Appendix
YKY31_Water Resilience Enhancement Case [Redacted]

YorkshireWater

Navigating this document

This Appendices document is separate to and supports the main business plan document.

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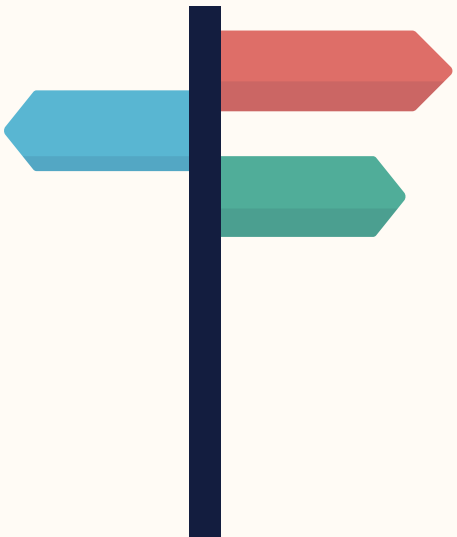
Read more links
This icon can be clicked on to link to any further documents or resources outside of this report

Read more about this at **websiteaddress.com or link**

Business plan links
This icon can be clicked on to go to the main Yorkshire Water Business Plan document where more information can be found.

More detail on this subject can be found in **Chapter 8 Part 2: What our plan will deliver**



Contents

[Content in this document has been redacted due to it containing commercially sensitive information or in the interests of security]

1. WSS Resilience Strategy Enhancement Case

1.1 Executive Summary

Drivers: Water Supply Resilience, Unplanned Outage, Water Supply Interruptions

This appendix sets out the case for c.£133.5m of investment in water supply system resilience. A summary of the key points is set out below:

- Water supply resilience is a key customer priority.
- We have completed a detailed systems-level risk and resilience analysis at our highest risk Water Supply Systems. We have used the latest SEMD guidance to identify high-risk single-source supplies.
- Content is redacted due to it containing commercially sensitive information or in the interests of security
- We have completed a detailed optioneering which has identified that the best solution to deliver the required resilience to customers is to build an additional 75MLD treatment works and grid-connected storage at our existing site.
- We have assessed this case and believe it meets the criteria for DPC.

1.1.1 Requested Investment:

Table 1.1: AMP8 Enhancement Costs for Water Resilience

	£m	Table Line Ref.
Enhancement Expenditure Capex	0	N/A
Enhancement Expenditure Opex	0	N/A
Base Expenditure Capex	0	N/A
DPC value	133.504	SUP12
Total	**133.504**	

1.1.2 Associated Reporting lines in Data Table:

Table 1.2: CW3 Reporting Lines

Line Number	Line Description
CW3.118	Resilience; enhancement water capex
CW3.119	Resilience; enhancement water opex
CW3.120	Resilience; enhancement water totex

All costs for water resilience enhancement have been deemed eligible for Direct Procurement for Customers (DPC) and as such the reporting lines in CW3 show £0 expenditure. All costs can be found in SUP12.

1.2 High Level Driver description:

1.2.1 Our WSS Resilience Strategy

Customers score resilience of potable water supplies as a high priority, emphasising the importance of a company's ability to provide uninterrupted supplies. There are various factors which make this increasingly challenging in the future, such as the impacts of climate change on raw water quality, a forecast increase in the supply demand deficit due to climate change and increasing population and an ageing asset base.

In order to maintain supplies, companies must ensure alternative supply arrangements are in place. This can take the form of an alternative piped supply or temporary alternative water supplies (TAWS). The requirement for TAWS has been reviewed and formalised under the latest SEMD guidance (Feb 2022). This states that companies are required to have sufficient plans and resources in place to deliver alternative water supplies to the equivalent of 1.5% of the population that they serve. In YW's case this equates to around 34,000 properties (80,000 population).

Read more about this at **Water security emergency measures direction feb2022.pdf**

Read more about this at **DWI response to Ofwat PR24 Draft Methodology.pdf**

We have recently implemented a new systems approach to long-term water supply resilience across our area in the form of a Water Supply System (WSS) Resilience Strategy. A key output of this WSS Strategy work was to identify those systems with a deficit between the number of at-risk properties and this SEMD guidance, followed by opportunities to close this gap. Resilience enhancement investment will initially be prioritised on those systems where a gap has been identified (see Figure 1.2). Our long-term ambition is to have no more than 34,000 properties (80,000 population) without an alternative supply.

We have developed our approach to water supply systems resilience through a series of workshops facilitated by our Strategic Planning Partner (Stantec), within which we take a holistic view of each system and identify risks, opportunities and solutions with our operational and asset planning subject matter experts (SMEs). This approach established and prioritised the strategic needs within each water supply system. Subsequent steps involved the identification of integrated, system-based solutions to form part of a long-term multi-AMP resilience improvement plan with input from various Yorkshire Water stakeholders with specialist experience and expertise in areas of each system and process.

The Water System Supply Strategy (WSSS) considers all the key components of the water supply system, including:

- Water resources,
- Raw water abstraction and transmission; and
- Water treatment, storage and transmission.

These main components are subject to multiple hazards, often with a low likelihood of occurring but with a potentially high consequence to the population supplied by these components.

Through the WSSS project, Yorkshire Water has applied a systems-thinking approach and embedded an expanded version of the four Rs of Resilience approach, developed for effective infrastructure resilience.

Yorkshire Water has adopted a five Rs approach (which includes reflection as the fifth R), which underpins WSS strategies and other streams of YW work. Considering the critical components of each WSS against a range or principal hazards to which they were exposed, the assessment considered:

- Resistance – is the system / component sufficiently protected against the hazards now and in the future.
- Reliability – can the system components continue to provide their required function under the expected range of current and future operating conditions.

- Redundancy – is there sufficient system level flexibility / redundancy to absorb the impacts of asset outages when hazards impacted the system with minimal service disruption.
- Response and Recovery – under the range of hazard impact scenarios can we expect to be able to restore system function / capability before supplies were interrupted.
- Reflection – did the workshop and engagement process allow us to learn from past experiences and understand both the system and organisational capability to respond to incidents.

The WSS project's systems-based approach enabled us to consider shocks (disruptive events) and stresses (long-term trends) in a structured manner.

Twenty Strategic Planning Areas (SPAs) were created covering the whole water supply area. The SPAs were reviewed and assigned a score based on resilience and known risks. This was used to rank the SPAs and identify their priority for further analysis. To date, 8 out of the 20 SPAs have been assessed in detail, and it is our intention to apply this approach to the remaining areas over the course of AMP8 to define needs from AMP9 and beyond.

Strategic solutions for these eight systems were developed and the synergies or conflicts with interventions from other plans, frameworks and strategies including the Water Resource Management Plan (WRMP), Drinking Water Inspectorate (DWI) water quality programme and Water Industry National Environment Programme (WINEP) were evaluated to ensure that the full need was identified and considered. A long list of options was rationalised into a series of preferred options to carry out more detailed cost benefit analysis and prioritisation and to inform our long-term water supply resilience plans.

We propose to progress resilience enhancement schemes across AMP8 and AMP9 for systems with the largest number of at-risk properties, particularly where they significantly exceed our Security and Emergency Measures Direction (SEMD) threshold (34,000 properties), which represents the maximum area we could support with alternative bottled / tankered water supplies in an emergency.

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Although we anticipate more will emerge as these studies are rolled out to the remaining areas in future AMPs.

1.2.2 Defining key terminology and acronyms:

AMP	Asset Management Period
DWI	Drinking Water Inspectorate
LTDS	Long Term Delivery Strategy
SEMD	Security and Emergency Measures Direction
SRO	Strategic Regional Options
WINEP	Water Industry National Environment Programme
WReN	Water Resources North Draft Regional Plan
WRMP	Water Resource Management Plan
WSS	Water Supply System
WTW	Water Treatment Works
YW	Yorkshire Water

1.3 Need

1.3.1 The Need for the Proposed Investment

We propose this expenditure under Ofwat's Resilience enhancement driver.

Customers highlight resilience as a top priority, with the most important issue being able to receive reliable, uninterrupted services. The ability to protect and reduce customer water supply interruptions, which can create significant disruption, is therefore one of the top priorities in relation to resilience assessment and in setting risk thresholds.

Yorkshire Water's Grid network, developed extensively since the drought in 1995, considerably enhanced the resilience of water supplies in the region. This grid does not however provide full redundancy to the whole region for treated water, and there are still customers who receive supplies from single sources. As such, improvements are needed to improve resilience to large systems supplied by a single WTW.

This resilience is particularly stretched when hazards beyond our control impact on our activities. For example, periods of high demand due to extremes in hot or cold weather, deteriorating raw water quality and population growth put pressure on our assets removing redundancy in the system.

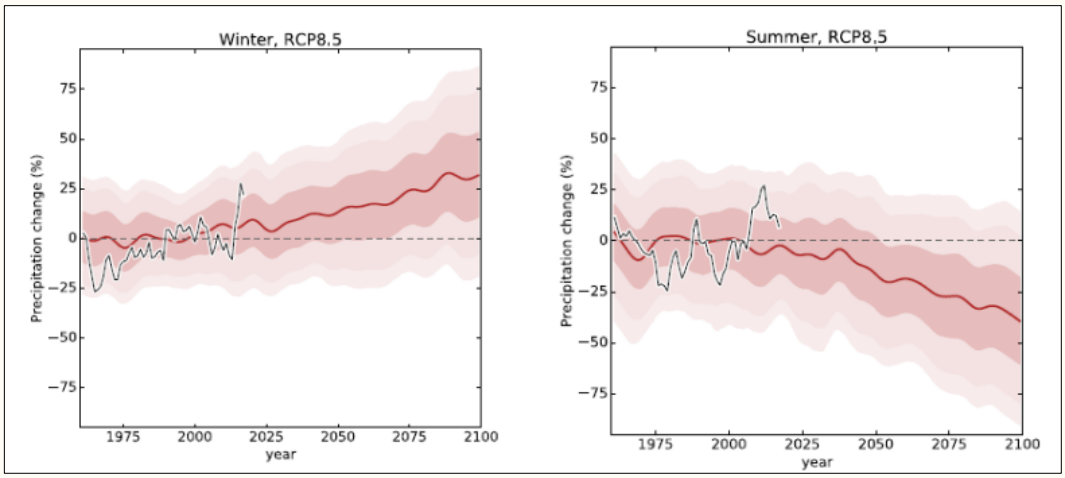
The investment proposed in this enhancement case is to increase our resilience to low likelihood, high impact events. Typically these events occur through a combination of factors, some of which are within and many of which are outside of our control. We cannot guarantee that extreme weather or raw water contamination will not cause our works to become non-operational our that assets will never fail as this would require unreasonable costly approaches to asset management that would not be efficient. However, we can ensure through resilience investment that the failure of assets has a much reduced impact on customers and meets their expectations of providing a secure drinking water supply.

Examples of shocks and stresses that could impact on the ability to operate our sites include:

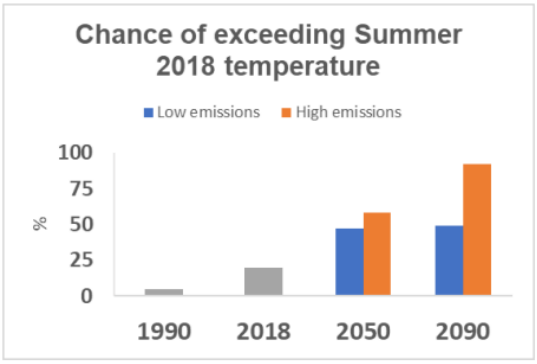
- Security
- Extreme Cold / Heat
- Heatwave/Drought
- Asset Failure
- Power Outage
- Cyber Attack
- Extreme Rainfall
- Natural Disasters / Storms
- Raw Water Quality

Many of these external pressures are forecast to increase into the future and whilst the high-level supply/demand balance is accounted for in our WRMP expenditure the impact of extreme events on the resilience of our assets is not. Winters are expected to get slightly warmer and wetter, and summers forecast to get significantly warmer and drier. Figure 1.1 below shows some relevant projections for the UK.

Figure 1.1: UKCP Climate Change Projections for rainfall and heatwave probability



- Chance of such hot summers low in the baseline period (<10%)
- By mid-century the chance of hot summers will be of the order of 50%
- Beyond 2050 the chance of a warmer summer more strongly depends on emission scenario



Source: Met office

Read more about this at
https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/summaries/headline-findings

Assessing and improving system resilience will be an ongoing and important activity for us going forward. At PR19, we carried out an extensive assessment of the resilience of our systems https://www.yorkshirewater.com/media/qmsnlec1/water-resilience-in-yorkshire.pdf. The principles and outcomes of this assessment remain valid and have been considered in the assessment and development of our WSSS.

We have five Water Supply Systems above our resilience threshold which need addressing. A number of workstreams have run in parallel to identify and address future water supply risks, including the WRMP, WINEP and DWI quality programmes. The WSSS programme has sought to ensure an integrated approach through maintaining visibility of common needs and opportunities across our water supply systems.

Ofwat guidance (Operational Resilience Discussion Paper, April 2022) states Water Companies should "*deliver improvements in areas where gaps and concerns have been identified*".

Read more about this at
Ofwat-Operational-resilience-discussion-paper-April-2022.pdf

1.3.2 The Scale and Timing of the Investment

In light of this new guidance, YW's Resilience/WSS Strategy for AMP8 and beyond is based around the identification and mitigation of risks in WSSs where there is a gap between our SEMD plans and total at-risk properties (i.e. those properties who solely rely on a single WTW or storage for their potable water supply and a prolonged outage or contamination event at that asset would impact our ability to supply).

Figure 1.2 details those systems which have been identified as having a gap as part of phase 1 of the WSS Strategy workshops.

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The scale of investment required is large as whilst we can continue to optimise sites and reduce the likelihood of outage through base expenditure on our existing assets this does not address the high impact where significant numbers of customers are supplied by a single site (high impact defined by the SEMD as >34,000 properties for YW). Solutions that mitigate single-source supply issues are largely limited to the building of additional treatment sites or new trunk main connections. Both of these solutions require significant capital investment.

The scale of the investment required to adequately reduce the risk to supplies in each of these areas, combined with potential further additions from future assessments of lower priority WSSs, means we do not consider it affordable to mitigate all resilience risks in a single AMP. To minimise the impact on customer bills we are proposing a a staged approach, beginning with the most urgent risks in AMP8, followed by subsequent risks in AMP9 and beyond.

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We propose to progress the design of these two work programmes and complete the majority of construction via the Direct Procurement for Customers (DPC) pathway.

Read more about this in
Introduction to Enhancement Cases

Project name	AMP8 Capex (£m)	AMP9 Capex (£m)	Annual opex (£m)	Year Operation Begins
	133.504	30.837	2.838	2032

1.3.3 Interactions with Base Expenditure

The proposed Resilience enhancement funding interacts both with base and enhancement funding at the site and in the wider WSS.

Base: There is existing base expenditure in AMP7, with more activity planned for AMP8. These schemes are based around improving asset condition and minimising water quality and unplanned outage risk. This does not directly interact with the proposed resilience expenditure, however, delivery under resilience enhancement funding will facilitate further base funded improvement nabling the delivery of base improvements that require more invasive work and as such, are not currently possible.

Cost Adjustment Claim (CAC): We are proposing a targeted asset health allowance for non-infrastructure investment in the form of a CAC for Asset Health.

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. Delivery of this scheme in unison with this resilience scheme could lead to further improvements in resilience, increases in totex efficiency (allowing additional asset health investment elsewhere) and additional opportunities to address supply/demand deficits in future AMPs (i.e. the potential to treat and store water from a new potential source in the area).

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Read more about this in
Cost Adjustment Claim appendix

1.3.4 Activities Funded in Previous Price Reviews

No activities were funded in relation to resilience enhancement in previous AMPs.

1.3.5 Long-Term Delivery Strategy Alignment

The Long -Term Delivery Strategy (LTDS) is focused on adaptive planning where decisions can be made under different future circumstances, considering resilience risks and interventions. The strategic planning frameworks of the WRMP, WSS Strategy and WINEP all feed into Yorkshire Water's LTDS

The AMP8 interventions identified through the WSS Strategy work forms a core pathway of 'no and/or low regret' enhancement investments, based primarily on the potential magnitude of customers impacted by an outage. The identified interventions will be revisited along with others as all the remaining zones are taken through the WSS strategy process. This will enable future long-term pathways to be developed.

Read more about this in
Long-Term Delivery Strategy

1.3.6 Customer Support

Through our extensive customer research, we know our customers place significant importance on water supply resilience. Customers ranked a continuous supply of clean, safe drinking water as their number one priority time and time again. In fact, continuous supply or avoidance of water supply interruptions are top priorities in our own research as well as the priorities research undertaken by Ofwat and CCWater – when considering the service area against other performance commitments. Customers reported that such interruptions were 'highly inconvenient'. Specifically examining interruptions in our own Valuing Water customer priority research found that preventing water supply interruptions was of medium importance, however, when triangulating this with customer contact data, we can see that the priority may be higher than initially analysed as this is a high-volume complaints area with roughly 5% of complaints related to this per annum.

To further support the inclusion of the enhancement case, our Water Resources North customer engagement (WReN) research focused on the long-term availability of water supply, and within this study, customers raised access to a reliable water supply as significantly important given the climate change pressures that are likely to impact supply in future.

> *'The only thing that matters to me is if I turn the tap on and no water comes out.' [Ref – Pg 27 Water Resources North Customer Engagement Report June 2021].*

Finally, in the qualitative Affordability and Acceptability testing phase of our draft plan following Ofwat guidelines, we included this enhancement case for customers as an optional additional investment of £126m at a customer cost of £1.47 per year to increase resilience for 135,000 customers who were more at risk of interruptions due to being on a single supply. More customers supported the inclusion of this additional investment than not, with remaining customers wanting to know more detail of the investment.

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In our quantitative study following Ofwat and CCWater Affordability and Acceptability testing guidelines we showcased this enhancement case as one of the six enhancement cases we

were permitted to present. The results were conclusive – 78% of customers found our plan acceptable, a plan which specifically included this enhancement case and the costs associated with it.

"Improved service is always a bonus especially if my bill does not rise too much." Bradford HH customer. [Affordability and Acceptability Qualitative Report August 2023.]

Given the importance of supply resilience to our customers across a range of our studies, including Ofwat and CCWater's study we believed including this enhancement case was vitally important.

To read more about our customer research, please visit Chapter 6 of our main business plan.

More detail on this subject can be found in
Chapter 6: Customer and Stakeholder Engagement

1.3.7 Factors Outside of Management Control

Drivers for this enhancement case are largely outside of management control. Base investment is available to address issues relating to existing assets, to ensure they are adequately managed, maintained and replaced as necessary under our wider asset planning approach. This reduces the likelihood of failure of existing assets at existing WTWs.

However, the investment proposed in this enhancement case is to increase our resilience to unexpected low likelihood, high impact events. Typically these events occur through a combination of factors, some of which are within and many of which are outside of our control. We cannot guarantee that extreme weather or raw water contamination will not cause our works to become non-operational or that assets will never fail as this would require unreasonable costly approaches to asset management that would not be efficient. However, we can ensure through resilience investment that the failure of assets has a much-reduced impact on customers and meets their expectations of providing a secure drinking water supply.

1.4 Best Option for Customers

1.4.1 Options Considered

Under the latest SEMD guidance (issued in February 2022) companies are obliged to have sufficient plans and resources in place to deliver alternative water supplies to the equivalent of 1.5% of the population that they serve. In our case this equates to around 34,000 properties. We have initially prioritised our resilience enhancement investment on those systems where the number of properties at risk exceeds that threshold.

This means that we should be able to provide at least the minimum level of service required under the SEMD legislation across all WSSs. From this baseline, we would expect to progressively enhance the ability of our systems to promptly restore a full piped water supply to all customers, in all but the most exceptional circumstances. The pace at which we achieve this will be determined by customer priorities and affordability constraints over future AMP periods.

As described, we carried out a full review of 8 of the 20 Strategic Planning Areas (SPAs) ahead of the finalisation of our PR24 business plan:

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1.4.2 Cost-Benefit Appraisal

A model to calculate resilience was developed to quantify the resilience benefits for each of the preferred solution options where a scope was developed.

Using five years of historic unplanned outage data for each WTW, an annual probability curve for each site was created for outages of varying duration. As part of the previous resilience assessments, survival times for each site were determined.These survival times were input into the model along with the most recent information of the properties at risk and properties without alternative supply for each WTW. The solutions developed in the WSS project were then individually input into the model to assess the impact on survival time, property-days lost and residual risk.

Alternative supplies have the effect of both lowering the water demand and lowering the households affected when the storage runs out, as the proportion of the zone supplied with the alternative supply can be valved off.

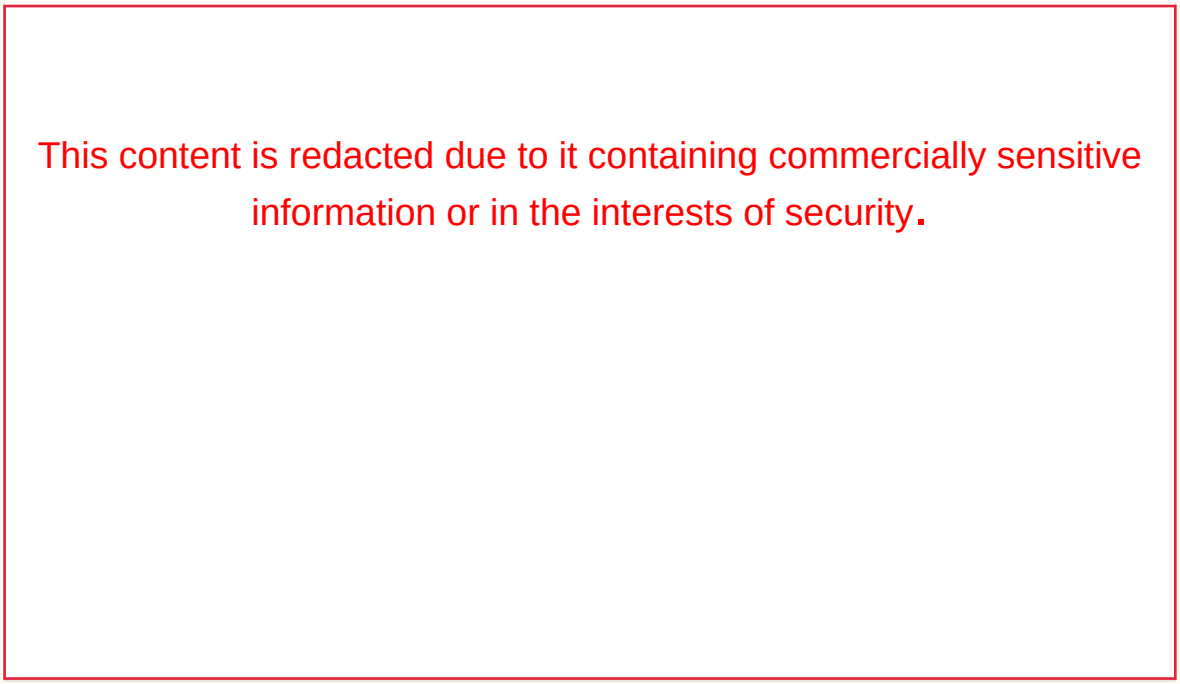
The resilience benefit model supports the overall strategy to improve resilience by considering network connectivity first, then storage, then treatment. The ability to bring in alternative supplies from elsewhere have a greater impact on reducing property-days lost.

1.4.2.1 AMP8 and AMP9

The impact of water supply interruptions for each system was quantified for each WTW as the property-days lost of supply. As described above, the overall SEMD guidance on single-source supplies formed the basis for prioritising sites and interventions for investment.

The number of properties without alternative supply within the water supply system for each water treatment works was determined and is plotted in Figure 1.2 below. There may be some variation in the exact number of properties at risk, depending on seasonal demand variation and other network operational factors.

Figure 1.2: Summary of Resilience Risk by Site (Orange line showing SEMD suggested threshold)



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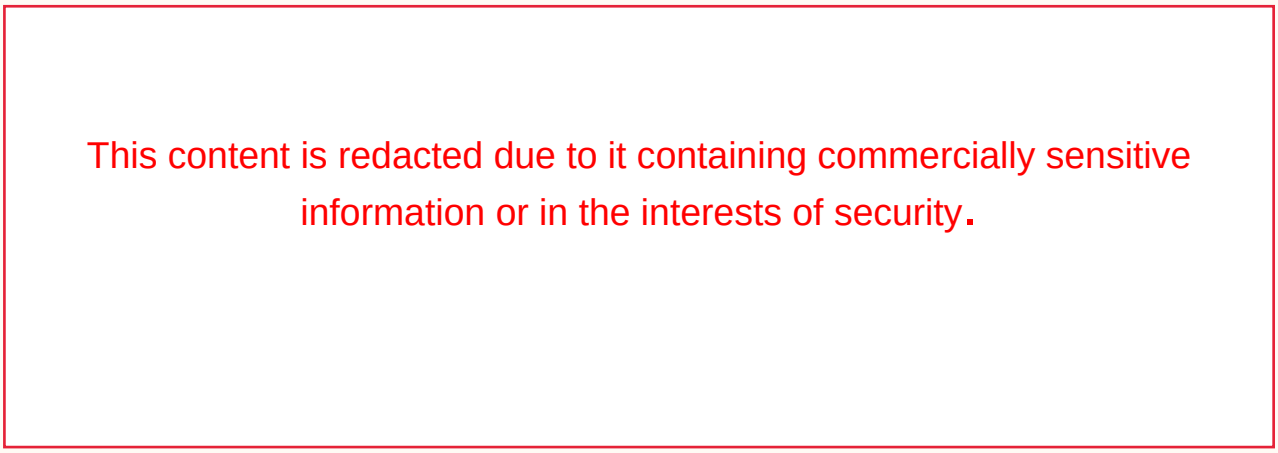
Based on the assessment process described above, the following schemes have been proposed for planned investment across the next two AMPs:



The table below summarises the short-listed options , including benefits, costs, cost benefit ratio and indication of the preferred option.

Table 1.4: Short-Listed Options

Solution Summary	Benefit (reduction in properties at risk)	Benefit (increase in survival time hours)	Benefit (Property-days reduction)	Totex Cost (£m)	EDA Cost Benefit Ratio	Preferred Option
	0	7	799	32.23	7.53	N
	135,598	90	5,144	95.53	3.10	N
	135,598	162	5,242	163.49	2.36	Y
	135,598	90	5,242	166.27	2.34	N

Content is redacted due to it containing commercially sensitive information or in the interests of security.

These costs have been based on a designed process to meet the specific challenges in the raw water and include an anticipated UV treatment process to increase resilience to cryptosporidium.

This investment reduces the number of properties solely supplied by over 135,000 to bring the system more in line with SEMD guidance. Additional storage in the network further mitigates the risk to potable water supplies, by increasing the survival time in response to an outage by 162 hours, to a total of 198 hours or over 8 days.

Other options considered but discounted:

Content is redacted due to it containing commercially sensitive information or in the interests of security

1.4.3 Carbon impact and best value

When calculating cost benefit, both embodied and operational carbon are considered as part of the assessment completed in YWs corporate risk system and framework. The table below summarises the carbon impact of each option.

Table 1.5: Carbon Impact

Solution Summary	Total Embodied Carbon, tCO2:	Total Annual Operational Carbon, tCO2/Yr
Content is redacted due to it containing commercially sensitive information or in the interests of security	12,269	1,841
	18,182	5,501
	50,534	5,501
	50,199	5,501

1.4.4 Impact Quantification

This investment is targeting low probability but high impacting events within a specific area in Yorkshire. We do not believe there will be an immediate benefit to the Unplanned Outage or Water Supply Interruption Performance Commitment in AMP8 due to both the expected duration of construction, and the nature of this investment addressing more strategic resilience rather than individual interruption to supply events.

The impact of the scheme will be to address the highest of our five identified unacceptable resilience risks from hazards that are beyond our control and aligns to our long-term risk management plan.

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1.4.5 Cost and Benefit Uncertainties

The notional solutions developed for the will be revised as we (and the DPC CAP) undertake site investigations, site selection and land purchase.

As this solution allows a connection to the Grid spine within Yorkshire, there are dependencies related to solution, which is in turn linked to

1.4.6 Third Party Funding

There is no third party funding for this case.

1.4.7 Direct Procurement for Customers (DPC)

This scheme is considered to be a suitable candidate for DPC. The project is considered suitably discrete, of the correct scale and with limited Operations & Maintenance and construction risks. The project would be considered viable, attractive and deliverable by a CAP and the timescales are suitable for DPC.

For more information on the process followed and the cases that were ultimately judged as suitable for DPC please see section 6.2 in Introduction to Enhancement Cases.

Operation and Maintenance

The ideal solution for the WTW and the water transfers would be a Design-Build-Finance-Operate-Maintain (DBFOM). If YW wanted to maintain overall control of the transfer pipeline it could retain operations of the pipeline, i.e., the transmission main becomes a DBFM.

BAU Procurement Approach

These projects fall within YWS and framework contractor's capabilities, similar projects have been delivered in the past. The project is under early stages of development, so the location of the WTW and routes for water transmission main are not yet finalised. There is still a reasonable element of development required to confirm the final scope.

Costs associated with DPC:

Table 1.6: DPC-Related Costs

Total AMP8 DPC related costs (£m)				
2025-26	2026-27	2027-28	2028-29	2029-30
1.009	1.009	1.009	1.009	1.009

1.5 Cost Efficiency

1.5.1 Cost estimate for our preferred options

This section outlines how our overall approach to cost estimation and cost efficiency, as outlined in section 7.3 in Introduction to Enhancement Cases, has been applied to this enhancement case. Table 1.1 at the beginning of this document summarises the costs associated with this enhancement case. The cost associated with the delivery of this scheme in AMP8 is £133.504m.

Ofwat guidance has been that water companies should look beyond single schemes to identify opportunities for Direct Procurement to Customers (DPC). As outlined earlier, we have identified a range of DPC opportunities which are included in this enhancement case. This has followed a rigorous optioneering process as outlined earlier in the document.

Our costing exercise has largely been driven by our Unit Cost Database (UCD) and Decision Making Framework processes. Our UCD system collects the historic costs of similar projects from across Yorkshire Water's activities. Following our optioneering process, we have been able to identify our scope for investment which have been able to leverage these costs to give us our expected costs. From here, we have been able to calculate the value of this DPC opportunity.

Efficiency of our cost estimate

Section 7.3 in Introduction to Enhancement Cases, outlines our approach to cost efficiency in enhancement cases, and how our internal process and delivery decisions are designed with efficiency in mind. In putting together these costs we have been proactive on challenging ourselves to ensure that our costs are efficient.

Our water resilience enhancement case includes a range of activities which are similar to projects carried out in previous AMPs. As a result, we have a reliable historic dataset in our UCD that we can leverage to provide accurate and efficient forecasted costs.

Further to this, given we propose a DPC route for this enhancement expenditure we anticipate bidders to potentially propose an optimisation of the solution and bring competitive tender to the approach which may drive further efficiency.

1.5.2 Need for enhancement model adjustment

Without a view of the Ofwat approach to setting cost allowances to each driver, anticipating any model adjustment requirements is challenging.

Due to the nature of this enhancement expenditure being a YW specific resilience case, it is unlikely that a comparable industry-wide data set will be available. We therefore anticipate that

Ofwat would normally assess these costs through a deep dive approach, but this may not be necessary with the DPC/markets-based approach being proposed.

1.6 External assurance

As outlined earlier in this enhancement case, Yorkshire Water contracted Arup to carry out external validation of our DPC selection against Ofwat's three DPC tests and HM Treasury's Value for Money tests. This review highlighted

- Value for Money against in-house delivery.
- Level of Market interest.
- Allocation of risk between Yorkshire Water and DPC providers.
- Assessment of customer costs in AMP8.

Our internal Unit Cost Database also has its own regular assurance process.

For more information on Assurance please see section 7.4 in Introduction to Enhancement Cases.

1.7 Customer Protection

Our enhancement totex does not meet the materiality threshold for PCDW16, because all enhancement funding is to be delivered via DPC.

For information on the methodology we have used and the central assumptions we have applied for our Price Control Deliverables (PCDs) please see section 8.2 in Introduction to Enhancement Cases.

1.7.1 Third Party Funding or Delivery Arrangements

As there is no third party funding being leveraged for this case this is not applicable.