverable (PCD) that will protect customers from non-delivery of benefit. The proposed PCD metric is equivalent network storage volume delivered through the implementation of rainwater management solutions.	7

3. Introduction

3.1.1 This document sets out an enhancement claim of £132.255m to allow UUW to invest in rainwater management across the North West to provide resilience to the increased risk of sewer flooding driven by the impacts of climate change on the wastewater system.

3.1.2 The North West is impacted by some of the wettest weather in England, with 40 % more urban rainfall than the industry average. In addition, the region has experienced numerous and more frequent, extreme storms in recent years, causing major disruption to communities and infrastructure, including our own. The North West has more combined sewers compared to other water companies; over 54% of our sewers carry both foul and surface water compared to an industry average of 33%. Combined sewers fill up quickly in a storm, as wastewater and rain collects in the same pipe.

3.1.3 We are planning for more frequent and intense rainfall because of climate change, as evidenced by the UK Climate Projections 2018 (UKCP18). Short, intense rainfall events can lead to an increased risk of sewer flooding, as the volume of surface water exceeds the capacity of the network. Modelling undertaken as part of our Drainage and Wastewater Management Plan (DWMP) found that between 2025 and 2050, if no mitigation action is taken, there will be a 63% increase in properties at risk of internal flooding. This risk is mainly driven by hydraulic overload resulting from increased rainfall due to climate change.

3.1.4 Resilience to the impact of more frequent and intense storms is a national priority. The Government's third national Climate Change Risk Assessment (CCRA3)[1], reported to Parliament and built on the latest evidence from scientific leaders, highlights the risks to infrastructure services from river, surface water and groundwater flooding as areas where further action is required now. The CCRA states that "river and surface water flooding is already a large risk to UK infrastructure, with each season adding new evidence to underpin the significant magnitude of the threat".

3.1.5 We need to act now to ensure long-term functionality and resilience to the growing impacts of climate change. If we do not act now, flooding performance will deteriorate despite investment through base expenditure; we risk leaving customers and communities at risk of having larger problems, requiring ever larger and more complex solutions for future generations to resolve. The costs incurred by customers and UUW will grow the longer that action to address these risks is delayed. UUW proposes a no-regrets rainwater management strategy, which can be enacted now to provide benefit without being certain of the extent of risk posed by climate change.

3.1.6 The DEFRA Storm Overflow Discharge Reduction Plan (2022)[2] presented to Parliament pursuant to the Environment Act (2021) recommends protecting the environment by better rainwater management (green/blue/separation solutions) rather than traditional storage tanks (grey solutions), wherever this achieves the best outcome for people and the environment. DEFRA continue to explain that rainwater management solutions will not only achieve a reduction in sewage discharges from storm overflows, but will improve water scarcity and reduce flood risk, with the latter supported in recommendations by the National Infrastructure Commission[3]. Additionally, Ofwat and the Environment Agency are promoting the use of nature-based solutions in favour of more carbon intensive alternatives, such as increasing storage capacity.

[1] HM Government: UK Climate Change Risk Assessment 2022 (2022), available here: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047003/climate-change-risk-assessment-2022.pdf

[2] DEFRA: Storm Overflow Discharge Reduction Plan (2022), available here: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1101686/Storm_Overflows_Discharge_Reduction_Plan.pdf

[3] National Infrastructure Commission: Reducing the risk of surface water flooding (2022), available here https://nic.org.uk/app/uploads/NIC-Reducing-the-Risk-of-Surface-Water-Flooding-Final-28-Nov-2022.pdf

3.1.7 This enhancement case proposes a shift from traditional grey storage solutions, towards rainwater management techniques to deliver an additional equivalent storage volume of 29,941 m3. This will be delivered through implementation of Sustainable Drainage Systems (SuDS) alongside increased network capacity via delivery of customer-side interventions (water butts). SuDS options gained significant support from customers owing to perceived additional benefits and getting to the 'root cause' of a problem, and are seen as the most sustainable approach to starting our long term adaptive plans, reducing the necessity for carbon intensive conventional solutions for future generations. As such, we are looking to accelerate no-regrets interventions such as SuDS through this Rainwater Management enhancement case for the investment period 2025-2030.

3.1.8 UUW considers this enhancement programme to represent a fundamental shift from the traditional activities historically deployed through base expenditure to mitigate flood risk. As such, UUW considers this enhancement funding to be entirely separate from allowances within base to allow us to sustainably complete a transition away from short-term mitigation towards rainwater management at scale without a detriment to short-term performance, accounting for the impact of climate change.

3.1.9 The rainwater management programme proposed within this enhancement case is separate to that proposed through our Advanced WINEP (A-WINEP). The A-WINEP programme is focused primarily on driving down storm overflow spill frequency through the implementation of SuDS schemes in the drainage areas of storm overflows. Since the existence of storm overflows within the combined sewer network is to provide hydraulic relief and prevent flooding, it follows that areas prone to flooding are unlikely to have storm overflows in the local contributing sewer network. Thus, where a hybrid solution is proposed through the A-WINEP, this will not be located within a flood cluster and so whilst some secondary flood risk benefit will be provided, it is unlikely to address flood risk directly.

3.1.10 The interventions proposed through this enhancement case have been informed by the outputs of our DWMP. Over 65,000 options were considered to address the modelled risks, and these have been iteratively screened and optimised to account for cost, performance, wider benefits and customer preference. Option blends have been developed within each drainage area to create a flexible approach that can be adapted as risk materialises and understanding improves.

3.1.11 We will leverage partnership opportunities within the delivery of this proposal, informed by the experience of our Green Recovery programme. We will look to build on our many existing partnerships and develop new ones in order to achieve long-term objectives and maximise wider societal benefits, ensuring we mitigate the negative performance impact of climate change on sewer flooding and therefore maximise the efficiency of base expenditure to reduce sewer flood risk.

4. Need for enhancement investment

4.1.1 UUW is committed to building climate resilience in the North West – protecting people, the built and natural environments – ultimately making the region stronger, greener and healthier. The North West has a unique set of operating circumstances by way of higher than average rainfall and associated prevalence of combined sewers. This creates proportionately greater challenges for draining wastewater, and leads us to managing a higher level of sewer flooding risk. This risk will be exacerbated by the impacts of climate change, as evidenced in literature and modelled in our Drainage and Wastewater Management Plan (DWMP). To ensure long-term functionality and resilience to the growing impacts of climate change on the sewer network, we need to design beyond historic trends and plan for the increase in the frequency and intensity of storm events. This requires a step change in our approach, away from traditional grey solutions towards more sustainable rainwater management solutions, such as Sustainable Drainage Systems (SuDS), as widely supported by Ofwat, DEFRA, and customers. UUW considers the need for enhancement investment to fund this step change to protect customers and the environment against future deterioration in flooding performance because of climate change.

4.1.2 The North West has a higher proportion of legacy combined sewers when compared to the industry average (54 % versus 33 %). Combined sewers are highly responsive to rainfall and have reduced hydraulic capacity during storms, increasing the risk of both surface water flooding and sewer flooding. In addition, the North West has a normalised urban rainfall 40 % higher than other regions and therefore greater volumes of surface water entering the sewer network. As highlighted in our Drainage Cost Adjustment Claim (see supplementary *UUW46 – Cost adjustment claims*), factors such as low potential evapotranspiration (PET) and unique local topographies further increase the volumes of surface water entering UUW's sewer network. These unique operating circumstances make the North West more vulnerable (responsive) to the impacts of climate change than areas with lower proportions of combined systems and lower rainfall.

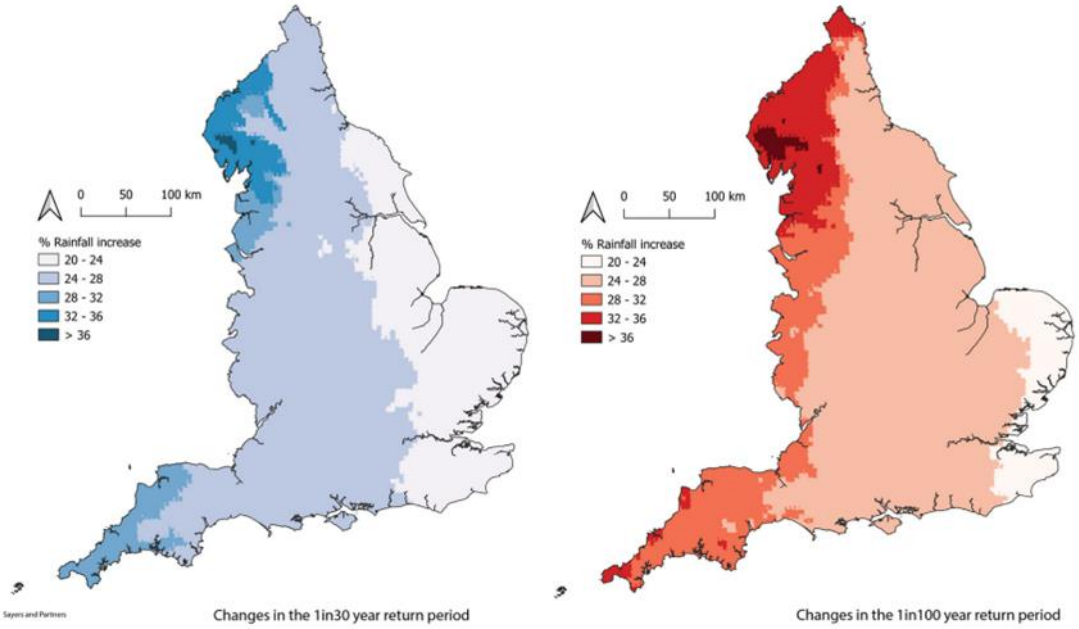
4.1.3 Climate change is forecast to bring more frequent and intense rainfall across the UK. As the atmosphere warms, it can hold more moisture as the rate of evaporation is increased. This results in clouds containing a greater number of larger rain droplets, thus creating more intense precipitation[4]. A recent study[5] found that with every degree Celsius of regional warming, the intensity of rainfall during extreme events increases by 5 – 15 %, and there are almost nine more extreme events per year across the UK. This projected increase in rainfall is unevenly distributed across England. In a report prepared for the National Infrastructure Commission, Sayers et al., (2022) report the North West experiencing greater shifts in rainfall increase than central and southern regions in both a 1 in 30 and 1 in 100 year storm by the 2080s (Figure 1)[6].

[4] Met Office: UK and Global extreme events – Heavy rainfall and floods, accessed here

[5] Kendon, E.J., Fischer, E.M. & Short, C.J. Variability conceals emerging trend in 100yr projections of UK local hourly rainfall extremes. Nat Commun 14, 1133 (2023), accessed here

[6] Modelled using the 2050s and 2070s outputs of the Convection Permitting Model (CPM - 2.2km UKCP18) for Representative Concentration Pathway 8.5 (RCP8.5)

Figure 1: Uplift in the 1 in 30 year (left) and 1 in 100 year (right) return period rainfall (mm/hr) by the 2080s from baseline period (1981 - 2000) assuming a 4oC Global-Mean-Surface-Temperature rise by 2100 (from pre-industrial times)



Source: National Infrastructure Commission, Sayers et al report

4.1.4 As a consequence of more frequent and intense rainfall, the risk of flooding is increased. When more rainfall falls in a shorter amount of time, the drainage system can become overwhelmed (surcharged) as the volume of rainfall exceeds the capacity of the sewer network (sewer flooding) or rainwater is unable to drain away through the drainage system or soak into the land (surface water flooding). The mechanisms are complex and are exacerbated by factors such as urban creep, which reduces the area of permeable surfaces thus increasing the volume and rate of surface water runoff.

4.1.5 The North West has experienced numerous extreme storms in recent years, causing major disruption to communities and infrastructure including our own. In 2015, Storm Desmond brought record-breaking rainfall and flooding across the North West, with Cumbria recording 341 mm of rainfall in 24 hours[7]. Research[8] determined that climate change made this rainfall event 40 % more likely. In January 2021, the North West experienced its wettest three-day period since 1891 because of Storm Christoph; parts of Cheshire, Greater Manchester and Lancashire recorded the equivalent of a month's worth of rainfall in 72 hours when compared with the long-term average for January[9]. As a consequence of this extreme rainfall brought by Storm Christoph and the unique operating circumstances for UUW's wastewater network, UUW recorded 123 flooding incidents over the course of January 2021; this is over 3.5 times as many incidents recorded historically in January over the last five years. Over 50% of these incidents occurred over the 3-day storm period alone.

4.1.6 The frequency and intensity of events such as Storm Desmond and Storm Christoph are set to increase as our climate changes, with the North West particularly affected. This, alongside the unique operating circumstances of the North West, is putting the natural and built land, as well as UUW customers at more risk of climate change driven flooding compared to other regions. To ensure long-term functionality and resilience to the growing impacts of climate change, we need to design beyond historic trends and plan for the increase in the frequency and intensity of storm events.

[7] Met Office: Storm Desmond, available here: https://www.metoffice.gov.uk/weather/warnings-and-advice/uk-storm-centre/storm-desmond

[8] Friederike E L Otto *et al* 2018 *Environ. Res. Lett.* **13** 024006, available here: https://iopscience.iop.org/article/10.1088/1748-9326/aa9663

[9] Met Office: Storm Christoph (2021), available here: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2021/2021_01_storm_christoph.pdf

4.2 DWMP Assessment

4.2.1 The need to address the increasing risk of sewer flooding is identified in our Drainage and Wastewater Management Plan (DWMP). In the development of our DWMP, long-term performance targets, termed planning objectives, were determined through bespoke customer research and stakeholder engagement. This enhancement case is aligned to our planning objective to "sustainably reduce the risk of sewer flooding in the North West".

4.2.2 Baseline Risk and Vulnerability Assessments (BRAVA) were conducted against each of the planning objectives. These allowed us to model baseline (2020) and future (2030 and 2050) performance, taking into account factors such as climate change and population growth, to understand where we are likely to see a deficit in achieving our planning objectives if no action is taken. This enables the planning for, and mitigation of the risk before there is an impact on UUW's wastewater service to customers and the receiving environment. The methodologies used within BRAVA were assured by Jacobs.

4.2.3 BRAVA were applied at a Tactical Planning Unit (TPU) level, which comprises a wastewater treatment works and its catchment. Due to the complexity and importance of sewer flooding, a number of assessments were run to fully understand the risk against this planning objective. This includes assessments to understand the risk of internal flooding, external flooding and flooding in a 1 in 50-year storm. The TPUs assessed against flood risk accounted for 99.8 % of UUW's population equivalent (2020).

4.2.4 There are two mechanisms for sewer flooding: Flooding Other Causes (FOC) and Hydraulic Overload. Both were considered within BRAVA. This required combining the outputs from two different types of model: PIONEER (our common asset deterioration framework tool) and hydraulic network models.

Flooding Other Causes risk

4.2.5 Flooding other causes accounts for flooding incidents that are not hydraulically driven, instead these may result from inappropriate items being flushed, (e.g. fats, oils and greases) or tree roots leading to blockages or collapses within the sewer network and consequent flooding. The PIONEER model calculated annualised risk across all wastewater network assets for internal and external flooding as a result of FOC. It simulated maintaining a broadly stable service, in line with our recent historical experience, and did not assess hydraulic risk or any effects of climate change.

4.2.6 This means that we select the most cost effective, proactive work to refurbish or replace those assets that present the largest predicted risk to service. This scenario helps us to identify; underlying trends in expected deterioration, future risk hotspots, overall investment needed as well as relative levels of investment between different types of assets in order to provide a stable long-term service. As this sort of scenario is financially unconstrained, it may lead to an unaffordable programme of work, so we would always look to challenge and further optimise the simulated programme by looking for synergies across other investment needs, over and above simply maintaining our existing assets.

4.2.7 This means that additional operating or maintenance expenditure to meet existing obligations are not included in the proposed enhancement investments for 2025-2050. Given that the baseline for our modelling ensures that maintenance requirements are excluded, this provides confidence that the need for enhancement expenditure is certain, incremental and is driven by the new performance standard required rather than "double counting" existing obligations that should be met through base cost allowances.

Hydraulic flooding risk

4.2.8 Hydraulic flooding risk was assessed using the outputs of our hydraulic network models. In order to assess against the 2030 and 2050 planning horizons, these models were uplifted to account for future growth, development and urban creep. Climate change was applied to all rainfall used for these future scenarios. The UKWIR 2017 report 'Rainfall Intensity for Sewer Design, 17/CL/10/17' is the basis of all climate change uplifts applied to the hydraulic network models for BRAVA. Therefore, the basis for both

the 2030 and 2050 planning horizons is the RCP8.5 high emissions scenario (assumes a 4.3 degree Celsius increase in global mean surface temperature by 2081-2100). The projections are based on the UKCP09[10] models and additionally, the REDUP tool associated with the UKWIR paper was used to perturb long-time series rainfall. For both the 2030 and 2050 planning horizons, the Central Estimate values are used for standard BRAVA with the High Estimate values used for complex catchments[11]. These scenarios represent the core scenario, as the most likely trajectory based on current projections and an upper bound to stress test the plan respectively.

4.2.9 Risk of hydraulic flooding was assessed through simulating all network models for a range of return periods (1, 10, 20 and 50 years) using 2D models and design rainfall. The 2D flood extents are used within geo-spatial queries to calculate for each property in the region the minimum return period at which the property is affected by overland flow. This return period is converted to an annualised flood risk for each property.

Outputs from BRAVA

4.2.10 Findings from BRAVA show increases in the percentage of properties at risk of flooding by 2050 from a 2025 baseline (Table 1). These increases in risk are mainly driven by additional surface water resulting from climate change, a factor that far surpasses the impacts of growth and urban creep. The largest increase in risk is that of internal flooding. This relates to sewer flooding inside domestic properties or businesses, and was found through DWMP customer engagement to be a higher priority than external or public space flooding among customers. Internal flood risk presents a larger increase than external flood risk since intense, short-duration storms impact on internal flooding, whereas longer duration events affect external flooding. Thus, the majority of areas at risk of external flooding are already realised today, and are less impacted by the increase in intense rainfall events driven by climate change.

Table 1: Results from BRAVA against the sewer flooding planning objective

Risk	Percentage increase in properties at risk by 2050 from 2025 baseline (%)12
Internal flooding	63.3
External flooding	5.58
Flooding in a 1 in 50 year storm	47.8

Source: UUW DWMP analysis

4.2.11 Some TPUs have greater flooding risks than others. For example, Preston was classified as a complex and strategic catchment due to its unusual network design (five distinct drainage areas) and projected population growth (13 % increase by 2050)[13] which could drive a significant amount of further development to meet housing need, and increase pressure on the network. It was therefore identified as requiring significant investment to mitigate the increased risk of flooding. However, there are opportunities to carry out investigations and stakeholder engagement before making decisions on the final strategy. This means that we can properly evaluate options before committing to significant investment. These investigations will take into account factors such as:

- Technical feasibility
- Benefit of the work

[10] UKCP18 outputs were not available within the timescales of the DWMP project but have since been tested to undertake a comparison against UKCP09 impacts in a small number of catchments where a reduction in uplift from UKCP09 was suggested in UKCP18. Testing indicated little change in flood numbers and provided evidence that the approach taken to model climate change was robust and appropriate.

[11] Catchments which had higher growth uncertainty and larger strategic needs were determined as complex and underwent a wider range of additional testing to assess the impact of uncertainty around climate change on internal and external sewer flooding.

[12] Modelled absolute values

[13] Reference: UUW: Drainage and Wastewater Management Plan – Strategic Planning (2023), accessed here

- Customer impact
- Environmental impact
- Cost
- Third party influence and collaboration (e.g. Local Planning Authority, highways and developers)

4.3 Scale and timing of investment

4.3.1 It is clear that a step change in service provision is needed now to protect customers and the environment, and secure long-term resilience against the effects of climate change. The risk of not delivering this is leaving communities at risk of having larger problems requiring ever larger and more complex solutions for future generations to resolve. Customers support the need to provide climate resilience, with 86% of households believing we should be addressing climate change[14].

4.3.2 UUW proposes a step change away from traditional storage solutions towards more sustainable rainwater management techniques to manage rainwater at source and provide resilience against the evidenced excess rainfall that will drain through our networks because of drivers such as climate change. Rainwater management techniques are an interpretation of Nature Based Solutions (NbS) and generally involve the attenuation and disconnection of rainwater from combined sewer networks, while supporting the delivery of multiple wider benefits. The shift towards more NbS is supported by Ofwat[15], DEFRA[16] and customers[17]. 98% of customers believe UUW has a role in managing rainwater[18].

4.3.3 This enhancement case proposes £132.255 million in AMP8 for investment in rainwater management techniques to sustainably reduce the amount of surface water entering our sewer network, maximising wider societal benefits in partnerships. The investment set out in this enhancement case is aimed at mitigating some of the risk of future deterioration in sewer flooding performance due to climate change; a factor which UUW considers to be outside of management control. If we do not invest now in sustainable rainwater management solutions, flooding performance will deteriorate despite investment through base expenditure due to the increased hydraulic risk our region is facing.

4.3.4 This case is justified through its alignment to our long-term plan to deliver statutory objectives by providing resilience to communities across the North West, and is based on UUW's modelled core pathway. This is our initial long-term strategy, which will be reviewed over time as the picture of risk changes, or interventions are realised. The core pathway prioritises 'no-regret' interventions first. To deliver on our planning objectives under less certain, more extreme future scenarios however, we may need to invest in different solutions.

4.3.5 The majority of investment set out in this enhancement case will fund the implementation of Sustainable Drainage Systems (SuDS). SuDS are designed to maximise the opportunities and benefits we can secure from rainwater management. The implementation of SuDS to manage the increased surface water entering our network is a no-regret investment that will take a precautionary approach to managing future risk in the face of an uncertain climate future. Feedback from UUW customer research conducted in 2021 through a suite of engagement activities consistently found that meeting future challenges through investing in sustainable solutions was a top priority for customers, second only to protecting the environment. SuDS options gained significant support owing to perceived additional benefits and getting to the 'root cause' of a problem. Managing excess input of rainwater through attenuation and disconnection is seen as the most sustainable approach to starting our long-term adaptive plans, reducing the likelihood for carbon intensive conventional solutions for future

[14] As found through research conducted during the development of our DWMP

[15] Ofwat: PR24 and beyond: Creating tomorrow, together – executive summary (2021), available here

[16] DEFRA: Storm Overflow Discharge Reduction Plan (2022), available here

[17] As found through UUW customer acceptability testing - DWMP (TA9) (page 41).

[18] unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/p___-rainfall-management-research/rainfall-management-household-research-report.pdf

generations. As such, we are looking to accelerate no-regrets interventions such as SuDS through this Rainwater Management enhancement case for the investment period 2025-2030.

4.4 Base versus enhancement

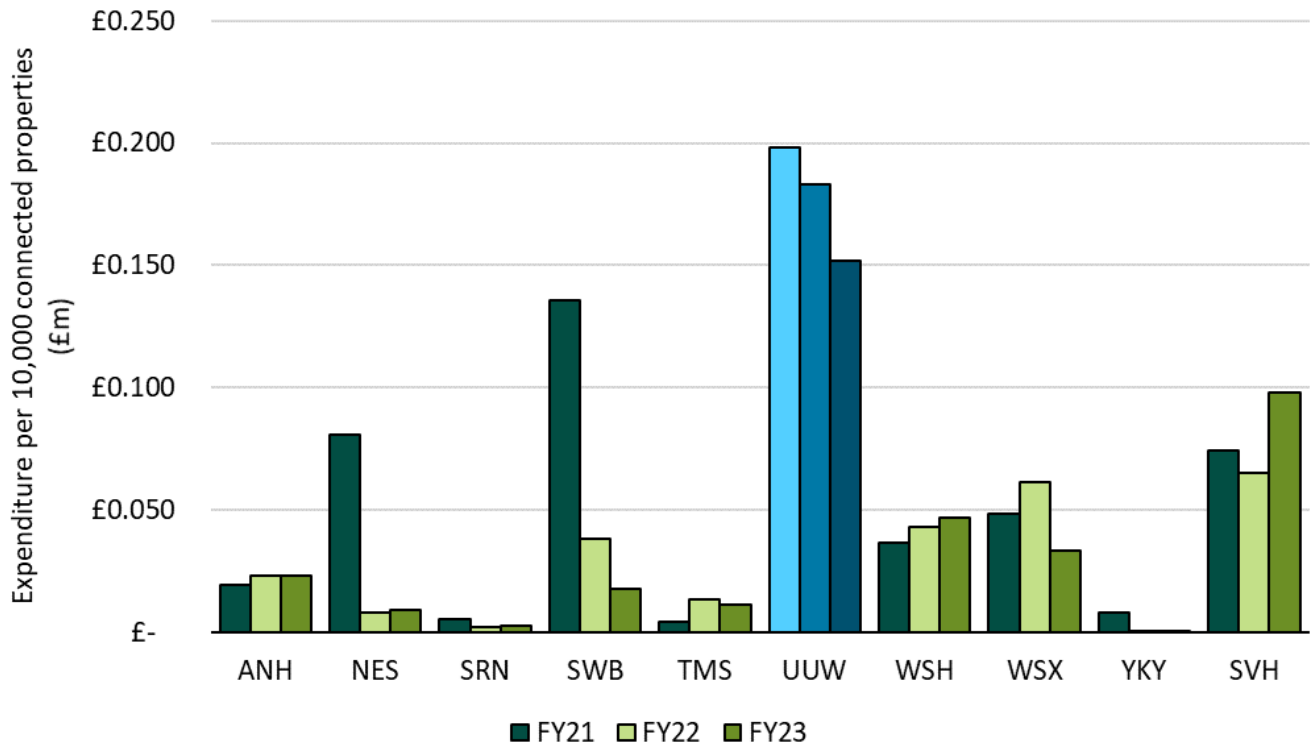
4.4.1 The aim of this enhancement case is to prevent deterioration in sewer flooding performance due to climate change by initiating a multi-AMP programme of investment in sustainable rainwater management solutions such as SuDS. The historic costs for such resilience activities are not contained within the PR24 base cost models. The enhancement programme represents a fundamental shift from the traditional activities aimed at delivering immediate operational benefits, such as property-level flood mitigation, towards implementation of NbS at a scale not observed historically. As such, the costs of these activities are not present within the historical dataset and therefore cannot be allocated by the cost models.

4.4.2 The scale of the operational change and total investment necessary to fundamentally reconfigure our network and control rainwater at source, thereby providing climate resilience, means that rainwater management investment must be staggered across multiple AMPs. It will thus take multiple AMPs for any significant benefits to be realised at a regional scale. Our reducing flood risk for properties' allowance will be used to fund the short-term flood mitigation measures needed to manage the unique operating circumstances of the North West whilst our longer-term vision to reduce rainwater entering combined systems is enacted. The implicit allowance for 'reducing flood risk for properties' within the PR24 base cost models will therefore be complementary to, but separate from, this enhancement case. The costs of this enhancement case cannot be absorbed into this allowance if we are to sustainably complete a transition away from short-term mitigation towards rainwater management at scale without a detriment to short-term performance.

4.5 Track record (past delivery)

4.5.1 UUW has had by far the largest total expenditure on 'reducing flood risk for properties' per 10,000 sewer connections within AMP7 to date and expenditure 27.9 % above the industry average over the period 2011-12 to 2021-22. Figure 2 outlines this. Over the first three years of AMP7, as a direct result of our higher flood risk, we have invested significantly in flood mitigation, installing over 1,600 flood mitigation devices, such as flood barriers and non-return valves, at customers' properties. Additionally, we have invested £36 million in our 'hydraulic flood risk resilience' schemes to reduce the impact of hydraulic incapacity through cut and pump solutions as well as planned installation of 9,945 m^3 of storage by the end of AMP7.

Figure 2: Expenditure on 'reducing flood risk for properties' per 10,000 sewer connections for FY21 and FY22.



Source: Ofwat, PR24 wastewater cost assessment master dataset

4.6 Distinction from other programmes

4.6.1 UUW recognises that rainwater management interventions are proposed through the Advanced WINEP (A-WINEP) programme. These interventions will aim primarily to drive a reduction in storm overflow spill frequency by unlocking rainwater management solutions in the drainage areas of storm overflows. As the existence of storm overflows within the combined sewer network is to provide hydraulic relief and prevent flooding, it follows that areas prone to flooding are unlikely to have storm overflows in the local contributing sewer network. We have tested this hypothesis by assessing for any overlap of contributing areas to flood risk clusters and storm overflows (Table 2). This was done by intersecting the upstream contributing areas of the DWMP flood clusters (based on areas with high annualised hydraulic risk) with hybrid solutions proposed under the A-WINEP. This analysis found minimal overlap demonstrating that where a hybrid solution is proposed through the A-WINEP, this will not be located within a flood cluster and so whilst some secondary flood risk benefit will be provided, it is unlikely to address flood risk directly. Figure 3 demonstrates our rainwater management strategy, and the distinction of the individual programmes.

Table 2: Results of overlap analysis between DWMP flood clusters and hybrid solutions proposed through the A-WINEP

DWMP flood clusters (ranked by highest risk, 2020)	Area of flood cluster (km²)	Percentage overlap with A-WINEP hybrid area (%)
Top 50 clusters	23.6	0.5%
Top 100 clusters	33.0	0.4%
Top 250 clusters	55.7	0.3%
Top 500 clusters	82.6	0.2%

Source: UUW analysis

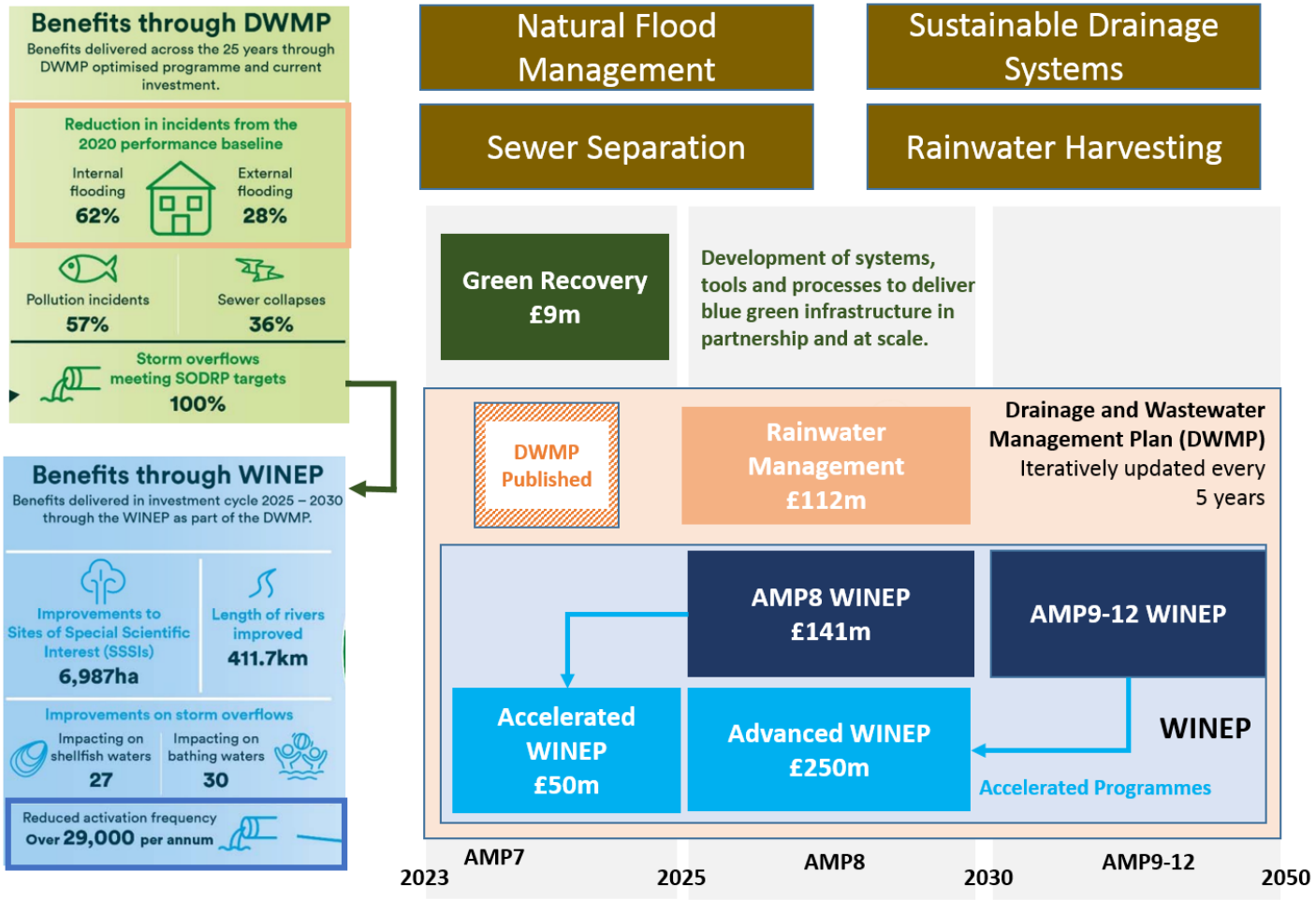
Figure 3: Demonstration of the distinction between various UUW proposed programmes involving rainwater management techniques

The DWMP delivers benefits, through reductions in incidents from the 2020 performance baseline, referring to internal flooding, external flooding, pollution incidents and sewer collapses. Our DWMP also accounts for 100% of our storm overflows SODRP targets by 2050.

The WINEP delivers targets within the Storm Overflow Discharge Reduction Plan (SODRP). This includes reducing spill frequency to an average of 10 by 2050.

Our Advanced WINEP proposals aim to provide learning in which regulation can adapt to promote more nature based solutions.

All Rainwater Management and Natural Solutions are delivered through the **Better Rivers, Better North West** team.



5. Best option for customers

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

5.1.2 Our Rainwater Management Programme to address the increased sewer flooding risk driven by climate change has been informed by the options development and appraisal process conducted through our Drainage and Wastewater Management Plan (DWMP). A wide range of options were considered in the development of the plan. These options were iteratively screened and optimised considering cost benefit data, six capitals benefits and customer preference. The output of this process was the best value plan for each tactical planning unit (TPU), which comprised a blend of options to address exceedances in our planning objective to "sustainably reduce the risk of sewer flooding". Although the outputs of this optimisation process have allowed for the estimation of enhancement investment required in AMP8, the plan must remain flexible to allow for uncertainty in cost and benefit delivery. The use of option blends has enabled this flexibility by ensuring lowest regret solutions are deployed first. A partnership approach has been considered in planning for the delivery of this programme, informed by the DWMP Partnership Opportunities Pipeline and learnings from our Green Recovery Programme.

5.2 DWMP Options Development and Optimisation

5.2.1 To develop the Rainwater Management Programme, a robust options development and appraisal process was followed through the DWMP. This was carried out in accordance with the DWMP Framework Appendix D[19]. A multitude of options over a range of different option types were explored in the development of the preferred plan. Figure 4 outlines UUW's approach to developing the initial generic options list.

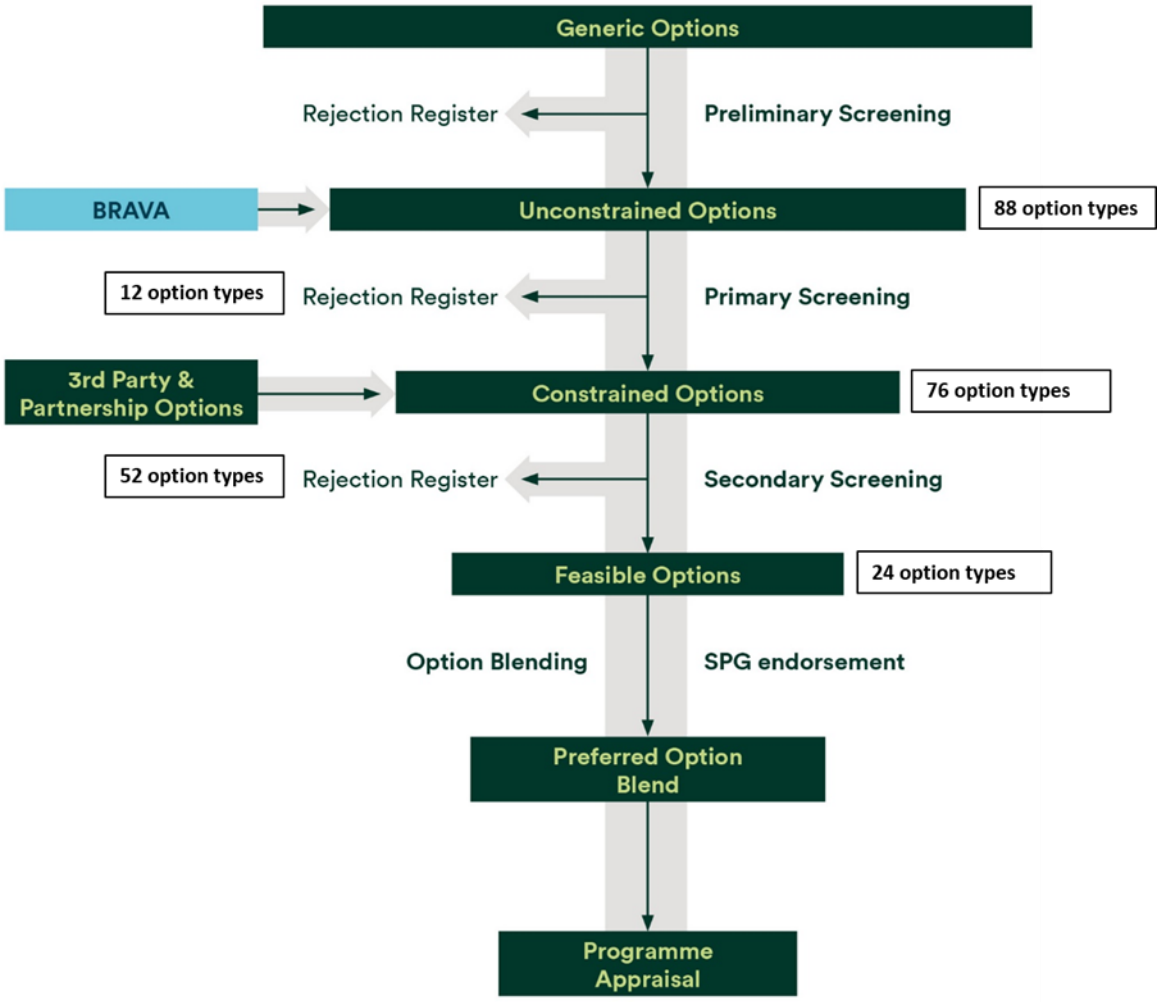
[19] Water UK: Options development and appraisal (2018), accessed here: https://www.water.org.uk/wp-content/uploads/2018/12/Water-UK-DWMP-Framework-Report_APPENDIX-D.pdf

Figure 4: UUW's approach to compiling generic options

5.2.2 An iterative screening process was used to narrow down and reject unfeasible options in each TPU. Figure 5 outlines this process. For each stage of screening and further development of options, the methodologies were developed internally by UUW, and assured by Jacobs and Deloitte. These methodologies set out the proposed approach and outputs, screening and application of screening criteria and methodologies for cost, performance and benefits assessment. Further detail regarding the development of options and screening methodologies is detailed in our DWMP Technical Appendix 7 (TA7)[20].

[20] UUW: Drainage and Wastewater Management Plan TA7, accessed here: https://www.unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/dwmp-2023/ta7_options-development-and-appraisal.pdf

Figure 5: DWMP Options Development Process



Secondary screening

5.2.3 Following initial screening, over 65,000 individual constrained options remained. To reduce this to a set of feasible options, secondary screening was undertaken. Our approach to secondary screening was informed by the DWMP framework, strategic environmental assessment (SEA) approach and engagement with our Strategic Planning Groups (SPGs).

5.2.4 During secondary screening, we undertook further detailed assessment on elements such as calculating monetary and carbon costs for each option. Additionally, an assessment on the six capitals (economic, social, financial, manufactured, human and natural capital) was conducted to be included alongside the assessment of cost and carbon in the decision making stage.

5.2.5 The six capitals framework allowed a value-based decision making approach to be adopted. By taking this approach, we have ensured that options, which may otherwise be discounted based on traditional cost benefit assessments, are considered further in the process. It has allowed a more holistic view of value, in a way that will allow us to monetise and compare options/solutions. Customers largely support UUW's move to the six capitals approach to decision making as they feel it covers many different bases and support the fact that UUW is considering communities and the environment[21].

5.2.6 A consideration was made for options where an opportunity for partnership had been identified through our engagement with the SPGs. Where opportunities were identified for co-delivery of options to resolve flooding exceedances a decrease in cost was applied, on the basis that these solutions are

[21] Found through research conducted during the development of the DWMP in accordance with the Ofwat standards for high quality research

more likely to secure partnership funding and allow a joint solution to be developed. For more information on our partnership approach, see section 5.4.

Cost Benefit Analysis

5.2.7 UUW has undertaken a cost benefit analysis (CBA) in order to provide a structured and objective approach to decision-making. CBA involves identifying the costs and benefits of each option and comparing them to determine which option provides the most significant net benefit. For this particular activity, UUW has completed a whole-life calculation of costs and benefits over a 30-year time horizon to align with Ofwat's and the Environment Agency's requirements for PR24 and WINEP.

5.2.8 The CBA was undertaken using the Green Book Spackman[22] approach to discounting, and cost benefit ratio calculated using our Automated Discounting Procedure (ADP) generated by the value assessment tool developed by UUW specifically for this purpose. There are four components to the ADP. These are as follows:

(1) Discounting of value/benefits over a 30-year time horizon

(2) Discounting of Totex over a 30-year time horizon in accordance with the Spackman approach

(3) Valuations and discounting of operational and embodied carbon over a 30-year time horizon

(4) Calculation of a Cost Benefit Assessment

5.2.9 To conduct the CBA, we first estimated the costs and benefits associated with each identified investment option. Costs included capital expenditure, operating costs, and maintenance costs. Section 6 details the methodology used to obtain these cost estimates. Benefits include risk reduction (performance) against each planning objective.

5.2.10 Once costs and benefits were quantified, a discount rate was applied to account for the time value of money. This helps to ensure that costs and benefits that occur in the future are appropriately valued in today's terms. The following equation was used to calculate a cost benefit ratio:

$$Total\ value = \left(\frac{Value\ NPV}{(Carbon\ NPV + Totex\ NPV}\right)$$

Six Capitals Assessment

5.2.11 A qualitative approach to scoring was adopted for the six capitals assessment due to the generic and high-level nature of the DWMP options. The assessment utilised a framework of impacts and dependencies, and scored them according to the following scale:

- Significant positive impact (score of 2)
- Minor positive impact (score of 1)
- No overall impact (score of 0)
- Minor negative impact (score of -1)
- Significant negative impact (score of -2)

[22] HM Treasury: The Green Book (2022), accessed here: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1063330/Green_Book_2022.pdf

Figure 6: Six Capitals assessed

Source: UUW DWMP publication

5.2.12 Scoring was based on the nature of the option including whether it is a nature-based solution, involves land use change or is a behavioural option. This was supplemented by information gathered during secondary screening, and in some cases, the wider literature was consulted to justify scores.

5.2.13 Assessments of resilience and asset health for each option type were scored using the same qualitative approach as the six capitals. These factors were combined with the six capitals factors to give a total average qualitative score for each option type.

Feasible Options Assessment

5.2.14 The cost benefit ratio calculated using the ADP was considered alongside the six capitals, resilience and asset health score. Options were screened out if they did not meet one of the following criteria:

- CBA > 1
- CBA > 0.75 plus a qualitative assessment scoring >=0; and,
- CBA > 0.5 plus a qualitative assessment scoring >0.

5.2.15 This means that an option with a lower cost benefit score will be brought through to feasible options if it has a net positive secondary score.

Programme optimisation

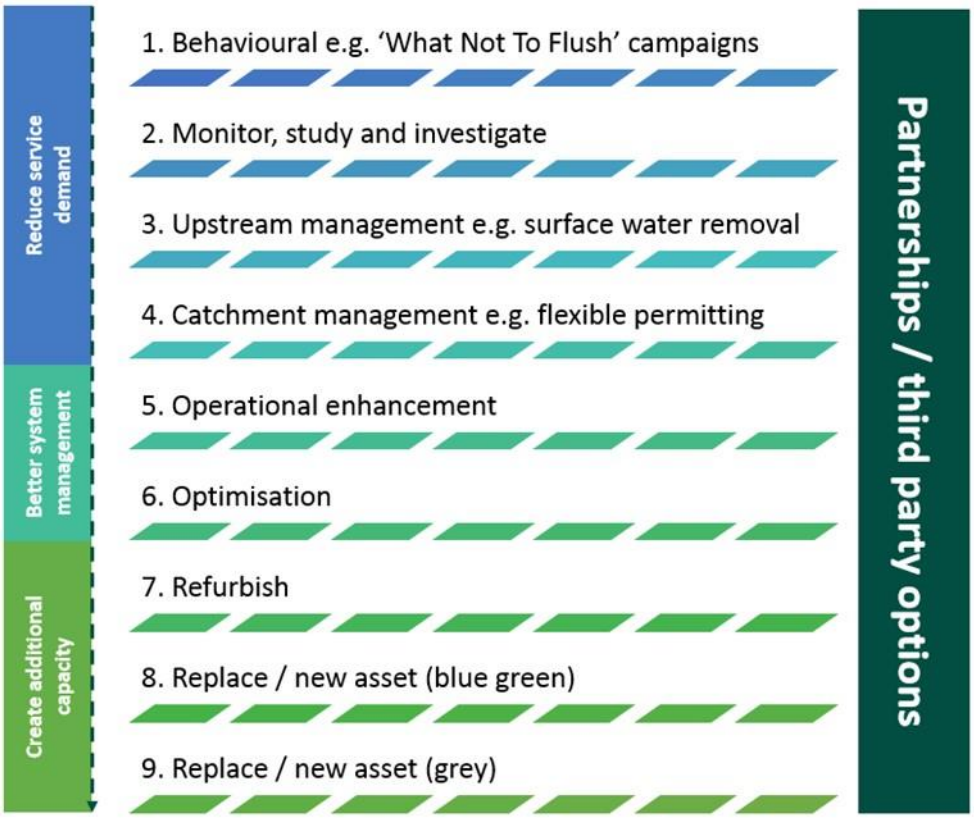
5.2.16 Following secondary screening, over 20,000 feasible options remained which were deemed suitable for further consideration to form part of the preferred options. The feasible options formed the basis of input into our DWMP optimisation process. The programme optimisation stage aimed to identify the most appropriate options to implement in the plan given the cost, performance, wider benefits and impacts of options.

5.2.17 It is recognised that preferred options for each TPU would need to be comprised of multiple options, as a singular solution is not often one that delivers the best outcome for customers, or strategically manages the issues identified. Consequently, option blends were developed which encompass a suite of measures to mitigate a risk identified through BRAVA.

5.2.18 Two methods were considered to create options blends; prioritisation according to lowest whole-life cost, or a best value approach that considers customer preference by using an Options Hierarchy. A sub group of UUW's Customer Challenge Group (CCG): 'Your Voice Environmental and Social Capital Sub Group', and UUW's SPGs were consulted on the best way to select the preferred option blends. UUW's CCG were unanimously in support of using the Options Hierarchy Approach, with 73 % of UUW's SPGs in support. This was therefore the selected approach to determining the preferred plan.

5.2.19 The Options Hierarchy was developed using outputs from customer engagement[23] conducted through the DWMP. Across the research groups, there was a similar pattern for customers' preferences on approaches to meeting long-term challenges, with appetite for more education, innovation and smart ways of working before the more traditional grey measures. This fits well with targeting more resilient rainwater separation and nature-based solutions, in the early phases of delivery. These findings were developed into the Options Hierarchy we have adopted (Figure 7). By using this approach, options which address a planning objective performance gap that are higher up the hierarchy are selected over those lower down. Options selected were still required to meet the feasible option cost benefit threshold as outlined in section 5.2.14.

Figure 7: DWMP Options Hierarchy



Source: UUW DWMP publication

5.2.20 To determine the optimum option blends for each catchment area, an innovative decision support tool, Copperleaf Portfolio, otherwise known as the optimiser, was used. The optimiser took inputs of cost, benefit and six capital data for each option as quantified in the secondary screening process, and used mixed integer linear algorithms to apply various constraints, and test against the Options Hierarchy. The output of this optimisation process was the prioritised plan for each TPU, which represents the best combination of options to meet the long-term planning objectives across the region.

[23] UUW: Drainage and Wastewater Management Plan TA9 (section 5), accessed here: https://www.unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/dwmp-2023/ta9_customer-engagement.pdf

5.3 Options Selection

5.3.1 The optimiser selected three primary option types as the best value approach when run against the Options Hierarchy to address the increased risk of sewer flooding identified through BRAVA. These have informed the selection of interventions included within this enhancement case. The three primary option types selected were:

- Sustainable Drainage Systems (SuDS)
- Increase the capacity of existing foul / combined networks
- Intelligent network operation (Dynamic Network Management (DNM))

5.3.2 These option types have been optimised to be deployed as a blend across 341 TPUs. They will deliver an additional equivalent storage capacity of 29,941 m^3 (Figure 9) across the North West for a net total expenditure value of £132.255m Figure 8). Although the optimiser outputs have informed the enhancement investment required to implement wide-scale rollout of rainwater management across the North West in AMP8, the plan has not been tested for deliverability, and as such needs to remain flexible to ensure options can be prioritised according to the need in a particular catchment.

Figure 8: Outputs from the DWMP optimisation process against the sewer flooding planning objective which have informed the development of the Rainwater Management enhancement case (by net total expenditure)

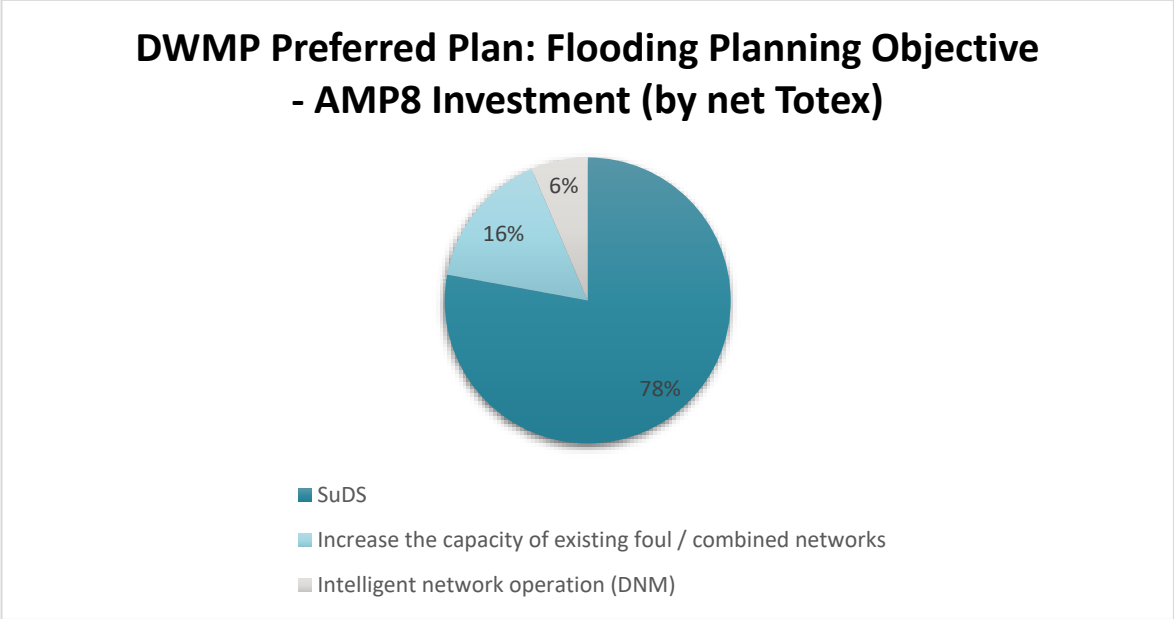
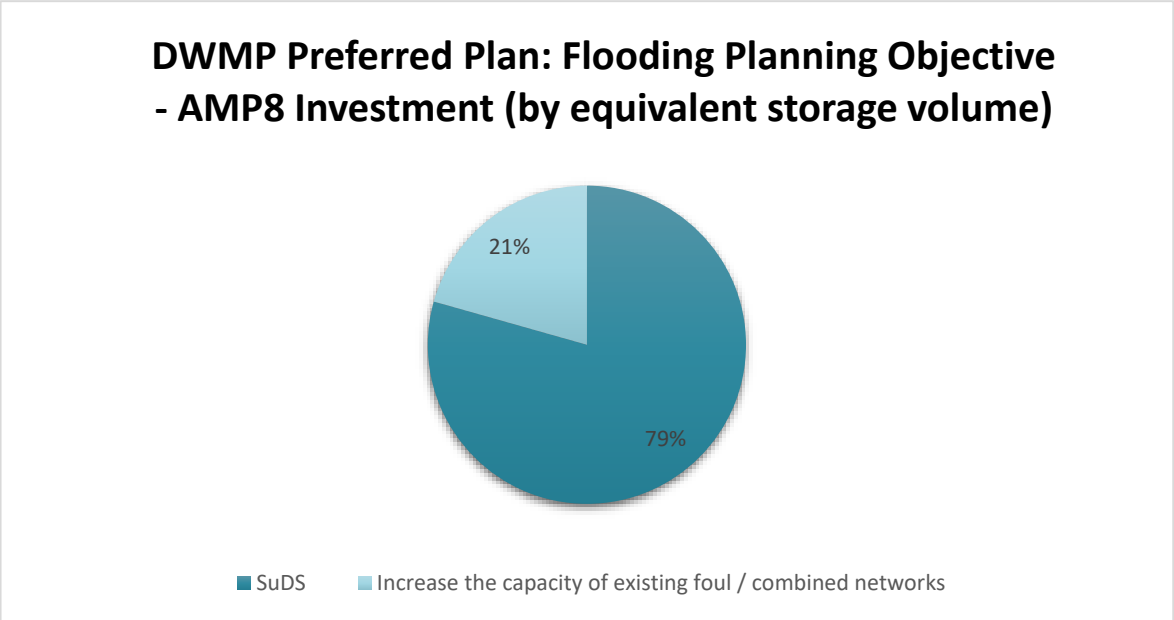


Figure 9: Outputs from the DWMP optimisation process against the sewer flooding planning objective which have informed the development of the Rainwater Management enhancement case (by equivalent storage capacity delivered)



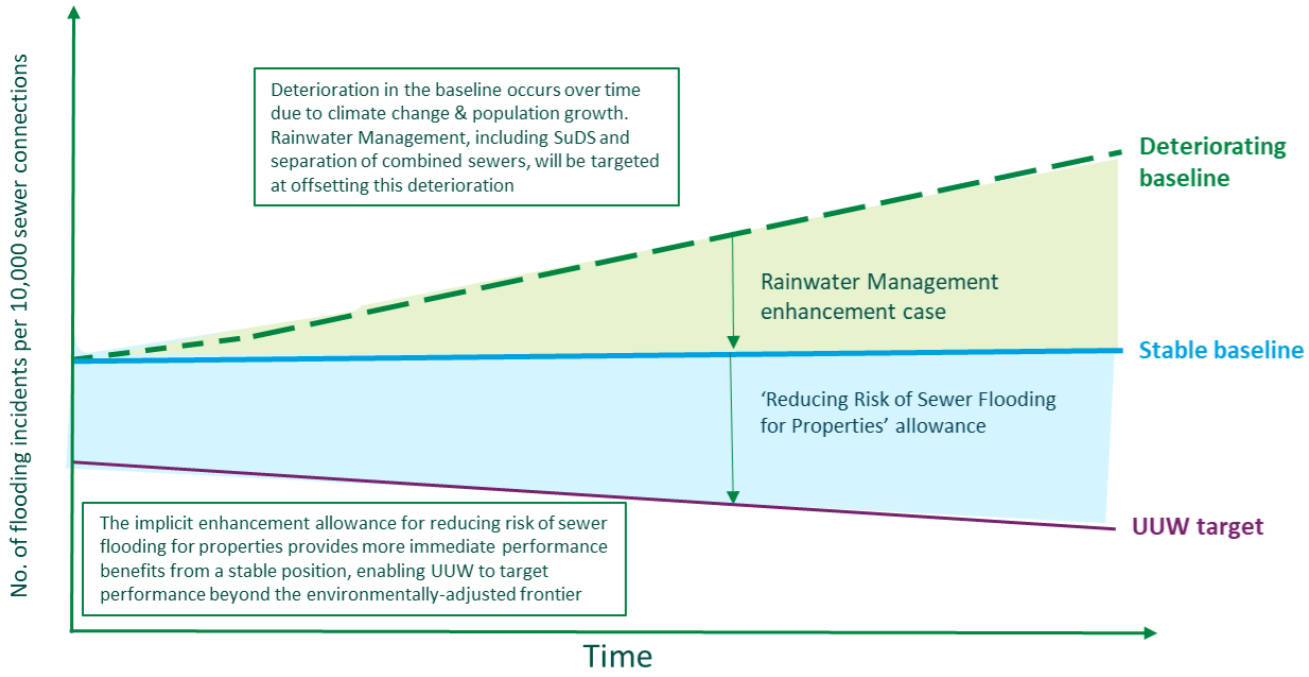
5.3.3 The option blend outlined above represents the first instalment of a multi-AMP programme of investment in sustainable rainwater management solutions to provide long-term climate resilience, and offset future deterioration in sewer flooding performance. Due to the scale of operational change and total investment required to fundamentally reconfigure our network and control rainwater at source, it will take multiple AMPs for any significant flooding benefits to be realised at a regional scale. Consequently, the enhancement case value assessment detailed in our data table CWW15 presents limited net flooding benefit, resulting in a cost benefit assessment less than 1.

5.3.4 The value assessment required by Ofwat for the data tables employs a stable baseline when establishing the benefits of enhancement cases. This results in a net value assessment. Accounting for the impact of external factors, most notably climate change, the assumption of a stable baseline is superseded by a deteriorating baseline. This is represented in Figure 10, whereby the gross benefits of all enhancement cases are calculated as the difference between the 'deteriorating baseline' and 'UUW target'.

5.3.5 The annual performance change for the deteriorating baseline (internal and external sewer flooding) was calculated using the 2050 forecast 'baseline' values from UUW's published DWMP data tables[24].

[24] www.unitedutilities.com/corporate/about-us/our-future-plans/Our-long-term-plans/dwmp-publication-may-2023/

Figure 10: A theoretical graph demonstrating the relationship between this enhancement case and the Reducing risk of sewer flooding for properties enhancement case, and the deteriorating baseline assumed for the gross value assessment of this enhancement case



5.3.6 When considering the gross flooding benefit from this Rainwater Management enhancement case, accounting for the impact of climate change on baseline performance deterioration, an equivalent cost-benefit assessment (as referenced in 5.3.3) gives a value greater than 2. The gross flooding benefit is equal to the sewer flooding incidents mitigated from the deteriorating baseline (termed 'Mitigated deterioration') plus the forecast flooding benefits from a stable baseline (termed 'Net benefit'), presented in our PR24 data table submission (CWW15). This is summarised in Table 3 below.

Table 3: Rainwater management enhancement case benefits profiles (based on 30-year NPV)

Value Assessment	Cost Benefit
Mitigated deterioration	2.622
Net benefit	0.241
Gross benefit	2.862

5.3.7 The value assessment presented above and the relationship between this enhancement case and our Reducing risk of sewer flooding for properties enhancement case demonstrates that both elements are required if we are to sustain a level of performance that is in line with, or beyond, the environmentally-adjusted frontier for sewer flooding (shown in Figure 10).

5.3.8 The rainwater management enhancement case will provide resilience against future deterioration in hydraulic flooding performance due to climate change and keep the baseline position stable, whilst the Reducing risk of sewer flooding for properties enhancement case will deliver solutions to mitigate existing sewer flooding issues and improve sewer flooding performance.

5.3.9 The implementation of SuDS as a no-regrets solution also enables multiple wider benefits, such as amenity, recreation and social value, to be established in AMP8 and continue to mature beyond 2030.

SuDS

5.3.10 SuDS make up the largest proportion of investment (£103m) and equivalent storage capacity[25] (23,767 m^3 (75 hectares)) proposed within this enhancement case, and this output is aligned to our vision to develop more sustainable solutions to manage the excess surface water draining into our network as a result of climate change. SuDS are designed to manage storm water locally to mimic natural drainage and encourage infiltration and attenuation, to manage flood risks resulting from urban run-off[26]. SuDS options gained significant support from customers in research conducted during the development of the DWMP, owing to perceived additional benefits and getting to the 'root cause' of a problem. Thus, we are accelerating investment in SuDS in this enhancement case.

5.3.11 SuDS opportunities were mapped using the Atkins' developed GIS tool SuDS Studio™. Opportunity for SuDS retrofit was determined through assessment of feasible routes between sources (areas of hardstanding that generate surface runoff) and sinks (potential locations for SuDS), and volume of runoff generated in a 1 in 30 year plus climate change storm (31.5mm rainfall depth). SuDS Studio™ presented the dominant SuDS options in each catchment (adjusted to reflect realistic uptake rates of SuDS at a large scale), characterised by monetary[27] and carbon[28] costs and predicted performance impact on sewer flooding[29]. This allowed for the calculation of a cost benefit ratio to be fed into the secondary screening process of the DWMP.

5.3.12 Table 4 shows the range of SuDS schemes that the optimiser could select from, and indicates those which have been initially selected for best value investment in AMP8. It is important to note that the solutions proposed are based on a desk study. Further site investigations to assess additional constraints (utility lines, changes in land use since the tool run, structural stability of the buildings to sustain green roofs, connectivity of downpipes and inlets, etc.) will need to be undertaken to confirm final feasibility of solutions. UUW will therefore remain flexible to ensure delivery of the optimum SuDS scheme according to catchment and community needs.

Table 4: SuDS interventions considered and selected by the optimiser

SuDS intervention type	Brief description	Selected by the optimiser as best value AMP8 investment?
Attenuating Rain Gardens	Surface planting with geocellular underground storage	Yes
Attenuation Pond	Suitable in large natural spaces only	Yes
Bio-retention	Includes pocket infiltration, bio retention and multiple tree pits	No
Disconnect Downpipes	Disconnect downpipes from large buildings to underground geocellular attenuation	Yes
Filter Drains	Trench filled with gravel allowing some attenuation of runoff before discharge	Yes
Gravel Paving	Gravel surface providing some attenuation, suitable for car parks etc.	No
Green Roof	Planted roof suitable for large flat roofed buildings only	No

[25] Equivalent storage capacity of SuDS has been estimated as the potential maximum volume of surface runoff to be stored in a 1 in 30 year plus climate change event (assumed rainfall depth of 31.5mm)

[26] Local Government Association: Sustainable Drainage Systems, accessed here

[27] Methodology for SuDS cost estimation is detailed in section 6.2

[28] Embodied carbon of each SuDS solution was estimated using Bill of Quantities data, and emissions factors derived from The Institution of Civil Engineers (ICE) Database V3.0.

[29] Determined via the development of performance curves based on six test catchment hydraulic models, and verified by a pilot study, to relate reduction of impermeable area to reduction in predicted flood risk

SuDS intervention type	Brief description	Selected by the optimiser as best value AMP8 investment?
Permeable Block Paving	Permeable paving surface with underground geocellular attenuation	Yes
Rain Garden (Box)	1m high boxes with surface planting, applicable to large buildings only	Yes
Rain Gardens (Surface)	Residential solution consisting of surface planting with some attenuation capacity	No
Soakaway	Excavation filled with gravel and covered with soil	No
Swales	Includes wet and dry, linear and round solutions	Yes
Tree pit	Single tree pits	No
Water Butts	Private solutions installed on residential buildings	No
Wetland	Shallow features suitable only in large natural spaces	No

Increase the capacity of existing foul / combined networks

5.3.13 Increasing the capacity of existing networks represents 16 % of the total net expenditure (£20.7m) proposed in this enhancement case, and 6,174 m^3 of additional equivalent storage capacity. A range of options to manage capacity in UUW's combined and foul sewer networks were evaluated. Hydraulic model data were used to determine performance curves for estimating size of storage required to reduce the risk of predicted hydraulic flooding at cluster level[30]. Seven options were developed for each internal flooding cluster, the largest sized to resolve all predicted internal flooding in the cluster up to a 50-year return period storm event, down to the smallest, which was sized to resolve all predicted internal flooding in a one-year event. Each option was therefore characterised by an average reduction in annualised risk, along with a monetary[31] and carbon[32] cost, allowing for the calculation of a cost benefit ratio to be fed into the secondary screening process of the DWMP.

5.3.14 Construction of storm water storage tanks was selected by the optimiser as the best value investment in AMP8. Although UUW recognises the need for a blend of conventional engineering solutions alongside nature-based solutions to manage the step change in challenges posed by climate change, we aim to optimise delivery of increased network capacity through exploration and implementation of customer-side management options such as Water Butts. UUW has conducted a pilot trial to test the effectiveness of Smart Water Butts in reducing the volume of rainwater entering the combined wastewater network. The findings of the trial concluded that the Smart Water Butts were up to 75 times as effective as a standard Water Butt and could attenuate up to 30,000 litres of water per residential population. This provides confidence that the use of Smart Water Butts is an effective storage solution to provide additional capacity in the network.

Intelligent network operation

5.3.15 Our Dynamic Network Management (DNM) operating model uses real-time data, artificial intelligence and machine learning to control the controllable elements of sewer flooding risk, such as blockages, by enabling proactive action to be taken. This maximises the utilisation of available storage within the

[30] Flood clusters were created from the model derived BRAVA 2D hydraulic flood zones defined by selecting properties that intersect with the flooding zones over 100mm depth (internal flooding threshold).

[31] Methodology for cost estimation of increased network capacity is detailed in section 6.2

[32] An embodied carbon value was applied to each storage tank based on estimated concrete required to avoid flotation, and emissions factors derived from Institution of Civil Engineers (ICE) Database V3.0

network prior to flooding incidents occurring. During the investment period 2020 – 2025 we have transformed wastewater network monitoring through the DNM programme in 160 drainage areas.

5.3.16 In the context of this enhancement case, additional DNM capability will be delivered to optimise and validate the performance of the rainwater management interventions, and to support benefit realisation along with integration into our existing DNM platforms. DNM represents 6% of total net expenditure (£8.5m) proposed in this enhancement case. Cost (monetary[33] and carbon[34]) and benefit data from our AMP7 installations have informed the calculation of cost benefit assessments.

5.4 Partnerships

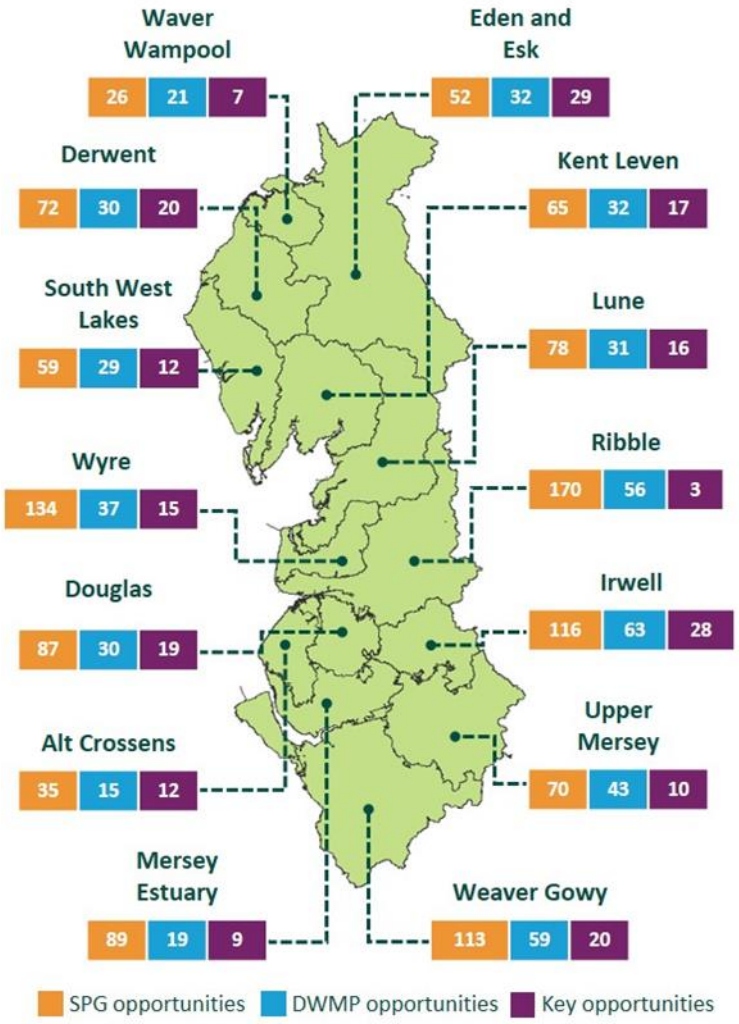
5.4.1 We recognise that the interconnected nature of drainage means that partnership and collaboration are fundamental in delivering our long-term targets. UUW has a track record of delivering innovative nature based solutions in partnership including the Wyre Natural Flood Management (NFM) project, Catchment Nutrient Balancing in the Petteril, peatland restoration and delivery of SuDS through our Green Recovery Programme. We will look to build on our many existing partnerships and develop new ones in order to achieve our long-term objectives.

5.4.2 Our DWMP was developed with support from stakeholders, regulators and customers from across the North West. Engagement through our Strategic Planning Groups (SPGs) has enabled the creation of the DWMP Partnership Opportunities Pipeline (Figure 11) through workshops to identify and map potential opportunities to work collaboratively in the catchment to address risk. Potential opportunities were screened depending on the opportunities timescales, proximity to UUW assets and the level of detail to allow UUW to refine the opportunities that were believed to have the most potential. The pipeline includes opportunities at a range of different levels of maturity and confidence in development; as such, these are not confirmed or funded schemes at this time. However, they provide an indication of areas where we may be able to work collaboratively with stakeholders in the future when more certainty is available on the need and funding.

[33] Methodology for cost estimation of DNM is detailed in section 6.2

[34] Embodied carbon assessment of DNM includes consideration of the sensor equipment, supply and transportation, installation and replacement

Figure 11: The DWMP Partnership Opportunities Pipeline



Source: UUW DWMP publication

5.4.3 We are using our Green Recovery programme to test different methods of delivering in partnership, to inform and provide a platform to mature our systems, tools and processes to efficiently and effectively spend money to deliver our targets. We are delivering eight SuDS schemes as part of our Green Recovery programme during AMP7. This investment will allow us to test delivering SuDS as part of street landscaping to allow disconnection of highway drainage from the public combined sewer, in a way that can deliver more holistic benefits, and align to local authority climate change objectives. This will provide us with the opportunity to test and understand the benefits of upscaling such interventions in partnership for multi-beneficiaries. The partnerships associated with these schemes are active with £9.4m of partnership funding committed to delivery of these projects in addition to £3.4m committed by UUW.

5.4.4 A partnership approach is particularly important when considering the delivery of SuDS schemes since they are delivered in the public realm and interface with local communities and the infrastructure that serves them. We have an ambition to deliver 85 %[35] of our DWMP SuDS schemes in partnership, however the pace of delivery, land requirement, technical suitability and stakeholder acceptability of SuDS solutions can affect our ability to deliver schemes and leverage funding from partners. We have used a leverage funding ratio of 9:1 (UUW funded: partner funded) to build our estimate for partnership expenditure. The leverage funding ratio has been informed by our historic approach and experience of equivalent schemes.

[35] By total expenditure

5.4.5 Gross total expenditure for AMP8 SuDS schemes proposed in this enhancement case is £112.6m, thus we include for £9.6m of third party funding for the delivery of SuDS schemes in partnership within this enhancement case. This creates a net total AMP8 SuDS expenditure of £103m, equivalent to UUW's contribution. As we progress delivery of these SuDS schemes and gain more experience, we aim to increase stakeholder acceptance of the efficacy of solutions therefore maximising the opportunity to deliver SuDS through partnerships.

5.5 Programme flexibility

5.5.1 By using an approach of option blends, we are able to deploy a suite of complimentary actions, which can be adapted as risks materialise and understanding improves. In the short-term, the Options Hierarchy ensures that lowest regret options are prioritised first which allows risks to be reviewed and benefit to be understood ahead of more expensive solutions. This results in the ability to phase delivery, monitor changes and adapt the approach accordingly. The additional benefit of creating option blends is that it creates an extra level of flexibility and mitigates innate uncertainty, for example options that are dependent on third parties.

5.5.2 Affordability is a hugely important issue for many people in the region as 40 % of the most deprived neighbourhoods in the country are in the North West. In 2021, 77 % of customers surveyed agreed that affordability should be a priority for UUW. We have strived to identify a best value plan, but are mindful that this is not necessarily equivalent of lowest cost, and a balance will need to be struck to ensure affordability for customers. Due to future uncertainty in increased risk from the impacts of climate change and growth, an adaptive approach is necessary to minimise impact on customer bills. An adaptive approach to implementing solutions will allow us to balance affordability with ambition for improvement. We have optimised the programme using mixed integer linear optimisation algorithms to maximize the value of our existing portfolio of investments, by selecting the appropriate set of investment alternatives, and the timing of those investments, that delivers the most value while respecting the specified constraint(s).

6. Cost efficiency

6.1.1 Multiple sources have been used to cost the intervention types specified within this enhancement case. The majority of investment is in SuDS, which have been priced in alignment with our WINEP methodology using SuDS StudioTM data created, developed and refined using industry learnings and international support surrounding best practice and efficiencies. For remaining option types such as intelligent network monitoring and increased network storage capacity, cost estimates were completed on the basis of cost curves developed from existing installations. These costs have been benchmarked against available data to ensure efficiency in our programme.

6.2 Approach to cost estimation

SuDS

6.2.1 The unit cost of SuDS is used as a key factor in determining which solution is selected as a dominant option in SuDS Studio™. A detailed model was developed for costing the different SuDS options, which was based on a bill of quantities (BoQ) breakdown of cost per unit for each option type. This provides an auditable build-up model that was imported into SuDS Studio™ as unit costs of each SuDS. This methodology is aligned to our engineering approach to options development for the WINEP overflow programme.

6.2.2 The unit costs of each SuDS were primarily based on Atkins' experience of previous SuDS installations, experience of project partners and clients and discussions with suppliers. These were benchmarked against externally available data to ensure efficiency in delivery (see section 6.3).

6.2.3 These costs are indicative, and at this stage may not reflect the actual costs of installing the scheme on site but should represent a price that allows delivery of the required area of surface water removal. This is due to the many variables affecting cost on any given site, which cannot be considered on a region-wide study, such as:

- The cost of land;
- Site constraints due to existing utilities/services on sites that need diversion;
- Trees;
- Potential contaminated soils; and,
- Contractor frameworks which could have an impact on different rates and material costs of solutions around the study area

6.2.4 These type of add ons are accounted for in the applied indirect cost uplifts. As more SuDS schemes are investigated and delivered, understanding of these costs will evolve and hence costs are likely to change in the future.

Table 5: Agreed unit costs for each SuDS intervention type

SuDS intervention type	Agreed unit cost (£/hectare)
Attenuating Rain Gardens	£604,808.72
Attenuation Pond	£2,594,926.56
Bio-retention	£1,800,000.00
Disconnect Downpipes	£1,725,851.60
Filter Drains	£1,781,475.57
Green Roof	£2,444,573.56
Permeable Block Paving	£1,700,000.00

SuDS intervention type	Agreed unit cost (£/hectare)
Rain Garden Box	£456,108.69
Rain Gardens (Surface)	£1,800,000.00
Soakaway	£2,820,818.29
Swales	£458,531.14
Tree pit	£5,032,373.66

6.2.5 To align with our WINEP methodology, no Opex costs for SuDS schemes have been accounted for within this enhancement case. This is due to the assumption that the Opex across the first five years of the SuDS lifecycle will be under the contractor's responsibility as performance of the SuDS is established. No Opex costs are therefore incurred by UUW in AMP8.

6.2.6 Opex costs were considered as part of the wider options appraisal process in the development of the DWMP as an inclusion of the Totex factor in CBA. Opex costs for SuDS were developed using various literature sources and validated against UUW experience and data. These costs replaced the Opex rates built in to SuDS Studio™ since these were identified to be significantly outdated.

Increase the capacity of existing foul / combined networks

6.2.7 Costs for increasing network capacity are based on the implementation of storm water storage tanks, and have been derived from historical construction costs for network storm water storage tanks delivered by UUW. A cost curve was developed with 27 data points from historic projects that ranged in size from 200m³ to 63,500m³. A cost per m³ was calculated and developed into a cost curve to enable a quick assessment of cost for network storage options. This work was done by UUW Estimating (Mott MacDonald).

6.2.8 We aim to optimise the delivery of increased network capacity through exploration and implementation of customer-side management options such as water butts, thus creating efficiency in delivery of the programme.

Intelligent network operation (DNM)

6.2.9 For commercial sensitivity reasons, full assessment in relation to costings for DNM (supply, installation, maintenance, etc.) could not be undertaken. Therefore estimates based on the 160 drainage areas this technology has been installed in have been applied and scaled dependent of population. There will be a period of investment beyond current maintenance, which, at present, is set to occur beyond the investment period 2025–2030.

6.2.10 It was assumed that while a set number of monitors have been commissioned to date by UUW (17,500), in the future there will be a reassessment to determine if the number of monitors commissioned needs to be either increased or decreased. This will consider upgrading a number of monitors/equipment to provide more accurate recordings and analysis. Costs in relation to monitor/equipment relocation (i.e. whether it's more cost effective to relocate existing monitors vs installation of new monitors and leave existing monitors to run to failure) need to be taken into future consideration.

6.3 Benchmarking

6.3.1 In order to validate the cost efficiency of the estimates in this enhancement case, we completed a benchmarking analysis.

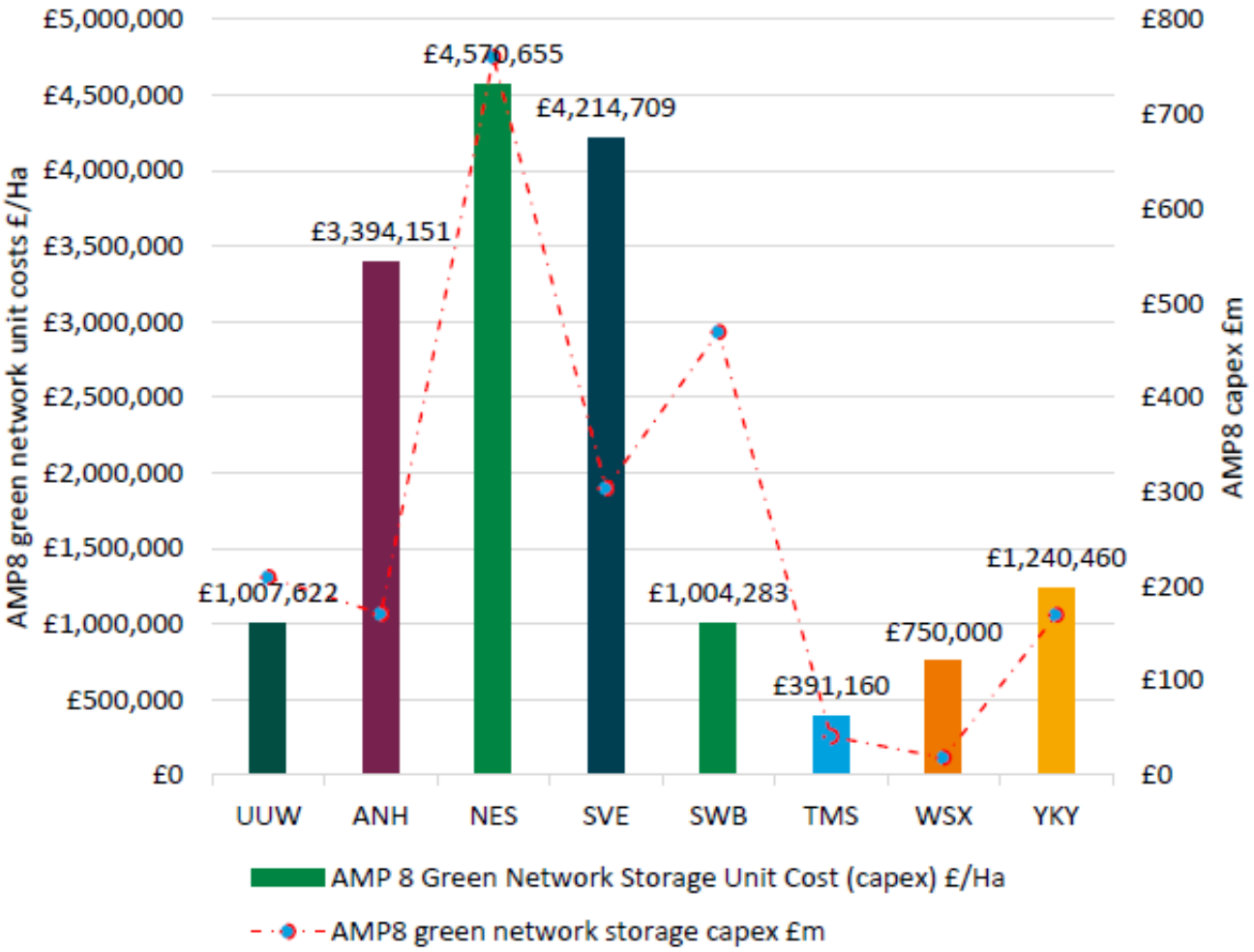
SuDS

6.3.2 Information regarding unit cost of SuDS and green network storage options are limited, as wide-scale roll out of SuDS is still in its infancy. The unit cost of SuDS schemes within this enhancement case are based on Atkins' experience of installing these schemes, along with experience of project partners,

clients and suppliers. The cost per hectare of surface water removed was analysed to ensure it was within the range expected. This revealed it to be higher than typically observed on such schemes. Data was subsequently gathered from Stantec, Jacobs and UUW's landscape framework contractors to allow a comparison and adjustment of the rates based on the available information. It should be noted that there is an UKWIR project[36] ongoing aimed at creating an evidence base (including costs), with supporting tools, to provide the water industry confidence to promote and deliver SuDS to tackle sewer flooding and storm overflow operations, and further develop understanding of the initial capital costs, long-term Opex costs, and whole life benefits of SuDS schemes.

6.3.3 Green network storage costs have been benchmarked against DWMP submission data. It is important to note that the DWMP data tables were completed on a different basis to the PR24 submission, and so the unit rates cannot be directly compared, however, the data suggests UUW has a relatively low unit cost for green storage, as demonstrated in Figure 12. This evidence, although limited, suggests we are relatively efficient.

Figure 12: Comparison of companies' green network storage unit costs referenced in DWMP submission



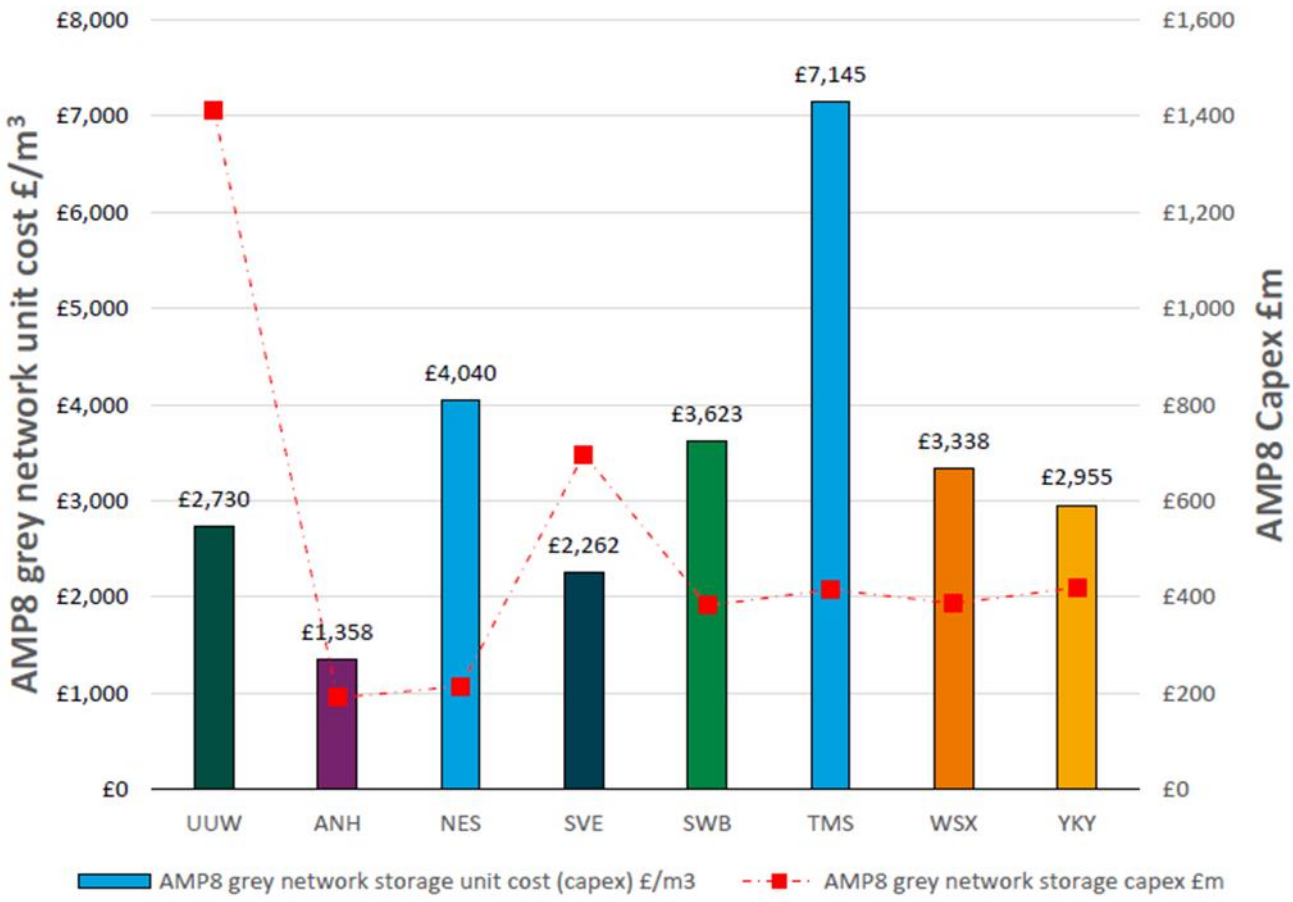
Increase the capacity of existing foul / combined networks

6.3.4 Since the cost estimates for this element of the enhancement case were built based on the implementation of storm water storage tanks, benchmarking has been completed against grey network storage. In a similar method to SuDS schemes, benchmarking against DWPM submission data shows that UUW's unit cost for grey network storage tanks is in line with other companies' DWMP submissions

[36] UKWIR: Understanding the long-term costs and wider benefits of surface water removal using Sustainable Drainage Systems (SuDS) to tackle sewer flooding and storm overflow operation, accessed here: https://ukwir.org/How-do-we-achieve-zero-uncontrolled-discharges-from-sewers-by-2050

(Figure 13). Whilst again this cannot be directly compared to PR24 costs, it does not suggest we are an outlier on a comparable unit cost basis.

Figure 13 : Comparison of companies' grey network storage unit costs referenced in DWMP submission



6.4 Third party assurance of our cost estimates

6.4.1 We commissioned two specific pieces of third party work to assure the cost efficiency of our enhancement cases:

- A bottom-up benchmarking exercise (Faithful and Gould); and
- Assurance on top-down benchmarking carried out by UUW (Deloitte).

6.4.2 We consider that the complementary and independent output of these pieces of work demonstrates that our cost estimates are efficient and represent excellent value for money for our customers.

6.4.3 We provide a description of each below.

Bottom-up benchmarking (Faithful and Gould)

6.4.4 Faithful and Gould undertook a bottom-up deep dive into the cost efficiency of our enhancement cases. This involved a close examination of our cost base relating to a sample of our enhancement programme, with comparisons made to similar activity carried out by third party companies across a variety of sectors.

6.4.5 F&G looked at our direct costs across each of the following categories:

(a) Staff including site supervision

(b) Mobilisation and site set up, running and removal of site offices and welfare

(c) Temporary services for general site use, such as water to wash out concrete skips

(d) Attendant plant and equipment, such as cranes, forklift for unloading deliveries etc

(e) Attendant labour, defined as hourly paid operatives not involved in productive works

(f) Site consumables, such as waste skips

(g) Set-up site compounds, erecting hoardings etc

(h) O&M manuals

(i) Health and safety

6.4.6 It also looked at the contractor's indirect costs (e.g. overhead and design costs) and UUW's indirect costs (e.g. land acquisition costs). Due to the size of the programme, F&G examined a sample of our enhancement cases. However, this sample included projects from each of our enhancement categories and covered £1.246bn of expenditure. Therefore, we consider this sample to representative of our overall enhancement programme.

6.4.7 F&G noted the effectiveness of UUW's cost estimation process:

"In addition to the benchmarking data held by Faithful+Gould we understand that UUW has applied multiple internal and external challenges to progressively refine the cost estimation undertaken to date. In particular we note UUW's use of its Investment Programme Estimating System (IPES) which is a bespoke parametric estimating tool containing data from AMP3 to AMP7, to provide historical cost curves alongside estimated data from third party organisations."

6.4.8 F&G found that our proposed costs are in line with rates typically seen across the industry:

"Overall, UUW's approach of utilising historic cost curves, market testing and obtaining specialist third party quotations demonstrates a sound proactive approach to cost planning. In total £1.2bn of schemes underwent targeted cost assessment with £573m making up the construction works element.

After presenting our initial findings it was encouraging to see UUW's commitment to addressing our findings and applying these to the wider enhancement estimates, charting a strategic route towards greater efficiency and scope clarification.

In light of this Cost Assurance work and evidence of UUW's responsive actions we have concluded that the data we have benchmarked is within a reasonable alignment with anticipated market rates."

Assurance on top-down benchmarking (Deloitte)

6.4.9 As part of our business plan submission, UUW carried out top-down benchmarking, which took two distinct forms:

- Unit cost analysis using recent data from the industry's APR datashare and other publications (e.g. Drainage and Wastewater Management Plans); and
- Where possible and feasible, econometric analysis based upon Ofwat's PR19 model suite.

6.4.10 As we discuss in *Chapter 8 – Delivering at efficient cost* and supplementary document *UUW46 – Cost Assessment Proposal,* recent supply-side shocks mean that the relationship between cost and cost driver reflected within the econometric models used to assess enhancement expenditure at PR19 is no longer appropriate. As such, we consider benchmarking carried out using more recent data to be more effective at assessing AMP8 enhancement costs. As such, we do not consider comparisons to cost estimates derived using the coefficients estimated at PR19 to be relevant.

6.4.11 In general, where recent and comparable data was available, our benchmarking analysis found our business plan costs align to similar comparator companies. This is reflected in Deloitte's findings:

"Overall, UUW has performed econometric benchmarking on programmes totalling £3,908m in enhancement case costs. We did not find any material errors in this econometric benchmarking…UUW's other top-down

benchmarking based on more recent data submitted by peer companies indicates that UUW PR24 costs are generally in line with expected costs."

7. Customer protection

7.1 Introduction

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

7.2 Price Control Deliverable

Table 6: PCD summary

Scheme delivery expectations	
Description of deliverable	Delivery of 29,941 m3 of equivalent storage capacity through sustainable rainwater water management measures across the North West. This will primarily be delivered through Sustainable Drainage Systems (SuDS) covering 75.5 hectares (754,521 square metres) and increased network capacity. This will be delivered by the end of AMP8, phased across the final three years of the AMP (2027 – 2030).
Output measurement and reporting	Delivery of 29,941 m3 of equivalent storage capacity through the use of SuDS and increased network capacity. Equivalent storage capacity of SuDS will be measured as potential maximum volume to be stored in a 1 in 30 year rainfall event. The analysis is not hydrodynamic, but instead applies a fixed total event rainfall depth to the source areas to estimate the required volume of surface water runoff needed to be stored within SuDS. For the purpose of the DWMP assessment, a 30 year plus climate change (CC) rainfall depth (31.5mm) was applied. I.e. total storage equivalent = 754,521m2 * 31.5mm / 1000 =23,767.4m3 equivalent storage from SUDS, plus 6,174m3 equivalent storage from increased network storage.
Assurance	In line with our APR process, independent assessment and assurance of completed milestones and forecast of likely outturn position at the end of March 2030.
Conditions on scheme	None
Impact on PCs	Assume zero because benefits will be realised over the long-term, with only a minor impact in AMP8. The aim of the rainwater management enhancement case is to help offset deterioration is baseline performance due to climate change and improve resilience across future AMPs. The in-AMP benefits for internal sewer flooding are therefore limited.

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

Table 7: PCD delivery profile

	Unit	AMP8	2024	2025	2026	2027	2028	2029	2030	Ultimate delivery
Cumulative delivery target for PCD	**m3 storage equivalent**		**-**	**-**	**-**	**-**	**9,980**	**19,961**	**29,941**	**29,941**
AMP8 Capex (22/23 pb)	£	128,660,498	-	-	-	-	42,886,833	42,886,833	42,886,833	
AMP8 Opex (22/23 pb)	£	3,594,796	-	-	-	-	-	1,797,398	1,797,398	
ODI impact per unit of PCD volume	£/m3 storage equivalent	0.00								

Table 8: Price Control Allocation

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

Table 9: PCD Incentive rates

	Unit	WR	WN+	WwN+	BR
Overall delivery	£/m3 storage equivalent	0	0	2,209	0
Time value rate	£/m3 storage equivalent	0	0	71	0
Late delivery	£/m3 storage equivalent	0	0	179	0

United Utilities Water Limited
Haweswater House
Lingley Mere Business Park
Lingley Green Avenue
Great Sankey
Warrington
WA5 3LP

unitedutilities.com

United Utilities

Water for the North West

UUW65

Wastewater Supply Demand

October 2023

Enhancement Case 16

United Utilities

Water for the North West

Contents

1. Enhancement submission

<table>
<tr><th colspan="2">Enhancement submission</th></tr>
<tr><td>Title:</td><td>Ww Supply Demand</td></tr>
<tr><td>Price Control:</td><td>Ww Network +</td></tr>
<tr><td>Enhancement headline:</td><td>AMP 8 Programme to support growth and development across the North West whilst protecting the aquatic environment.

Enhancement programme will deliver the capacity to treat an additional 61,736 population equivalent (PE)</td></tr>
<tr><td>Enhancement expenditure

(FY23 prices)</td><td>
<table>
<tr><th></th><th>AMP8 Capex inc TI (£m)</th><th>AMP8 Opex (£m)</th><th>AMP8 Totex (£m)</th></tr>
<tr><td>Pre RPE and Frontier Shift</td><td>139.524</td><td>0.829</td><td>140.353</td></tr>
<tr><td>Post RPE and Frontier Shift</td><td>136.234</td><td>0.805</td><td>137.038</td></tr>
</table>

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

2. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	• Base costs only cover the cost of meeting current environmental permit compliance and maintenance activities • Once the treatment works reaches capacity, further growth cannot be accommodated without causing potential environmental deterioration and potentially triggering tighter permit limits • In order to fulfil our statutory obligations we need to make investment at these specific locations where the increase in population exceeds the headroom capacity of the receiving wastewater treatment works during the business plan timescale. This is to finance projects to enhance capacity to avoid deterioration and cause adverse environmental impact. • We have identified 12 locations that require investment in AMP8 to meet supply and demand needs for this 5 year period.	Section 4 Section 4.2.2; 4.2.5 Section 4.2.1 Section 4.3.5; 4.8
Best option for customers	• Customers and stakeholders expect us to provide services that keep pace with new development and that the capacity of our systems will not limit economic growth. • A risk based approach was taken to ensure the schemes included in the programme were those where we are confident that new development will have an impact during the business plan timescale. • This programme is flexible to accommodate changes in development size, location or timescale and will enable us to prioritise the highest risk locations. • Projects will accommodate the projected growth for the business plan timescale and beyond to ensure resilience to future risk.	Section 4.7 Section 5.2.5
Cost efficiency	• The introduction of a risk and value (R&V) assessment across all our major projects has supported better challenge of our expenditure requirements, including enhancements. • This ensures that when we decide projects are necessary, we only do what we need to do, that our decisions are based on strong evidence, and the value to both business and customers is clear. • The process ensures that we keep challenging and validating both the need for our projects and the way we deliver them.	Section 6
Customer protection	• We will report the total additional population equivalent (P.E.) that will be served as a result of investment to increase wastewater treatment works capacity. • The programme is subject to a price control deliverable (PCD), which will result in underpayment penalties if we do not deliver the programme of improvement we have committed to. • This enhancement case is also linked to the common performance commitment on discharge permit compliance. Failure to deliver investment will affect our ability to meet permit limits resulting in penalties and potentially reputational damage if we fail to achieve 4 * EPA rating as a result.	Section 7 Section 7.1 Section 7

	• The flexibility of the programme protects customers in that the highest priority locations will attract investment, even if those priorities alter during the business plan timescale. The underperformance payments contribute to driving the most efficient and sustainable outcomes. The design horizons and the quality of the forecast data ensures an optimum level of resilience.	Section 7.2

3. Introduction

3.1.1 This enhancement document sets out the scope of investment required in order to support wastewater treatment supply and demand growth in United Utilities operational area, and how we have assessed the locations that need investment.

3.1.2 Resident population the North West area is forecast to increase from just over 7.1 million to 8 million by 2050. We have 567 wastewater treatment works with a broad range of flow and load capacity. These range from very small works such as Ashley, serving a population equivalent of 153 to Davyhulme WwTW which serves a P.E. of 1,149,060. In many locations this capacity is gradually being utilised by growth and new development; these locations are often those where further growth is forecast. Investment is required at locations where the increase in flow or load will have an impact on the treatment works ability to meet environmental requirements.

3.1.3 We have identified 12 sites that we have a high confidence will require investment to protect the environment from this impact during AMP8. The wastewater treatment works vary in size and location from 147 population equivalent (P.E.) at Calverhall North in Cheshire to 106,228 P.E. at Carlisle in Cumbria. Projects will accommodate the projected growth beyond the business plan timescale to ensure resilience to future risk. The growth forecast for the Carlisle area is due to the need to serve St Cuthberts Garden Village (SCGV), the largest development project in the North West at the current time, with predicted growth of over 23,000 P.E. by 2050. Here, our current preferred option is to build a brand new treatment works to serve this area to the south of the city.

3.1.4 An outcome focussed price control deliverable (PCD) has been developed for this programme to manage uncertainty at programme level whilst protecting customers from benefits not delivered. The PCD reports the total additional population equivalent that will be served as a result of investment to increase wastewater treatment works capacity thus protecting the environment from decline.

3.1.5 Population growth is subject to inherent uncertainty, particularly with regard to timing and location which is outside management control; there is potential for the scope, timescale and location of projects to change if updated information alters the expected impact at individual locations. This document will cover how we mitigate against this uncertainty by building flexibility into the programme whilst at the same time protecting customers with a PCD in place, in the event of less P.E. being delivered than that we have committed to within AMP8.

3.2 Cost of the enhancement

3.2.1 Our cost estimate for this enhancement programme in AMP8 is a gross Totex value of £137.038 million

4. Need for enhancement investment

4.1.1 This section sets out the need for the enhancement investment case and goes into more detail to demonstrate why this investment is necessary in the business plan time frame, and how the locations for investment were determined.

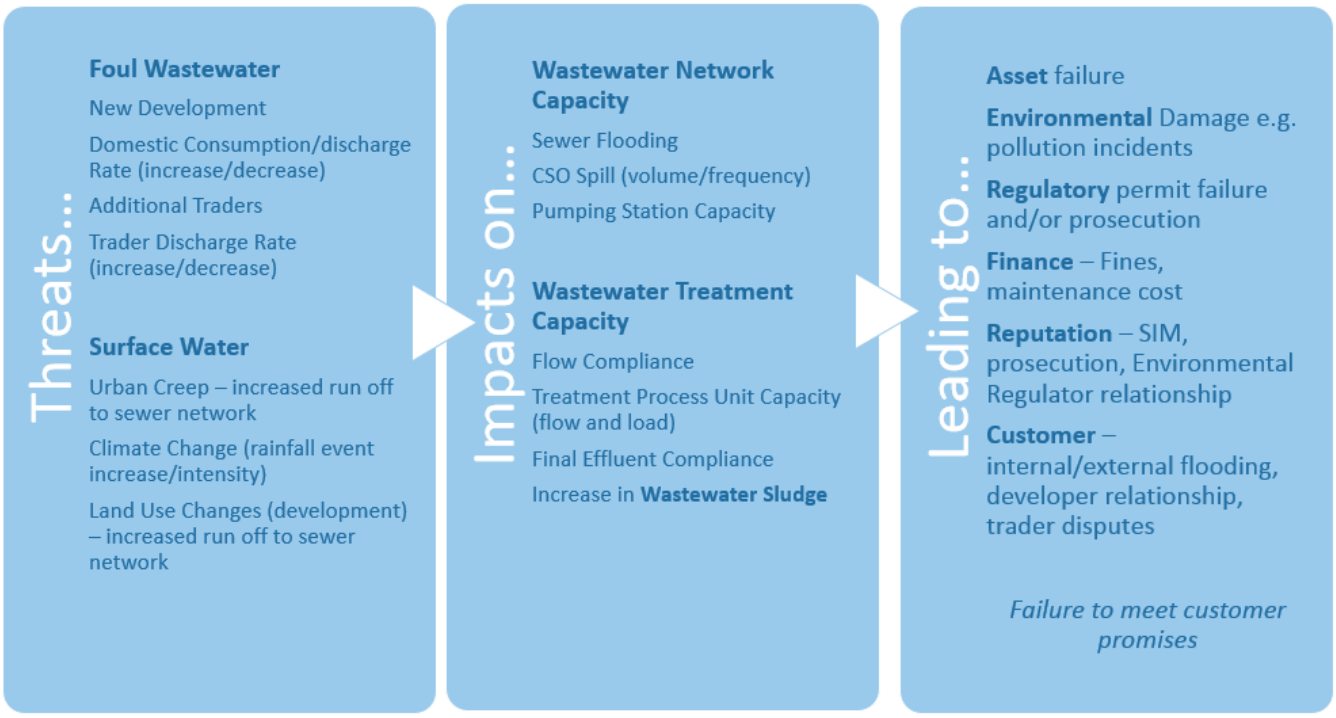
4.2 Statutory Obligation

4.2.1 There is a statutory obligation (Water Industry Act 1991, Section 94) to extend our system to ensure we continue to effectively drain our area. To meet these requirements we have to ensure that new developments have available wastewater network capacity and the resultant flow and load is treated to the required standard in order to protect watercourses in the long term.

4.2.2 We are also legally required to comply with wastewater treatment works permit conditions and the increased population equivalent can contribute to non-compliance of some or all of these conditions if an intervention is not delivered. The detail of this risk and how it is measured and reported is discussed in TA5_PR24 performance commitments; section 3.9 PR24_DPC_Discharge Permit Compliance.

4.2.3 Figure 1 below shows the risks and the potential impact on the service we provide. The scale of the impact depends on the timing, location and capacity available within the wastewater system.

Figure 1: Growth and new development risks and impact



4.2.4 In addition to new development, trade effluent forecasts indicate volumetric growth of approximately five per cent by the end of AMP8. There may also be local variations in the additional trade load where trader type's change or individual traders increase their output. The government's growth plan (2022) also has a clear ambition to drive growth across the country which may increase levels of trade in some locations.

4.2.5 United Utilities have 567 wastewater treatment works with a broad range of flow and load capacity. In many locations this capacity is gradually being utilised by the flow and load from growth generated by new development and these locations are often those where further growth is forecast, Warrington South Wastewater treatment works is a good example of this. Additional population above the design capacity presents a compliance risk and is likely to have an adverse environmental impact due to

premature spills to the environment if the inlet works and storm tanks are too small and/or insufficient treatment to meet the final effluent permit. Both of these scenarios can result in damage to the receiving watercourse and ecosystems due to oxygen depletion and are likely to result in the wastewater treatment works failing the discharge permit compliance performance commitment.

4.2.6 In most situations, the choice of treatment works to accommodate new development is limited due to discrete sewer drainage systems that do not allow interconnectivity, particularly in urban areas with an extensive network discharging to a single treatment works. We therefore need to accommodate the growth at the receiving wastewater treatment works by building new treatment capacity.

4.2.7 A programme has been identified to accommodate the risk that is likely to materialise during the business plan timescale with a solution design that will incorporate all growth where there is certainty in the forecast data available (including growth beyond 2030). This will enable us to deliver solutions that are more resilient in the longer term. Additional drivers - environmental quality or maintenance requirements - are also reviewed alongside any growth projects to facilitate identification of further efficiencies.

4.2.8 Without investment, the treatment works identified will not operate to the expected performance levels and environmental quality is likely to deteriorate, as outlined above.

4.2.9 Alongside this investment, revenue from developer charges is used to increase network capacity and accommodate additional flow and load from new developments where required. The solution to protect the network and the treatment works can be delivered as part of one project to resolve the full impact.

4.3 Approach taken

4.3.1 Customers and stakeholders expect us to provide services that keep pace with new development and that the capacity of our systems will not limit economic growth. To identify the extent of the need over the business plan timescale, a review of the risk was undertaken.

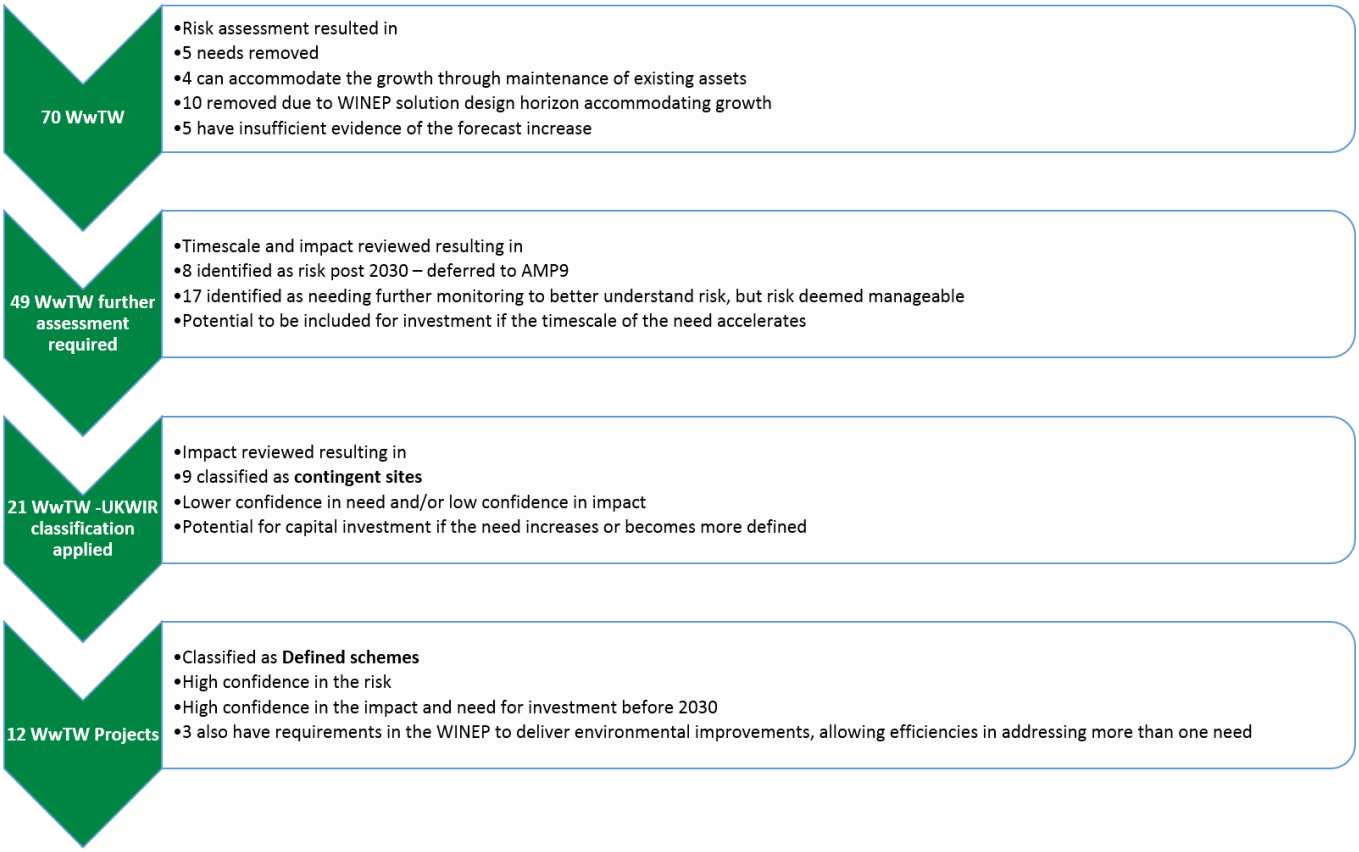
4.3.2 Local authority plans usually forecast new development for up to fifteen years and these plans are reviewed every five years. These are at various stages in adoption across the region and therefore the numbers forecast have varying levels of definition. In addition to this there are long term strategies being developed for Greater Manchester and other urban areas to plan for and accommodate the growth and provide the infrastructure required. Changes in trade flow and load can also have an impact on our treatment and network processes; we engaged a third party to carry out econometric modelling to provide an assessment of future flows up to 2055. The number of development sites and locations identified in local authority plans can change significantly during the business plan timescale so in addition to the information from local plans, planning applications and enquiries and information from regular liaison with local authorities is used to inform risk.

4.3.3 This information has been used to establish where the risk is most likely to occur and the timescale over which it will have an impact within each wastewater treatment works drainage area.

4.3.4 Identification of the risk follows the framework outlined in the UK Water Industry Research (UKWIR) report No. 07/RG/08/2 *'Long term/least cost planning for wastewater supply-demand'* and updated report '*Wastewater Supply-Demand Framework*' report no. 14/RG/08/6. This approach represents national best practice and is consistent with our approach. This is recognised as a robust approach by both Ofwat and the Environment Agency (EA).

4.3.5 Following this process we identified a number of sites that had the potential to require investment in AMP8, and this list was then subject to further internal challenge to identify 12 defined schemes for AMP8. See Figure 2 below.

Figure 2: Breakdown of AMP8 build to protect the environment from growth and new development



Definition of the UKWIR categorisation shown below in Table 1.

We have high level estimated costs for 34 of the 68 sites assessed above, which totalled £358.75 million. By carrying out this assessment we reduced this significantly to the final total of £137.04 million.

Defined Schemes

4.3.6 Only Defined Schemes have been included in the programme build. This approach ensures that the programme includes the locations with the highest risk where the impact cannot be managed through the current treatment process and where we have a high degree of certainty that development will occur.

Table 1: UKWIR definition of projects to be included for investment to accommodate development

UKWIR Category	Definition
Defined Schemes (DS)	Refers to a situation where there is high certainty that investment is required and it is possible to identify the appropriate solution at the time of business plan preparation
Defined Contingent (DC)	Refers to a situation where it is preferable to wait for the outcome of a key uncertainty before deciding which of the identified (and costed) investment options should be undertaken
Non Specific (NS)	In contrast to defined schemes, non-specific investment refers to situations for which is not possible to pre-define or allocate investment to specific assets

4.3.7 One of the defined schemes in AMP8 is to accommodate growth to support the development of St. Cuthbert's Garden Village to the south of Carlisle. This area is forecast to generate a large increase in PE and includes a number of schools and light industrial units.

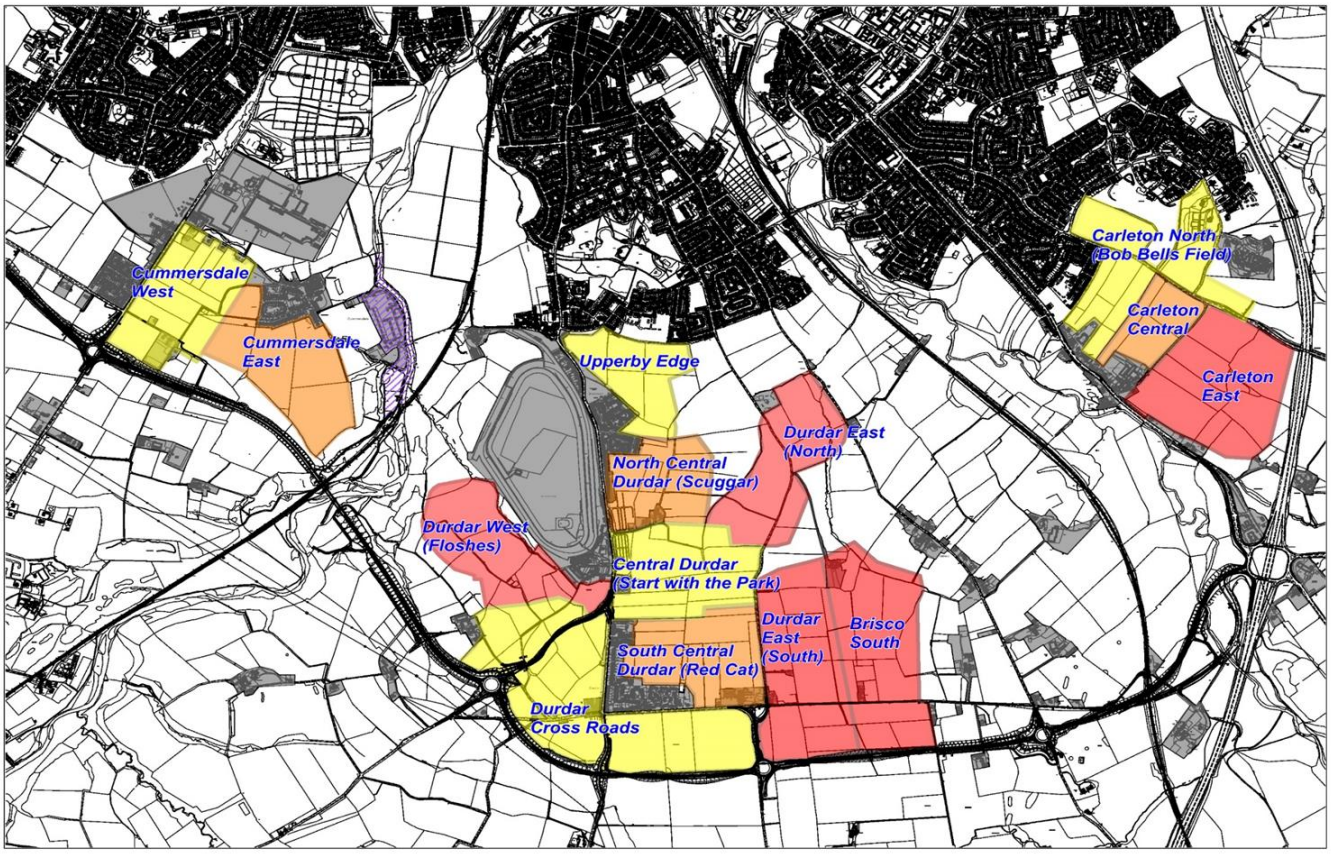
Case study 1 – St Cuthbert's Garden Village

Background

4.3.8 St Cuthbert's Garden Village (SCGV) was identified as a broad location for growth in the Carlisle District Local Plan, adopted in November 2016, and in January 2017 St Cuthbert's was designated as a Garden Village as part of the Government's Garden Towns and Villages Programme. Linked to ambitious economic development plans for the area, the SCGV local plan encompasses approximately 10,000 housing units over a 30 year period together with retail, leisure, health and educational facilities. This would equate to a 23-25,000 increase in population growth.

4.3.9 The garden village development would cover 3 distinct areas to the south of the city. Over the last decade, Carlisle has been the 4th fastest growth area in the UK, and witnessed historically high housing completion rates over the past 3 years. Working closely with the local authority, we have been provided with the latest phased development housing numbers, together with timeframes for the delivery of new primary and secondary schools and other associated development to help build the new community, see location plan below.

Figure 3: Location Map & Phasing profile – St. Cuthberts Garden Village



4.3.10 Key shown in Table 2 below.

Table 2: St Cuthbert's Garden Village House building phasing profile

Phase	No. of housing units	Other
Early: 2023 - 2030	2839	3 x primary school 1 x secondary schools
Medium: 2030 – 2040	4865	
Late: 2040 – 2050	4263	1 x primary school Community use and education

4.3.11 The catchment is currently served by Carlisle WwTW to the north of SCGV development. In addition to growth forecast due to the garden village development, there are also other pockets of development predicted within the next AMP in other areas of the city. When assessing the growth in the area we have a number of challenges to accommodate all growth at the existing Carlisle WwTW, including network flooding risk and land availability to expand the existing works.

4.3.12 We have a high degree of confidence development will happen in this area, due to the construction of a new ring road to serve Carlisle South, and the findings and recommendations contained in a housing market demand and capacity assessment carried out on behalf of Carlisle local authority 1. Assessing the end to end wastewater system – network and treatment - our current proposal at this time is to build a new treatment works, Carlisle South. This will enable us apply an innovative approach to treatment, using biological low phosphorus removal technology, to explore a zero/low carbon option and using a modular design so we can add on additional capacity as the need arises. This will allow us to invest to accommodate growth over AMP8 and beyond, but also allows us to have an adaptive plan whereby we can defer investment if growth doesn't materialize as planned, and reduces the need for large scale investment at this location in AMP8.

4.3.13 In terms of the overall supply and demand programme, the level of risk may change at specific locations over the course of the AMP8 programme if the size of the predicted developments increase or reduce. Additional locations may be identified at risk, and growth from housing developments may also accelerate or slow down over the business plan period. These potential changes lead to the requirement for a flexible programme to enable reprioritisation of projects and a proportional PCD.

4.4 Alignment with long term strategy

4.4.1 Our AMP8 growth plans align to our DWMP strategy which assesses the risk of growth across the region, and gives us a long term view on where increased capacity may be needed. The large garden village developments being planned in a number of locations within the region such as the Cuerdale Garden village near Blackburn and the Handforth garden village in Cheshire are areas we are monitoring as part of our longer term plans. In line with the DWMP we have developed adaptive pathways in order to assess and amend our plans if growth forecasts change within the AMP, which will continue to be our approach when assessing risks posed by these large garden village type developments. In the case of accommodating growth in the south of the Carlisle catchment discussed above, the build out rate may be affected by skills shortages in the construction sector, or the large number of houses being built may drive down costs and cause developers to slow down their programmes. These are risks identified in the housing market demand and capacity assessment, so our plans need to be adaptive in order to manage changes caused by external factors, and change our investment plan if necessary; this plan also includes the network system in the area in line with our systems thinking approach.

[1] https://www.stcuthbertsgv.co.uk/Portals/0/Documents/Masterplan/Housing%20Demand%20and%20Capacity%20Assessment%20-%20Final.pdf

4.5 Overlap with WINEP enhancement case

4.5.1 Some sites forming part of this enhancement case also have WINEP environmental drivers, and have been included in the WINEP programme enhancement case. Where there are dual drivers, we have assessed what needs to be delivered in order to meet the quality (Q) driver, and then what additional costs are incurred in order to increase treatment capacity to accommodate growth. The cost allocation for those sites also included in the WINEP quality programme is shown in table 3 below. Barton Wastewater treatment works has a WINEP driver for P removal, the solution to meet this and the supply and demand driver will be delivered at the same time to allow for the most efficient delivery mechanism but with costs split to reflect the proportion of investment needed to address each driver. In the case of Barton, the overall project estimate is £41.07m with 80 % being included as the S&D investment element.

4.5.2 Similarly, some solutions such as Warrington South include an element of maintenance or refurbishment of existing assets, an X on Q driver. The cost percentage allocated is also shown in table 3, and has not been included within enhancement case totex costs. For any other solutions where a maintenance need is identified ahead of or during construction, this work will be funded from the base programme.

Table 3: Cost allocation split - Supply & Demand v WINEP and X on Q expenditure

Site name	Cost allocation Percentage		
	Supply & Demand	Quality (WINEP programme)	X on Q (maintenance)
Barton WwTW	80	20	-
Clitheroe WwTW	50	50	-
High Bentham	81		19
Warrington South WwTW	53	37	10

Source: UUW totex plan

4.6 Funding in previous price reviews

4.6.1 Supply and demand was funded as an implicit allowance in AMP7, rather than as enhancement funding as is proposed for AMP8. In AMP7 we were implicitly allowed £51.51m (in 2022-23 CPIH prices) for growth. We forecast we will deliver the population growth we committed to, at a cost of £31.152 million by the end of AMP7.

4.6.2 We put forward a number of sites as having supply and demand needs based on our assessment at the time of our PR19 business plan submission, with an outcome measure of increase in population equivalent rather than specific project delivery. As we highlighted during our PR19 submission, the programme needed to have flexibility and where further assessment of population equivalent figures ahead of making investment suggested the demand profile within a drainage area had changed, we didn't proceed with increasing capacity at these locations, but invested elsewhere the need was identified .

4.6.3 This was due to a number of factors, largely due to growth expected being delayed or not materialising which allowed us to manage the risk during AMP7. External factors including the COVID-19 pandemic and supply chain issues have had an adverse impact on house building during the PR19 business plan period and have contributed to changes in forecast population growth. 2 Government statistics show that between March and June 2021 almost 40,000 fewer homes were built in England and Wales as a result of Covid-19. 3 Of the 12 deferred sites, there were a number of reasons they were removed from

[2] https://www.gov.uk/government/news/new-homes-england-statistics-show-overall-housing-starts-down-reflecting-the-impact-of-covid-19-on-housebuilding

[3] https://www.showhouse.co.uk/news/almost-40000-fewer-homes-built-as-a-result-of-covid-19

the programme, as shown in the table below. Examples include Kirkby Thore where expected development didn't end up going ahead. As the rate of housebuilding slowed down due to COVID – 19, sites were reassessed and seven were deemed to have a manageable level of risk without capital investment being needed whilst growth in the drainage area was monitored. Use of mobile equipment was used at some sites such as High Bentham Wastewater treatment works in order to provide additional ammonia removal as a short term solution. The risk at Tebay Wastewater treatment works was due to an increase in flow, but further investigation here highlighted the increase in flow was due to infiltration so we were able to address this via a network solution.

Table 4: Reasons for deferral in AMP7

Primary reason for deferral	Number of sites
Level of growth didn't materialise	2
Level of risk deemed acceptable and manageable due to reduced growth forecast	8
Network solution	1
Maintenance	1

4.6.4 Whilst we made the decision to not proceed with investment at some of the sites within the AMP7 programme for the above reasons, other sites were added into the programme where the need for increased capacity was identified. Audlem and Preston Wastewater treatment works were added, and there was an increase in the additional PE requirement for Forton once updated data was available in AMP7. With these additions, the forecast is that we will over deliver on our AMP7 target of 75,113, delivering additional treatment capacity equivalent to 97,219 PE.

4.6.5 This approach ensured that investment has not been made where not required within the AMP, but was made where it was needed, which we consider to be the best use of funding. In AMP7 this measure is subject to an ODI; customers are therefore protected as this will result in financial penalty if we fail to deliver the increased capacity across the North West for customers. Failure to increase capacity where needed will also result in failure to achieve compliance with the discharge permit. Performance against this metric is essential in order to meet the EA requirements to be considered for a four star EPA rating; achieving 99.0 percent is a gateway measure in this environmental assessment

4.6.6 Of those sites where the level of risk was seen as acceptable due to housing development not being built as quickly as forecast in AMP7, four are included within our AMP8 programme. These sites are Calveley, High Bentham, Kirkbride and Warrington South, plus Calverhall North and Clitheroe were in our defined contingent list in AMP7.

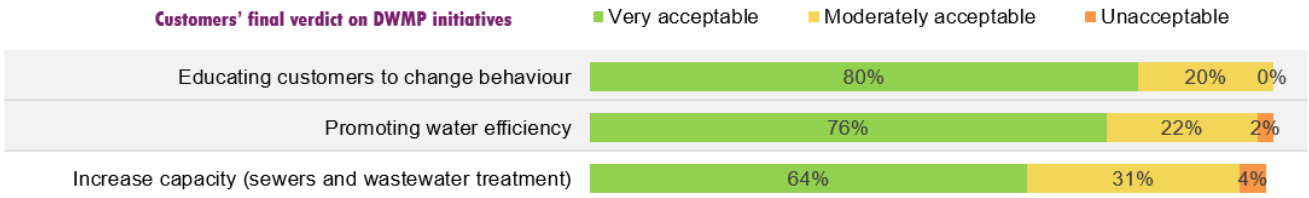
4.6.7 From an environmental perspective, climate change has the potential to affect hydraulic capacity which can also contribute to uncertainty about where additional capacity is most needed. The current economic crisis is also having an impact on the housing development sector, and we can foresee that this may be a contributory factor in changes in population growth in specific locations and so we will monitor this and adjust the AMP8 programme accordingly as per the process outlined above.

4.7 Customer support

4.7.1 Population growth was seen by participants as the biggest long term challenge during immersive customer research carried out in April 2021.[4] This research - conducted as part of DWMP preparation - showed increasing capacity of sewers and wastewater treatment works was scored a very acceptable by 64% of those surveyed making it a key priority for investment, and an 'inevitable' expenditure.

[4] WRMP & DWMP Research, April 2021

Figure 4: Immersive customer researc used to inform DWMP development



'Updating the sewers and wastewater stood out to me.
Modernising these would bring many advantages environmentally and give us cleaner healthier water'.

4.7.2 Customer listening research conducted to gain feedback on UUWs four part plan to improve river health and recreation showed that reducing harmful impacts on rivers was considered to be the most important goal of this initiative. Population growth leading to insufficient capacity at wastewater treatment works within the AMP would have a negative impact on this.

4.7.3 Other pieces of customer research, particularly those carried out more recently show river quality and health scored highly amongst customers, including those listed below.

- UUW State of the Nation research – wave on wave we have seen an increase in those ranking 'protecting river health' in their top 3 things UU should prioritise/ 67% of customers thought that protecting wildlife and biodiversity was important.
- CCW Awareness and perceptions of river water quality , 65% want planned improvements to ensure that the river is a healthy habitat for wildlife
- CCW/ Ofwat Customer preferences – river water was rated highly as an important environmental PC

4.7.4 Investment in those treatment works which will have insufficient capacity to treat wastewater effectively due to population growth is one of the actions necessary to deliver against customer priorities, and supports this enhancement case, alongside other investment into rainwater management, and Suds for example. The DWMP also now helps forecast longer term where we might need to invest further in assets to ensure the necessary capacity is available.

4.8 AMP8 Defined schemes

4.8.1 The programme is comprised of 12 locations where the impact of new development and growth cannot be met within the current treatment capacity without a deterioration in the environmental impact, and lead to non-compliance with discharge permit requirements. These requirements are made up of a number of limits on the final effluent discharged into a watercourse and vary depending upon size of watercourse and ecology but can include quality limits such as ammonia, phosphorus and measures of chemicals with oxygen depleting properties, measured as Biological Oxygen Demand (BOD). In addition to quality limits, permits also contain volumetric limits relating to flow to full treatment and dry weather flow, both of which are critical to providing the necessary treatment capability.

4.8.2 We identified treatment works where we are confident that growth within AMP8 cannot be accommodated in the headroom of the existing treatment works. The size of the development, the design capacity of the receiving treatment works and the headroom available all contribute to the cost of the project which can vary substantially for each location. As the map below shows, this investment is region wide and includes some large and very small sites that require investment. Locations for investment are shown in Figure 5.

Figure 5: Location of all S&D defined schemes

4.8.3 For each location identified to be at risk, solutions will be delivered in line with other needs, WINEP quality drivers for example, to enable efficiencies and using an appropriate design horizon to ensure resilience is in place for the future population. Table 5 below illustrates the level of costs for all projects included in the programme build and where we have currently allocated investment, subject to changes in new development allocation

Defined Supply & Demand Schemes for delivery in AMP8

4.8.4 The sites in the table below are those where current forecast population numbers and our capacity assessment shows the treatment works will be unable to accommodate the predicted growth, and where we have confidence the growth will be realised by the end of AMP8. The costs given for the proposed solutions are based on engineering estimates and are best value, discussed further in section 5.

Table 5: Defined supply & demand schemes

AMP8 Projects (WwTW)	2021 Domestic population	Additional domestic population by 2030	Percentage increase	2021 total PE	Additional total PE (2050 design horizon)	Totex (£ million) [1]
Barton	4732	7,225	153	7033	10737	£32.73
Calveley	124	74	60	129	78	£1.41
Calverhall North	144	34	24	147	38	£1.94
Carlisle	82830	24,632	30	0[2]	15504[2]	£36.18
Clitheroe	19264	896	5	22355	6532	£1.40
Cockerham	338	302	89	1432	1281	£6.34
High Bentham	1927	303	16	2191	1170	£5.54
Kirkbride	476	52	11	480	224	£5.58
Melling	1945	797	41	1986	470	£12.16
Sandbach	21529	5,175	24	21983	5284	£6.39
Warrington South	42300	8,636	20	44626	17451	£19.20
Whalley	5426	496	9	5595	2967	£8.16
Total					**61736**	**£137.04**

1 FY23 cost base

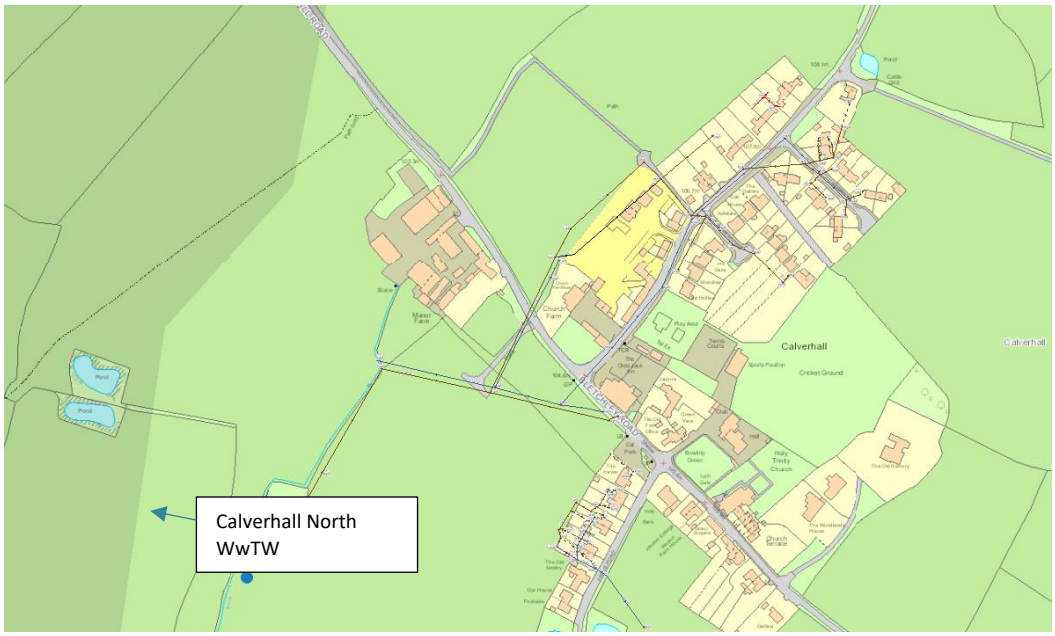
2 new Carlisle South WwTW

4.8.5 As mentioned in section 3, the sites range in size including some very small sites, such as Calverhall North WwTW in the very south of the region which currently serves a household population of 147. Here a development review has forecast additional population and the works is already at the capacity of what it can treat. At this site we have estimated costs based on a traditional submerged aerated filter (SAF) solution but are currently exploring the potential for a natural solution. We are working with the land owner and Mersey Rivers Trust in this area to develop a wetland solution. If this proves not to be feasible, we would deliver the more traditional solution and have included the cost for this in this enhancement case but the nature based solution cost estimate is very similar.

Case Study 2 – Calverhall North

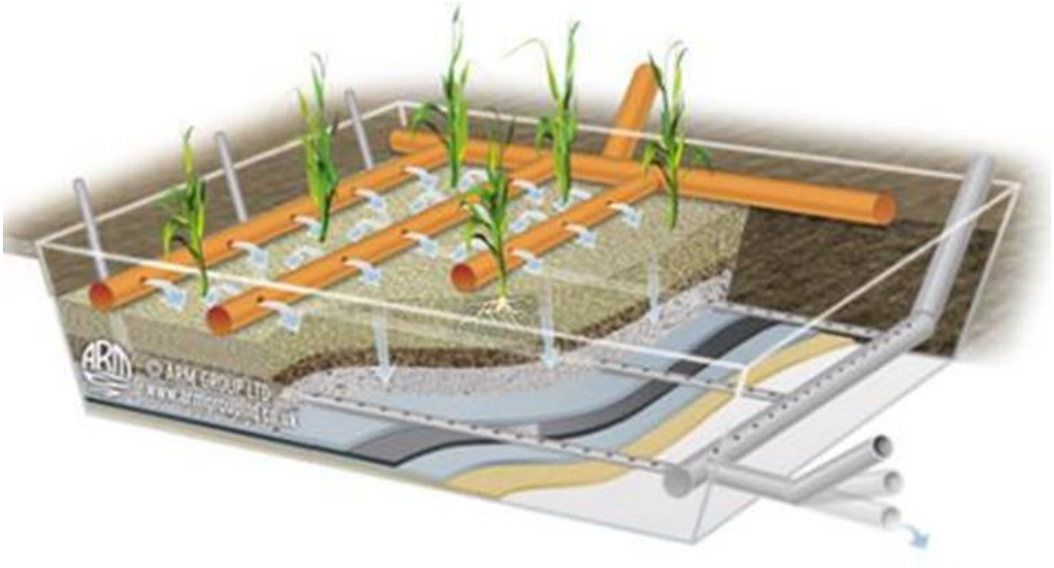
4.8.6 Calverhall North is a small village at the very south of UUWs area of appointment, map below. The current treatment works comprises of a primary tank, tipper pan and small filter, discharging to a tributary of the River Duckow.

Figure 6: Calverhall North Wastewater treatment works catchment



4.8.7 Development in the village means we need to increase treatment capacity at Calverhall North in order to prevent deterioration in quality of the receiving small watercourse. Due to location, scale and relationship with the landowner in the area, an option that we are developing involves the addition of a wetland solution as part of the treatment solution – see below.

Figure 7: Vertical flow reed bed



4.8.8 The effluent is applied in a batch process across the surface of the bed until the surface is flooded. The effluent gradually drains down through the bed with air replacing the wastewater in the bed as it drains. The next dose traps the air which leads to a highly aerated system with good oxygen transfer permitting increased microbial growth and activity. Unsaturated vertical flow (VF) systems are more effective than horizontal flow (HF) systems at ammonia removal due to increased oxygen levels within them and can cope with stronger effluents. The effluent is distributed over the bed sometimes aided by a layer of sand and then passes through the bed where treatment occurs. The effluent is collected in pipes positioned along the bottom of the bed and discharged through the outlet.

4.8.9 As well as being a cost efficient option this has the benefit of also being a low carbon solution, and may be possible to install without the need for a power supply. If we are unable to use this solution however, we would install a more traditional SAF treatment unit.

Defined Contingent schemes

4.8.10 Where locations have been identified with less confidence in the population increase or the impact on the treatment works is not definite, a defined contingent (DC) programme has been identified (Table 3.5). This has not been included as part of the cost, but projects may be delivered in AMP8 if better information becomes available and the risk is justified. Developments in these areas will be monitored and we may need to intervene with additional temporary solutions or add into the supply and demand programme. Conversely we may see accelerated growth in other locations, which require in AMP investment, and subject to appropriate scrutiny and appropriate level of sign off within UUW, and agreement with regulators, we may decide to invest elsewhere.

Table 6: Defined Contingent scheme

Contingent Schemes	2020-21 household population	2030 household population	Increase by 2030	Percentage increase	Justification
Great Orton WwTW	233	271	38	16%	DWF risk, monitor growth rate
Pilling WwTW	1,685	1,983	298	18%	DWF risk, and final effluent permit risk. Further investigation to see if infiltration is an issue
Culgaith WwTW	485	697	212	44%	Some capacity but If all growth occurs site will require investment. Medium confidence
Low Bentham WwTW	673	793	123	18%	Some capacity available, monitoring development
Newchurch in Pendle WwTW	158	170	12	8%	Proposed development of mill into flats, confidence level is low
Holmes Chapel WwTW	10,978	13,217	2,239	20%	Some assets under capacity, may require AMP8 investment. Compliance risk identified
Northbank WwTW	12,337	14,371	2,034	16%	Reasonable level of growth predicted. Site performing well but model suggests potential capacity issues
Penrith WwTW	19,394	26,122	6,728	35%	Some capacity available,increase in DWF at this level won't trigger permit review but needs monitoring. May require AMP8 investment.
Burscough WwTW	31,747	36,738	4,991	16%	Localised flooding issue, network and process study to be carried out to assess where capacity pinch points are and inform when investment may be needed

4.8.11 This approach has allowed to us to develop a programme that meets the current risks we perceive in AMP8 but with sufficient flexibility designed in to allow the most appropriate level of investment to be made to support growth in the North West.

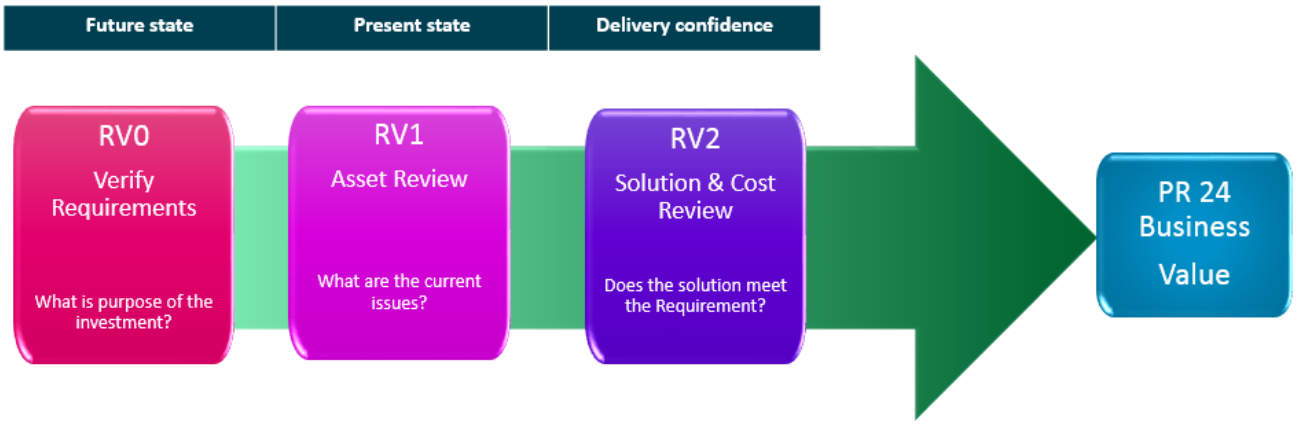
5. Best option for customers

5.1.1 This sections outlines how we identified solutions we feel are best value, highlighting the process we went through when estimating all engineering schemes, and covering some specific examples related to how we have applied an innovative view to the development of our capital programme.

5.2 Options development

5.2.1 PR24 options development followed the fundamental principles of United Utilities defined value management process, and the process followed for the supply and demand programme aligned with that used for the WINEP programme. Risk and Value for PR24 (RV) was a three stage process (shown in the diagram below), aimed at positively challenging our projects to ensure we have sufficient evidence behind decisions. It provides United Utilities with confidence that they are proposing the right projects for the AMP8 Programme and therefore managing and maximising the value for their customers from their investments. It also ensures that the organisation adopts the correct approach to option identification, development and selection to maximise the realisation of benefits associated with these investments.

Figure 8: Risk and Value process



5.2.2 Once the requirements have been clearly verified RV1 was completed in order to understand the current asset condition and performance. Without this understanding there is significant risk that proposed solutions will fail to deliver the value intended and may even fail to satisfy the requirements. This initial baselining was essential in order to allow identification of possible options against the generic high level solutions (GHLS).

5.2.3 Options to address PR24 requirements passed through a series of stages before the agreed solution was confirmed, from an initial 'un-constrained' list of options through to confirmation of the defined and estimated scope associated with a preferred solution.

5.2.4 Within the options development process, un-constrained options were identified against a list of GHLS categories. If un-constrained options were deemed viable then additional screening was carried out to identify 'constrained' options, with further screening taking place to refine the feasible solutions and determine those to be progressed to detailed scope development and estimating. In developing feasible options the engineer will always have taken which solution could represent the best value to the customer into consideration.

Table 7: Generic High Level Solutions

GHLS	Description
Monitor & Respond	Accept risk with agreed contingency plan
Operational Intervention	Solve need by identifying targeted maintenance to restore performance
Optimise Asset	Solve need by improving performance of existing equipment
Partnership	Solving need by assistance of third parties, i.e. assisting farmers reduce pollution of watercourses
Refurbish Asset	Major asset refurbishment to restore asset life and performance
Replacement	Replace asset(s) on like for like basis
New Asset	Build new asset when all other options are not possible (this could be a NBS)
Integrated Approach	Integrated solution across asset boundaries e.g. network, process, bio-resources or catchment level solutions. An integrated solution is a systems thinking response and could be a combination of the above solution types.
Combination of generic high level solutions	Example - SuDS and a storage tank to address CSOs

5.2.5 Should a refurbishment, replacement or new asset solution be identified, a number of design tools were used to develop the requirement through to an estimated solution, and costs allocated to appropriate investment drivers . Base design data was gathered from United Utilities' corporate systems to inform the design, including flow, quality and treatment performance data. In the majority of cases a 2050 design forecast was used, the exception being when there was a high level of uncertainty in the design forecast thus ensuring the most efficient design for the future.

5.2.6 A standardised methodology to solution identification was developed for wastewater treatment works to ensure a consistent approach. The 'Process Decision Support Tool' cross referenced permit values, population and flow data with United Utilities' treatment processes and asset standards to identity and size interventions to meet the requirements. Solutions proposed by the tool included conventional (including chemical and biological phosphorus removal, innovative and nature based solutions.

5.2.7 A potential partnership opportunity was identified by the United Utilities' strategy managers, at Calverhall North Wastewater treatment works – see 4.8.7 -based on an existing relationship being built with the land owner in the area, giving the potential opportunity for a nature based solution designed as a potential option. This relationship is at a relatively early stage but we have developed and costed a solution we hope to progress further once the programme funding is determined.

5.2.8 Use of optioneering tools ensured the process was proportionate to the scale of the risk to be addressed. They provided a quick and effective way of ruling out unsuitable options and identifying feasible solutions over a range of different option types.

5.2.9 A detailed engineered design was then developed for all the feasible solutions identified during this screening process in order to provide comprehensive cost and carbon data.

5.2.10 It is at this stage that the options were also assessed for deliverability. A review was undertaken by the Planning, Land & Environmental Team and United Utilities' Construction Services which allowed identification of risks and potential mitigation measures. This will have improved the cost accuracy associated with implementing the PR24 solution, it also allowed elimination of options which are not deliverable thereby confirming feasibility. This also included an assessment of the likely delivery route (including Direct Procurement for Customers) which was then used as the basis for the Contractor add-ons in the cost estimate.

5.3 Innovation

5.3.1 Throughout AMP7 United Utilities' has taken learning from AMP6 innovation roll out (such as that demonstrated with Nereda and Typhon) to deliver a new Technology Approval Process. This process identifies opportunities for innovative technologies and nature based solutions and provides a

methodical approach to due diligence, innovation risk identification and mitigation planning. The approved technologies/solutions include:

- Those we have identified ourselves
- Those suggested by our construction partners
- Those identified by other WASCs but not yet progressed by United Utilities in AMP7 i.e. I-PHYC Algal bioreactors
- Global innovation insights such as that secured through our engineering service provider Jacobs and other consultants such as Stantec.

5.3.2 Our Technology Approval Process has allowed us to progress technologies into approval without the need to trial, for example the Mobile Organic Biofilm technology approved and now in detailed design and construction for our Macclesfield AMP7 scheme. This approach highlights United Utilities' credentials as a fast adopter of new technology but with deeper awareness of the inevitable innovation risks that need to be managed.

5.3.3 To develop our PR24 submission we have incorporated the technologies that have now secured "Approved" status into our Process Decision Support Tool which was used to identify innovation opportunities by driver and site details. Where these innovation opportunities present the best value solutions they have been selected to be taken forward as the preferred solution. If the value of these novel and less well understood solutions cannot be determined with sufficient certainty they have been identified as an opportunity for United Utilities to pursue in the period between submission and delivery. Alongside this, we will continue to review those innovations or solutions not yet approved but are relevant to AMP8 drivers and progress these through our Technology Approval Process and, where deemed truly necessary, deliver specific innovation trials. We believe this sets United Utilities in good standing in terms of understanding the key opportunities that innovation can deliver within our PR24 submission but will also allowing for further efficiency driven by our Innovation programme.

5.3.4 In terms of the supply and demand programme, we believe our approach to the Carlisle South population growth for example shows an innovative approach. In addition to the modular design, enhanced biological P removal, we are currently looking to develop a zero carbon option, and we have commissioned a further engineering studies to explore this in more detail.

5.4 Options selection

5.4.1 The water sector is moving towards a "best value" approach, promoted by the regulators, with a best value option being one which drives the best outcomes for the environment, society and United Utilities over the long term.

5.4.2 The value associated with the various options was assessed using the value assessment tool developed by United Utilities specifically for this purpose. This tool lists intervention type and pulls through the associated benefits and value. It assesses value against a number of benefits including all the wider environmental outcomes as requested in the EA WINEP Options Development Guidance. The benefits were drawn from the MyRisk Risk Breakdown Structure (RBS), currently widely used in United Utilities. The wider value element, was also taken from the EA's WINEP guidance on Wider Environmental Outcomes.

5.4.3 The inputs to the value tool included costs (CAPEX, OPEX and whole life), carbon (embedded, operation and whole life), data on biodiversity plus risks and benefits as described above. The outputs from the tool included a cost benefit analysis and allowed the selection of the preferred solution based on the comparison of value between the various options (RV2). The option selected was therefore that which provides the best value to customers.

Table 8: Options considered

Option	Rational	Selected/Rejected	Reason
Do nothing	Assumption increased flow/load can be accommodated without capital investment	Rejected	Assessment based on population growth projections, planning data and outputs from process capacity tool highlight risk of failing discharge compliance permit compliance is high risk, therefore option rejected.
Maintenance	Option to carry out maintenance only in the form of refurbishment of existing assets considered as part of this option.	Rejected	Refurbishment of existing assets would not provide the additional capacity necessary to meet the PE growth demand for the level of growth predicted at the defined scheme list. Option may be appropriate at some of the sites named in the defined contingent list.
Mobile modular treatment units	The use of mobile units e.g. SAF unit to increase capacity at a specific process treatment stage.	Rejected	Mobile modular treatment used as a temporary measure at e.g. High Bentham WwTW however identified as not best option due to high opex costs leading to higher whole life cost option.
Capital investment – new assets	Investing to increase treatment capacity at specific named locations where the alternative options discounted	Selected	Once other options rejected this is the only viable solution. An appropriate design horizon used in order to provide resilience in the long term. Solutions developed assessed via best value tool.

5.4.4 The solutions chosen for each site represent both best value and least cost for this enhancement case.

6. Cost efficiency

6.1.1 **Section 6 explains how we have built up costs, and demonstrates how we believe this provides us with a cost efficient methodology**.

6.1.2 UUW's PR24 capital cost estimating approach has been based on data collected over a number of AMPs (AMP3 to AMP7) updated to reflect the present market conditions under which UUW and the UK Water Industry are operating. Mott Macdonald (MM) have provided an estimating service to UUW over AMP6 and AMP7. MM also provide an estimating service to a number of other UK Water Companies, which allows them to provide a benchmarked approach to UUW's PR24 capital cost estimates.

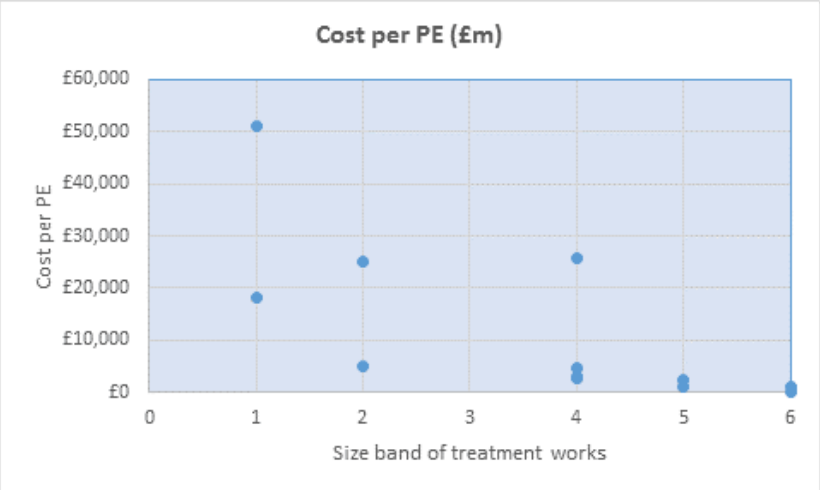
6.1.3 The capital costs are made up of Contractor Direct Costs (CDCs), Contractor Indirect Costs (CICs), UUW Risk, UUW Costs to Serve and UUW Corporate Overhead. MM have benchmarked UUW's direct costs and cost curves and assessed the water industry construction inflation based on their Construction Industry Basket of Goods (CIBOG) index. The CIBOG approach is important as it has been considerably higher than CPI(H) over the last few years due to post-COVID infrastructure growth and activity.

6.1.4 Contractor Indirect Costs (CICs) cover design costs, construction staff costs, risk, fee and profit margin. These indirect costs have been increasing over the last four AMPs and this has been due to more risk being transferred to contractors, more refurbishment work on existing plant and equipment, more optioneering and value engineering to minimise CDCs and a more risk averse approach post the collapse of Carillion. MM have benchmarked CICs across UUW's supply chain, the UK Water Industry and UK Transport Industry and have seen the increase accelerate in AMP7, which has been due to the reasons mentioned above and also the large increase in post-COVID infrastructure spend, which has driven significant growth into resource wages. Contractors are also actively picking sectors and work type to maximise profit returns and this means that some have reduced their work in the water sector or exited completely. MM and UUW have, therefore, reflected this benchmarking data into the WINEP estimating approach. The CICs applied to the cost estimates have been based on current market performance with adjustments for project size, complexity and Operating Delivery Model (ODR). The ODR and associated CICs' percentage is based on AMP7 market data and also the proposed AMP8 delivery model, which will select the chosen runway based on risk management and level of design between UUW and its extended supply chain.

6.1.5 There are several aspects of project costs, which are impacted by the scale of the programme and thus as the AMP8 programme matures, they may be subject to change.

6.1.6 The supply and demand programme for AMP8 includes a high proportion of smaller works - band 4 and below – which does mean that solutions are relatively more expensive to deliver per population equivalent increase. Figure 9 below showing the cost to deliver each unit of PE capacity illustrates this, highlighting the benefit of economies of scale with these projects.

Figure 9: Cost per PE based on wastewater treatment works size band



6.2 Third party assurance of our cost estimates

Bottom-up benchmarking (Faithful and Gould)

6.2.1 Faithful and Gould undertook a bottom-up deep dive into the cost efficiency of our enhancement cases. This involved a close examination of our cost base relating to a sample of our enhancement programme, with comparisons made to similar activity carried out by third party companies across a variety of sectors.

6.2.2 F&G looked at our direct costs across each of the following categories:

(a) Staff including site supervision

(b) Mobilisation and site set up, running and removal of site offices and welfare

(c) Temporary services for general site use, such as water to wash out concrete skips

(d) Attendant plant and equipment, such as cranes, forklift for unloading deliveries etc

(e) Attendant labour, defined as hourly paid operatives not involved in productive works

(f) Site consumables, such as waste skips

(g) Set-up site compounds, erecting hoardings etc

(h) O&M manuals

(i) Health and safety

6.2.3 It also looked at the contractor's indirect costs (e.g. overhead and design costs) and UUW's indirect costs (e.g. land acquisition costs). Due to the size of the programme, F&G examined a sample of our enhancement cases. However, this sample included projects from each of our enhancement categories and covered £1.246bn of expenditure. Therefore, we consider this sample to representative of our overall enhancement programme.

6.2.4 F&G noted the effectiveness of UUW's cost estimation process:

"In addition to the benchmarking data held by Faithful+Gould we understand that UUW has applied multiple internal and external challenges to progressively refine the cost estimation undertaken to date. In particular we note UUW's use of its Investment Programme Estimating System (IPES) which is a bespoke parametric estimating tool containing data from AMP3 to AMP7, to provide historical cost curves alongside estimated data from third party organisations."

6.2.5 F&G found that our proposed costs are in line with rates typically seen across the industry:

"Overall, UUW's approach of utilising historic cost curves, market testing and obtaining specialist third party quotations demonstrates a sound proactive approach to cost planning. In total £1.2bn of schemes underwent targeted cost assessment with £573m making up the construction works element.

After presenting our initial findings it was encouraging to see UUW's commitment to addressing our findings and applying these to the wider enhancement estimates, charting a strategic route towards greater efficiency and scope clarification.

In light of this Cost Assurance work and evidence of UUW's responsive actions we have concluded that the data we have benchmarked is within a reasonable alignment with anticipated market rates."

7. Customer protection

7.1 Introduction

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

7.2 Price Control Deliverable

Table 9: PCD summary

Scheme delivery expectations	
Description of deliverable	Delivering an increase in wastewater treatment capacity, capable of treating an additional 61,736 PE by the end of AMP8.
Output measurement and reporting	Project completion, weighted by the PE of capacity increased for each project. There are 12 projects that will deliver the PE capacity increase, each of which has a delivery date which will be tracked quarterly. Project sign off process will include review of evidence that required PE growth has been delivered. Subject to regulatory reporting through APR
Assurance	OIU process and reporting in APR
Conditions on scheme	None
Impact on PCs	Failure to deliver will impact on the discharge permit compliance PC number of WwTW 385, 1 WwTW is 0.260%, ODI rate for 1% is £2,880,000 12 WwTW, average PE per scheme is 5145 1 PE = £145.40

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

Table 10: PCD delivery profile

	Unit	AMP8	2024	2025	2026	2027	2028	2029	2030	Ultimate delivery
Cumulative delivery target for PCD	**PE of capacity increased**		**-**	**-**	**-**	**-**	**6,532**	**29,383**	**61,736**	**61,736**
AMP8 Capex (22/23 pb)	£	136,233,837	342,517	1,600,973	11,010,031	22,676,148	47,496,936	42,550,247	10,556,985	
AMP8 Opex (22/23 pb)	£	804,557	-	-	-	-	23,565	191,702	589,290	
ODI impact per unit of PCD volume	£/PE of capacity increased	145.40								

Table 11: Price Control Allocation

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

Table 12: PCD Incentive rates

	Unit	WR	WN+	WwN+	BR
Overall delivery	£/PE of capacity increased	0	0	964	0
Time value rate	£/PE of capacity increased	0	0	31	0
Late delivery	£/PE of capacity increased	0	0	31	0

United Utilities Water Limited
Haweswater House
Lingley Mere Business Park
Lingley Green Avenue
Great Sankey
Warrington
WA5 3LP

unitedutilities.com

United Utilities

Water for the North West

UUW65

Coastal and River Erosion

October 2023

Enhancement Case 17

United Utilities

Water for the North West

Contents

1. Enhancement submission

<table>
<tr><th colspan="2">Enhancement submission</th></tr>
<tr><td>Title:</td><td>Coastal and River Erosion</td></tr>
<tr><td>Price Control:</td><td>85% Wastewater Network Plus, 15% Water Network Plus</td></tr>
<tr><td>Enhancement headline:</td><td>UUW is situated in an operating region that is especially susceptible to coastal and river erosion. Climate change projections indicate that the North West will experience more frequent and intense winter storms[1], storms that can be expected to accelerate the rate of erosion of the land supporting our critical infrastructure.

To secure the long-term resilience of our coastal and riverine asset base against accelerated erosion rates, we set out an enhancement case of £28.595 million. This will allow us to protect approximately 2.8 km of sewers, 3 outfalls, 2 WwTWs and 5 (0.6 km) clean water mains from increasing erosion risk. We consider that this case satisfies Ofwat's requirement for resilience enhancement investment to '…manage increasing risks, or changing acceptance/acceptability of risks from hazards that are beyond their control and not covered by other enhancement areas'. [2]</td></tr>
<tr><td>Enhancement expenditure

(FY23 prices)</td><td>
<table>
<tr><th></th><th>AMP8 Capex inc TI (£m)</th><th>AMP8 Opex (£m)</th><th>AMP8 Totex (£m)</th></tr>
<tr><td>Pre RPE and Frontier Shift</td><td>29.281</td><td>0.000</td><td>29.281</td></tr>
<tr><td>Post RPE and Frontier Shift</td><td>28.595</td><td>0.000</td><td>28.595</td></tr>
</table>

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

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

[1] Environment Agency (2022) *North West River Basin District Flood Risk Management Plan 2021 to 2027.* Available here: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1120229/North-West-FRMP-2021-2027.pdf

[2] Ofwat (2022) *Appendix 9 Setting expenditure allowances.* Available here: https://www.ofwat.gov.uk/wp-content/uploads/2022/12/PR24_final_methodology_Appendix_9_Setting_Expenditure_Allowances.pdf

2. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	• Climate change projections indicate an acceleration in the rate of erosion of the land supporting our critical infrastructure. UUW thus considers that continuing to respond reactively through our base expenditure is not sustainable as the risk of asset failure and service disruption increases. We therefore set out a resilience enhancement case of £28.595 million to allow UUW to manage and mitigate the increasing risk from this hazard.	*3.1.2*
	• UUW is situated in an operating region that is especially susceptible to coastal and river erosion. Indeed, a desktop resilience assessment conducted as part of our DWMP indicated 107 km of linear Ww assets, 201 Ww Network point assets and 804 Wastewater Treatment Works (WwTW) structures are at a high risk of coastal and/or river erosion. Additionally, 48 clean water mains have been identified as being 'exposed in river bed'.	*4.2*
	• It is therefore imperative that UUW acts now to improve the resilience of our assets against accelerated erosion. For risks where the need is well-defined and service disruption may otherwise occur in AMP8, UUW will invest £24.114 million in erosion protection measures. However, where the need is poorly understood (i.e. across the highest risk sites identified through the desktop assessments), UUW proposes conducting ground investigations £4.481 million to define investment programmes for future price control periods.	*4.5*
Best option for customers	• In order to ensure that the proposed solutions represent the best value for customers, communities and the environment over the long-term, we considered a range of intervention types to protect our assets from accelerated erosion rates. All types of mitigation were considered, including resistance; reliability; redundancy; respond and recover (4Rs).	*Figure 6*
	• 26 solutions progressed to detailed design and estimation in order to provide comprehensive cost and carbon data. All options were also assessed for deliverability allowing for identification of risks and potential mitigation measures.	*5.3*
	• The value associated with the various options was assessed using the value assessment tool developed by UUW. The inputs to the value tool included costs (CAPEX, OPEX and whole life), carbon (embedded, operation and whole life), data on biodiversity plus risks and benefits. The outputs from the tool included a cost benefit analysis, allowing for the selection of the option that delivers the best value for customers. All selected solutions were highly cost-beneficial, with a 30-year NPV across the programme of £244.046 million]. Wherever possible, preference was given to engineering solutions that work with the natural processes of the watercourse and deliver wider environmental outcomes.	*5.4*
	• We recognise that by working in partnership with other Risk Management Authorities (RMAs) and stakeholders across the North West, we can improve the resilience of services and communities to erosion risk in a more integrated way. Wherever possible, we have therefore sought to leverage partnership funding. In order to protect Crosby Northern pumping station and an adjoining 2 km length of 600 mm diameter rising main, we are therefore	*5.5*

	proposing a contribution of £[✂]to an erosion protection partnership scheme led by Sefton Council's; a contribution we consider proportionate to the benefits we receive from the protection of a critical asset. • This enhancement case has been scoped based on those risks that are of the highest priority at the time of PR24 business plan submission in October 23. However, we recognise that given the dynamic nature of erosion patterns, especially in fluvial environments, there is inherent uncertainty associated with predicting future rates of erosion. We therefore propose to retain a degree of flexibility within the programme where appropriate.	*5.6*
Cost efficiency	• In producing cost estimates for this case, estimators drew upon a range of sources including framework rates, cost curves, outturn costs from historic projects and estimator judgement. In this way, we have been able to ensure any assumptions adopted during the estimating process are appropriate. • Benchmarking for erosion schemes is difficult as site-specific conditions, such as access constraints, ground conditions and compensation requirements, strongly influence outturn expenditure. However, where benchmarking has been possible, the evidence indicates that UUW's costs are efficient.	6.2 6.3
Customer protection	• Ofwat defines material investments as 1% of total expenditure (totex). The value of this case does not meet the materiality threshold and we therefore consider that a price control deliverable (PCD) is not required. However, should investment be cancelled, delayed or reduced in scope, we consider that customers are fully protected by performance commitments (PCs), namely the total pollution, serious pollution and water supply interruptions PCs.	7

3. Introduction

3.1.1 This document sets out an enhancement case of £28.595 million to allow UUW to investigate and mitigate the effects of coastal and river erosion on our asset base across the North West.

3.1.2 In recent years, we have already experienced how the North West's dynamic fluvial and coastal environments can present challenges for the stability of sediments supporting our assets and over the long term this is forecast to worsen as a result of climate change. Analysis of Environment Agency (EA)[3] and British Geological Survey (BGS) data[4] demonstrates that the North West has a surface geology that is more susceptible to riverine and coastal erosion than that of most other operating regions.

3.1.3 Indeed, a desktop study completed as part of our 25-year Drainage and Wastewater Management Plan (DWMP) indicated that UUW own and operate approximately 107 km of linear Ww assets, 201 Ww Network point assets and 804 Wastewater Treatment Works (WwTW) structures that are at a high risk of erosion. Additionally, 48 water mains have been identified as being 'exposed in river bed'. These vulnerable assets are likely to be placed under an increased risk of failure as rates of erosion accelerate. UUW therefore recognises that we must act now to secure the long-term resilience of our asset base against accelerated erosion and thereby protect against service disruption.

3.1.4 Continuing to respond reactively to this risk through our base expenditure is becoming increasingly inefficient as erosion rates accelerate and service disruptions become more likely. UUW therefore considers that we need to invest to '…manage increasing risks, or changing acceptance/acceptability of risk, from hazards that are beyond (our) control and not covered by other enhancement cases' as per Ofwat's definition of resilience enhancement expenditure[5].

3.1.5 UUW proposes a dual approach for managing erosion risk. For instances where erosion could otherwise result in service disruption in AMP8, £24.114 million of investment in engineering solutions is outlined. For those highest risk sites identified in the DWMP and vulnerable mains database where the need requires validation, we propose expenditure of £4.481 million on ground investigations to enable UUW to tailor and schedule solutions appropriately across future price control periods.

3.1.6 Cost estimates for this enhancement case have been derived based on the existing highest priority sites. This claim therefore will protect approximately 2.8 km of sewers, 3 outfalls, 2 WwTWs and 0.6 km of clean water mains whilst enabling ground investigations to be conducted across an additional 6.5 km of sewers, 50 Ww point assets and 43 clean water mains. Those sites for which this enhancement case has been scoped against are outlined in Table 1. We do, however, consider it imperative that we retain flexibility regarding which specific schemes comprise this enhancement programme given the inherent unpredictability regarding the rate and location of erosion. Therefore, should it become apparent that another site is at a higher risk of erosion between October 2023 and project delivery, UUW considers it appropriate to substitute such a risk for an equivalent scheme in the programme, provided the overall programme outcomes are still delivered and the scheme delivers comparable value. Retaining a level of flexibility ensures that the schemes that are delivered represent the best value for customers.

3.1.7 Whilst retaining flexibility is important, we recognise the need to balance flexibility with the provision of adequate protection for customers for large-scale high-value schemes. Approximately ✂% of this case's value is attributable to a £[✂]partnership contribution to a proposed coastal erosion protection scheme for Crosby, led by Sefton Council, and we therefore consider that it would be inappropriate to substitute this scheme for another scheme(s). The scheme will protect Crosby Northern pumping station and ~2 km of 600 mm diameter rising main along the Crosby coastline from accelerated

[3] Environment Agency (2022) *National Flood and Coastal Erosion Risk Management Strategy for England.* Available here: https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2

[4] BGS (2022) *BGS GeoScour Open.* Available here: https://www.bgs.ac.uk/datasets/bgs-geoscour-open/

[5] Ofwat (2022) *Appendix 9 Setting expenditure allowances.* Available here: https://www.ofwat.gov.uk/wp-content/uploads/2022/12/PR24_final_methodology_Appendix_9_Setting_Expenditure_Allowances.pdf

erosion rates; the cliff edge is now only ~20 m from these assets. A partnership contribution to this scheme will provide the best value option for customers, not only securing the resilience of our own asset base, but also reducing coastal erosion risk for ~169 properties, creating intertidal habitats and enhancing the coastline. We strongly believe that the Crosby coastal erosion protection scheme will provide an exemplar for how water companies and other Risk Management Authorities (RMAs) can work in partnership to provide resilience against common threats posed by climate change, addressing the joint regulatory call from Ofwat and the EA to engage with and deliver collaborative partnership schemes of this type[6].

Table 1: A breakdown of the proposed enhancement expenditure

Intervention Type	Asset	Cost
Engineering Solution	-]	£12,675,000
Engineering Solution	-]	£634,236
Engineering Solution	-]	£746,554
Engineering Solution	-]	£1,563,347
Engineering Solution	-]	£895,885
Engineering Solution	-]	£506,175
Engineering Solution	-]	£506,176
Engineering Solution	-]	£719,030
Engineering Solution	-]	£995,669
Engineering Solution	-]	£305,608
Engineering Solution	-]	£527,484
Engineering Solution	-]	£541,543
Engineering Solution	-]	£1,529,379
Engineering Solution	[✂]	£1,967,891
Investigations	-]	£1,885,640
Investigations	-]	£1,237,892
Investigations	-]	£1,357,677
	Total	**£28,595,186**

3.1.8 In summary, this enhancement case will enable UUW to proactively manage the increased risk posed by accelerated coastal and river erosion rates, thereby improving the resilience of our asset base and reducing the likelihood of service disruption. This claim will protect approximately 2.8 km of sewers, 3 outfalls, 2 WwTWs and 0.6 km of clean water mains from erosion and fund ground investigation studies for those highest risk sites identified through desktop studies. We are targeting investment in solutions at sites where there is a high certainty in need, and investment investigations where risk is less certain. Through the proposed ground investigations, we will better understand our erosion risk and ensure that interventions are scheduled appropriately as part of a long-term adaptive plan.

[6] EA and Ofwat (2022) *A joint approach for how water companies should consider flood and coastal resilience in the context of their statutory roles and duties.* Available here: https://www.ofwat.gov.uk/wp-content/uploads/2022/06/Ofwat-Environment-Agency-joint-letter-about-flood-and-coastal-resilience-approach.pdf

4. Need for enhancement investment

4.1.1 Coastal and river erosion pose a real risk to the integrity of our asset base and consequently an increased risk to the core services we provide customers across the North West as well as the environment in which we operate. Climate change projections indicate an acceleration of the rate of erosion of the land supporting our critical infrastructure, heightening this risk.

4.2 Coastal and river erosion risk

4.2.1 Climate change projections indicate that the North West will experience more frequent and intense winter storms, storms that can be expected to accelerate the rate of erosion of the land supporting our critical infrastructure. It is therefore imperative that we ensure our network and treatment infrastructure is as resilient as possible to the accelerated rates of erosion anticipated under most likely climate change scenarios.

4.2.2 To understand the vulnerability of our wastewater assets to erosion, we conducted a desktop resilience assessment as part of our DWMP. The study focused on Ww assets currently listed in UUW's GIS database as within a 5 m of a river or within 10 m of a tidal zone. The following asset classes were considered:

- Network structures
- Pressure sewers
- Discharge points
- Gravity sewers
- WwTW assets – this assessment returned all assets within a WwTW's estates boundary, within the specified buffer zones, that might be at risk. These assets include: Buildings, structures, roads, tracks, paths and land.

4.2.3 Erosion risk was calculated using the following equation:

$$Risk = LoF * LoF_M * IoF$$

whereby LoF = likelihood of failure, LoF_M = likelihood of mitigation to the risk of asset failure, IoF = impact of asset failure.

- LoF = The likelihood of failure was determined by assessing the susceptibility of the sediments supporting a given asset to erosion on a scale of 1 to 5 using the British Geological Survey (BGS) geology codes, whereby the most resistant geological material types scored 1 and the least resistant scored 5.
- LoF_M = A mitigation factor was introduced to account for the mitigating effect that certain sewer material types and surface types can have on ground stability. For example, some materials, such as flexible plastics and metals, are more likely to retain structural integrity even with the partial loss of surrounding soils and urban coverings can stabilise soil.
- IoF = The impact of asset failure was assessed separately for point assets and linear assets using a common scale of 1 (low impact) to 5 (very high impact). For point assets, our standard criticality assessment ratings have been used, which are based on factors such as proximity to bathing and shellfish waters, watercourse sensitivity and permit sensitivity. For linear assets, IoF was calculated as a function of the following factors: (a) the diameter of the sewer, (b) the surface type, (c) proximity to recognised areas of high environmental value and (d) proximity to built infrastructure.

4.2.4 The overall erosion risk score was assigned a RAG status. Table 2 shows the number of assets that were deemed to be at a high (i.e. red) risk from erosion using this methodology.

Table 2: Volumes of Ww assets calculated to be at a high risk of tidal and river erosion in the DWMP resilience assessment

	Number/Length at a High Risk of Tidal Erosion	Number/Length at a High Risk of River Erosion
Gravity Sewers	28 km	65 km
Pressure Sewers	6 km	8 km
Network Structures	2	6
Discharge Points	41	152
WwTW assets	74	730

Source/notes to be populated

4.2.5 Whilst the assessment does not take account of the depth of an asset, it is considered that the above represents a reasonable estimation of the erosion risk across our Ww asset base. Our DWMP assessment has therefore highlighted an urgent need to increase the long-term resilience of vulnerable assets against accelerated erosion rates.

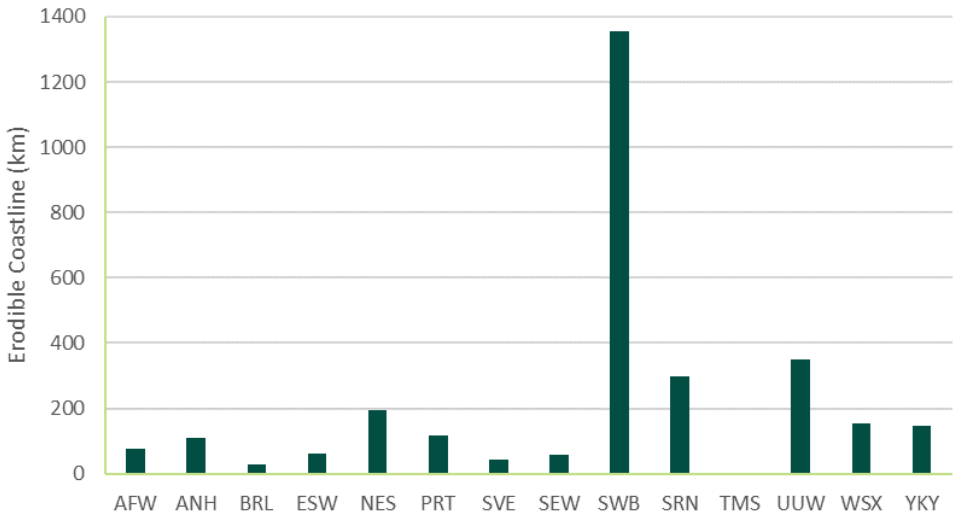
4.2.6 Separately to the DWMP assessment, a database of vulnerable clean water mains was collated based on operational knowledge from subject matter experts. Data collated for each main included the number of properties and DMAs supplied and a description of the consequence of failure, allowing risk level to be determined. 48 vulnerable mains were identified as being 'exposed in river bed' through this method.

4.3 Comparative information: Coastal erosion

4.3.1 UUW has the second largest length of erodible coastline across all WaSCs operating in England.

4.3.2 A national comparison of susceptibility to coastal erosion, as determined by the EA's National Coastal Erosion Risk Mapping (NCERM), demonstrates that UUW has the second largest length (351 km) of erodible coastline across all WaSCs in England, second only to South West Water who are a significant industry outlier (Figure 1). This increased susceptibility of sediments to erosion is combined with a large tidal range of around 10 m with the cumulative result being that the North West's coastline is highly dynamic[7]. UUW's coastal assets are therefore more susceptible to the effects of coastal erosion than assets owned by most other WaSCs operating in England.

Figure 1: Length of erodible coastline by company in England (Environment Agency, 2022)



Source: Environment Agency, 2022

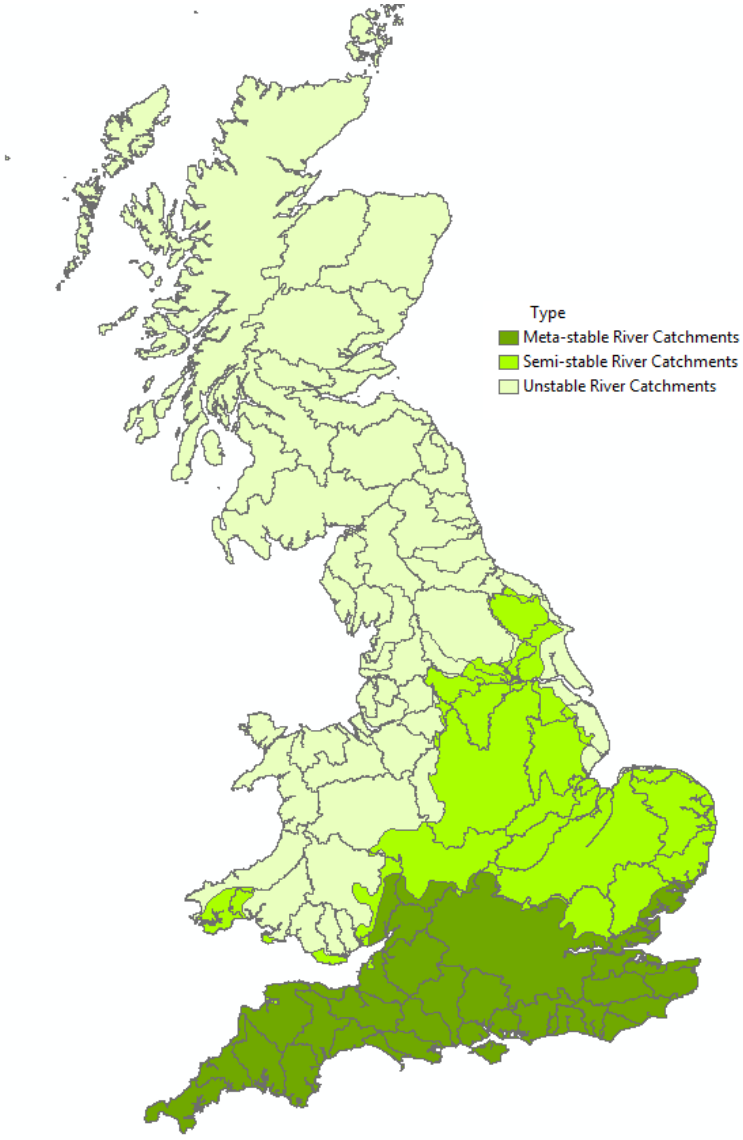
[7] Environment Agency (2022) *National Flood and Coastal Erosion Risk Management Strategy for England.* Available here: https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2

4.4 Comparative information: River erosion

4.4.1 The North West's riverine environments have geological properties that make them more susceptible to river erosion than those in most other operating regions. UUW has more catchments with an overall medium-high susceptibility to river erosion than any other company in England and Wales. These catchments host some of the major urban centres in the North West, posing a threat to the long-term resilience of our infrastructure.

4.4.2 A national comparison of erosion susceptibility was enabled by analysis of the British Geological Survey's (BGS, 2022) GeoScour database[8]. The GeoScour database provides an assessment of the natural characteristics and properties of catchment and riverine environments for the assessment of river scour in Great Britain. At the highest level, the entirety of the North West is characterised as having an unstable river catchment (Figure 2 below), in which river systems are still undergoing landscape adjustment following the last glaciation. Table 3 outlines the characteristics of unstable river catchments that increase the eroding power of the river and make the surrounding landscape especially susceptible to erosion.

Figure 2: The whole of the North West has an unstable river catchment. Our river systems are therefore very unpredictable and characterised by rapid changes in discharge and flow regime (BGS, 2022)



[8] BGS (2022) *BGS GeoScour Open.* Available here: https://www.bgs.ac.uk/datasets/bgs-geoscour-open/

Table 3: Characteristics of unstable river catchments

	Attributes
Behaviour 1	A dynamic catchment with hillslopes and rivers still adjusting to non-glacial conditions.
Behaviour 2	Unpredictable river catchment response that is not in equilibrium with its host geology or relief.
Behaviour 3	Elevated sediment supply to river driven by hillslope instability and catchment fill.
Behaviour 4	Highly-variable changes in discharge and flow regime.
Potential Issues for Management 1	Highly-unpredictable river catchment at all temporal and spatial scales.
Potential Issues for Management 2	Elevated hillslope instabilities contributing higher and more variable levels of sediment to channels.
Potential Issues for Management 3	High and complex patterns of river scouring and floodplain aggradation.
Potential Issues for Management 4	High-magnitude (e.g. storms) and transient (e.g. periods of prolonged rainfall) events, plus localised changes in catchment management (e.g. land-use, drainage, channel modification) are likely to have a high impact on channel processes.

4.4.3 The latter attribute is particularly pertinent due to the North West's high exposure to Atlantic depressions incoming from the west. An elevated frequency of high-magnitude and prolonged rainfall events combined with highly transient river morphologies collectively result in a high river erosion risk in the North West.

4.4.4 The BGS also assessed the susceptibility of every length of river in Great Britain to erosion under average-case, best-case and worst-case scenarios. These results have been aggregated to the Water Framework Directive (WFD) catchment (cycle 2) scale to provide an overall susceptibility rating for each catchment (Figure 3 below). Even in the best-case scenario, the North West has four catchments, namely the Ribble, Douglas, Alt & Crossens and Lower Mersey, in the medium-high susceptibility class; no other WaSC operating region in England contains a catchment with a susceptibility rating above low-medium in this scenario. The North West's vulnerability is further compounded by the co-location of areas of high erosion susceptibility with areas of high urban density (Figure 4 below). Erosion risk thus coincides with locations in which a large proportion of our WwTWs, sewers, discharge points and water mains are located.

Figure 3: BGS (2022) assessment of the susceptibility of catchment surface geology to erosion under (a) average-case (b) best-case and (c) worst-case scenarios. In all scenarios, the North West has the highest number of catchments in England and Wales in the medium-high susceptibility class and above.

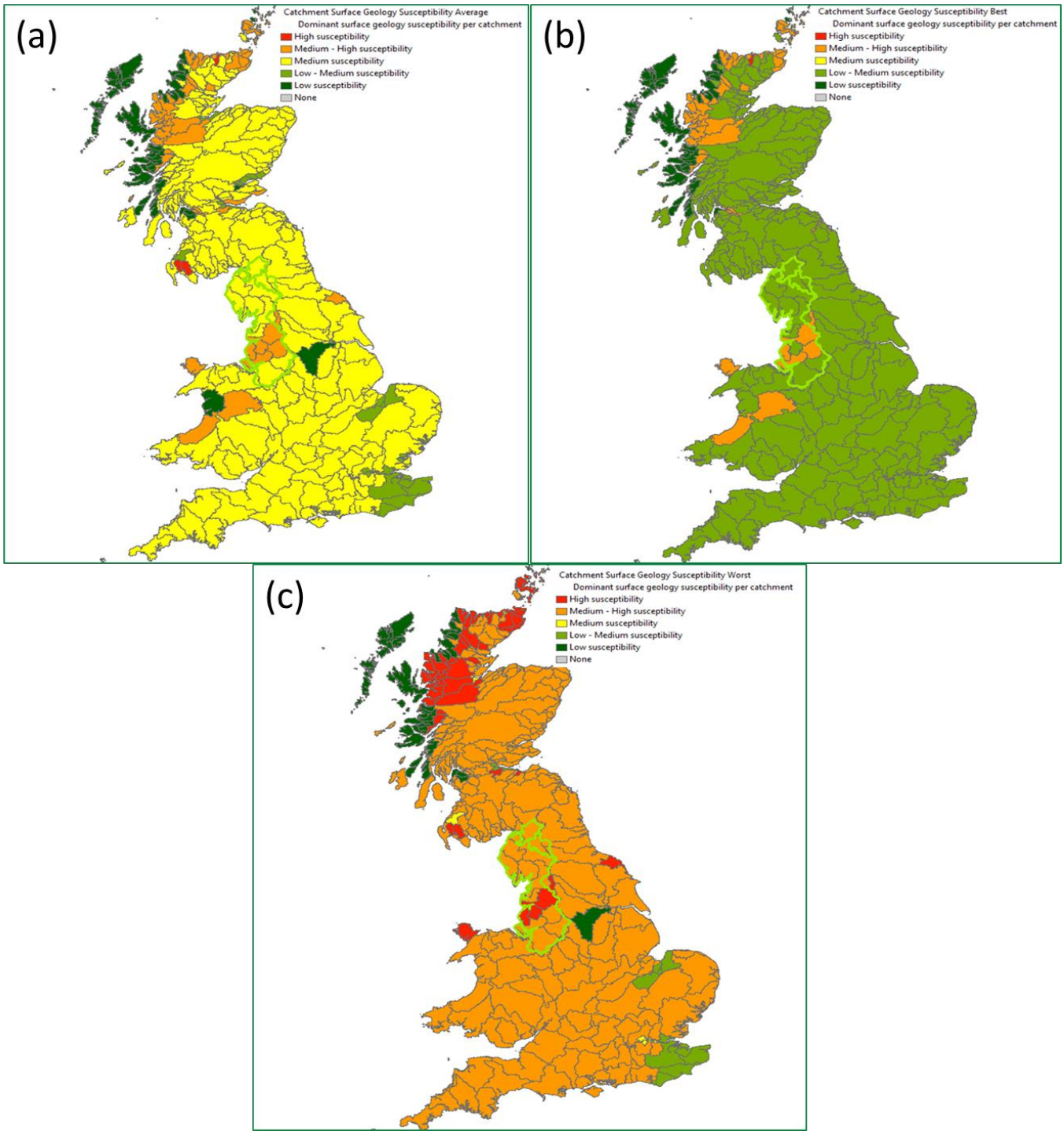
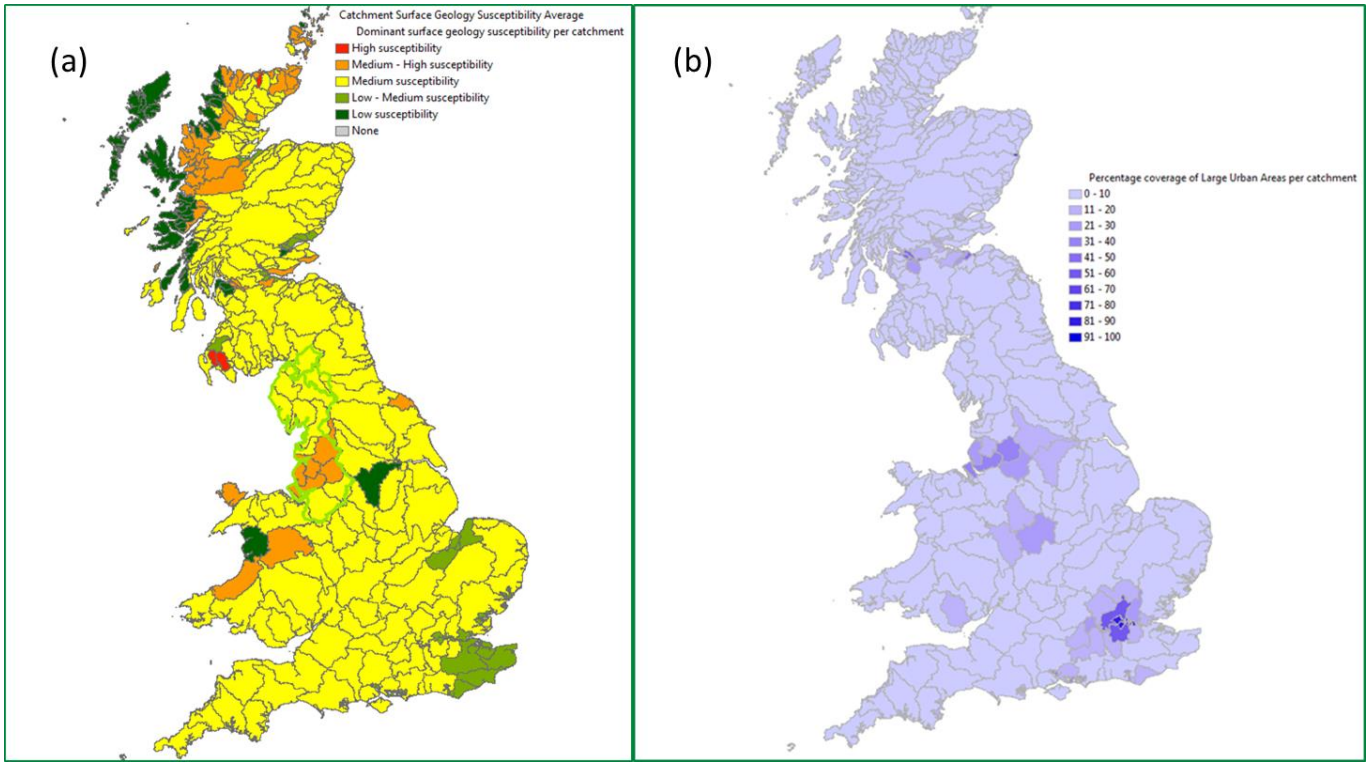


Figure 4: A side by side comparison of (a) catchment surface geology susceptibility for the average-case scenario and (b) the percentage coverage of large urban areas per catchment. River erosion risk is concentrated in urban areas.



4.5 Scale and timing of investment

4.5.1 UUW proposes a dual approach for managing erosion risk. For instances where erosion could otherwise result in service disruption in AMP8, £24.114 million of investment in engineering solutions is outlined. For those highest risk sites identified in the DWMP where the need requires validation, we propose expenditure of £4.481 million on ground investigations to enable UUW to tailor and schedule solutions appropriately across future price control periods.

4.5.2 Taking into consideration the scale of the coastal and river erosion risk identified, it is clear that UUW must invest now to enhance the resilience of our asset base against erosion. Understanding and building resilience to erosion risk is critical in delivering our long-term ambition to reduce water supply interruptions, sewer collapses and pollution incidents impacting upon water and wastewater services. In determining the value of this claim, we sought to define an appropriate level of risk tolerance, identifying where we could delay investment in capital interventions to minimise impact on customer bills and instead manage the risk through more detailed ground investigations.

4.5.3 In summary, this resulted in UUW proposing to implement capital solutions to protect 2.8 km of sewer, 5 (0.6 km) vulnerable water mains, 3 outfalls and 2 WwTWs from river erosion. See Table 4. A decision was made to intervene at these locations as, whilst erosion is not affecting service provision at present, the risk of service disruption in AMP8 is intolerable if a 'do nothing' approach is adopted.

4.5.4 As identified by the DWMP assessment and vulnerable mains database, erosion risk is far from restricted to these assets. UUW is therefore proposing to conduct ground investigations on 6.5 km of the highest risk linear assets and 50 highest risk point assets (including WwTWs) identified through the DWMP and 43 vulnerable mains exposed in river beds, see Table 5. The phasing for this programme of work has prioritised interventions at only the most high risk sites in AMP8, with investigations at other high risk sites informing future intervention needs. By better understanding our erosion risk profile, we can ensure that interventions are scheduled appropriately as part of a long-term adaptive plan, implementing engineering interventions only when pre-defined site-specific trigger points are exceeded. As erosion rates are uncertain in the context of climate change, UUW considers it appropriate to complete preparatory work to enable quick adaptation to change in future price control periods.

Table 4: Number/length of assets to be protected via enhancement funding. A full breakdown of the solutions can be found in section 4 'Best Option for Customers'.

Asset Type	No./length to be protected via Engineering solutions	Cost (£m)
Sewers	2.8 km	15.62
Ww Network Outfalls	3	1.91
WwTWs	2	3.50
Water Mains	5 (0.6 km)	3.09
	Total	24.11

Table 5: Number/length of assets to undergo ground investigations via enhancement funding. Ground investigations will be conducted on the highest risk assets following a desktop study to screen and remove risks as necessary.

Asset Type	No./length to undergo ground investigations	Cost (£m)
Ww Point Assets (inc. WwTWs, outfalls and PSs)	50	1.24
Sewers (inc. rising mains)	6.5 km	1.89
Water Mains	43	1.36
	Total	4.48

4.6 Base vs enhancement expenditure

4.6.1 UUW considers this enhancement case to be entirely separate from base expenditure. This case pertains to the expenditure required to manage the increasing risk from an exogenous hazard, namely accelerated coastal and river erosion rates driven by climate change. We therefore consider that this case fully satisfies Ofwat's requirement for resilience enhancement expenditure "to manage increasing risks, or changing acceptance/acceptability of risk, from hazards that are beyond their control and not covered by other enhancement areas"[9].

4.6.2 Further, the solutions required to enhance resilience against this increasing hazard are not traditional base maintenance solutions entirely on existing UUW-owned assets. For example, solutions selected include reinstatement of the original river channel, implementation of bio-engineered protection measures and installation of gabion baskets (Table 7). Proactive management of erosion risk using such methods at scale is new to UUW and therefore the costs of completing such work are not reflected in our historical base allocation. Compounding this, there are no cost drivers within Ofwat's proposed base cost model suite that capture erosion susceptibility within a given operating region. We therefore do not consider there to be an implicit allowance for proactive erosion protection measures within the modelled base allowance. Enhancing the resilience of our asset base against the increasing risks posed by coastal and river erosion requires a fundamental transformation in the way we manage erosion risk that is not reflected in historical cost allocations.

[9]Ofwat (2022) *Appendix 9 Setting expenditure allowances.* Available here: https://www.ofwat.gov.uk/wp-content/uploads/2022/12/PR24_final_methodology_Appendix_9_Setting_Expenditure_Allowances.pdf

4.7 Customer support

4.7.1 Customers expect UUW to play our part in protecting the environment.

4.7.2 Customers have repeatedly voiced that playing our part in protecting the environment is of high importance to them, ranking 4th out of 18 priorities in our Customer Priorities research[10]; for future bill payers this ranked 2nd, reflecting the growing expectations being placed on UUW. Our research into customer's concerns surrounding climate change[11] demonstrated that the impact climate change will have on the environment is of the highest concern across household customers. UUW therefore recognises that it is important that we play our part in protecting riverine and coastal environments from erosion where service provision could otherwise be at risk.

4.8 Management control

4.8.1 UUW cannot control the susceptibility of the riverine and coastal sediments supporting our assets to erosion. Nevertheless, we have taken all possible steps to manage the risk through our botex allowance but we do not consider this a sustainable position if we are to improve the resilience of our asset base against climate change. Steps taken to manage erosion risk to date include:

- Conducting a resilience assessment through our DWMP to identify assets at a high vulnerability to erosion. In this way, we have been able to develop our understanding of regional risk and prioritise this enhancement case accordingly;
- Where necessary, we have developed contingency plans for vulnerable assets, detailing over-pumping arrangements, tankering needs and access requirements, to minimise reactive costs and the level of service disruption experienced by customers; and
- Engaging with the responsible landowner, where the landowner is not UUW, to ensure that they fulfil their responsibilities and understand whether we can deliver lower-cost solutions in partnership.

4.8.2 Whilst the above measures have allowed us to manage erosion risk in the short-term, continuing to respond reactively through our base expenditure is not sustainable as accelerated erosion rates increase the risk of asset failure. Reactive failure can result in damage to the environmnent or interruption to the service we provide to customers, as well as incurring significant costs associated with overpumping, tankering and the provision of alternative supply vehichles.

[10] Impact Research Ltd. on behalf of United Utilities, *United Utilities Customer Priorities*, December 2021. Available here: https://www.unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/p143-customer-priorities-2021/final-report.pdf

[11] DJS Research Ltd. on behalf of United Utilities, *Research report: Climate change,* 2021. Available here: https://www.unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/p124-climate-change--resilience/final-report.pdf

5. Best option for customers

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

5.2 Risk prioritisation

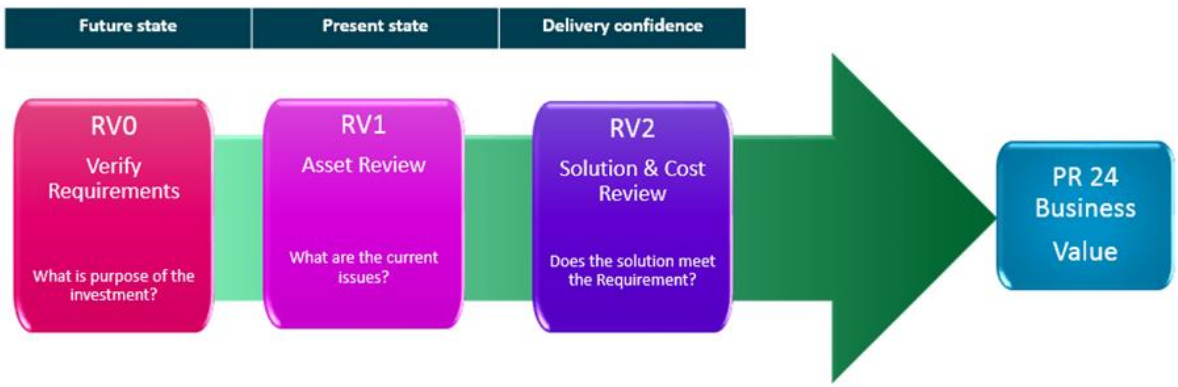
5.2.1 To define the highest priority locations for intervention, we considered a number of factors such as: proximity of the asset to the watercourse, operational knowledge of rates of change in erosion, population served by the asset, diameter of the asset and the likelihood of environmental damage. Based on these metrics, it was possible to determine those sites, namely 2.8 km of sewers, 0.6 km of clean water mains, 3 outfalls and 2 WwTWs, where there is a high likelihood of service disruption and/or environmental impact within AMP8 if a 'do nothing' approach is adopted.

5.2.2 However, we recognise that erosion risk is not constrained to these sites. Therefore, the results from the DWMP resilience assessment outlined in Section 4.2 were used to define an investigation programme for those highest risk assets where the effect of erosion on our asset base is poorly understood. This programme will enable us to obtain invaluable data that can be used to define and prioritise investment profiles across future price control periods, supporting UUW's transition towards a more proactive approach to erosion mitigation.

Risk & Value Process

5.2.3 To provide assurance that the investment represents the best value for customers, the proposals progressed through UUW's defined Risk and Value (RV) process. RV is a three stage process (Figure 5), aimed at positively challenging our projects to ensure we have sufficient evidence behind decisions. It provides UUW with the confidence that we are proposing the right projects for the AMP8 Programme and therefore managing and maximising the value for customers from our investments. It also ensures that we adopt the correct approach to option identification, development and selection to maximise the realisation of benefits associated with these investment.

Figure 5: UUW's Risk & Value Process



5.2.4 The requirement for this enhancement case was split into two parts:

(1) To scope an investigation programme to quantify the risks to assets defined in the DWMP assessment

(2) Engineering interventions for the 2.8 km of sewers, 3 outfalls, 2 WwTWs and 0.6 km of clean water mains identified as high priority sites

5.2.5 For requirement (1), following receipt of the Requirement at RV0, a meeting took place with the RV Practitioner to discuss the RV strategy. The review concluded that the contribution of RV would have limited impact on this type of project and therefore RV not required in this instance.

5.2.6 For (2) the full RV approach was followed and the process which defines the best option for customers.

5.2.7 Once the requirements had been clearly verified, RV1 was completed in order to understand the current asset condition and performance. Without this understanding, there is significant risk that proposed solutions will fail to deliver the value intended and may even fail to satisfy the requirements. This initial baselining was essential in order to allow identification of possible options against the generic high level solutions (GHLS).

5.2.8 Through the RV process, we were therefore able to provide an extra layer of assurance that the need is absolutely necessary and the investment cannot be postponed.

5.3 Options development

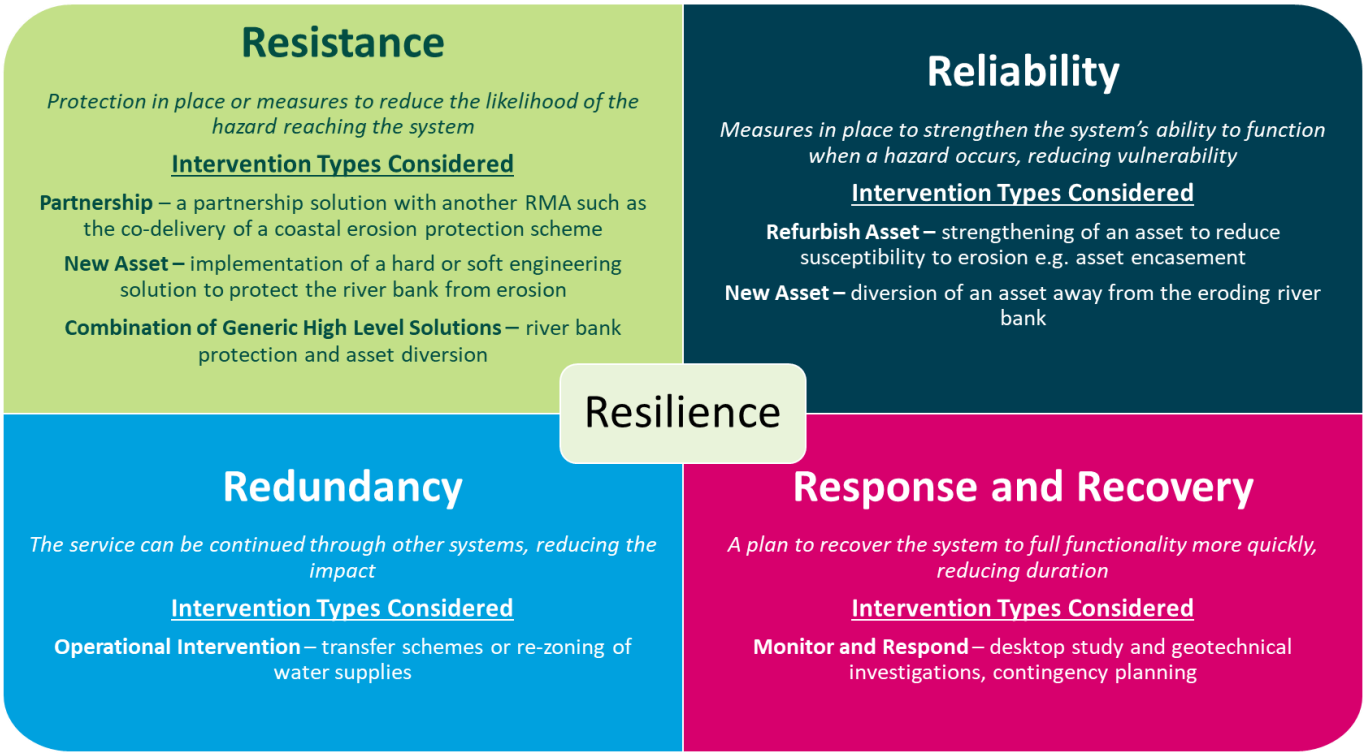
5.3.1 Options to address PR24 requirements passed through a series of stages before the agreed solution was confirmed, from an initial 'unconstrained' list of options through to confirmation of the defined and estimated scope associated with a preferred solution.

5.3.2 Within the options development process, unconstrained options were identified against a list of Generic High Level Solution (GHLS) categories - see Table 6 - to ensure that solutions were considered across a broad range of option types. The GHLSs were overlaid against the 4Rs (resistance; reliability; redundancy; respond and recover) framework for resilience to a holistic approach to reducing vulnerability and building system resilience (Figure 6). For example, not only did we consider resistance measures to slow the rate of erosion, we also considered how we could enhance the ability of our asset base to withstand exogenous hazards and how system redundancy could be increased. Some GHLSs were discounted at this early stage, for example, like for like replacement of an asset would not provide any protection against erosion.

Table 6: The Generic High Level Solutions Hierarchy

Monitor & Respond	Accept risk with agreed contingency plan
Operational Intervention	Solve need by identifying targeted maintenance to restore performance
Optimise Asset	Solve need by improving performance of existing equipment
Partnership	Solving need by assistance of third parties
Refurbish Asset	Major asset refurbishment to restore asset life and performance
Replacement	Replace asset(s) on a like for like basis
New Asset	Build new asset when all other options are not possible (this could be a NBS)
Integrated Approach	Integrated solution across asset boundaries e.g. network, process or catchment level solutions. An integrated solution is a Systems Thinking response and could be a combination of the above solution types.
Combination of GHLSs	

Figure 6: Optioneering considered all types of mitigation across the '4Rs'



5.3.3 If unconstrained options were deemed viable then additional screening was carried out to identify 'constrained' options, with further screening taking place to refine the feasible solutions and determine those to be progressed to detailed scope development and estimating.

5.3.4 Across the programme, a total of 26 options progressed to detailed scope development and estimating, ranging from detailed ground investigations to reinstatement of the original river channel to slow erosion rates. A detailed engineered design was developed for all the feasible solutions identified in order to provide comprehensive cost and carbon data. Solution types that progressed to this stage included both traditional hard engineering approaches, such as asset diversion and sheet piling, and emerging erosion protection measures, including vegetated sand bags. Broadly, the solutions that progressed to detailed design could be categorised into 6 overarching types:

- **Diversions and asset replacements** – Re-location of the asset at a greater distance from the point of maximum erosion;
- **Traditional erosion protection measures** – Utilising artificial structures, such as gabions, rock armour or sea walls to slow rates of erosion;
- **Non-traditional erosion protection measures –** Emerging approaches to managing erosion risk, such as innovative vegetated retaining walls and channel reinstatement;
- **Hybrid interventions** – A combination of option types, for example, implementing erosion protecting measures and also diverting the asset;
- **Partnership solutions** – Working in partnership with other Risk Management Authorities (RMAs) or other stakeholders where there are overlapping drivers within a location;
- **Investigations** – Conducting geotechnical investigations, geomorphological surveys and condition assessments to improve our understanding of erosion risk.

5.3.5 During the detailed design stage, the options were also assessed for deliverability. A review was undertaken by the Planning, Land & Environmental Team, Ground Engineering and UUW's Construction Services which allowed identification of risks and potential mitigation measures. This will have improved the cost accuracy associated with implementing solutions and allowed elimination of options which were not deemed to be deliverable thereby confirming feasibility. This also included an assessment of

the likely delivery route (including Direct Procurement for Customers) which was then used as the basis for the Contractor add-ons in the cost estimate.

5.3.6 Key risks identified during this deliverability screening included: access constraints; the presence of landfill and contaminated land and concerns regarding slope stability (Health & Safety). Mitigation measures were therefore incorporated into the scope of the project to limit the risks to delivery. These measures include: the construction of temporary access tracks; incorporation of an allowance for landowner compensation; provisions for geotechnical assessments and hazardous spoil removal and construction of toe support, i.e. support installed at the base of an eroding river bank to provide structural stability.

5.4 Options selection

5.4.1 In order to select the best option for customers, we adopted a 'best value' approach, with a best value option being one which drives the best outcomes for the environment, society and UUW over the long term.

5.4.2 The value associated with the various options was assessed using the value assessment tool developed by UUW specifically for this purpose. This tool lists intervention type and pulls through the associated benefits and value. It assesses value against a number of benefits including all the wider environmental outcomes as requested in the EA WINEP Options Development Guidance. The benefits were drawn from the MyRisk Risk Breakdown Structure (RBS), currently widely used in UUW. The wider value element was also taken from the EA's WINEP guidance on Wider Environmental Outcomes.

5.4.3 The inputs to the value tool included costs (CAPEX, OPEX and whole life), carbon (embedded, operational and whole life), data on biodiversity plus risks and benefits as described above. The outputs from the tool included a cost benefit analysis and allowed the selection of the preferred solution based on the comparison of value between the various options (RV2). The option selected was therefore that which provides the best value to customers. More detail on this approach can be found within 'Our approach to deliver best value totex'.

5.4.4 Where possible, and as determined by the value assessment tool, preference was given to solutions that deliver multi-capital benefits and work with the natural processes of the watercourse.

5.4.5 Table 7 below outlines the more detailed solution types that were selected or rejected following detailed design and estimation.

Table 7: Solution types selected or rejected following detailed design and estimation

Option	Select/Reject	Rationale	Site(s) where the selected option was chosen
Ground investigations	Select	Suitable solution for sites where a desktop study has identified an erosion risk but this has not been confirmed on site. Purpose of the investigations is to better understand our erosion risk profile and ensure that interventions are scheduled appropriately across future price control periods.	6.5 km of the highest risk sewers identified through the DWMP 50 highest risk Ww point assets identified through the DWMP 43 highest risk clean water mains
Contribution to a coastal erosion protection partnership scheme with the LLFA	Select	The partnership scheme will provide multi-capital benefits, including protection of properties sensitive ecosystems from erosion and access and recreation benefits for the local community (see case study).	Crosby Rising Main

Option	Select/Reject	Rationale	Site(s) where the selected option was chosen
Installation of erosion protection measures (non-traditional soft engineering) on river bank	Select	Where possible, solutions were chosen that deliver environmental and amenity benefits and work with the natural processes of the watercourse. Examples include reinstatement of the original river channel and implementation of bio-engineered protection measures (e.g. vegetated sand bags).	Halcroft Cottages Sewer London Road Terrace Leyland WwTW Bowden WwTW
Installation of erosion protection measures (traditional hard engineering) on river bank	Reject	Soft engineering solutions generally provided environmental and amenity benefits that hard engineering solutions such as sheet piling did not.	
Installation of erosion protection measures (hybrid – soft and hard engineering) on river bank	Select	In this instance, a hard engineering solution (sheet piling) was deemed necessary to complement soft engineering erosion protection measures in order to cut off groundwater.	Rhodes Business Park Sewer
Sewer diversion	Reject	Asset diversion does not slow erosion rates and provider the wider environmental benefits that soft engineering solutions do	
Hybrid – sewer diversion and erosion protection	Reject	Least cost solution (i.e. soft engineering erosion protection scheme) was preferred	
Replacement of outfall and installation of erosion protection measure (soft engineering)	Select	Replacement of outfall deemed necessary to prevent H&S and amenity impact. Soft engineering solutions preferred for reasons outlined above.	Clammerclough Cemetry Outfall Common Road Outfall Longsight Road Outfall
Installation of a new water main at greater depth	Select	Deemed necessary as the existing mains are very shallow and vulnerable to exposure in the river bed.	High Waterside Clean Water Main Skirden Bridge Clean Water Main Haverigg Clean Water Main Mill Bridge Clean Water Main
Installation of erosion protection measures (hard engineering) on river bed	Select	Installation of gabion baskets deemed to be able to provide sufficient protection at this site.	Parsonby Clean Water Main

5.4.6 The value assessment tool demonstrated that all selected solutions are highly cost-beneficial, with a 30 year NPV of £244.046 million across the preferred programme. The outputs from the value assessment tool therefore confirm that the proposed solutions represent best value for customers, communities and the environment over the long-term.

5.4.7 The value tool calculated a total embodied carbon impact of 2793 tCO_2e across the programme. We do, however, strongly consider that the environmental benefits associated with this investment, namely protection of fluvial and coastal environments from the impacts of erosion and avoidance of serious pollution incidents and water supply interruptions caused by damage to assets, outweigh the carbon disbenefit. Further, if proactive erosion protection measures were not implemented across these sites, there is a high likelihood that erosion would ultimately undermine the stability of these assets and result in the need to implement temporary measures, such as overpumping, tankering and the use of alternative supply vehicles (ASVs), to maintain service. These activities are highly carbon intensive and therefore we consider that the installation of proactive erosion protection measures provides the best outcomes for the environment, as well as for customers.

5.5 Partnerships

5.5.1 We recognise that by working in partnership with other Risk Management Authorities (RMAs) and stakeholders across the North West, we can improve the resilience of services and communities to erosion risk in a more integrated way, maximising the delivery of wider environmental outcomes whilst minimising costs for customers. Such benefits were outlined in the joint approach to flood and coastal resilience as proposed by Ofwat and the EA, which strongly encouraged water companies "to collaborate and work in partnership with others within and beyond the sector, reflecting the needs of the areas in which they operate"[12]. We have therefore sought to leverage partnership funding where there are overlapping objectives within a location and applied Ofwat's public value principles to determine an appropriate financial contribution that is proportionate to the benefits delivered for customers. We have identified an opportunity to collaborate with Sefton Council to protect one of our pumping stations and the adjoining rising main in Crosby, Sefton, from coastal erosion.

Crosby Rising Main

5.5.2 Erosion rates across the Crosby Coastline are accelerating such that the cliff edge is now ~20 m from Crosby Northern Rising Main (600 mm diameter) and pumping station as its closest point (Figure 7). These assets serve a population of 27,779 and it is estimated that 2 km of the rising main is at risk. Independent evidence provided by Sefton Council suggests that the asset could be lost to erosion by 2030-35, but storm events could accelerate this. Indeed, in Dec 2013, one storm resulted in an 11 m retreat across one area of the coastline in a 12 hour tidal cycle.

[12] EA and Ofwat (2022) *A joint approach for how water companies should consider flood and coastal resilience in the context of their statutory roles and duties.* Available here: https://www.ofwat.gov.uk/wp-content/uploads/2022/06/Ofwat-Environment-Agency-joint-letter-about-flood-and-coastal-resilience-approach.pdf

Figure 7: Coastal erosion along the Crosby coastline is posing a risk to a large diameter rising main and pumping station

5.5.3 UUW has investigated multiple methods of managing this risk, including asset diversions, but costs were in excess of £[✂]and alternative solutions, such as sheet piling, were considered to be environmentally insensitive. . We instead consider that by working in partnership with Sefton Council to implement an erosion protection scheme, we can provide best value for customers at the lowest cost. The latest available estimate for the total cost of this scheme is £[✂].

5.5.4 UUW has determined that a proportionate contribution is £[✂]when taking into account the benefits afforded by this scheme for UUW and our customers, including protection of a critical asset and avoidance of a likely category 1 pollution event. All solutions scoped internally, including diversion of the rising main and construction of a new pumping station, were in excess of £20 million and did not deliver wider environmental outcomes beyond asset protection. We therefore consider that a contribution of £[✂]represents good value for money for customers, as confirmed by the benchmarking analysis outlined in section 6.3 whilst still being a fair contribution that is proportionate to the benefits we expect to receive.

5.5.5 The project scope includes placing rock armour at low points along the Alt Training Wall and north of the Coastguard Station, as well as replacing existing sea defences south of the coastguard station with a stepped sea wall. The project will therefore protect ~2km of the Crosby coastline against the accelerated erosion rates anticipated with climate change. In addition to protecting our rising main and pumping station from loss to erosion, thereby preventing a potential category 1 pollution, the scheme will deliver the following the multi-capital benefits:

- Reduction in erosion risk for 169 properties;
- Stepped revetment enhances the amenity value of the area, including access to Anthony Gormley's Another Place statues;
- Creation of intertidal habitat for birds in rock revetment;
- Alt Training Bank works can allow placement of rock to enhance existing roosting and feeding habitat for birds; and,
- Stabilisation of contaminated land, including preventing mobilisation of asbestos.

5.5.6 UUW therefore considers that a partnership contribution is the most appropriate option for mitigating erosion risk at Crosby, limiting the impact on customer bills and delivering wider multi-capital benefits.

5.5.7 We do, however, recognise that there is inherent risk associated with partnership projects where delivery is dependent on multiple parties. Indeed, as per Ofwat's PR24 Final Methodology, *"all companies will face uncertainty over contributions from potential partners".* We have taken all possible steps to limit risks to delivery, including regular engagement with Sefton Council regarding progress updates since project inception in 2018 and contribution of £[ ] for enabling works and short-term mitigation measures. We are confident that the proposals are at a sufficient degree of maturity to seek enhancement expenditure to contribute to the delivery of the scheme.

5.6 Programme flexibility

5.6.1 This enhancement case has been scoped based on those risks that were defined to be of the highest priority at the time of UUW's business plan submission in October 23. It should, however, be recognised that given the dynamic nature of erosion patterns, especially in fluvial environments, there is inherent uncertainty associated with predicting future rates of erosion. Therefore, should it become apparent that another site is at a higher risk of erosion between October 2023 and project delivery, UUW considers it appropriate to substitute such a risk for an equivalent scheme in the programme, provided the overall programme outcomes are still delivered and the scheme delivers comparable value. We have a robust tier process for escalating and prioritising risks and have developed a standardised mechanism for assessing the criticality of assets based on the societal implications of failure, the likely service impact and the repair complexity.

5.6.2 By retaining programme flexibility, we can ensure that customers continue to get the best value for money in line with Ofwat's principles for customer protection that it should be focused on outcomes '… set at the highest level possible to retain flexibility over the benefits to deliver using the most efficient solutions'[13]. We do, however, recognise the need to balance flexibility with the provision of adequate protection for customers for large-scale high-value schemes. As outlined above, [✂% of this case's value is attributable to a £[✂]partnership contribution to proposed coastal erosion protection scheme for Crosby and we therefore consider that it would be inappropriate to substitute this scheme for another scheme(s).

[13]Ofwat (2022) *Appendix 9 Setting expenditure allowances.* Available here: https://www.ofwat.gov.uk/wp-content/uploads/2022/12/PR24_final_methodology_Appendix_9_Setting_Expenditure_Allowances.pdf

6. Cost efficiency

6.1.1 In producing cost estimates for this case, our estimators drew upon a range of sources including framework rates, cost curves, outturn costs from historic projects and estimator judgement. As detailed further in *Chapter 8 – Delivering at efficient cost*, we have applied assumptions that reduce the overall indirect costs and overheads incurred relative to those observed in AMP7, improving cost efficiency. Whilst benchmarking for erosion schemes is difficult, due to site-specific conditions strongly influencing outturn expenditure, where it has been possible to do so, the evidence indicates that UUW's costs are efficient.

6.2 Approach to cost build

Investigation programme

6.2.1 UUW has a long history of delivering geotechnical assessments and pipe condition surveys and therefore we were able to use our framework rates to estimate the cost of the investigation programmes. Key assumptions applied to the investigation programme include:

(a) A more detailed desktop study will take place to review each of the locations to determine whether the risk is appropriate or can be removed from the programme;

(b) Works are to be batched so that a number of local sites can be surveyed within the same time. It was assumed that 40 sites per week can be surveyed for Ww linear assets and 20 sites for linear clean water assets;

(c) For ground investigation costs, if the linear asset length < 150 m, the cost is £[✂]. For linear assets > 150 m, the cost is £[✂]. Ground investigation costs include for environmental/ecological surveys and EA liaison;

(d) Surveying costs for CCTV surveys and topographical and bathymetric surveys are differentiated for urban and rural areas to account for differences access and traffic management costs. Costs for CCTV surveying and jetting therefore ranged from £[✂]per 1000 m length of gravity main. For topographical surveys, the rates for were assumed to be £[ ] per ha and £[ ] per ha for rural and urban areas, respectively. For topographical surveys within a highway, a rate of £-]per ha was assumed. 5% of sites were assumed to be located within the highway;

(e) 30% of all Ww Linear assets will require a bathymetric survey;

(f) Where water main works are identified as being adjacent to a railway or electricity an additional £[✂]is included to cover increased permitting/risk assessments.

6.2.2 We consider that the above assumptions are appropriate, balancing the opportunity for the delivery of efficiencies through preliminary screening and the batching of works geographically with the need to account for site-specific conditions such as traffic management and permitting requirements.

Engineering interventions

6.2.3 Costs for each solution were developed internally by collaboration across our Engineering and Estimating functions using a bottom-up estimating approach. Our Engineering teams developed an estimating brief and all solutions underwent a deliverability assessment. The Planning, Land & Environmental Team, Ground Engineering and UUW's Construction Services undertook a review to challenge the scheme design and eliminate any options that were not deemed feasible, thereby improving cost accuracy undertook a review. This also included an assessment of the likely delivery route (including Direct Procurement for Customers) which was then used as the basis for the Contractor add-ons in the cost estimate.

6.2.4 Item elements were costed based on a combination of contractor framework rates, estimator judgement and cost curves where available. For instances where standard rates were not available

within our River Restoration framework or from cost curves, unit rates were determined using outturn costs from historic projects and estimator judgement. For example, costs for rock roll purchase and installation were assumed to be £30 per m based on an erosion protection scheme completed at Stockport WwTW in 2018. Such costs were benchmarked where comparative unit costs were available externally to provide assurance that such costs were efficient, as outlined in section 6.3. Where new innovative techniques that have not been adopted historically within UUW were proposed, such as bioengineered retaining walls, potential suppliers were approached directly for a cost estimate.

6.2.5 Across the programme, the following assumptions were applied to estimate additional costs:

(a) [✂]

(b) [✂]

(c) [✂]

(d) [✂]

(e) [✂]

6.2.6 We consider the assumptions above to be appropriate for this programme, as they incorporate significant efficiencies relative to the indirect costs and overheads observed across our capital programme in AMP7. More information regarding how we are transforming our delivery approach to minimise indirect costs across all programmes can be found in *Chapter 5 – Delivering great service* of our main business plan submission.

6.3 Benchmarking

6.3.1 In order to validate the cost efficiency of the estimates, we completed a benchmarking analysis. It should, however, be noted that for river erosion projects in particular, outturn expenditure was difficult to obtain as these smaller-scale projects do not tend to be as widely publicised as larger-scale erosion projects. Instead, for river erosion schemes, we relied on comparative data for directs cost incurred for individual erosion protection measures, such as gabions and rock rolls, as compiled in the EA's unit cost database. We understand that Anglian Water submitted an enhancement case for expenditure to mitigate coastal erosion, as well as pluvial and fluvial flooding risk, at PR19. However, we do not consider the cost estimates to be sufficiently detailed to allow us to benchmark against these.

6.3.2 The outturn expenditure on erosion protection schemes can vary significantly depending upon the site-specific circumstances and this should be kept in mind when interpreting the benchmarking results. For example, the following factors can influence costs:

- Accessibility constraints;
- H&S requirements associated with working in or close to watercourses;
- Ground conditions and the presence of contaminated land;
- The depth and width of the channel;
- Peak flows of the river and tidal range for coastal protection;
- Landowner compensations requirements; and,
- Impact of environmental designations on choice of construction techniques and material delivery.

Coastal erosion schemes

6.3.3 As part of this enhancement case, we will be making a financial contribution to a scheme designed to protect 2 km of the Crosby coastline from erosion. [✂].

6.3.4 In 2018 Southern Water invested ~£3.5 million (FY23 prices) on sea defences Portsmouth to protect three underground storm tanks from erosion[14]. The rock armour protected a 115 m section of coastline and hence the cost per m is approximately £30,000. Working in partnership with Sefton Council will therefore allow UUW to leverage substantial savings relative to the costs observed by Southern Water.

6.3.5 There is limited information available regarding any other coastal erosion protection schemes within the water industry. However, comparison with projects implemented by local authorities and the EA similar demonstrate that the Crosby erosion scheme is good value for money for UUW and our customers. For example, the Southsea Coastal scheme[15] will protect 4.5 km of coastal from erosion for £180 million, equating to a cost per m of ~£40,000. A best practice scheme, namely Fairhaven Coastal Protection scheme delivered protection to 3.9 km of the Fylde coastline at a cost (adjusted to FY23 prices) of ~£6500 per m.

6.3.6 UUW's contribution of £[ ] per m is therefore in line with, or lower than, prices observed on other coastal protection schemes.

River erosion schemes

6.3.7 Publically available outturn data for comparable river erosion protection schemes is limited, particularly for mains replacement at river crossings. It is also rarely appropriate to directly compare outturn expenditure for schemes given the site-specific conditions outlined above and the differing scope of schemes. We have therefore sought to benchmark the direct capital costs associated with scheme components, primarily using the EA's 'cost estimation for fluvial defences'[16] and 'cost estimation for channel management'[17] adjusted for inflation. The outputs from this analysis are outlined in Table 8.

Table 8: External benchmarking for erosion protection measures

Erosion protection measure	UUW unit cost	External unit cost	Source
Sheet piling	£300 per m^2	Urban reach < 100 m: 1692.06 per m^2 Urban reach > 100 m: 636.33 per m^2 Rural reach: 278.72 per m^2	EA (2015) Cost Estimation for Fluvial Defences[18]
Gabion baskets	£120 per m^3	£80-£104 per m^3	EA (2015) Cost Estimation for Channel Management[19]
Rock roll	£30 per m	£74 per m	EA (2015) Cost Estimation for Channel Management[20]
Rock mattresses	£95 per m^2	£154 per m^2*	Thames Water Lockwood Reservoir Project[21]

[14] Southern Water (2018) *Fort Cumberland Sea Defences.* Available here.

[15] Southsea Coastal Scheme (2023) *Securing Southsea's future.* Available here.

[16] Environment Agency (2015) *Cost estimation for fluvial defences – summary of evidence.* Available here.

[17] Environment Agency (2015) *Cost estimation for channel management – summary of evidence.* Available here.

[18] assets.publishing.service.gov.uk/media/6034ed2ed3bf7f264f23eb51/Cost_estimation_for_fluvial_defences.pdf

[19] assets.publishing.service.gov.uk/media/6034ed6ee90e0766047734a9/Cost_estimation_for_channel_management_-_summary_of_evidence.pdf

[20] assets.publishing.service.gov.uk/media/6034ed6ee90e0766047734a9/Cost_estimation_for_channel_management_-_summary_of_evidence.pdf

[21] waterprojectsonline.com/wp-content/uploads/case_studies/2018/Thames_Water_Lockwood_2018.pdf

source states that £350k rock mattress solution saves £104/m^2 relative to £650k gabion solution. Therefore m^2 protected = (£300,000/£104) = 2884.6. £350,000/2884.6 = £121.4 per m^2, adjustment for inflation = £154 per m^2.

6.3.8 The benchmarking analysis therefore confirms that for those scheme components for which direct comparison is possible, UUW's costs are in line with those observed externally.

6.4 Third party assurance of our cost estimates

Bottom-up benchmarking (Faithful and Gould)

6.4.1 Faithful and Gould undertook a bottom-up deep dive into the cost efficiency of our enhancement cases. This involved a close examination of our cost base relating to a sample of our enhancement programme, with comparisons made to similar activity carried out by third party companies across a variety of sectors.

6.4.2 F&G looked at our direct costs across each of the following categories:

(a) Staff including site supervision

(b) Mobilisation and site set up, running and removal of site offices and welfare

(c) Temporary services for general site use, such as water to wash out concrete skips

(d) Attendant plant and equipment, such as cranes, forklift for unloading deliveries etc

(e) Attendant labour, defined as hourly paid operatives not involved in productive works

(f) Site consumables, such as waste skips

(g) Set-up site compounds, erecting hoardings etc

(h) O&M manuals

(i) Health and safety

6.4.3 It also looked at the contractor's indirect costs (e.g. overhead and design costs) and UUW's indirect costs (e.g. land acquisition costs). Due to the size of the programme, F&G examined a sample of our enhancement cases. However, this sample included projects from each of our enhancement categories and covered £1.246bn of expenditure. Therefore, we consider this sample to representative of our overall enhancement programme.

6.4.4 F&G noted the effectiveness of UUW's cost estimation process:

"In addition to the benchmarking data held by Faithful+Gould we understand that UUW has applied multiple internal and external challenges to progressively refine the cost estimation undertaken to date. In particular we note UUW's use of its Investment Programme Estimating System (IPES) which is a bespoke parametric estimating tool containing data from AMP3 to AMP7, to provide historical cost curves alongside estimated data from third party organisations."

6.4.5 F&G found that our proposed costs are in line with rates typically seen across the industry:

"Overall, UUW's approach of utilising historic cost curves, market testing and obtaining specialist third party quotations demonstrates a sound proactive approach to cost planning. In total £1.2bn of schemes underwent targeted cost assessment with £573m making up the construction works element.

After presenting our initial findings it was encouraging to see UUW's commitment to addressing our findings and applying these to the wider enhancement estimates, charting a strategic route towards greater efficiency and scope clarification.

In light of this Cost Assurance work and evidence of UUW's responsive actions we have concluded that the data we have benchmarked is within a reasonable alignment with anticipated market rates."

7. Customer protection

7.1 Introduction

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

7.2 Coastal and river erosion enhancement price control deliverable

7.2.1 We have not included a PCD for this area as it is small in size, and below Ofwat's indicated threshold. It would also be highly complex to represent in a PCD, given the different types of actions involved.

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United Utilities

Water for the North West

UUW65

Reducing Risk of Sewer Flooding for Properties

October 2023

Enhancement Case 18

United Utilities

Water for the North West

Contents

1. Enhancement submission

<table>
<tr><th colspan="2">Enhancement submission</th></tr>
<tr><td>Title:</td><td>Reducing Risk of Sewer Flooding for Properties</td></tr>
<tr><td>Price Control:</td><td>100% Wastewater Network Plus</td></tr>
<tr><td>Enhancement headline:</td><td>This enhancement case summarises the expenditure required to deliver improvements in 'reducing flood risk for properties' and the delivery of our Drainage and Wastewater Management Plan.

As a result of the unique operating circumstances in the North West, including 40% higher than average urban rainfall and the highest proportion of legacy combined sewers in the industry, UUW provides services to an operating region with an elevated sewer flooding risk. This expenditure is therefore imperative in enabling us to reduce the risk of sewer flooding for customers and deliver the service improvements required. Activities within this enhancement case include the expansion of our highly successful dynamic network management (DNM) operating model, enhanced targeting of proactive interventions in areas of historically high flood risk and expansion of our property-level flood mitigation programme.</td></tr>
<tr><td>Enhancement expenditure

(FY23 prices)</td><td>
<table>
<tr><th></th><th>AMP8 Capex inc TI (£m)</th><th>AMP8 Opex (£m)</th><th>AMP8 Totex (£m)</th></tr>
<tr><td>Pre RPE and Frontier Shift</td><td>142.21</td><td>-</td><td>142.21</td></tr>
<tr><td>Post RPE and Frontier Shift</td><td>139.00</td><td>-</td><td>139.00</td></tr>
</table>

The table above shows the total expenditure, inclusive of accelerated programme and transitional investment, on both a pre-efficiency (i.e. pre frontier shift and real price effects basis, consistent with the cost data tables), and a post efficiency and RPE basis (i.e. consistent with the value we propose to be recovered from price controls). All numbers referenced hereafter in this enhancement case are on a post efficiency and RPE basis.</td></tr>
<tr><td>Benefit (30 Year NPV): (£)</td><td>n/a</td></tr>
<tr><td>This case aligns to:</td><td>For full reconciliation between enhancement costs and data table lines, see enhancement mapping tabs in UUW117 – Project allocations CW3 and CWW3.</td></tr>
<tr><td>PCD</td><td>n/a</td></tr>
</table>

2. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	• UUW provides services to a region in which several exogenous factors interact to make the drainage system more susceptible to sewer flooding. These factors include: (a) urban rainfall is typically 40% higher than the industry average, (b) having the highest proportion of legacy combined sewers in the industry (54% vs industry average of 33%), (c) a low soil permeability and below industry average potential evapotranspiration (PET), (d) an above average density of food service establishments (118.2 per 100,000 population vs national average of 90.8 per 100,000 population) and (e) unique local topographies.	*4.2*
	• Therefore, we must implement a sustained programme of enhancement interventions to reduce the risk of sewer flooding for customers. Our core flooding strategy comprises three key elements; a base programme focused on avoiding operational/maintenance failures, the schemes set out within this enhancement case that seek to drive a step change in sewer flooding performance by mitigating existing sewer flooding issues and the 'Rainwater management enhancement case' that aims to offset future deterioration in flooding performance due to climate change. All three elements are required if we are to be successful in achieving our proposed stretching performance commitment level (PCL).	*4.3*
	• We recognise that sewer flooding is one of the worst service failures that customers can experience. Customer research shows that sewer flooding matters to customers and highlights the devastating impact that experiencing sewer flooding can have on the affected customer's livelihoods and mental health.	*4.5*
Best option for customers	• We have a portfolio of options to deliver these service enhancements. We propose to use an optimum blend of options to deliver against our overall strategic objective to 'control the controllable' to reduce preventable FOC flooding and improve resilience to severe weather. • These options include: • **Dynamic Network Management (DNM)** - Expanding on our success to date by expanding the provision of DNM, increasing monitor coverage across existing DNM drainage areas and expanding to new drainage areas such that more customers can benefit from the step change in service provision that DNM provides; • **Enhanced targeting** - Deploying a place-based risk management approach to proactively target interventions such as lining and cellar disconnection in areas of historical flood risk; • **Property-level flood mitigation programme** - Installing property-level flood mitigation devices, such as flood barriers and non-return valves, at properties otherwise at risk of repeat hydraulic flooding;	*5.2*

	• **Storage optimisation** - Using enhanced monitoring to identify areas of the network where upstream storage capacity is not being fully utilised and employing interventions to hold back flows to prevent downstream hydraulic flooding. • Our positive track record in deploying interventions that reduce the risk of sewer flooding has enabled us to track the benefits from our proposed options, providing us with confidence that they are highly cost-beneficial. • As Ofwat has proposed to include this enhancement expenditure within its overall base cost modelled allowance, our performance from base forecasts for internal and external flooding, reported in OUT2.4 and OUT2.5, respectively, are inclusive of the expenditure within this case. We have proposed a highly stretching and ambitious 30.9% reduction in internal sewer flooding and 12.4% reduction in external sewer flooding for these combined expenditures.	*5.5*
Cost efficiency	• Faithful and Gould has undertaken a bottom-up deep dive into the cost efficiency of our enhancement cases. This involved a close examination of our cost base relating to a sample of our plan, with comparisons made to similar activity carried out by third party companies across a variety of sectors. This found that our proposed rates are in line with rates typically seen across the industry. • Deloitte has provided assurance on top-down benchmarking and we have also tested our proposed investment opposite a top-down benchmark by deriving an implicit allowance using Ofwat's proposed models from the base cost consultation which indicates that our proposed costs are 12% more efficient than the projected industry upper-quartile. • As a result of these combined benchmarking and assurance activities, we are confident that our proposed costs are not only efficient, but stretching.	6 **Error! Reference source not found.**
Customer protection	• We consider that customers are fully protected from non-delivery through the combination of cost sharing and Outcome Delivery Incentives (ODIs). As such, no Price Control Deliverable (PCD) is required. • We calculate that potential underperformance payments under the Outcome Delivery Incentive framework could total £97.98m if this investment were cancelled, delayed or reduced in scope. The protection provided by cost sharing would be £69.5m (assuming 50:50 cost sharing). Overall, this provides customer protection well in excess of the £139m included within this enhancement case and therefore, we do not consider a Price Control Deliverable to be necessary or proportionate.	7 7.2

3. Introduction

As a result of the combination of exogenous factors in the North West, including urban rainfall that is 40% higher than average and the highest proportion of legacy combined sewers in the industry, UUW operates in a region with an elevated sewer flooding risk. To help manage this risk and improve future performance levels, enhancement expenditure to reduce the risk of sewer flooding for properties is required. Activities within this programme of activity include an expansion of our highly successful Dynamic Network Management (DNM) operating model and the installation of flood mitigation devices at over 1,000 additional properties.

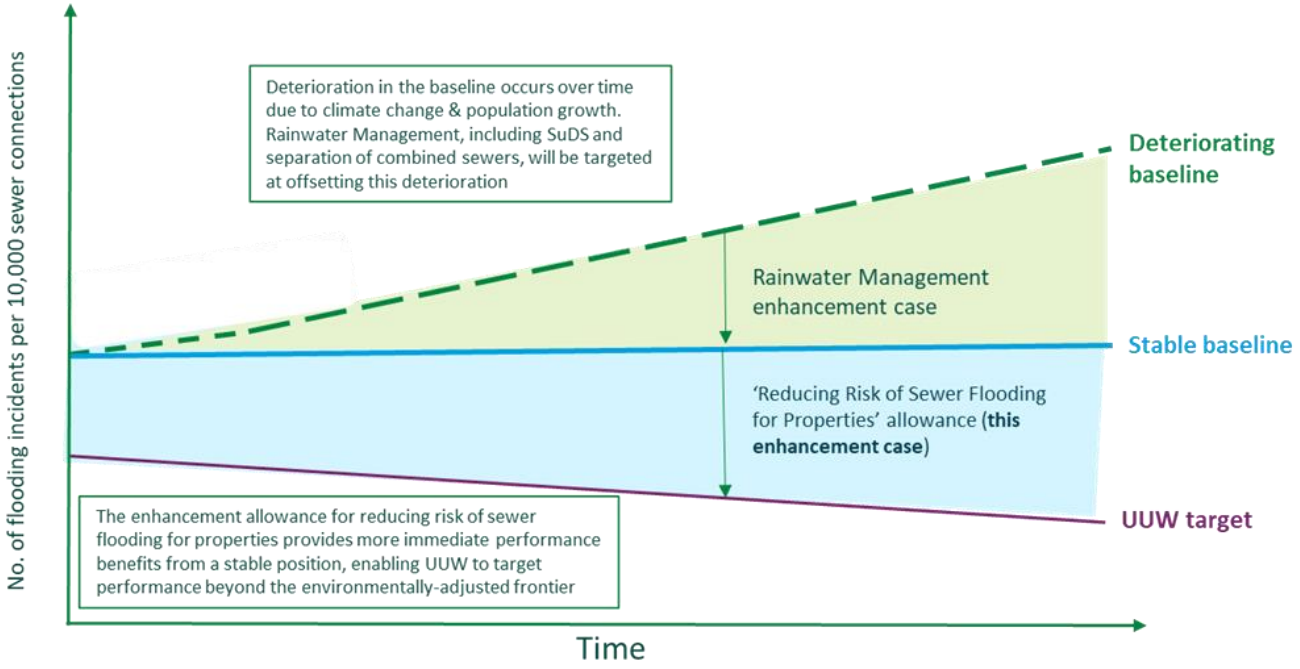
3.1.1 UUW recognises that internal sewer flooding is one of the worst service failures that customers can experience. Indeed, qualitative joint research conducted by the Consumer Council for Water (CCW) and Ofwat shows that any type of sewer flooding has a significant negative impact on customers irrespective of severity, with feelings of stress, anxiety, hopelessness and disempowerment reported by customers[1]. UUW's own customer research into sewer flooding experiences further confirms the scale of the long-term psychosocial impact[2]. It is therefore imperative that we continue to reduce the immediate exposure of our communities to existing sewer flooding risk through implementation of targeted interventions.

3.1.2 UUW operates in a region in which a number of exogenous factors interact to increase sewer flooding risk above that observed in other regions, including 40% higher than average urban rainfall and the highest proportion of legacy combined sewers in the industry. This enhancement case details the expenditure required to aid in 'reducing the risk of sewer flooding for properties' when dealing with this combination of exogenous factors. Separate from this expenditure is our Rainwater Management enhancement case (*UUW65 – Wastewater Quality Additional Requirements – case 15*), which aims to prevent future deterioration in baseline sewer flooding performance due to climate change by initiating a multi-AMP programme of investment in sustainable blue green solutions, such as SuDS and sewer disconnection activities. These two distinct, but complementary, programmes of work form the central tenets of UUW's flooding strategy as outlined in Figure 1.

[1] Ofwat (2022) *Customer experiences of sewer flooding: A joint report by CCW and Ofwat.* Available here: https://www.ofwat.gov.uk/publication/customer-experiences-of-sewer-flooding-a-joint-report-by-ccw-and-ofwat/

[2] Verve Research on behalf of United Utilities, *Sewer Flooding Experience, May 2021.* Available here: https://www.unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/p142-sewer-flooding-experiences/final-report.pdf

Figure 1: A theoretical graph demonstrating the relationship between this enhancement case and the rainwater management enhancement case in delivering environmentally-adjusted frontier levels of performance



3.1.3 Figure 1 demonstrates that both elements are required if we are to sustain a level of performance that is in line with, or beyond, the environmentally-adjusted frontier. While the rainwater management enhancement case will provide resilience against future deterioration in hydraulic flooding performance due to climate change and keep the baseline position stable, this enhancement case will fund solutions to mitigate existing sewer flooding issues and improve sewer flooding performance.

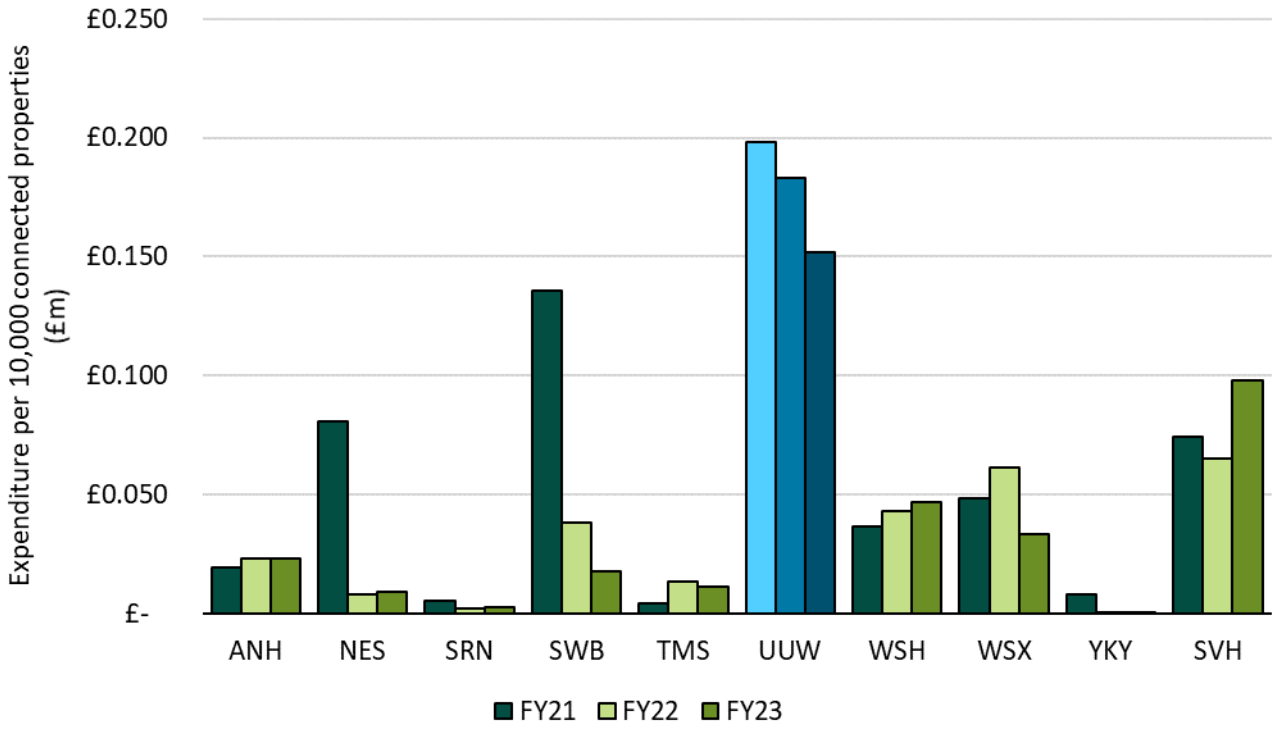
3.1.4 This enhancement case sets out £139 million of expenditure on activities to reduce the risk of sewer flooding for properties. It should be noted that we have submitted a cost adjustment claim relating to Ofwat's proposed wastewater network plus and sewage collection models [3] that contains an implicit upward adjustment for reducing sewer flooding risk for properties. **Therefore, we have not uplifted the value of this enhancement case in line with the cost adjustment claim to prevent double counting.**

3.1.5 We recognise that Ofwat's proposed approach to cost assessment will mean that the enhancement expenditure for reducing risk of sewer flooding for properties will ultimately be determined by base cost models rather than a separate model or deep dive assessment. However, the purpose of this enhancement case is to provide transparency to Ofwat and to customers regarding the activities that are included within our plan that is proposed to be funded via that allowance.

3.1.6 UUW has an excellent track record in delivery of enhancement expenditure to reduce the risk of sewer flooding for properties. Indeed, in the first three years of AMP7, UUW has had by far the largest total expenditure on 'reducing flood risk for properties' per 10,000 sewer connections (Figure 2) and expenditure 27.9% above the industry average over the period 2011-12 to 2021-22. We have reinvested outperformance back into our operations, with over £66 million invested in our Dynamic Network Management (DNM) operating model, including the deployment of 17,500 intelligent sensors, alongside enhanced monitoring on more than 1,500 point assets, across 160 drainage areas. DNM allows UUW to manage our wastewater network more proactively and is believed to be the largest integrated solution of its kind globally. Additionally, we have invested over £36 million in our 'hydraulic flood risk resilience' schemes to reduce the impact of hydraulic incapacity through cut and pump solutions as well as planned installation of 9,945 m^3 of storage by the end of AMP7.

[3] UUW (2023) *Cost Adjustment Claim: Drainage.* Available here: https://www.ofwat.gov.uk/wp-content/uploads/2023/06/UUW_CAC_002-Drainage-Cost-Adjustment-Claim_Redacted.pdf

Figure 2: Expenditure on 'reducing flood risk for properties' per 10,000 sewer connections for FY21, FY22 and FY23. Source: Ofwat, PR24 wastewater cost assessment master dataset[4].



3.1.7 This enhancement case builds and expands upon those activities implemented to date and supports us in achieving our vision to digitally enable our Network to be the most proactively managed across the Industry and reduce sewer flooding risk for customers.

3.1.8 We plan to expand our network of sensors to additional drainage areas, which will improve coverage across the region and ensure that more customers can benefit from the proactive service provision enabled by DNM, as well as maturing our DNM capabilities to trial how we can optimise our storage availability to reduce hydraulic flood risk. We will extend our flood mitigation programme to protect over 1,000 additional properties from internal sewer flooding, through installation of property-level flood devices, including non-return valves and flood barriers. Activities such as these, will be critical in enabling us to achieve a proposed 31.9% reduction in internal sewer flooding incidents and a 12.9% reduction in external sewer flooding incidents over the course of AMP8.

[4] https://www.ofwat.gov.uk/wp-content/uploads/2023/04/PR24-Cost-Assessment-Master-Dataset-Wholesale-Wastewater-Base-Costs-v4.xlsx

4. Need for enhancement investment

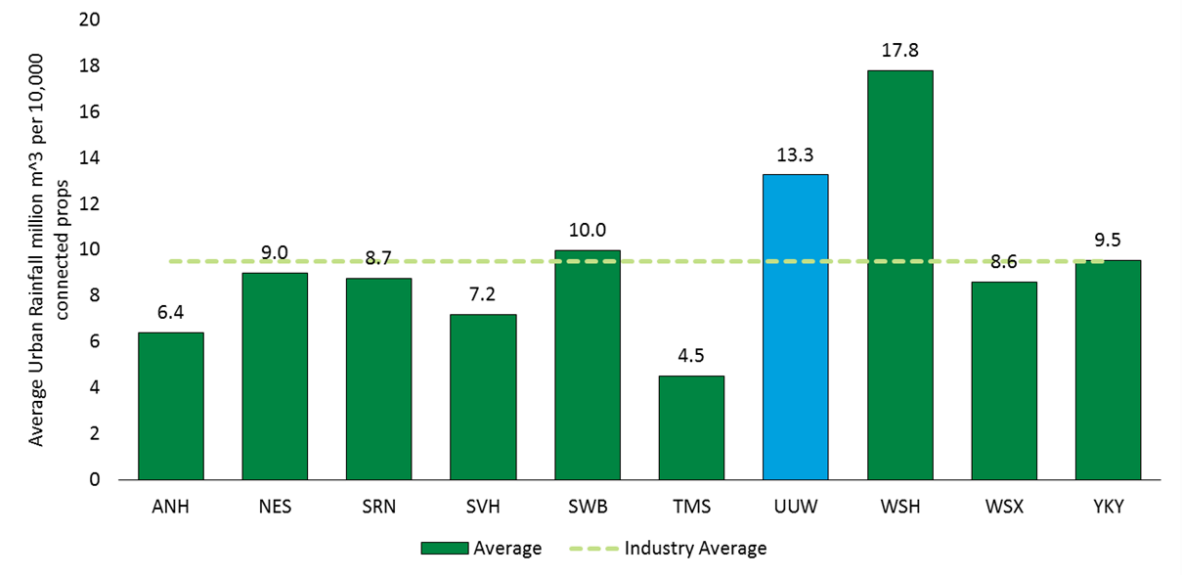
4.1.1 **Customers have repeatedly highlighted the devastating impact that experiencing sewer flooding can have on the affected customer's livelihoods and mental health.**

4.1.2 **UUW operates in a unique and challenging environment, where a number of exogenous factors interact to increase the risk of sewer flooding. In order to ensure that the risk of sewer flooding is reduced, UUW must implement a sustained programme of enhancement interventions.**

4.2 Sewer flooding risk

4.2.1 UUW provides services to a region in which multiple exogenous factors combine to make our drainage system more susceptible to sewer flooding. UUW's position to the North West of England results in a high exposure to prevailing winds from the south west that carry warm moisture-laden air from the Atlantic Ocean[5]. This air cools as it is forced to rise over high ground of the west Pennines resulting in large totals of orographic rainfall. UUW therefore receives 40% more urban rainfall than the industry average (Figure 3), with the result that greater volumes of rainwater fall onto hard, impermeable urban surfaces and enter the sewer system than in most other operating areas.

Figure 3: Urban rainfall (million m3) (wastewater – LAD) per 10,000 connected properties. Source: Ofwat, urban rainfall calculations[6].



4.2.2 In addition to this, UUW has the highest percentage of combined public sewers in the industry at 54% compared to an industry average of 33%[7]. Combined sewers convey both foul and surface water flows and therefore have less hydraulic capacity than separate systems during periods of heavy rainfall, compounding the impact of the 40% higher than average urban rainfall on the vulnerability of our drainage system to sewer flooding.

4.2.3 There are a number of additional factors that act to exacerbate the risk of sewer flooding risk in the North West, including:

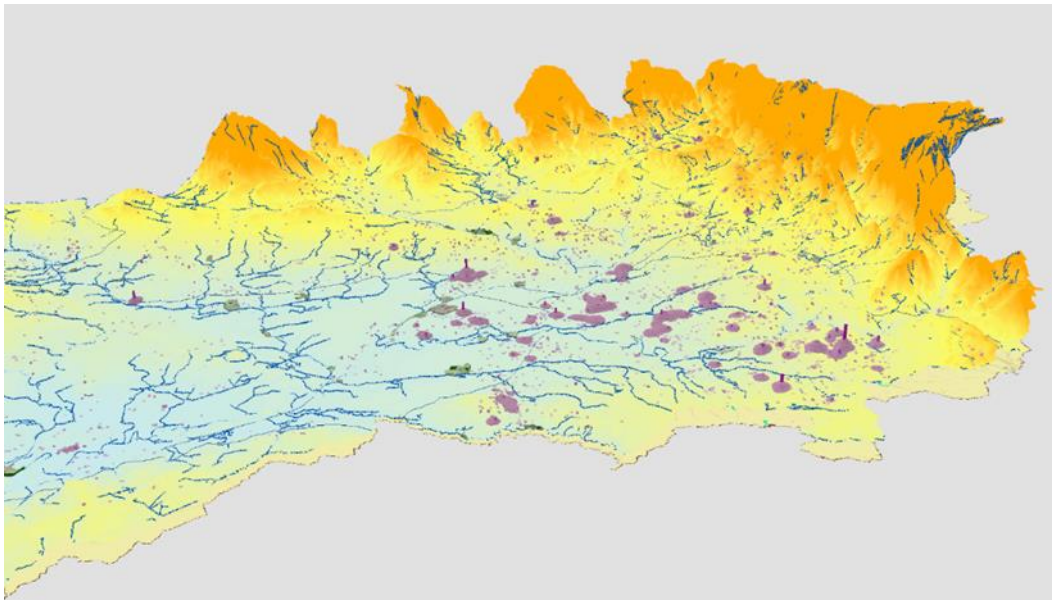
[5] Burt and Howden (2013) *North Atlantic Oscillation Amplifies Orographic Precipitation and River Flow in Upland Britain.* Available here: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/wrcr.20297

[6] https://www.ofwat.gov.uk/publication/urban-rainfall-calculations/

[7] Ofwat (2023) *PR24 wastewater cost assessment master dataset*. Available here: https://www.ofwat.gov.uk/wp-content/uploads/2023/04/PR24-Cost-Assessment-Master-Dataset-Wholesale-Wastewater-Base-Costs-v4.xlsx

- **Below average potential evapotranspiration (PET)**[8] - PET is a measure of the rate of the maximum potential loss of water via evaporation from the land surface and transpiration by plants. A low PET thus means that less water is being lost from the surface via these routes and is therefore available to run overland into UUW's sewer network;
- **Low soil permeability** - Much of the North West has large swathes of slowly permeable soils with a low infiltration potential. Indeed, analysis of Soilscapes data, a freely accessible dataset published by Cranfield University[9], demonstrates that significant areas of the North West, including surrounding major urban centres such as Manchester, are covered by slowly permeable seasonally wet loamy and clayey soils The implication is that rainfall that falls in UUW's operating region is more likely to flow overland into our sewer network;
- **A high density of food service establishments (FSEs)** - Analysis of Public Health England (2018) (PHE, 2018)[10] data demonstrates that the North West has a higher FSE density (118.2 per 100,000 population) than the national average (90.8 per 100,000 population). We have demonstrated that a higher density of FSEs increases sewer flooding risk, as FSEs can discharge large volumes of fat, oil and grease (FOG) into the network, causing blockages;
- **Unique local topographies** - Specifically, Manchester's unique 'bowl' topography (Figure 4) holds water and directs it towards our network. Manchester is situated at the base of the Pennines and therefore, when moist air from the Atlantic hits the Pennines, moisture condenses to produce orographic rainfall that then flows back into the base of the 'bowl', i.e. the centre of Manchester. As the base of the bowl is flat, hydraulics dictate that the system remains surcharged for longer following rainfall, reducing capacity in the system and increasing the risk of sewer flooding. Further, Manchester has a high cellar density, exacerbating the effect of topography on flood risk, as cellar locations coincide with low spots on the network in flat base of the 'bowl'.

Figure 4: A 3D topographic representation of the Manchester Drainage Area



[8] Ofwat (2022) *Urban rainfall calculations.* Available here: https://www.ofwat.gov.uk/publication/urban-rainfall-calculations/

[9] Cranfield Soil and Agrifood Institute (N/A) *Soilscapes.* Available here: https://www.landis.org.uk/soilscapes/

[10] Public Health England (2018) *Fast food outlets: density by local authority in England.* Available here: https://www.gov.uk/government/publications/fast-food-outlets-density-by-local-authority-in-england

The Manchester drainage area has a 'bowl' topography whereby orographic rainfall generated by the Pennines is forced to runoff and enter the sewerage system in the urban centre of Manchester. Purple areas represent internal flooding clusters.

4.2.4 These factors compound to elevate the risk of sewer flooding in the North West above that of other operating regions. A full overview of these exogenous factors and evidence demonstrating how they drive higher drainage costs can be found in our drainage cost adjustment claim UUW_CAC_002[11].

4.2.5 Therefore, UUW must implement a sustained programme of enhancement interventions in order to reduce the risk of sewer flooding for customers.

4.3 Scale and timing of investment

4.3.1 The scale and timing of this investment is fully justified and aligns to UUW's long-term ambitions as defined in our Drainage and Wastewater Management Plan (DWMP) and Long-Term Delivery Strategy (LTDS). Our core flooding strategy comprises of 3 complementary programmes of work:

- **A base programme** - a programme delivering continuing gradual improvements in performance, focused on avoiding maintenance/operational failures. This includes activities such as our 'What not to Flush' and 'Stop the Block' customer awareness campaigns as well as engagement with FSEs regarding appropriate FOG disposal practices; our targeted planned cleaning and sewer serviceability programmes; ongoing maintenance costs for our DNM monitors and platform and proactive interceptor trap removal. Our base programme is therefore focused on 'controlling the controllable' through avoidance of flooding and other causes (FOC) flooding, i.e. flooding that is caused by operational issues such as blockages, tree roots, sewer collapses or mechanical failures.
- **A 'reducing risk of sewer flooding for properties' enhancement programme (this enhancement case)** - a programme that drives a step change in sewer flooding performance, allowing UUW to mitigate existing sewer flooding issues and supporting us to achieve our proposed ambition to achieve environmentally-adjusted frontier levels of performance by 2030. Due to cost allocation issues (i.e. interactions between base and enhancement) (see section 4.4), Ofwat proposes to aggregate this enhancement expenditure within the base cost models. It is for this reason that this expenditure was implicit within the 'performance from base' forecasts for our DWMP and within the equivalent forecasts in OUT 2.4 and OUT 2.5 of the PR24 data tables. Nevertheless, there are some distinctive activities that comprise our reducing risk of sewer flooding for properties enhancement programme; a programme that targets both FOC and hydraulic flooding. Such activities include: installation of property-level flood mitigation devices; expansion of our DNM capabilities and enhanced targeting in areas with a high risk of FOC flooding. A sustained programme of investment in these activities has been, and will continue to be, fundamental in delivering a step change in sewer flooding performance.
- **A rainwater management resilience enhancement programme** - We have also submitted a £132 million rainwater management enhancement case in alignment with the need identified through the DWMP. This case will primarily fund investment in Sustainable Drainage Systems (SuDS) covering 75 hectares across the North West and customer-side interventions such as water butts. The investment is designed to **offset future deterioration** in flooding performance due to climate change, thereby maintaining a stable baseline against which the benefits of the current enhancement case can be realised.

4.3.2 All three elements of our flood strategy are required if we are to be successful in achieving our proposed stretching PCL. If immediate performance improvements are to be made, the reducing risk of sewer flooding for properties enhancement investment must be implemented as a sustained programme. The scale of the operational change and total investment necessary to fundamentally reconfigure our

[11] UUW (2023) *Cost adjustment claim: Drainage.* Available here: https://www.ofwat.gov.uk/wp-content/uploads/2023/06/UUW_CAC_002-Drainage-Cost-Adjustment-Claim_Redacted.pdf

network and control rainwater at source means that rainwater management investment must be staggered across multiple AMPs. It will thus take multiple AMPs for any significant benefits to be realised at a regional scale. Our reducing flood risk for properties' allowance will be used to fund the short-term flood mitigation measures needed to manage the unique operating circumstances of the North West while our longer term vision to reduce rainwater entering combined systems is enacted.

4.3.3 The scale of requirements that underpin this enhancement case has been determined to achieve the performance levels proposed in our business plan, which assumes that Ofwat accepts our cost adjustment claim for environmentally-adjusted PCLs (UUW_CAC_002)[12]. However, if Ofwat rejects our proposal, we consider that an upward adjustment to our base allowance, inclusive of the 'reducing sewer flooding risk for properties' enhancement, will be required to ensure UUW's cost allowances better reflect our operating circumstances, as per our drainage cost adjustment claim.

4.4 Base vs enhancement expenditure

4.4.1 Ofwat includes the reducing risk of sewer flooding enhancement expenditure within the base cost models due to cost allocation issues, i.e. interaction between base and enhancement. Within this context, we cannot eliminate the overlap with activities to be delivered through base by design, but instead set out what we consider to be our enhancement expenditure requirements on reducing sewer flooding risk for properties.

4.4.2 We recognise that Ofwat has proposed to assess sewer flooding enhancement expenditure as part of its modelled base allowance. Therefore elsewhere in our submission we refer to this expenditure as the 'implicit allowance' expected from these enhancement interventions, as implicitly, they will be assessed congruently. For example, we have included the benefits associated with enhancement expenditure within the amount delivered by the 'base' rather than explicitly recognising it within the enhancement tables. This is discussed in more detail in section 5.5 and we also provide a breakdown of the relative benefits for all investment within Table 2.

4.4.3 As outlined in section 3.1.6, UUW has an excellent track record in delivery of enhancement expenditure on for reducing the risk of sewer flooding for properties, including by far the largest total expenditure on 'reducing flood risk for properties' per 10,000 sewer connections across the industry in AMP7 to date. We are therefore well on track to fully spend our AMP7 allowance with the result that this enhancement case cannot be considered to overlap with, or duplicate, expenditure already funded at previous price reviews.

4.5 Customer support

4.5.1 Customer research shows that sewer flooding matters to customers and highlights the devastating impact that experiencing sewer flooding can have on the affected customer's livelihoods and mental health. Indeed, our sewer flooding experiences research found that experiencing sewer flooding frequently lead to feelings of shame, embarrassment and anxiety[13].

4.5.2 In qualitative joint research conducted by Ofwat and CCW[14], customers go further and describe the experience of internal sewer flooding as a violation, irrespective of scale. Ofwat's implied rankings from this collaborative research indicate that customers believe that internal and external sewer flooding are the most important service failures to mitigate against.

[12] UUW (2023) *Cost adjustment claim: Drainage.* Available here: https://www.ofwat.gov.uk/wp-content/uploads/2023/06/UUW_CAC_002-Drainage-Cost-Adjustment-Claim_Redacted.pdf

[13] Verve Research on behalf of United Utilities, *Sewer Flooding Experience, May 2021. Available here:: https://www.unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/p142-sewer-flooding-experiences/final-report.pdf*

[14] Ofwat, *Customer experiences of sewer flooding: A joint report by CCW and Ofwat, May 2022. Available here: https://www.ofwat.gov.uk/publication/customer-experiences-of-sewer-flooding-a-joint-report-by-ccw-and-ofwat/*

4.5.3 Taken together, this research provides strong evidence that customers are concerned about sewer flooding and expect UUW to take steps to reduce this risk.

4.6 Management control

4.6.1 The drivers of sewer flooding are all entirely, or largely, outside of management control:

- **Urban rainfall** – Management cannot control the amount of rainfall falling within a region, nor the degree of urbanisation. We do, however, exert some degree of control over the way in which rainwater is managed. Our rainwater management enhancement case aims to increase attenuation of rainwater, within both urban areas and the wider catchment, through measures such as SuDS and natural flood management (NFM). However, the scale of the operational change and total investment necessary to fundamentally reconfigure our network and control rainwater at source means that rainwater management investment must be staggered across multiple AMPs. Urban rainfall is therefore outside of short to medium-term management control.
- **Proportion of combined sewers** – Our combined sewers are legacy assets inherited at privatisation. We could not control the asset base we inherited and while we are looking to increase surface water separation, this is an expensive and complex process to conduct at scale. Indeed, Defra's consultation on the Government's Storm Overflows Discharge Reduction Plan[15] states *"This evidence project estimates that the complete elimination of all storm overflows at coastal and inland waters by completely separating the sewer network would cost between £350 billion and £600 billion. It would cause significant disruption. For example, most of the combined system runs under our towns and cities and would have to be dug up".* We therefore consider that separation at the scale would be prohibitively expensive and disruptive for customers and therefore this variable is outside of short to medium term management control.
- **Local topography** – Topography is entirely outside of management control.
- **Soil permeability and PET** – Both factors are entirely outside of management control.
- **FSE density** – Numbers and location of FSEs are outside of management control, although we do have an active programme of engagement with FSEs to improve their understanding of appropriate FOG disposal practices and thereby decrease discharges to the network. We manage this engagement through our base expenditure programme.

4.6.2 The need for investment to reduce flood risk for properties is therefore driven by factors outside of management control.

[15]Defra (2022) *Consultation on the Government's Storm Overflows Discharge Reduction Plan.* Available here: https://consult.defra.gov.uk/water-industry/storm-overflows-discharge-reduction-plan/supporting_documents/Final%20Consultation%20Document%20PDF.pdf

5. Best option for customers

5.1.1 We have a broad portfolio of options for delivering improvements to reduce the risk of flooding. We will use an optimum blend of options to deliver against our overall strategic objective to 'control the controllable' to reduce preventable FOC flooding and improve resilience to severe weather. These options include: expansion of our dynamic network management (DNM) capabilities; enhanced targeting of proactive interventions such as lining and cellar disconnection in high risk localities; expansion of our property-level flood mitigation programme and trials automatic control solutions to optimise storage and reduce hydraulic flooding.

5.2 Portfolio of Options

5.2.1 UUW has a positive track record of delivering interventions to reduce the risk of sewer flooding for properties. Our experience has allowed us to develop a diverse portfolio of options for enhancing sewer flooding performance, ranging from traditional methods such as property-level flood mitigation devices to non-traditional methods, including expansion of our Dynamic Network Management (DNM) capabilities and optimisation of storage capacity using automatic control capabilities. Our proposed programme of work seeks to deliver an optimum blend of these options, supported by our wider base programme that is focused on avoiding maintenance/operational failures.

5.2.2 Our overall flooding strategy can be summarised as 'controlling the controllable' to reduce preventable FOC flooding, i.e. flooding caused by operational issues such as blockages, tree roots and collapses, while increasing resilience to severe weather to prevent hydraulic flooding. This enhancement programme will fund activities that satisfy both of these strategic objectives, with the activities to be completed outlined below.

5.3 'Controlling the controllable'

Dynamic Network Management

5.3.1 The Dynamic Network Management, or DNM, operating model has enabled UUW to manage our wastewater network more proactively and is believed to be the largest integrated solution of its kind globally. The DNM programme involved the installation of over 17,500 intelligent sensors, alongside enhanced monitoring on more than 1,500 point assets, across 160 drainage areas. By improving the monitoring capabilities in our network and applying predictive analytics and machine learning to spot deviations from ‘normal’ flow signatures, we have been able to identify and resolve key causes of flooding, such as blockages, before customers are even aware of the problem. The proactive alerts generated by this network of sensors have detected over 2,100 sewer blockages since August 2021, blockages that may have otherwise lead to sewer flooding.

5.3.2 Given the success of this initiative, we will look to expand the provision of DNM, increasing monitor coverage across existing DNM drainage areas and expanding to new drainage areas such that more customers can benefit from the step change in service provision that DNM provides. In this way, we can prevent more FOC incidents by further increasing the ability to proactively detect blockages and intervene before the system has time to become sufficiently surcharged to cause a service impact. Over the remainder of AMP7, we will be continually reviewing the outputs from our DNM platform to further understand the optimum number of sensors for a given area and scale the size of our AMP8 programme accordingly.

Enhanced targeting

5.3.3 At PR19, we identified that over 70% of our FOC flooding incidents occurred within 150m of a historic FOC incident and found that there are common risk factors that elevate the risk of sewer flooding within a given geographical location. Using this principle, our enhanced targeting approach seeks to use observed and modelled data on these risk factors to identify hotspot areas and proactively intervene to

prevent future incidents at other properties in the area. Typically, this involves attending these high-risk localities and undertaking proactive CCTV imagery to understand any underlying root causes of historical incidents, such as tree root ingress or structural deformation of a pipe. This allows us to tailor interventions to the underlying root cause and intervene before incidents in nearby properties transpire. For example, we may proactively line sections of pipe that may otherwise cause future incidents, either through collapse of that pipe or deformations that may impede flow and encourage blockage formation. In this way, we can extend the life of that asset and proactively prevent flooding incidents. In areas with a history of flooding, we may undertake proactive cellar disconnection. Cellars are at a particular risk of flooding, with nearly 60% of internal sewer flooding incidents occurring in cellars. Cellar disconnection involves disconnection of the existing pipe with a pump installed to move flow from the property. This prevents the sewer surcharging, causing flooding, while allowing wastewater out of the property.

5.3.4 Proactively targeting areas of high flood risk through our enhanced targeting initiative allows us to protect against future flood risk and thereby deliver a step change in service provision in these areas. We will continue to adopt this place-based approach in AMP8, applying both our DWMP Baseline Risk and Vulnerability Assessment (BRAVA) outputs and observed data to target the highest risk areas.

5.4 Increasing resilience to severe weather

Flood mitigation programme

5.4.1 UUW has a well-established flood mitigation programme, primarily targeting properties that are at risk of repeat hydraulic flooding. Since the beginning of AMP7, we have installed over 1,600 property-level flood mitigation devices, such as non-return valves, flood barriers and flood doors as part of this programme. Properties that have experienced hydraulic flooding in non-severe weather (less than 1 in 30 year return period) are automatically eligible for a flood mitigation device and those that experience hydraulic flooding in severe weather more than once become eligible. We will consider whether a flood mitigation device(s) would be suitable for properties that fall outside of these criteria in line with our wider risk prioritisation and escalation process.

5.4.2 We have closely tracked the benefits of this programme, comparing the annualised risk at a postcode level before installation with that observed afterwards. The results indicate that flood mitigation devices installed to date have helped contribute to a reduction in the annualised risk of internal sewer flooding of over 280 incidents. The solutions deployed therefore have high efficacy and we are looking to continue this deployment in AMP8, with a target to protect over 1,000 additional properties over the AMP.

Storage optimisation

5.4.3 Storage optimisation via deployment of automatic control capabilities within our network is a developing area for UUW but is an option we are looking to trial in AMP8. The premise of this idea is that we can use enhanced monitoring to identify areas of the network where upstream storage capacity is not being fully utilised and employ interventions to hold back flows to prevent downstream hydraulic flooding. The feedback loop should be fully autonomous such that detection of upstream availability automatically triggers a control mechanism, such as gate closure, without manual intervention. The control philosophy behind storage optimisation is complex and therefore we are seeking to conduct small-scale trials to inform whether this approach can be applied at a local scale in AMP8, as a progression of DNM into the realm of hydraulic flooding.

5.5 Benefits quantification

5.5.1 Through successive implementation of these programmes, we have accrued a library of information that we have used to track benefits realisation against original business cases as outlined above. In this way,

we are confident that the above interventions are highly cost-beneficial, with more work to be done on understanding the costs and benefits of storage optimisation given its development status.

5.5.2 In determining PCLs and quantifying benefits against the performance commitment, we have not sought to separate the activities contained within this enhancement case from the 'performance from base forecasts' reported in OUT2.4 and OUT2.5. This is in line with the way Ofwat has proposed to assess this enhancement expenditure as part of its overall modelled base allowance, and is consistent with the assumption adopted within our DWMP performance forecasts.

5.5.3 Our 'performance from base' forecasts therefore state the performance that we aim to achieve from our combined investments in totality, inclusive of this £139 million of enhancement expenditure. In OUT2.4 and OUT2.5, we forecast that we can achieve a highly stretching and ambitious 30.9% reduction in internal sewer flooding and 12.4% reduction in external sewer flooding from our proposed expenditure.

5.5.4 We have undertaken a high-level carbon assessment for this programme. We concluded that there would be no significant increase in operational carbon as a result of this measure, as there is no notable increase in power, fuel or chemical consumption, for example. Therefore, we did not conduct an operational carbon assessment. For the embodied carbon assessment, we applied a benchmark value, giving a total embodied carbon value attributable to the implicit allowance of 28,548 tCO_2e.

6. Cost efficiency

Assurance on top-down benchmarking (Deloitte)

6.1.1 As part of our business plan submission, UUW carried out top-down benchmarking, which took two distinct forms:

- Unit cost analysis using recent data from the industry's APR datashare and other publications (e.g. Drainage and Wastewater Management Plans); and
- Where possible and feasible, econometric analysis based upon Ofwat's PR19 model suite.

6.1.2 In general, where recent and comparable data was available, our benchmarking analysis found our business plan costs align to similar comparator companies. This is reflected in Deloitte's findings:

"Overall, UUW has performed econometric benchmarking on programmes totalling £3,908m in enhancement case costs. We did not find any material errors in this econometric benchmarking…UUW's other top-down benchmarking based on more recent data submitted by peer companies indicates that UUW PR24 costs are generally in line with expected costs."

6.2 Top-down benchmarking

6.2.1 We have also used top-down econometrics as a further benchmarking tool to ensure that our proposed costs are efficient. To do so, we have calculated a modelled implicit allowance by;

- Using the wastewater models as defined by Ofwat in its base cost model consultation[16][17].
- We then remove all 'reduce flooding risk for properties' enhancement expenditure from the definition of modelled cost (dependent variable) and calculated the resulting upper-quartile modelled allowance using the business plan projected explanatory factors.
- The resulting allowance can then be compared to the upper-quartile allowance generated by a model that included 'reduce flooding risk for properties' enhancement expenditure with the same forecast variables.
- The difference between these two models is the implicit allowance.

6.2.2 We note that these model suites did not include a variable relating to urban rainfall. As we set out in UUW46 'Cost Assessment Proposal', we consider that urban rainfall should be accounted for within performance targets. Therefore, there is a risk that utilising urban rainfall within cost calculations could lead to a double count.

6.2.3 The results of this approach and resulting implicit allowance are set out below within Table 1.

Table 1: Summary of top-down benchmarking results and implicit allowance calculation

£m	2025-26	2026-27	2027-28	2028-29	2029-30	AMP8
Base scenario	444.32	445.85	447.37	448.89	450.40	2,236.83
Remove flooding expenditure	413.03	414.46	415.90	417.33	418.76	2,079.47
Implicit allowance	31.30	31.38	31.47	31.56	31.64	157.35
Proposed business plan expenditure	**27.8**	**27.8**	**27.8**	**27.8**	**27.8**	**139.00**

UUW calculations

[16] https://www.ofwat.gov.uk/wp-content/uploads/2023/04/Econometric_base_cost_models_for_PR24_final.pdf

[17] Specifically: SWC1, SWC2, SWC3, SWT1, SWT2, SWT3, WWNP1, WWNP2, WWNP3 and WWNP4.

6.2.4 The top-down modelling indicates our proposed business plan expenditure is 12% more efficient than the top-down upper quartile implicit allowance.

6.2.5 As set out above, this implicit allowance has been calculated by reference to a model suite without an urban rainfall term. This is due to UUW's position that urban rainfall is best reflected within company-specific performance targets. However, we understand that Ofwat may not find this position acceptable. For this reason, we have submitted a conditional cost adjustment claim that reflects companies' regional characteristics within a symmetrical adjustment.

6.2.6 The adjustment set out within that claim would effectively represent a higher expenditure allocation for both base and 'reduce flooding risk for properties' enhancement. As such, this would be completely incremental to the implicit allowance contained within a model suite with no urban rainfall term i.e. there would be no overlap or double count between the scope of this enhancement case and the scope of the cost adjustment claim.

7. Customer protection

7.1.1 **We consider that customers are fully protected from non-delivery via cost sharing and Outcome Delivery Incentives (ODIs). As such, no Price Control Deliverable (PCD) is required**.

7.1.2 This section sets out the evidence and analysis underpinning this position.

7.2 Protection via ODI and cost sharing mechanisms

7.2.1 We do not believe that a PCD is warranted for this enhancement case, as the scale of the related ODI rates for internal and external sewer flooding means that customers are already adequately protected against non-delivery and late delivery. The remainder of this section sets out how we have arrived at this conclusion.

7.2.2 We calculate that potential penalties under the Outcome Delivery Incentive framework could total £97.98m. These calculations are set out in Table 2.

Table 2: Customer protection afforded by Outcome Delivery Incentives

	Units	2024-25 (forecast)	2025-26 (PCL)	2026-27 (PCL)	2027-28 (PCL)	2028-29 (PCL)	2029-30 (PCL)	AMP8
Internal sewer flooding (ISF) PCL	nr	2.88	2.32	2.23	2.14	2.05	1.96	
External sewer flooding (ESF) PCL	nr	15.66	15.2	14.75	14.40	14.07	13.65	
Maintain ISF performance (base only)	nr	2.88	2.88	2.88	2.88	2.88	2.88	
Maintain ESF performance (base only)	nr	15.66	15.66	15.66	15.66	15.66	15.66	
ISF delta (base only to PCL)	nr	0	-0.56	-0.65	-0.74	-0.83	-0.92	
ESF delta (base only to PCL)	nr	0	-0.46	-0.91	-1.26	-1.59	-2.01	
ISF penalty from delta (Rate = £15.1m)	£m	0	-8.46	-9.81	-11.17	-12.53	-13.89	-55.87
ESF penalty from delta (Rate = £6.76m)	£m	0	-3.11	-6.15	-8.52	-10.75	-13.59	-42.11
Total potential penalty	**£m**		-11.57	-15.97	-19.69	-23.28	-27.48	**-97.98**

Source: UUW analysis

7.2.3 We calculate the protection provided by cost sharing to be £69.50m, assuming a 50:50 cost sharing rate:

$$Implicit\ allowance\ \times\ cost\ sharing\ rate = customer\ protection$$

$$\rightarrow £139m\ \times\ 0.5 = £69.50m$$

7.2.4 This means that in the event UUW does not spend the enhancement expenditure, we will hand back £69.50m to customers through the cost sharing mechanism, and a further £97.98m in ODI penalties.

7.2.5 Overall, this provides customer protection well in excess of the proposed investment of £139m associated with this enhancement case. This is shown in Table 3 below:

Table 3: Overall customer protection

	Unit	
Customer protection provided by cost sharing	£m	69.50
Customer protection provided by ODIs	£m	97.98
Total customer protection	£m	167.48

7.2.6 Therefore, we do not consider a Price Control Deliverable to be necessary or proportionate.

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United Utilities

Water for the North West

UUW65

Wastewater Reservoirs

October 2023

Enhancement Case 19

United Utilities

Water for the North West

Contents

1. Enhancement submission

<table>
<tr><th colspan="2">Enhancement submission</th></tr>
<tr><td>Title:</td><td>Ww Reservoirs</td></tr>
<tr><td>Price Control:</td><td>Ww Network Plus</td></tr>
<tr><td>Enhancement headline:</td><td>Under the Reservoir Act 1975 UUW have a duty to inspect and maintain reservoir structures and undertake and remedial action identified by a Qualified Civil Engineer. UUW have identified 10 legacy sludge sites (with multiple sludge lagoons) for further investigation and remediation to ensure compliance under the Act.

This enhancement case will deliver the detailed site surveys, actions plans, registration and any necessary structural improvements or remediation in line with the Reservoirs Act 1975 and the Health and Safety at Work Act 1974.

The total cost of this enhancement case is £19.331m.</td></tr>
<tr><td>Enhancement expenditure

(FY23 prices)</td><td>
<table>
<tr><th></th><th>AMP8 Capex inc TI (£m)</th><th>AMP8 Opex (£m)</th><th>AMP8 Totex (£m)</th></tr>
<tr><td>Pre RPE and Frontier Shift</td><td>19.777</td><td>0.000</td><td>19.777</td></tr>
<tr><td>Post RPE and Frontier Shift</td><td>19.331</td><td>0.000</td><td>19.331</td></tr>
</table>

The table above shows the total expenditure, inclusive of accelerated programme and transitional investment, on both a pre-efficiency (i.e. pre frontier shift and real price effects basis, consistent with the cost data tables), and a post efficiency and RPE basis (i.e. consistent with the value we propose to be recovered from price controls). All numbers referenced hereafter in this enhancement case are on a post efficiency and RPE basis.</td></tr>
<tr><td>This case aligns to :</td><td>For full reconciliation between enhancement costs and data table lines, see enhancement mapping tabs in UUW117 – Project allocations CW3 and CWW3.</td></tr>
<tr><td>PCD</td><td>No</td></tr>
</table>

2. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	Sludge lagoons are legacy assets historically used for the storage of wastewater sludge. These are non-operational assets, usually within the boundary of wastewater treatment works, which fall within the wastewater network plus price control. UUW are reviewing the future of redundant assets and want to ensure that they are safe and compliant. Following a desk top study, ten sites have been identified as requiring further investigation to determine whether they are considered a reservoir under the Reservoir Act 1975. The Reservoir Act 1975 is longstanding statutory driver that dictates what activity reservoir owners must undertake to ensure dams do not pose a risk to the public. Structural failure of one of these assets is less likely to impact public safety but would pose a health and safety risk to the people using and working on these sites and is more likely to cause significant environmental damage. The registration and proactive management of reservoirs, dams, and other structures is a regulatory requirement under the Reservoirs Act 1975 and the Health and Safety at Work Act 1974. Reservoirs registered under the Act must have an appointed Qualified Civil Engineer to undertake structural surveys used to inform statutory maintenance or monitoring requirements to be undertaken by the reservoir owner. Any new wastewater assets that are constructed will be built to the required standards and operating procedures required under the Act however existing assets have not been built or assessed to these same standards. A topographic and bathymetric survey is required to identify the hydraulic connectivity between legacy sludge lagoons on each site to determine the retention capacity Any site identified with an escapable volume of 25,000m3 (or 25ML) or more must be registered with the Environment Agency. This enhancement case will support data collection, hydraulic survey and remedial action at 10 sites to ensure that these sites are safe and compliant with the Reservoir Act 1975 and the Health and Safety at Work Act 1974. The total cost of this enhancement case is £19.331m.	*3.1.4* *3.1.3* *3.1.3* *4.3.63.1.5* *4.3.6*
Best option for customers	In line with our PR24 plan, several options have been considered. We have reviewed the value assessment and whole life cost of the options to identify the best options for customers. Sludge lagoons are large impounding structures, a breach one of these structures, whilst unlikely, would result in significant environmental damage and pose a risk to people using or working in the local vicinity. To assume that these sites are compliant would not be acceptable and therefore we propose to investigate and undertake remedial action to make impounding structures safe.	4.7 Table 2
Cost efficiency	A risk based approach has been taken to identify sites that require additional work. Over 100 assets identified under the corporate systems. All assets assessed against a set criteria including: • Potential escapable volume >25ML above natural ground level • Single points of failures	4.3.2

	• No. of cells within the volume	
Customer protection	Investment accounting for greater than 1% of the wastewater totex programme is defined as material and requires a price control deliverable. The cost of this enhancement case accounts for <1% of the total Ww programme and therefore is not considered for a PCD however any environmental impact caused by a breach of a sludge lagoon structure would be captured as an environmental pollution and reported within our performance commitments (Total pollution and Serious pollution) and the Environment Agency's Environmental Performance Assessment (EPA). If appropriate the Environment Agency have powers to prosecute non-compliant companies.	Section 6

3. Introduction

3.1.1 This documents sets out an enhancement case of £19.331m to allow UUW to investigate and undertake remedial action at legacy wastewater sludge lagoons that may be capable of storing 25ML and therefore may need to be registered under the Reservoirs Act 1975.

3.1.2 United Utilities has a long standing history for management of reservoirs, operating the largest fleet of reservoirs of the water companies in England and Wales. The registration and proactive management of reservoirs, dams, and other structures is a regulatory requirement under the Reservoirs Act 1975 and the Health and Safety at Work Act 1974.

3.1.3 Any reservoir with an escapable volume of 25 ML or more and registered under the Reservoirs Act 1975 is subject to independent safety inspections by a Qualified Civil Engineer at least every 10 years. The independent Inspecting Engineer is empowered to issue the reservoir operators with statutory actions that must be undertaken within the specified time. Actions can range from investigation and monitoring to structural improvements.

3.1.4 Sludge Lagoons are legacy assets constructed before privatisation of the water industry. These lagoons are often one or more impounding structures historically used for the collection and treatment of sewage sludge. United Utilities have undertaken an initial exercise to review these non-operational assets to ensure they are safe and compliant with current legislation. Ten sites have been identified for further investigation.

3.1.5 A desk top survey has identified that 10 sites may have lagoons with an escapable volume of 25 ML or more. A topographic and bathymetric survey is required to identify the hydraulic connectivity between legacy sludge lagoons on each site to determine the capacity and escapable volume, any site identified with an escapable volume of 25 ML or more must be registered with the Environment Agency or appropriately managed to ensure that the escapable volume does not exceed the threshold.

3.1.6 UU are seeking £19.331m for the investigation and delivery of critical activity associated with the safety and future management of these legacy assets.

3.1.7 This enhancement case applies to legacy assets only, any new storage assets will be assessed against current regulatory requirements to determine whether they need to be registered as a reservoir under the Reservoir Act 1975. To date only one wastewater asset has been registered as a reservoir in AMP7. This is the new storm tanks built at Preston WwTW with a volume of 118,200m^3 (storm tanks and interconnecting pipework).

3.1.8 The cost of this enhancement case accounts for <1% of the total Ww programme and therefore is not considered for a PCD however any environmental impact caused by a breach of a Sludge Lagoon structure would be captured as an environmental pollution and reported within our performance commitments (Total pollution and Serious pollution) and the Environment Agency's Environmental Performance Assessment (EPA). Also, where appropriate the Environment Agency have powers to prosecute non-compliant companies and therefore we believe that there is appropriate mechanisms in place to ensure delivery and completion of the investigation and remedial actions.

4. Need for enhancement investment

4.1.1 Under the Reservoir Act 1975 and the Health and Safety at Work Act 1974, UUW have a duty to inspect and maintain reservoir structures and undertake any remedial action identified by a Qualified Civil Engineer. United Utilities have undertaken a review of sludge lagoons within the wastewater network plus price control and identified 10 sites for further review by a civil engineer and potential registration with the Environment Agency under the Reservoir Act 1975. Sludge lagoons have not previously been considered under the Act and so this is a new requirement on existing legacy assets.

4.2 Wastewater sludge lagoons

4.2.1 Sludge lagoons are often one or more impounding structures historically used for the collection and storage of sewage sludge. These are large legacy assets no longer in use, however the structures often remain within the boundaries of some of our large wastewater treatment works. These structures may be capable of holding or storing large volume of water and therefore need to be considered under the Reservoir Act 1975. Historically these sites have never been assessed against this statutory requirement and in many cases were constructed prior to the Act being transcribed into UK law. The investigation and implementation of remedial actions is therefore a new requirement for UUW on existing, non-operational assets transferred to WwN+ when bioresources and WwN+ price controls were separated.

4.2.2 Whilst these assets have remained in their current state for many years, if in the unlikely event that an impounding wall was breached these sites could cause significant environmental damage. The associate risk to life is very low due to the location of the assets and that they are not actively filled. Any environmental impact would be reportable to the Environment Agency as a pollution event. All category 1, 2 and 3 events are recorded within the EA's environmental performance assessment (EPA) and against the pollution performance commitment.

4.2.3 The Reservoirs Act 1975 requires operators to register any reservoir that has the potential to hold 25,000 cubic meters (25ML) of water above ground level. The Act defines a reservoir as a raised structure capable of storing 25ML of water above the natural water level of the surrounding area or a raised lake or other area capable of storing 25ML of water which has been created or enlarged by artificial means.

4.2.4 Registration of a reservoir requires detailed, site specific surveys to gather information required for asset information packs and a reservoir flood plan, these are technical documents required to protect public health in the event of structural failure of an impounding reservoir. The production of these documents requires technical assessments of individual sites and is a statutory requirement under the Act. Upon registration of a reservoir the Environment Agency will determine whether the reservoir is high risk. The determination of high risk or not informs the undertaker (UUW) of future, ongoing requirements.

4.2.5 Under the Reservoir Act 1975 UUW must appoint a Qualified Civil Engineer to undertake regular health and safety inspections to assess the structural integrity of the impounding structure. The independent inspecting engineer is empowered to issue the reservoir operators with statutory actions that must be undertaken within the specified time. Actions can range from investigation and monitoring to structural improvements.

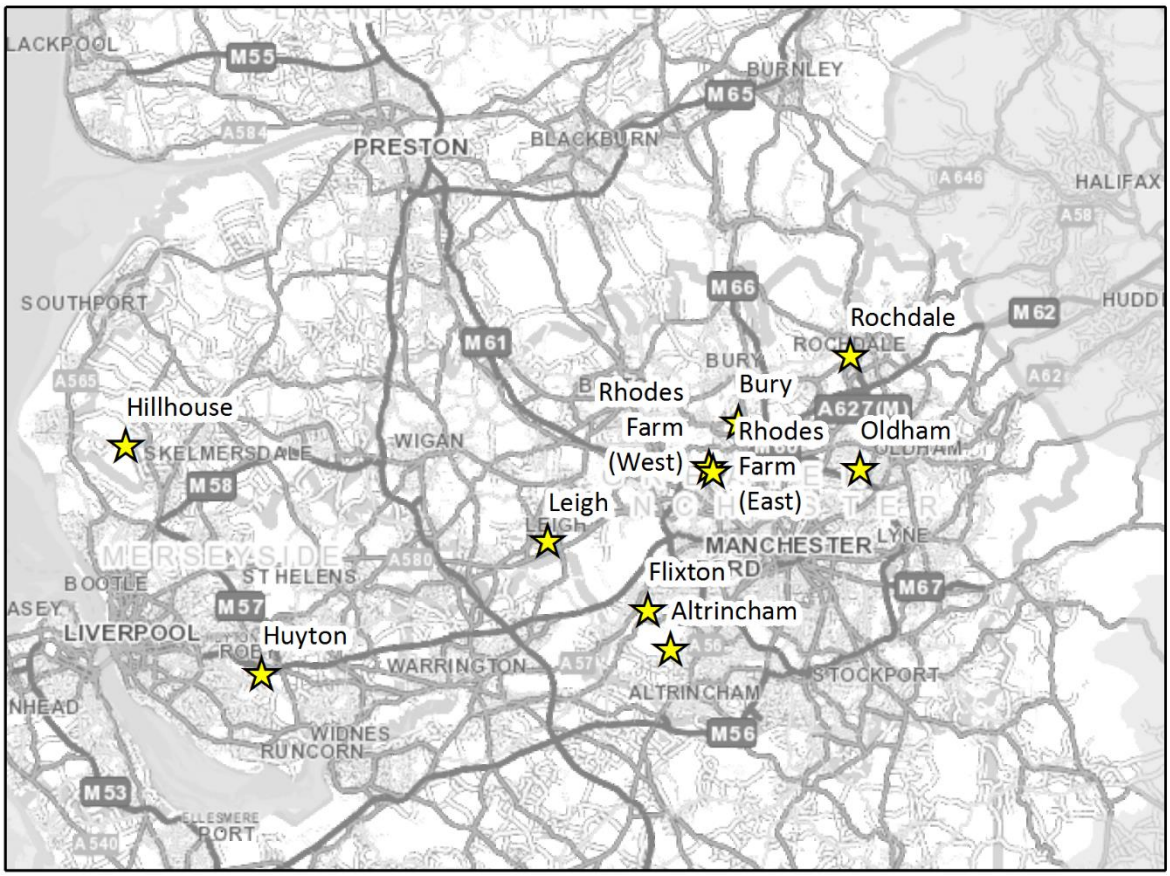
4.2.6 An initial review carried out by UUW gathered information from site visits and desk top assessment to identify the current condition (where visible), current maintenance approach and assessment of approximate capacity (desk based assessment looking at surface area and assumed embankment height). Following this assessment, 10 sites have been identified for further work to undertake bathymetric surveys to confirm the capacity or retention capability of these assets and a standard cost to bring assets to an acceptable standard for the future.

4.2.7 To ensure that the costs are appropriate we have used existing projects to benchmark costs used to build up this programme, we have assessed different solutions to identify the lowest whole life cost solution to managing these assets, £19.331m is required to deliver the preferred solution at 10 sites.

Table 1: Summary information for legacy sludge lagoons

Name/Location	Number of tanks or lagoons
Altrincham	8
Bury	1
Flixton	13
Hillhouse	4
Huyton	4
Leigh	11
Oldham	2
Rhodes Farm (East)	2
Rhodes Farm (West)	2 large, plus several minor lagoons
Rochdale	2

Figure 1: Location of legacy sludge lagoons



4.2.8 At present the Reservoir Act 1975 applies only to a structures that has the potential to hold 25ML, in July 2022 Government announced a plan to reform the reservoir safety with a view of consulting on

modernisation plans in 2023/24[1]. This consultation may result in changes to current regulation, bringing in additional requirements including lowering the capacity threshold of a reservoir to 10ML. To ensure that this enhancement case only covers the statutory requirement we are only seeking funding to deliver requirements under the current legislation, if this changes then we will incorporate future requirements into our DWMP and future business plans.

4.3 Scale and timing of investment

4.3.1 UUW are reviewing the future of our redundant assets to ensure that they are safe and meet current standards. Sludge lagoons are legacy assets transferred over to the WwN+ price control, these are non-operational assets covering a large area which are often located within the boundaries of large wastewater treatment facilities.

4.3.2 To ensure that we are targeting the right sites, UUW has taken a risk based approach to identify sites within this programme. Over 123 assets were reviewed and assed against three common criteria:

- Escapable volume of >25ML
- Single points of failures
- Number of cells/units within the volume

4.3.3 The intention of the Reservoirs Act is to protect people and the environment from failure of an impounding structure. Sludge lagoons have been assessed as legacy impounding structures that could pose a risk to public and environmental safety if there was a breach of the retaining wall.

4.3.4 A desktop exercise using ArcGIS, topographical surveys, aerial imagery, previous surveys and inspections has been used to identify the theoretical escapable volume and allowed us to designate a likely risk criteria (high or low). This has been used to inform the 10 sites promoted for AMP8. In July 2022 Government announced a plan to reform the reservoir safety, this may include addition duties on operators of reservoirs and could reduce the capacity threshold from 25ML to 10ML for registration with the Environment Agency. To minimise the size of this programme and to ensure that focus remains on our statutory obligations, UUW have chosen to focus on sites with a theoretical escapable volume of 25ML or more.

4.3.5 The enhancement case can be broken down into two key milestones:

- Investigation
- Remediation

4.3.6 The total cost to enable and undertake the detailed hydraulic assessment to determine the escapable volume at all sites in the programmes is £0.779m and the cost for remediation works is a further £18.552m. The cost of the investigation is based on a topographic and bathymetric survey plus and the cost for remedial action have considered any potential one-off breach repairs and costs to deliver activities in the interest of safety from the Section 10 inspection. The remedial requirements are currently unknown without results from a Qualified Civil Engineer inspection. The costs have been estimated based on the lowest whole life cost solution identified in Section 4 identified from years of experience in managing over 140 water assets. The preferred and lowest whole life cost option assumes discontinuance of the assets through construction of an appropriate drainage mechanism. Other remediation solutions were also considered, including:

- Do nothing. E.g. the survey identifies the asset is <25ML, or low risk, or complies with all necessary Section 10 criteria
- Discontinuance

[1] https://www.gov.uk/government/news/government-to-strengthen-and-modernise-reservoir-safety-regime

- Minor one-off breach repairs and/or valve improvements
- Drawdown improvements

4.3.7 An example of discontinuance can be seen at Sunnyhurst – a raw water impounding reservoir in Lancashire. This site was identified for a project to reduce the probability of embankment failure. At Sunnyhurst the probability of failure was removed through the discontinuance of the reservoir through the installation of a V- notch in the embankment. Notching the embankment reduces the ability of this structure to store large volumes of water therefore reducing the risk of failure. Figure 2 shows the notch under construction and Figure 3 the completed install.

Figure 2: Sunnyhurst notch during construction - Courtesy of Suave Aerial Photos[2]

[2] https://waterprojectsonline.com/custom_case_study/sunnyhurst-earnsdale-impounding-reservoirs/?looking=case-study[2]

Figure 3 Sunnyhurst notch with overflow structure. The screening chamber can be seen at the top of the photograph

4.4 Management control

4.4.1 Any designated reservoir will require an inspection by a Qualified Civil Engineer whom will:

- produce a report and certificate of their inspection
- identify any safety measures that need to be carried out, and set a deadline
- certify that recommended safety measures have been carried out

4.4.2 As the operator, any remedial actions identified from an inspection must be completed.

4.4.3 Where discontinuance is the preferred option, a Qualified Civil Engineer will confirm that the solution is appropriate.

4.5 Best option for customers

4.5.1 **Sludge lagoons are impounding structures historically used to store wastewater sludge. A breach of an impounding structure is likely to result in significant environmental harm and risk safety of anyone using or working at these sites.**

4.5.2 In 2021 we surveyed over 3,000 customers to identify their priorities[2]. UUW undertook online events, in-depth sessions, interviews and surveys to gather feedback and insight from a wide range of customers in the North West. Customers identified environmental measures as the second most important group of priorities (after water quality), ranking 3 environmental measures within their top 5 discretionary investment priorities, in addition over 50% of customers identifying these measures as essential. Prevention pollution due to UUW activity was the highest ranking environmental measure.

4.5.3 This enhancement case will support the investigation, registration (if appropriate) and ongoing structural activities to ensure that legacy sludge lagoon structures are safe. This will minimise the risk of failure and any environmental damage that is likely to occur if the impounding structure is breached. Unlike most water reservoirs, a structural breach of a sludge lagoon is less likely to result in flooding as these assets tend to be on land situation on or near wastewater treatment works that is not nearby houses or public land however a breach could result in significant environmental harm.

4.5.4 It is a statutory requirement to register reservoirs with an escapable volume greater than 25ML. In order to register these assets bathymetric surveys are required to confirm details of the structure needed for registration.

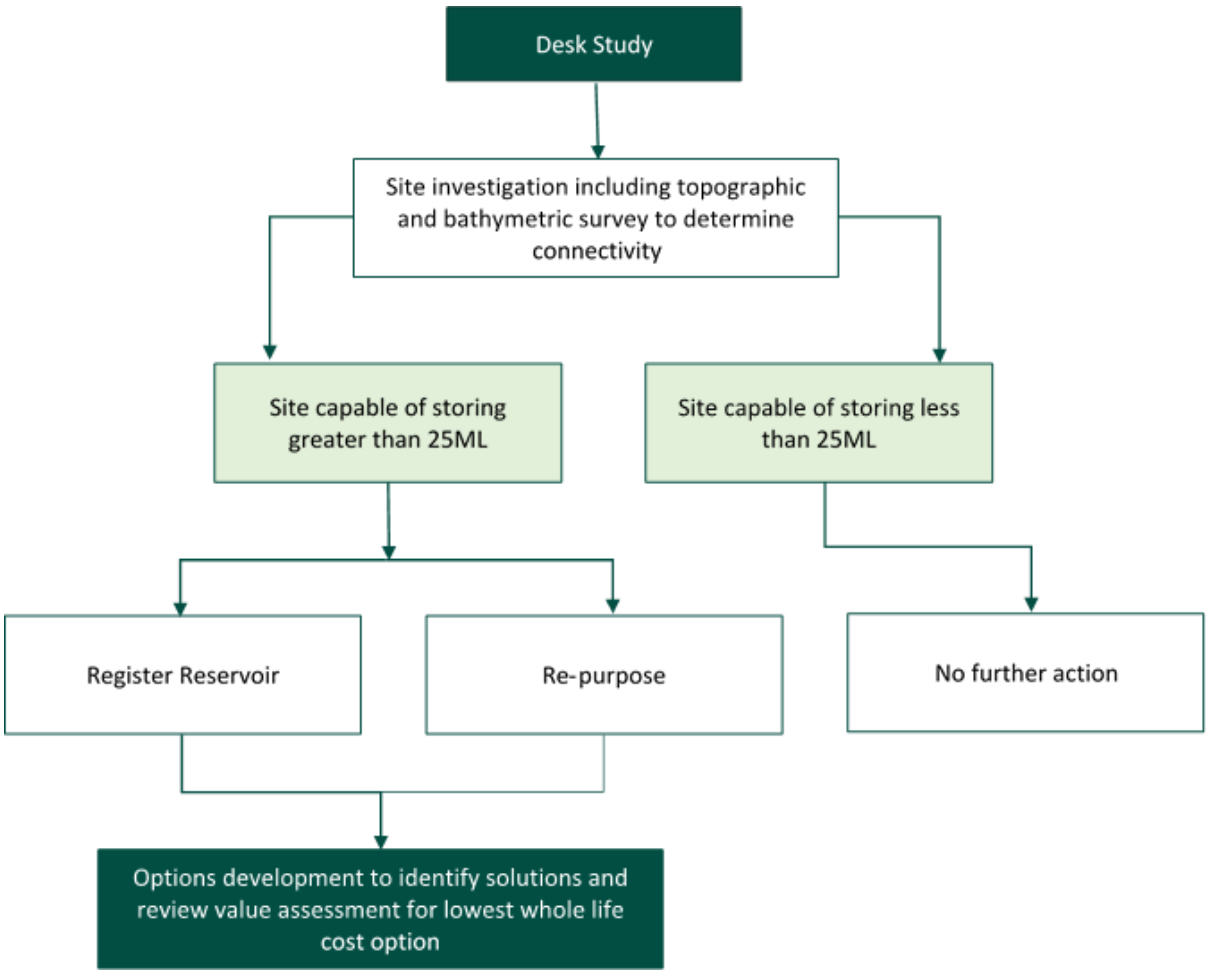
4.5.5 To ensure that UUW are prioritising expenditure and delivering what is required in AMP8, over 100 assets have been assessed against a common criteria to minimise the size and scale of the required enhancement and multiple options were considered to ensure that we are delivering the best value option.

4.6 Options Development

4.6.1 Options development followed the fundamental principles of United Utilities defined value management process. This process identifies the long term cost of a solution and the value that it will deliver to customers to ensure that we are proposing the right projects in AMP8.

4.6.2 The ten sites identified for investigation and remediation will follow the process set out in Figure 4.

Figure 4: Options development process



4.6.3 The engineering analysis has identified that a phased approach with investigations followed by a site specific solution provides the most cost effective solution to comply with the Act by providing best value for customers whilst balancing cost and risk. Through our Delivery Route Allocation Planning (DRAP) process, we have identified the most cost effective procurement route for delivering these solutions should they be required.

4.6.4 The scope and costs applied for the survey and inspection are based on projects undertaken in previous AMPs. The remediation scope and costs are based on the lowest whole life cost option which delivered the best value for customers. This option assumes discontinuance of the assets though appropriate

drainage. The cost for discontinuance has been estimated based on the material and height of the impounding wall structure and compared to a similar project undertaken at a water reservoir. Other interventions considered include further investigations, monitoring, slope stability & erosion improvements and works to valve/ pipework systems.

4.7 Options selection

4.7.1 The water sector is moving towards a "best value" approach, promoted by the regulators, with a best value option being one which drives the best outcomes for the environment, society and United Utilities over the long term.

4.7.2 The value associated with the various options was assessed using the value assessment tool developed by United Utilities specifically for this purpose. This tool lists intervention type and pulls through the associated benefits and value. It assesses value against a number of benefits including all the wider environmental outcomes as requested in the EA WINEP Options Development Guidance. The benefits were drawn from the MyRisk Risk Breakdown Structure (RBS), currently widely used in United Utilities. The wider value element, was also taken from the EA's WINEP guidance on Wider Environmental Outcomes.

4.7.3 The inputs to the value tool included costs (CAPEX, OPEX and whole life), carbon (embedded, operation and whole life), data on biodiversity plus risks and benefits as described above. The outputs from the tool included a cost benefit analysis and allowed the selection of the preferred solution based on the comparison of value between the various options. For this enhancement case only one option was taken forward for valuation as this was deemed the only appropriate option. The options considered can be found in Table 2 along with the reason for section or rejection.

Table 2: Options considered

Option	Rational	Selected/Rejected	Reason
Do nothing	Option assumes that all assets comply with statutory regulation.	Rejected	Initial study suggests actions plans required for 10 legacy sludge lagoons and therefore this option is not appropriate.
Discontinuance	Sludge lagoons with estimated escapable volume >25ML included. Option includes installation of a v-notch to appropriately drain sites to minimise the environmental and public risk in the unlikely event of an impounding wall breach.	Selected - preferred	Option includes costs for investigation and construction of v-notch within the embankment. The value assessment identified this as the best value/lowest whole life cost option therefore this option has been selected as the preferred option.
>10ML escapable volume	Assets with estimated escapable volume >10ML included. Option includes study to confirm escapable volume, registration of assets and remedial action to make safe.	Rejected	Not a current legislative requirement and therefore rejected to minimise scope and focus on AMP8 specific requirements

Option	Rational	Selected/Rejected	Reason
>25ML escapable volume	Sludge lagoons with estimated escapable volume >25ML included. Option includes study to confirm escapable volume, registration of assets and remedial action to make safe.	Selected	Option includes costs for investigation, registration and remedial action and therefore meets the requirements of this case however value assessment identified as not best option.

5. Cost efficiency

5.1.1 **United Utilities has a long standing history for management of reservoirs, with 160 impounding reservoirs, UU has more reservoirs than any other water company. To develop this programme we have used our extensive knowledge and examples of work carried out at water reservoirs to build the cost profile for individual activities, this can broadly be separated into a hydraulic connectivity investigation and remedial action.**

5.2 Approach to cost build

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

5.3 Approach to challenging our assumptions

5.3.1 The cost to investigate 10 sites (including topographic and bathymetric survey) were based on studies and works delivered at statutory reservoirs, derived cost curves, and costs of similar work carried out across UUW. We have also undertaken an internal challenge to ensure that we are delivering the best and most cost efficient programme, as a result we have high confidence these costs.

5.3.2 The investigation will inform what remedial action is required however various option have been considered (Table 2) with the preferred option identified as the best value/lowest whole life cost option for these sites. UUW may choose to undertake an alternative delivery option where new information identified this as the best value for customers however any additional funding required must be provided by UUW. If registration is required, UUW will appoint a Qualified Civil Engineer to undertake structural inspection of the site and will optioneer and undertake studies to develop and agree an appropriate cost effective solution.

5.4 Third party assurance of our cost estimates

Bottom-up benchmarking (Faithful and Gould)

5.4.1 Faithful and Gould undertook a bottom-up deep dive into the cost efficiency of our enhancement cases. This involved a close examination of our cost base relating to a sample of our enhancement programme, with comparisons made to similar activity carried out by third party companies across a variety of sectors.

5.4.2 F&G looked at our direct costs across each of the following categories:

a) Staff including site supervision

b) Mobilisation and site set up, running and removal of site offices and welfare

c) Temporary services for general site use, such as water to wash out concrete skips

d) Attendant plant and equipment, such as cranes, forklift for unloading deliveries etc

e) Attendant labour, defined as hourly paid operatives not involved in productive works

f) Site consumables, such as waste skips

g) Set-up site compounds, erecting hoardings etc

h) O&M manuals

i) Health and safety

5.4.3 It also looked at the contractor's indirect costs (e.g. overhead and design costs) and UUW's indirect costs (e.g. land acquisition costs). Due to the size of the programme, F&G examined a sample of our enhancement cases. However, this sample included projects from each of our enhancement categories and covered £1.246bn of expenditure. Therefore, we consider this sample to representative of our overall enhancement programme.

5.4.4 F&G noted the effectiveness of UUW's cost estimation process:

"In addition to the benchmarking data held by Faithful+Gould we understand that UUW has applied multiple internal and external challenges to progressively refine the cost estimation undertaken to date. In particular we note UUW's use of its Investment Programme Estimating System (IPES) which is a bespoke parametric estimating tool containing data from AMP3 to AMP7, to provide historical cost curves alongside estimated data from third party organisations."

5.4.5 F&G found that our proposed costs are in line with rates typically seen across the industry:

"Overall, UUW's approach of utilising historic cost curves, market testing and obtaining specialist third party quotations demonstrates a sound proactive approach to cost planning. In total £1.2bn of schemes underwent targeted cost assessment with £573m making up the construction works element.

After presenting our initial findings it was encouraging to see UUW's commitment to addressing our findings and applying these to the wider enhancement estimates, charting a strategic route towards greater efficiency and scope clarification.

In light of this Cost Assurance work and evidence of UUW's responsive actions we have concluded that the data we have benchmarked is within a reasonable alignment with anticipated market rates."

5.5 Industry comparison

5.5.1 The cost to survey each site has been taken from previous surveys carried out at statutory reservoirs within the North West. The cost for discontinuance is based on works carried out at Sunnyhurst impounding reservoir which have been verified by internal estimates based on the size and structure of the dams included within this enhancement case. UUW has also looked externally to understand whether the cost within this case are efficient.

5.5.2 At PR19 Severn Trent submitted an enhancement case to undertake remedial action at two legacy sludge lagoons where an independent Inspecting Engineer has identified capital works and on-going maintenance activities, the total cost of this case was £18.7m[3].

5.5.3 Curdworth Sludge Lagoon, also operated by Severn Trent, required improvements to the embankment to reduce the risk of failure. The value of the contract awarded in 2017 was circa. £6.5m[4].

[3] https://www.stwater.co.uk/content/dam/stw/about_us/pr19-documents/sve_appendix_a8_securing_cost_efficiency_r.pdf page 103.

[4] https://waterprojectsonline.com/custom_case_study/minworth-stw-curdworth-sludge-lagoons/

6. Customer protection

6.1 Introduction

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

6.2 Ww reservoirs enhancement price control deliverable

Table 3: PCD summary

Scheme delivery expectations	
Description of deliverable	Achieve reservoir safety risk reduction points of 15.46 by 31st March 2030. As part of a programme of reducing risk in line with Health and Safety Executive guidelines, though our PRA (Portfolio Risk Assessment process). This excludes our ITIOS actions, which are statutory remedial actions, for which it is not possible to represent on a common measurement basis as the PRA actions. The statutory itios actions also have a very low risk of non-delivery.
Output measurement and reporting	We have an existing ODI in AMP7 for reservoir risk reduction points. For AMP8 delivery will be reported through the APR process based on the AMP7 ODI reporting methodology. Additional detail necessary can be set out as appropriate in table commentary to table CW18. Risk reduction points are the difference in annual probability of failure between the pre-project state of the reservoir, and the post-project state of the reservoir (pre-project is when the reservoirs is in an 'intolerable risk' category as defined by the HSE, post-project is when the reservoir risk has been reduced to an 'acceptable' risk category as defined by the HSE). Risk reduction is achieved through engineered changes to the dam structure, operational changes to water level, changing information about risk state arising from detailed geophysical surveys, and so on. Pre-project annual probability of failure (intolerable risk) – Post-project annual probability of failure (acceptable risk) = risk reduction points
Assurance	Calculation done by multi-disciplinary technical team. Independent third party assessment of completed milestones undertaken through the APR assurance process.
Conditions on scheme	None
Impact on PCs	None

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

Table 4: PCD delivery profile

	Unit	AMP8	2024	2025	2026	2027	2028	2029	2030	Ultimate delivery
Cumulative delivery target for PCD	**risk points**		**0.00**	**0.00**	**0.00**	**2.44**	**5.70**	**8.95**	**15.46**	**15.46**
AMP8 Capex (22/23 pb)	£	98,901,907	0	0	£ 19,780,381	£ 19,780,381	£ 19,780,381	£ 19,780,381	£ 19,780,381	
AMP8 Opex (22/23 pb)	£	0	0	0	0	0	0	0	0	
ODI impact per unit of PCD volume	£/risk points	0.00								

Table 5: Price Control Allocation

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

Table 6: PCD Incentive rates

	Unit	WR	WN+	WwN+	BR
Overall delivery	£/risk points	3,198,639	0	0	0
Time value rate	£/risk points	103,316	0	0	0
Late delivery	£/risk points	215,268	0	0	0

United Utilities Water Limited
Haweswater House
Lingley Mere Business Park
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WA5 3LP

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United Utilities

Water for the North West

UUW65

Green Recovery

October 2023

Enhancement Case 20

United Utilities

Water for the North West

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Appendices

1. Enhancement submission

<table>
<tr><th colspan="2">Enhancement submission</th></tr>
<tr><td>Title:</td><td>Green Recovery 1 – Investments at Bury WwTW and Nuttall Hall Road CSO</td></tr>
<tr><td>Price Control:</td><td>Ww Network +</td></tr>
<tr><td>Enhancement headline:</td><td>Continuation of Green Recovery 1 into AMP8, with final delivery of benefits related to two projects in Bury. The two projects described in this case are: -
• WINEP reference 7UU200793 - Bury WwTW Storm Tanks WFD 99%ile intermittent standards for Dissolved Oxygen and Ammonia. WINEP regulatory date 31/03/2028.
WINEP reference 7UU200802 - Nuttall Hall Road CSO (BRY0002) WFD 99%ile intermittent standards for Dissolved Oxygen and Ammonia. WINEP regulatory date 31/08/2027.</td></tr>
<tr><td>Enhancement expenditure
(FY23 prices)</td><td>
<table>
<tr><th></th><th>AMP8 Capex inc TI (£m)</th><th>AMP8 Opex (£m)</th><th>AMP8 Totex (£m)</th></tr>
<tr><td>Pre RPE and Frontier Shift</td><td>24.078</td><td>0.000</td><td>24.078</td></tr>
<tr><td>Post RPE and Frontier Shift</td><td>23.887</td><td>0.000</td><td>23.887</td></tr>
</table>

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

2. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	As part of the Government's Green Recovery 1 process where investment was accelerated and allowed into AMP7 there are 2 schemes with delivery dates that are in the AMP8 timeframe. This case describes the updated delivery profile and associated investment and also reiterates the need and the required investment to finalise these projects and to realise the benefits to the Manchester Ship Canal in full. The total cost of this enhancement case is £23.887m.	*Section 4* *Page 6*
Best option for customers	Customer research shows a strong preference to protect the environment from deterioration. The accelerated programme will ensure earlier water quality benefits to both the River Irwell and the Manchester Ship Canal. These schemes relate to statutory drivers required in AMP8 that have been accelerated in delivery following support through Green Recovery 1	*Section 5* *Page 10*
Cost efficiency	In developing the costs for these schemes we have: - • Embraced the totex and outcomes approach, delivering significant improvements from innovative approaches and technologies; • Improving our approach to totex, by better challenging both needs and solutions. The introduction of a risk and value (R&V) assessment across all our major projects has supported better challenge of our expenditure requirements, including enhancements. This ensures that when we decide projects are necessary, we only do what we need to do, that our decisions are based on strong evidence, and the value to both the environment and customers is clear. The process ensures that we keep challenging and validating both the need for our projects and the way we deliver them	*Section 6* *Page 12*
Customer protection	As the value of this case is below the 1% of Wastewater Totex and to support projects already underway we do not propose a PCD.	*Section 7* *Page 14*

3. Introduction

3.1.1 This documents sets out an enhancement case of £23.887m (post-efficiency totex) to finalise two schemes agreed through Green Recovery 1. The pre-efficiency value is £24.078 million which can be found in CWW3. All figures referred to in this document will be post-efficiency.

3.1.2 In July 2020, Defra, Ofwat, the Environment Agency (EA), the Drinking Water Inspectorate (DWI) and the Consumer Council for Water (CCW) invited water companies to identify ways to support the country's green economic recovery from the COVID-19 pandemic.

3.1.3 Defra and the regulators set out an ambition to build back greener from the pandemic: delivering lasting environmental improvements for current and future generations, whilst meeting the economic and social challenges England faces. This was known as 'Green recovery'.

3.1.4 Water companies were asked to bring forward new proposals and accelerate existing ones to deliver an innovative and more resilient future for customers, society and the environment.

3.1.5 Following submissions from companies in January 2021, Ofwat issued its final decisions in July 2021. We received endorsement to progress with additional funding on top of our existing PR19 final determination. This funding included £44.060m (FY17/18 prices) to accelerate improvements at Bury WwTW and Nuttall Road combined sewer overflow (BRY002).

3.1.6 Investment into AMP8 was always forecast, however we have experienced some delays in delivery which will be described in this document. These delays have resulted in less expenditure in AMP7 and more than anticipated investment into AMP8. This case describes progress in AMP7 and outlines the request the funding for final completion of the two schemes in AMP8.

3.2 Background to Water Quality in the Manchester Ship Canal

3.2.1 The Manchester Ship Canal is a canalised river. The features of the canal make it deep and slow moving and in summer months this can lead to a reduction in dissolved oxygen which is a barrier to a thriving fish population. The canal has failed to meet the requirements of the statutory Freshwater Fish Directive which were subsumed into the Water Framework Directive (WFD) in 2013. We have been working with both the Environment Agency and the Mersey Rivers Trust to drive the long-term strategy for this catchment and while it has been acknowledged that failure to meet water quality targets in the canal is not solely due to the discharges from our assets, a multi-AMP approach to discharge enhancements is a necessary element of this strategy.

3.2.2 Aeration of the canal to improve dissolved oxygen was the preferred initial approach to achieving the water quality targets. Following extensive modelling in AMP6 and input from expert consultants, this was widely recognised as being technically infeasible due to the nature of the canal and the requirement for continued shipping access. Detailed strategic discussions then took place between United Utilities, the Environment Agency and Mersey Rivers Trust to agree the best alternative for the aeration. Ahead of the PR19 final determination it became clear that Bolton Wastewater Treatment Works (WwTW) would need significant improvements as one of the largest discharges in the upstream catchment. Additionally, we agreed to explore what further aeration could be done in proximity to the affected part of the canal. Following modelling of the Canal and upstream river system, a suite of measures was subsequently agreed which would deliver a significant improvement in dissolved oxygen.

3.2.3 This more detailed modelling highlighted that the key feeder river systems (Irwell and Mersey) would need to be brought up to Water Framework Directive standards. In the case of the River Irwell we have a mature understanding of the solutions required for this river system. Discharges from Bury WwTW Storm Tanks and Nuttall Hall Road Combined Sewer Overflow (CSO) (BRY0002) are verified in the United Utilities/Environment Agency agreed water quality model, and impact both the River Irwell to which they discharge and the Manchester Ship Canal. There remains certainty of the impacts from these assets and the requirement to resolve them. Finalising the proposed schemes detailed in this document is part

of the long-term strategy agreed with the Environment Agency and the Mersey Rivers Trust and will not impede any future integrated or innovative approaches for the rest of the catchment. A copy of the joint, agreed strategy is included as an appendix to this document. This agreement has been reflected on the WINEP with AMP8 delivery dates for both of these schemes:

- WINEP reference 7UU200793 - Bury WwTW Storm Tanks WFD 99%ile intermittent standards for Dissolved Oxygen and Ammonia. WINEP regulatory date 31/03/2028.
- WINEP reference 7UU200802 - Nuttall Hall Road CSO (BRY0002) WFD 99%ile intermittent standards for Dissolved Oxygen and Ammonia. WINEP regulatory date 31/08/2027.

3.2.4 The case for green recovery was to bring these confirmed schemes forward for earlier delivery for the benefit of the economy, environment and customers. For final delivery of these two projects in AMP8 we propose this case for £23.887m. While there has been some delay in delivery, the outcome will still be delivered before the regulatory date, had we not proposed the schemes into the Green Recovery process.

3.2.5 This document sets out the background to the Green Recovery 1 enhancement requirements. It explains why there is certainty over the measures at Bury WwTW Storm tanks and Nuttall Hall Road CSO (BRY0002), explanation of the project delays and why these schemes require some investment in AMP8. It also covers why these requirements are outside of management control, our approach to solution development the Manchester Ship Canal strategy and how we have ensured that costs are robust.

4. Need for enhancement investment

4.1.1 The need for the improvement schemes detailed in this document comes from the requirement to improve the dissolved oxygen in the canal that was originally required to comply with the statutory requirements of the Freshwater Fish Directive which were subsumed into the Water Framework Directive in 2013.

4.1.2 The planned spend for these schemes is not currently forecasting to overspend or underspend compared to the Green Recovery submission. However, the forecast spend profile is different to our submitted spend profile. This is because it is now anticipated that more of the projects' deliverables will be in 2025/26, although we continue to look for opportunities to improve the position.

4.2 Manchester Ship Canal Water Quality Needs

4.2.1 The Manchester Ship Canal finished construction in 1894. It canalised the natural river to allow for the transportation of raw supplies for manufacturing in the booming city of Manchester and transporting goods to the port of Liverpool. The Ship Canal has been an important transport link over the past 129 years and continues to be used to this day. In more recent times the Ship Canal has been used for recreation. The turning basin area in Salford is a major area of development for Greater Manchester, providing key locations for the BBC, ITV and Lowry Theatre as well as water-front development focusing more interest in the canal and its water quality. The Manchester Ship Canal corridor in Salford and Trafford is a key focus area for growth in the North West and builds on the increased amenity value already delivered by improvements to UU's discharges delivered since privatisation.

4.2.2 The need for the improvement schemes detailed in this document comes from the requirement to improve the dissolved oxygen in the canal that was originally required to comply with the statutory requirements of the Freshwater Fish Directive which were subsumed into the Water Framework Directive in 2013.

4.2.3 As the canal is deep and slow moving, during the summer months, flows are often low, and water is held back in the canal to ensure there is sufficient water for ship navigation. This slow-moving water leads to a risk of low concentrations of dissolved oxygen that natural, flowing rivers enjoy. The low level of dissolved oxygen is a barrier to a thriving fish population and limits the migration of fish to the upstream rivers which cover a large urban area including virtually all of Greater Manchester.

4.2.4 The 2 schemes below are confirmed AMP8 requirements, satisfy the statutory driver and were agreed through the Green Recovery process which concluded July '21: -

(a) WINEP reference 7UU200793 - Bury WwTW Storm Tanks WFD 99%ile intermittent standards for Dissolved Oxygen and Ammonia. WINEP regulatory date 31/03/2028

(b) WINEP reference 7UU200802 - Nuttall Hall Road CSO (BRY0002) WFD 99%ile intermittent standards for Dissolved Oxygen and Ammonia. WINEP regulatory date 31/08/2027

4.2.5 Completion of the schemes at Bury WwTW storm tanks and Nuttall Hall Road CSO (BRY0002) have been modelled to contribute towards downstream improvements to dissolved oxygen in the Ship Canal and will also enable the River Irwell to meet ammonia and dissolved oxygen Water Framework Directive biological standards.

4.2.6 It has been recognised that improving the Ship Canal to meet Water Framework Directive compliance and support migratory fish cannot be achieved by United Utilities investment alone. The establishment of the Mersey Rivers Trust hosted Manchester Ship Canal Partnership Forum, with support from the Environment Agency and other key catchment stakeholders, is intended to co-design and co-deliver a long term multi beneficial environmental improvement strategy for the Canal.

4.2.7 The accelerated completion of these schemes in Bury will result in an earlier improvement to the River Irwell, and are a stepping stone on the journey to the long-term strategy for the Manchester Ship Canal, which the Environment Agency and the Mersey Rivers Trust have signed up to.

4.3 Scale and timing of investment

4.3.1 Summary of investment projected for AMP8 can be seen in Table 1 below: -

Table 1: Summary of investment projected for AMP8

		2025/26 (£m)
AMP8 WINEP Investments at Bury	Network storage at Nuttall Hall road	3.170
	Additional storm tank capacity at Bury WwTW	20.717
	Total	**23.887**

Source: UUW data

4.4 Management control

4.4.1 Despite considerable effort to deliver an innovative aeration solution in the Manchester Ship Canal it has not been feasible and therefore the only management option left is to address the individual discharges to the canal and its catchment. The Environment Agency has now signed a joint statement, along with the Mersey Rivers Trust and United Utilities (following a workshop on 21st June 2019), confirming this position.

4.4.2 Following agreement of the schemes to deliver improvements to this catchment we have been progressing towards delivery and benefit realisation. However, there have been some challenges that we have been managing and required to overcome at both Nuttall Hall Road and Bury wastewater treatment works. As a result of these challenges there is a larger proportion of the investment than anticipated in AMP8 required to conclude these projects and realise the full benefits.

Bury Wastewater Treatment Works Storm Tanks

4.4.3 Bury wastewater treatment works is situated adjacent to the river Irwell and has disused large, deep and buried structures with interconnecting pipework. The proposed construction is for 20m diameter, 15m deep tanks. The determination of the construction methodology, establishing the appropriate site investigation and the collation of information to support the abstraction licence has been complex and has taken time to develop. During excavation, groundwater is required to be removed to allow for safe construction of the underground structures and tanks. The removal of groundwater required an abstraction licence from the Environment Agency. The requirements to support the abstraction licence have been detailed and time-consuming. These challenges and delay has resulted in a larger than anticipated proportion of the scheme completing in AMP8.

Nuttall Hall Road – BRY0002

4.4.4 The Nuttall Hall Road site is located in an area with a rich heritage dating back to the 13th century and is also on the site of an old mill adjacent “The lost village of Nuttall Park”. Both have archaeological interest to Greater Manchester Archaeological Association Society and a local group; Ramsbottom Heritage Society. It has been necessary to carefully engage with nine key stakeholders to ensure a smooth planning application. Land has been purchased from a key stakeholder, which was an issue and delayed the project by 8 months. The site footprint is constrained and determination of the construction methodology, establishing the appropriate site investigation and collation of information to support the abstraction licence has taken time to minimise construction delays. During excavation, groundwater is required to be removed to allow for safe construction of the underground structures and tanks. The removal of groundwater required an abstraction licence from the Environment Agency. The requirements to support the abstraction licence have been detailed and time-consuming. These

challenges and delay has resulted in a larger than anticipated proportion of the scheme completing in AMP8.

4.4.5 With these initial issues overcome and the projects now well established we are confident of delivery early AMP8. The planned spend for these schemes is not currently forecasting to overspend or underspend compared to submission, however there has been a slip of investment from AMP7 into AMP8

5. Best option for customers

5.1.1 Customer support for environmental improvements and river water quality remains strong. Finalising these schemes in AMP8 and full benefit realisation is the best option for customers.

5.1.2 Through research, customers have shown a strong preference to protect the environment from deterioration. In our AMP7 state of the nation research, 67% surveyed support improvements in service to enhance river quality, one of the highest of any service area in our choice experiment. Due to the statutory nature of this driver, there remains a requirement to deliver these schemes for the environmental outcome.

5.1.3 Further research into customer support for this scheme was carried out as part of the Green Recovery process. Results from this research of 2,054 customers indicate support for these schemes, with 78% supportive. With only 2% of those surveyed opposing it. 66% of respondents were willing to accept a 70p increase on their annual bill from 2025 to complete this proposal. This research concludes that there is clear customer support for these schemes and their progression for completion early in AMP8.

5.1.4 Delivery of these schemes will ensure earlier water quality benefits to both the River Irwell and the Manchester Ship Canal. Investment in this clearly defined statutory requirement will help to smooth the profile of expenditure on Manchester Ship Canal improvements as there are other large investments required in the catchment in AMP8 and AMP9. This will ensure we can keep key resources employed and engaged in the water industry, providing that consistency of employment through the transition from AMP7 to AMP8.

5.1.5 These schemes are actively supporting the UK economic recovery post COVID-19 pandemic.

5.2 Options Development

5.2.1 We had originally developed a solution for these overflows as part of our PR19 preparation process; this and the schedule for delivery was then reviewed and agreed through the Green Recovery process.

5.2.2 The project scope for Bury WwTW Storm tanks and Nuttall Hall Road CSO (BRY0002) as part of a long-term catchment-based strategy is construction of additional storm tank storage at Bury WwTW and storage at Nuttall Hall Road CSO (BRY0002).

5.2.3 We have worked closely with the Environment Agency to confirm that the option of aerating the Ship Canal is not practically feasible and alternatives are required to address the dissolved oxygen issue. Whilst doing this, we are carefully focusing to avoid drawing in schemes which are not going to make a significant contribution to meeting this objective. Where interventions need more planning because of interaction with other requirements and considering the dynamic growth of the catchment, we will work with the Environment Agency, Mersey Rivers Trust and Manchester Ship Canal Forum to understand potential requirements for delivery in AMP8 and the longer term so that the optimal solution across the system can be delivered for customers at lowest possible cost and best value.

5.2.4 Water quality modelling scenarios undertaken have forecast that the proposed improvements at Bury WwTW Storm Tanks and Nuttall Hall Road CSO (BRY0002) will improve water quality in the downstream Manchester Ship Canal and move water quality towards required dissolved oxygen standards as part of a long-term catchment strategy. As part of the water quality modelling, we have carried out an options review looking at how the storage could be balanced across the catchment to minimise cost whilst achieving the required water quality standards in the River Irwell and Manchester Ship Canal.

5.2.5 When assessing the option for these overflows, the following generic high-level solutions were considered:

(a) Do nothing

(b) Operations and Maintenance

(c) Optimise Asset

(d) Partnership/catchment solution

(e) Refurbish asset

(f) New asset

5.3 Options selection

5.3.1 A modelling assessment was undertaken to seek alternative locations and sizes of tanks for the Nuttall Hall Road CSO (BRY0002), however an alternative location or size was not taken forward as an option for pricing due to network constraints. Surface water separation was also considered, but the quantity required to achieve Water Framework Directive compliance was significant and was more expensive than a storage option.

5.3.2 A modelling assessment was also undertaken for Bury WwTW storm tanks to seek alternatives locations and sizes of tanks. An alternative location or size of tank has not been taken forward as an option due to the interaction with existing overflows and storm tank volumes. Any storage introduced upstream of Bury WwTW storm tanks results in a larger storage volume than is required at Bury WwTW. This is due to the drain-down of the tank having to be limited to not increase spills at the existing storm tanks.

5.3.3 We explored an alternative solution to increase the flow to full treatment at Bury WwTW storm tanks. This was assessed as a potential opportunity. However on a totex assessment it did not progress due to additional and extensive upgrades to assets at Bury wastewater treatment works.

5.3.4 United Utilities' engineering disciplines (Civil, Mechanical, Electrical, Environmental, Geotechnical, Construction, Hydraulics, Network Modelling and Process Engineering) assessed the significant time or cost risks and technical feasibility. This engineering assessment concluded that the confidence in the solution, considering associated risks and opportunities, is robust and in-line with business planning processes.

6. Cost efficiency

6.1.1 Delivery of these schemes ahead of the AMP8 WINEP dates has required time and resources from United Utilities which we are committed to for final delivery. We are also committed to finance these schemes without recourse to customer bills until AMP8, in the interests of delivering as soon as practicable our contribution to improvements in the Manchester Ship Canal.

6.2 Approach to cost build

6.2.1 Costs were assessed and allowed using a benchmark at a programme level in line with the approach that Ofwat took at PR19 where it assessed 'WINEP in the round'. Making a programme level assessment better accounts for the limitations of simple models to accurately predict individual schemes (or drivers) and recognises that at a programme level, limitations (for under and over estimations) will even themselves out to give an efficient allowance in aggregate. Costs for these two schemes continue as per the Green Recovery process and progress is reported through the APR.

6.3 Approach to challenging our assumptions

6.3.1 In addition to following our assured process for scoping and costing the schemes we have tested the scope of the preferred option in detail as part of process in working together with the Environment Agency and Mersey Rivers Trust. This involved investigating the options and testing the preferred option with UU Engineering discipline leads to ensure the approach and scope was robust.

6.4 Third party assurance

6.4.1 We commissioned two specific pieces of third party work to assure the cost efficiency of our enhancement cases:

- A bottom-up benchmarking exercise (Faithful and Gould); and,
- Assurance on top-down benchmarking carried out by UUW (Deloitte).

6.4.2 We consider that the complementary and independent output of these pieces of work demonstrates that our cost estimates are efficient and represent excellent value for money for our customers.

6.4.3 We provide a description of each below.

Bottom-up benchmarking (Faithful and Gould)

6.4.4 Faithful and Gould undertook a bottom-up deep dive into the cost efficiency of our enhancement cases. This involved a close examination of our cost base relating to a sample of our enhancement programme, with comparisons made to similar activity carried out by third party companies across a variety of sectors.

6.4.5 F&G looked at our direct costs across each of the following categories:

(a) Staff including site supervision

(b) Mobilisation and site set up, running and removal of site offices and welfare

(c) Temporary services for general site use, such as water to wash out concrete skips

(d) Attendant plant and equipment, such as cranes, forklift for unloading deliveries etc

(e) Attendant labour, defined as hourly paid operatives not involved in productive works

(f) Site consumables, such as waste skips

(g) Set-up site compounds, erecting hoardings etc

(h) O&M manuals

(i) Health and safety

6.4.6 It also looked at the contractor's indirect costs (e.g. overhead and design costs) and UUW's indirect costs (e.g. land acquisition costs). Due to the size of the programme, F&G examined a sample of our enhancement cases. However, this sample included projects from each of our enhancement categories and covered £1.246bn of expenditure. Therefore, we consider this sample to representative of our overall enhancement programme.

6.4.7 F&G noted the effectiveness of UUW's cost estimation process:

"In addition to the benchmarking data held by Faithful+Gould we understand that UUW has applied multiple internal and external challenges to progressively refine the cost estimation undertaken to date. In particular we note UUW's use of its Investment Programme Estimating System (IPES) which is a bespoke parametric estimating tool containing data from AMP3 to AMP7, to provide historical cost curves alongside estimated data from third party organisations."

6.4.8 F&G found that our proposed costs are in line with rates typically seen across the industry:

"Overall, UUW's approach of utilising historic cost curves, market testing and obtaining specialist third party quotations demonstrates a sound proactive approach to cost planning. In total £1.2bn of schemes underwent targeted cost assessment with £573m making up the construction works element.

After presenting our initial findings it was encouraging to see UUW's commitment to addressing our findings and applying these to the wider enhancement estimates, charting a strategic route towards greater efficiency and scope clarification.

In light of this Cost Assurance work and evidence of UUW's responsive actions we have concluded that the data we have benchmarked is within a reasonable alignment with anticipated market rates."

Assurance on top-down benchmarking (Deloitte)

6.4.9 As part of our business plan submission, UUW carried out top-down benchmarking, which took two distinct forms:

- Unit cost analysis using recent data from the industry's APR datashare and other publications (e.g. Drainage and Wastewater Management Plans); and
- Where possible and feasible, econometric analysis based upon Ofwat's PR19 model suite.

6.4.10 As we discuss in '*Chapter 8 – Delivering at efficient cost*' and *'UUW46 – Cost Assessment Proposal'*, recent supply-side shocks mean that the relationship between cost and cost driver reflected within the econometric models used to assess enhancement expenditure at PR19 is no longer appropriate. As such, we consider benchmarking carried out using more recent data to be more effective at assessing AMP8 enhancement costs. As such, we do not consider comparisons to cost estimates derived using the coefficients estimated at PR19 to be relevant.

6.4.11 In general, where recent and comparable data was available, our benchmarking analysis found our business plan costs align to similar comparator companies. This is reflected in Deloitte's findings:

"Overall, UUW has performed econometric benchmarking on programmes totalling £3,908m in enhancement case costs. We did not find any material errors in this econometric benchmarking…UUW's other top-down benchmarking based on more recent data submitted by peer companies indicates that UUW PR24 costs are generally in line with expected costs."

7. Customer protection

7.1 Introduction

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

7.2 Green recovery enhancement price control deliverable

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

Appendix A Manchester Ship Canal Catchment System Strategy; Joint Statement

Manchester Ship Canal Catchment System Strategy
Workshop 2 (03/09/19) Joint Statement

United Utilities – helping life flow smoothly | Environment Agency | Mersey Rivers Trust

Work completed to date:

- All parties believe that they are presented with an exciting opportunity to build on the improvements tha have been achieved over the last 25 years by the development of a vision for the future with the aim of seeing a sustainable coarse fish population in the canal and salmon in the upper reaches of the catchmen goal on which wider catchment measures could be based.
- All parties acknowledge that the modelling completed to date is of value, and will be vital in informing the strategy going forward.
- All parties acknowledge that further refinements and additional modelling will be of value.

UU's proposals for an alternative to MSC Aeration:

Summary

- UU proposed a draft strategy for improvements of (or in support of) UU assets, as an alternative to aeration of the MSC:
  - Completion of short term mitigation actions in AMP6
  - Completion of improvements at Bolton WwTW in AMP7 (dependent on funding)
  - Support the inclusion of multiple site improvement (as determined by the strategy) items in to the PR24 submission and subsequent price reviews for delivery in AMP8+.

AMP6

- All parties agreed with UU's proposal on the potential extent of short term measures to be delivered in AMP6, which will be confirmed following assessment of feasibility and delivery timescales. Specifically these measures are:

a) Further refinement, and additional modelling to inform the strategy

b) Aeration of Salford WwTW outfall.

c) Optimising and improving aeration in the Turning Basin (subject to further modelling and technical review in conjunction with APEM, and Salford City Council)

d) Development of fish refuge strategy, under the guidance of MRT.

AMP7

- UU informed the workshop that a submission has been made to Ofwat for the inclusion of improvements to Bolton WwTW in the AMP7 WINEP uncertainty mechanism as if Bolton were an amber certainty WINEP scheme. This would allow UU to access funding for the scheme if Ofwat agree to the change. The outcome of this is unlikely to be known until final determination in December 2019. The proposed investment would amount to £78m in AMP7. Bolton was selected by UU on the grounds that it is one of the largest influencing factors on ammonia and DO within the MSC; is an

needs to be circulated ahead of submission. A timeline needs to be developed for this and there is a need to confirm what information is required to put this proposal to Defra to change the NEP obligation. An outline of what should be included was raised:-

- A schedule of actions to address the dissolved oxygen issue against the key dates of the
  - end of AMP6 (March 2020)
  - end of the 2nd RBMP (December 2021)
  - end of AMP7 (March 2025)
  - AMP8

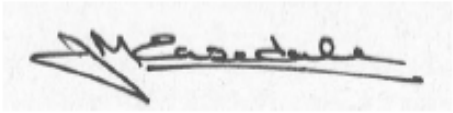
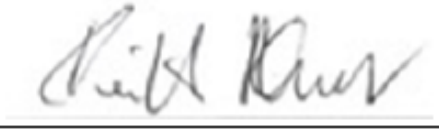
- Confirmation of the funding mechanism

11. It was noted that UU have made representations to Ofwat on their draft determination (DD) as the way their WINEP uncertainty mechanism is written in the DD only allows schemes to be removed from their AMP7 business plan. Whilst UU have asked for early feedback from Ofwat because this issue is important to the Manchester Ship Canal Strategy there is a risk that this does not materialise until the final determination is published by Ofwat in December 2019. This may leave a challenge in terms of timescales for getting Defra approval to an alternative strategy for the Manchester Ship Canal. UU are continuing to try to influence this issue.

12. A SWOT analysis of measures that in the main could be implemented before March 2020 was undertaken. The output is to be considered further.

13. Further meetings:
    a. Next workshop scheduled for 3rd September 2019 which will focus on options and the 25 year objective for the Canal.
    b. Further modelling technical review meetings to be held on 27th June and 25th July 2019.

Endorsement for this Joint Statement is provided by:

	**Mark Garth** United Utilities Wastewater Area Business Manager – South Area
	**Mark Easedale** Environment Agency Area Environment Manager
	**Keith Hendry** Chairman, Mersey Rivers Trust

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United Utilities

Water for the North West

UUW65

First time sewerage

October 2023

Enhancement Case 21

United Utilities

Water for the North West

Contents

1. Enhancement submission

<table>
<tr><th colspan="2">Enhancement submission</th></tr>
<tr><td>Title:</td><td>First Time Sewerage</td></tr>
<tr><td>Price Control:</td><td>100% Wastewater Network Plus</td></tr>
<tr><td>Enhancement headline:</td><td>In line with the requirements of Section 101A Water Industry Act 1991 we will invest £5m to undertake assessment and delivery of first time sewerage schemes across the North West in AMP8.

The investment will protect and improve the environment and amenity value in the first time sewerage areas.</td></tr>
<tr><td>Enhancement expenditure

(FY23 prices)</td><td>
<table>
<tr><th></th><th>AMP8 Capex inc TI (£m)</th><th>AMP8 Opex (£m)</th><th>AMP8 Totex (£m)</th></tr>
<tr><td>Pre RPE and Frontier Shift</td><td>5.132</td><td>0.000</td><td>5.132</td></tr>
<tr><td>Post RPE and Frontier Shift</td><td>5.000</td><td>0.000</td><td>5.000</td></tr>
</table>

The table above shows the total expenditure, inclusive of accelerated programme and transitional investment, on both a pre-efficiency (i.e. pre frontier shift and real price effects basis, consistent with the cost data tables), and a post efficiency and RPE basis (i.e. consistent with the value we propose to be recovered from price controls). All numbers referenced hereafter in this enhancement case are on a post efficiency and RPE basis.
</td></tr>
<tr><td>This case aligns to :</td><td>Water Industry Act 1991

For full reconciliation between enhancement costs and data table lines, see enhancement mapping tabs in UUW117 – Project allocations CW3 and CWW3.</td></tr>
<tr><td>PCD</td><td>No</td></tr>
</table>

2. Enhancement case summary

Gate	Summary	Location reference
Need for enhancement investment	• Under Section 101A of the Water Industry Act 1991, water companies have a statutory obligation to provide public sewers to be used for the drainage of domestic properties if the relevant criteria are fulfilled. • Improved public awareness regarding the impact of private drainage on river water quality is expected to lead to an increase in S101A applications received for assessment, with the result that UUW will be required to deliver a greater number of first time sewerage schemes. Applications vary in volume, size, complexity and cost. • UUW forecasts that we will be required to deliver first time sewerage schemes for 70 properties over the course of AMP8.	*4* *4.3* *4.3*
Best option for customers	• To ensure that schemes represent the best value for customers, communities and the environment over the long term, applications must pass through a series of gateways to demonstrate S101A assessment criteria have been met. This includes carrying out a technical assessment of public versus private solutions and a cost benefit analysis for proposed connections. • The following criteria must be met for a first time sewerage application to be successful: – The application must concern two or more properties that are not currently connected either directly or indirectly to the public sewerage system; – The properties in question are used for domestic purposes only; – The drainage of any of the premises in question is giving rise to such adverse effects to the environment or amenity that it is appropriate to provide a public sewer for the drainage for domestic sewerage purposes of the premises in question; – The environment or amenity problem cannot be more appropriately resolved by improved maintenance or operation of the existing systems. • UUW's robust process for assessing applications ensures that first time sewerage schemes are only delivered where it can be demonstrated that connection to a new public sewer delivers better outcomes, for both customers and the environment, than the existing private system.	*5.2* *5.2* *5.3*
Cost efficiency	• We have based our costs for our AMP8 first time sewerage programme on the benchmarking model used by Ofwat in its PR19 Final Determinations. This ensures that our first time sewerage costs are efficient as a) the model is developed by direct reference to other companies' costs in the industry and b) using a PR19 enhancement model represents an implicit efficiency challenge as recent economic shocks have caused our costs to increase significantly. • To derive our AMP8 cost, we multiplied our AMP8 programme with the modelled coefficients. We then adjusted the resulting modelled allowance to 22-23 CPIH prices and applied the PR19 catch-up efficiency challenge of 10% to calculate our final cost allowance of £5m.	*6.2*

Customer protection	• As per Ofwat guidance, water companies are expected to define material investments as 1% of relevant total expenditure (totex). The investment requested for first time sewerage does not meet this threshold and therefore a price control deliverable (PCD) is not required for this case. • However, customers are protected from non-delivery or partial delivery by statutory deliverables covered under S101A of the Water Industry Act 1991, whereby companies are obligated to provide first time sewerage where a duty is identified. Where duty has been accepted, enforcement action may be undertaken in the event that the connection has not been made in the agreed time frame. Enforcement action may also be undertaken under such a circumstance that the Environment Agency has determined that duty exists in the case of a dispute.	*7*

3. Introduction

3.1.1 This document sets out an enhancement case for £5 million to enable UUW to fulfil our statutory obligation to provide first time public sewers in the region as per Section 101A of the Water Industry Act 1991.

3.1.2 In the North West, it is estimated that approximately 64,700 properties are not connected to the public wastewater network and rely on privately owned, operated and maintained wastewater collection and treatment systems. Such systems include septic tanks, cesspits and small package treatment plants, which, when installed and maintained properly, provide a sustainable method for wastewater disposal.

3.1.3 There are a number of factors which impact the long-term sustainability and effectiveness of private wastewater systems including;

- Location (including access)
- Ground conditions
- Property size(s)
- Age of systems

3.1.4 These factors can lead to a detriment in long-term performance as a result of, for example, ineffective maintenance due to access restrictions which consequently result in an unsatisfactory discharge of wastewater to the environment (direct to land or waterbody).

3.1.5 It is estimated that private wastewater systems contribute to 3% of total phosphorus (P) load, nationally[1] but can be important locally, particularly in the headwaters of catchments during summer low flows when toxicity from septic tanks is higher. Indeed, May et al. (2010)[2] found that septic tank systems can collectively make up to 20% of catchment P loads in rural areas. In addition, unsuited ground conditions, such as heavy clay soils are found to be less effective at retaining and treating septic tank effluents, meaning flows could be causing a greater level of environmental detriment than previously thought.

3.1.6 Siting of systems on impermeable soils with a limited capacity for effluent infiltration appears a common cause of failure. May *et al*. (2010) suggest that over 80% of septic tank systems in the UK are probably working inefficiently, and consequently they are a potentially significant and underestimated source of phosphorus to nearby watercourses[3].

3.1.7 In circumstances where a sustainable long-term wastewater disposal system is not possible, an application to connect to the public wastewater network may be considered in order to protect environmental and/or amenity value. Under Section 101a Water Industry Act 1991 we are required to provide first time public sewers in the region where there is, or likely to be, an environmental and amenity issue caused by inadequate private sewerage facilities where certain criteria are met.

3.1.8 Public awareness regarding the impact of private drainage on river water quality is increasing. UUW therefore foresees that first time sewage applications will increase over the course of AMP8. This investment will therefore ensure that, where appropriate, connections to existing UUW sewerage infrastructure can be made for typically rural settlements, protecting the local environment and amenity value.

[1] Environment Agency (2019) Phosphorus and Freshwater Eutrophication Pressure Narrative. Available here: https://consult.environment-agency.gov.uk/environment-and-business/challenges-and-choices/user_uploads/phosphorus-pressure-rbmp-2021.pdf

[2] May *et al.* (2010) *The impact of phosphorus inputs from small discharges on designated freshwater sites.* Available here: https://nora.nerc.ac.uk/id/eprint/512494/

[3] Quantifying the impact of septic tank systems on eutrophication risk in rural headwaters, Withers P J A, Jarvie H P, Stoate C. Environment International 37 (2011) 644–653. Available here: https://www.sciencedirect.com/science/article/pii/S0160412011000043

4. Need for enhancement investment

4.1.1 Water companies have a statutory obligation to assess S101A applications and provide sewerage if the criteria are met. Public focus on water quality is expected to lead to an increase in applications received for assessment and put pressure on companies to deliver a greater number of first time sewerage schemes. Applications vary in volume, size, complexity and cost which makes S101A challenging to forecast.

4.2 Evidence enhancement is required

4.2.1 In the North West we estimate there are approximately 64,700 properties on private septic tanks who are eligible to enquire or submit an application for first time sewerage at any time. We have a statutory obligation to assess applications and provide sewerage where applications meet the criteria. The location and need for the service lies outside of the company control. However, to mitigate this risk we engage with stakeholders to understand where there may be upcoming applications.

4.2.2 Table 1 below shows the number of applications received since AMP5. UUW delivered a large number of schemes in AMP5 and earlier, targeting large clusters of properties that would benefit from being connected to the public sewer network. Whilst we do not expect to deliver schemes of a similar scale to those observed in AMP5, as many of the most cost-beneficial schemes have been delivered, we do expect to observe an increase in applications in AMP8 given the significant national scrutiny on public and private sewerage infrastructure.

Table 1: Historical First Time Sewerage Applications (property count)

	AMP5	AMP6	AMP7*
Application Received/Assessed**	30	30	18
Duty Accepted	8	2	1
Schemes Delivered	8	1	1
Properties Delivered	382	4	7

**AMP7 to date **UU process 6 applications per year on average*

4.2.3 In order to fulfil our obligation we need to assess applications, develop solutions and, where the application fulfils the criteria, provide the infrastructure necessary to convey and treat the additional flows. Once applications have been submitted for first time sewerage connection, technical assessment and cost-benefit analysis are completed by UUW before a decision is taken on whether the criteria for accepting Duty have been reached or not. There are currently 6 live applications (assessment and appeal stage) consisting of 44 properties in total.

4.3 Scale and Timing of Investment

4.3.1 The profile for AMP8 investment has been determined based on historical and live applications, technical assessment requirements and schemes to be delivered in AMP8. It should, however, be noted that applications vary in volume, size, complexity and cost which makes S101A a challenging measure to forecast. Our best estimate of a delivery profile is shown in Table 2 below:

Table 2: AMP8 First Time Sewerage Schemes (by property) - forecast

	2025-26	2026-27	2027-28	2028-29	2029-30	Total
Properties	5	10	15	20	20	70

4.3.2 From the live applications that are forecast to progress for delivery in AMP8, it is profiled that these schemes will be delivered within the first half of the AMP. The second half of the AMP takes into account an increase in applications to be received given public focus on the environment, media coverage and heightened campaigning by environmentalist groups.

Increasing public awareness

4.3.3 In addition, local partnership activities such as Love Windermere are expected to bring further attention to private discharges and thereby lead to an increase in S101A applications received by the industry. An example of the types of projects included in the Love Windermere partnership include a project by The Lake District Foundation and Environment agency to work with owners of septic tanks to develop community emptying schemes and provide advice regarding how to best manage private sewerage systems. Other activities include the monitoring of water quality and trialling innovative technology designed to remove nutrients from septic tank effluent[4].

4.3.4 Furthermore, in addition to the monitoring of public assets through our Dynamic Network Management (DNM) programme, UUW will be trailing the Windermere Dynamic Catchment Management (DCM) project, engaging with stakeholders to install additional monitoring to a number of private assets. Via this engagement we will be bringing to life optimised monitoring and detailed understanding of private discharges. It is anticipated that these activities will bring increasing awareness to failing septic tanks, resulting in additional demand for first time sewerage beyond the immediate catchment.

Long-term delivery strategy

4.3.5 Beyond AMP8, in our core long-term delivery strategy (LTDS) pathway, we forecast a flat profile of expenditure across future AMPs as we deliver small-medium scale first time sewerage schemes from applications that meet criteria set out in legislation, as and when received. We do, however, recognise that demand for FTS is sensitive to exogenous factors and set out two alternative pathways to reflect potential changes in external drivers:

- In the 'adverse demand' pathway, expenditure increases to £7.5 million in AMP9 and AMP10 and £10 million in AMP11 and AMP12. This scenario reflects the likely expenditure level if there were to be a continuous increase in applications, facilitated by a growing level of environmental awareness beyond that assumed in the core pathway.
- The 'adverse changing expectations' pathway observes expenditure increasing at a rate beyond that witnessed historically, increasing from £5 million in AMP8 to £20 million in AMP12. We consider this scenario to be unlikely, but could be realised if, for example, amendments are made to the qualifying criteria for First Time Sewerage applications as set out in the Water Industry Act 1991.

4.3.6 Continued investment is driven by the legislation set by S101A of the Water Industry Act. When applications meet criteria and duty is accepted, we will draw from this investment to deliver the best option and most cost efficient scheme, as and when required.

4.4 Overlap with base and previous price reviews

4.4.1 We do not consider there to be any overlap with base expenditure. As per Ofwat's PR24 data table guidance for costs, first time sewerage is a standard enhancement expenditure item as we are extending the provision of our current level of service to new customers.

4.4.2 At PR19, our first time sewerage final determination allowance was £3.4 million. Our AMP7 expenditure to date on first time sewerage is £2.62 million and therefore we are on track to spend our allowance. We therefore do not expect there to be any overlap with activities funded at previous price reviews.

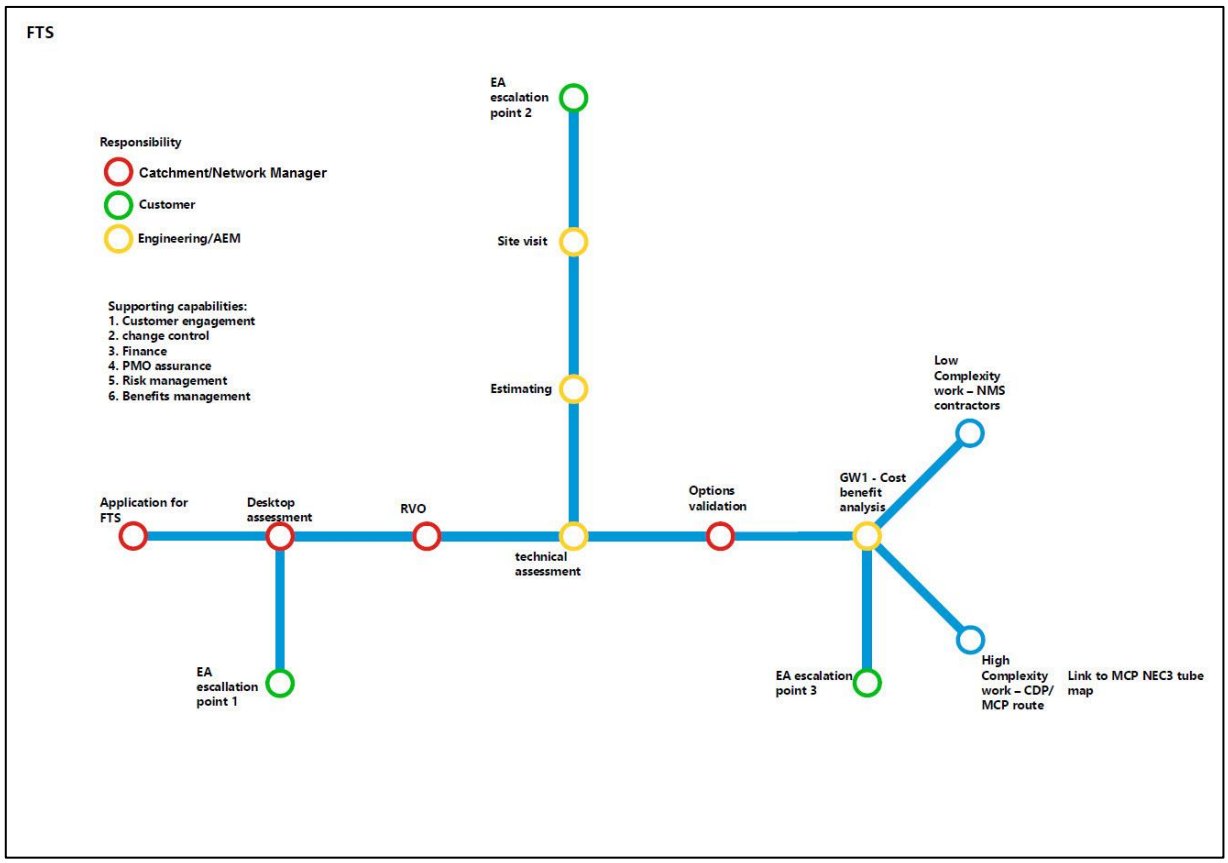
[4] Lake District National Park – Love Windermere. Available here

5. Best option for customers

5.1.1 To ensure the proposed solutions represent the best value for customers, communities and the environment over the long term, applications must pass through a series of gateways to demonstrate S101A assessment criteria have been met. This includes carrying out a technical assessment of public vs private solutions and a cost benefit analysis for proposed connections at company expense.

5.1.2 First time sewerage schemes pass through a series of gateways (as detailed in Figure 1 below) before a decision is taken on whether Duty will be accepted and a scheme delivered to provide the properties with a public sewer.

Figure 1: UUW has a robust process for assessing S101A applications



5.2 Process and legislation

5.2.1 When a first time sewerage application is received, it is checked against the essential criteria, set out in the legislation to ensure each one is met. The criteria are:

- Two or more properties are not currently connected either directly or indirectly to the public sewerage system;
- The properties in question are used for domestic purpose only;
- The drainage of any of the premises in question is giving rise to such adverse effects to the environment or amenity that it is appropriate to provide a public sewer for the drainage for domestic sewerage purposes of the premises in question; and,
- The environment or amenity problem cannot be more appropriately resolved by improved maintenance or operation of the existing systems.

5.2.2 We discuss the process and the costs and benefits of the scheme with the applicant to ensure the approach is appropriate for the applicant as well as the environment. If this stage is passed then the proposed project will pass through to the technical assessment stage.

5.2.3 The technical assessment is designed to firstly assess the environmental conditions of the area, the existing infrastructure and maintenance regime. If it is confirmed that there is a non-preventable issue that is causing an environmental problem then the proposed project will be passed on for financial assessment.

5.3 Cost-benefit analysis

5.3.1 To assess true cost benefit, the proposed project must be compared to a private alternative to confirm that a public solution is in the interests of both our existing and potential customers. The project is input to an Investment Appraisal Model which accounts for both private and public options and the varying financial factors, such as loan rates and VAT deductions. Whole life costs are considered within the assessment criteria based on each option. In this way, we determine whether the proposed public solution is cost beneficial and therefore the best option for both new and existing customers. In addition, we carry out a total embodied carbon (CO_2e) assessment for each solution option to quantify the environmental impact which contributes to the benefit scoring of each first time sewerage scheme. As the embodied carbon impact is therefore scheme-specific, and we do not know the specific conditions of each scheme to be delivered in AMP8 yet, we used an average benchmark of 0.1849 £/tC02e to deduce the overall carbon impact of the claim.

5.3.2 Our robust application assessment process therefore ensures that we only deliver first time sewerage schemes where private solutions are having a detrimental impact on the environment and a connection to the public sewer is the most cost-beneficial means to resolve the issue.

6. Cost efficiency

6.1.1 We valued the enhancement case using Ofwat's PR19 benchmarking model. This ensures our first time sewerage costs are efficient as a) the model was developed by direct reference to other companies' costs in the industry and b) using a PR19 enhancement model represents an implicit efficiency challenge as recent economic shocks have caused our costs to increase significantly.

6.1.2 To determine the number of properties likely to apply and be eligible for first time sewerage schemes in AMP8, we have utilised a range of data sources, including: the number of historical applications received; the likelihood of duty being accepted for live applications and the impact of increased public awareness of the impact of private drainage on water quality. As a result, we forecast to deliver S101A schemes for 70 properties in AMP8.

6.2 Approach to cost build

6.2.1 We have based our costs for our AMP8 first time sewerage programme on the benchmarking model used by Ofwat in its Final Determinations[5]. Ofwat's approach used two alternative models, one based upon historical data and one based upon forecast AMP7 data. The models use a scale variable and a squared scale variable. The models are set out in Table 3 below.

Table 3: Ofwat's PR19 FTS benchmarking model

Variable name	Historical model	Forecast model
Connectable properties served by s101A schemes smoothed	0.0339	0.0424
Connectable properties served by s101A schemes smoothed squared	-0.00002	-0.00004
Constant	0.3789	0.5138

6.2.2 We derived our FTS costs directly using the PR19 model. This ensures that our proposed FTS costs are efficient because:

- The model is developed by direct reference to other companies' costs in the industry; and
- Using a PR19 enhancement model represents an implicit efficiency challenge. As we evidence in our supplementary document, *UUW46 - Cost Assessment Proposal*, recent economic shocks have led input costs to increase significantly. Therefore, the relationship between cost and cost driver implied by PR19 models is likely to understate the costs companies will face in future AMPs. As such, basing our AMP8 FTS programme upon will act as an implicit stretch our costs.

6.2.3 To derive our AMP8 FTS cost we multiplied our AMP8 FTS programme with the coefficients set out in Table 3. We then adjusted the resulting modelled allowance to 22-23 CPIH prices and applied the PR19 catch-up efficiency challenge of 10% to calculate our final cost allowance of £5m.

6.3 Third party assurance of our cost estimates

6.3.1 We commissioned two specific pieces of third party work to assure the cost efficiency of our enhancement cases:

- A bottom-up benchmarking exercise (Faithful and Gould); and,
- Assurance on top-down benchmarking carried out by UUW (Deloitte).

[5] Ofwat (2019) First time sewerage enhancement assessment. Available here: https://www.ofwat.gov.uk/wp-content/uploads/2019/12/FM_E_WWW_first-time-sewerage_FD.xlsx

6.3.2 We consider that the complementary and independent output of these pieces of work demonstrates that our cost estimates are efficient and represent excellent value for money for our customers.

6.3.3 We provide a description of each below.

Bottom-up benchmarking (Faithful and Gould)

6.3.4 Faithful and Gould undertook a bottom-up deep dive into the cost efficiency of our enhancement cases. This involved a close examination of our cost base relating to a sample of our enhancement programme, with comparisons made to similar activity carried out by third party companies across a variety of sectors.

6.3.5 F&G looked at our direct costs across each of the following categories:

a) Staff including site supervision

b) Mobilisation and site set up, running and removal of site offices and welfare

c) Temporary services for general site use, such as water to wash out concrete skips

d) Attendant plant and equipment, such as cranes, forklift for unloading deliveries etc

e) Attendant labour, defined as hourly paid operatives not involved in productive works

f) Site consumables, such as waste skips

g) Set-up site compounds, erecting hoardings etc

h) O&M manuals

i) Health and safety

6.3.6 It also looked at the contractor's indirect costs (e.g. overhead and design costs) and UUW's indirect costs (e.g. land acquisition costs). Due to the size of the programme, F&G examined a sample of our enhancement cases. However, this sample included projects from each of our enhancement categories and covered £1.246bn of expenditure. Therefore, we consider this sample to representative of our overall enhancement programme.

6.3.7 F&G noted the effectiveness of UUW's cost estimation process:

"In addition to the benchmarking data held by Faithful+Gould we understand that UUW has applied multiple internal and external challenges to progressively refine the cost estimation undertaken to date. In particular we note UUW's use of its Investment Programme Estimating System (IPES) which is a bespoke parametric estimating tool containing data from AMP3 to AMP7, to provide historical cost curves alongside estimated data from third party organisations."

6.3.8 F&G found that our proposed costs are in line with rates typically seen across the industry:

"Overall, UUW's approach of utilising historic cost curves, market testing and obtaining specialist third party quotations demonstrates a sound proactive approach to cost planning. In total £1.2bn of schemes underwent targeted cost assessment with £573m making up the construction works element.

After presenting our initial findings it was encouraging to see UUW's commitment to addressing our findings and applying these to the wider enhancement estimates, charting a strategic route towards greater efficiency and scope clarification.

In light of this Cost Assurance work and evidence of UUW's responsive actions we have concluded that the data we have benchmarked is within a reasonable alignment with anticipated market rates."

Assurance on top-down benchmarking (Deloitte)

6.3.9 As part of our business plan submission, UUW carried out top-down benchmarking, which took two distinct forms:

- Unit cost analysis using recent data from the industry's APR datashare and other publications (e.g. Drainage and Wastewater Management Plans); and
- Where possible and feasible, econometric analysis based upon Ofwat's PR19 model suite.

6.3.10 As we discuss in *Chapter 8 – Delivering at efficient cost* and *UUW46 – Cost Assessment Proposal,* recent supply-side shocks mean that the relationship between cost and cost driver reflected within the econometric models used to assess enhancement expenditure at PR19 is no longer appropriate. As such, we consider benchmarking carried out using more recent data to be more effective at assessing AMP8 enhancement costs. As such, we do not consider comparisons to cost estimates derived using the coefficients estimated at PR19 to be relevant.

6.3.11 In general, where recent and comparable data was available, our benchmarking analysis found our business plan costs align to similar comparator companies. This is reflected in Deloitte's findings:

"Overall, UUW has performed econometric benchmarking on programmes totalling £3,908m in enhancement case costs. We did not find any material errors in this econometric benchmarking…UUW's other top-down benchmarking based on more recent data submitted by peer companies indicates that UUW PR24 costs are generally in line with expected costs."

7. Customer protection

7.1 Introduction

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

7.2 First time sewerage enhancement price control deliverable

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

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