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3.3.3 SUFFOLK RESILIENCE

TABLE WS2: WHOLESALE WATER CAPITAL AND OPERATING ENHANCEMENT EXPENDITURE BY PURPOSE

LINE 14: RESILIENCE

3.3.3 SUFFOLK RESILIENCE

Name of claim	Barsham SR/WPS and North Suffolk strategic mains resilience
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 14 Resilience
Total value of claim for AMP7	£14,540,000
Total opex of claim for AMP7	£0
Total capex of claim for AMP7	£14,540,000
Remaining capex required after AMP7 to complete construction	Expected to complete schemes by 2025
Whole life totex of claim	n/a
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	1.2%
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No
Need for investment/expenditure	Enhanced resilience
Need for the adjustment (if relevant)	Customer protection from loss of service risk
Best option for customers (if relevant)	Refer to main text of business case
Robustness and efficiency of claim's costs	Refer to main text of business case
Customer protection (if relevant)	Refer to main text of business case
Affordability (if relevant)	Refer to main text of business case
Board Assurance (if relevant)	Refer to main text of business case

Contents

Executive summary

This business case is about addressing localised supply risks in northern Suffolk which are connected to the increasing potential for abstraction to be limited at Ormesby and Barsham WTW. We do not consider this a water resource issue as the Suffolk Northern Central Water Resource Zone has a supply surplus at a zonal level. However, there are limitations on treated water transfer which create supply-demand risks. For this reason, we categorise the risks described in this business case as resilience issues. We propose to address these issues by introducing a new source of stored water with a water pumping station to protect 36,614 customer supplies from long duration supply interruptions and addressing some hydraulic restrictions on mains to improve water transfer capabilities across the wider area of North Suffolk.

Need
Two of our treatment works in northern Suffolk are increasingly at risk of being unable to abstract sufficient volumes of water to meet demand. Barsham WTW and Ormesby WTW are currently both single sources of supply for the populations they serve (36,614 and 43,570 properties respectively). They are affected by different intake risks which are beyond management control. The worst case impact on service would be that a large number of customers could experience an extended supply failure, which could last for 3 days in the case of Barsham works because of a lack of strategic storage in the network. Some properties supplied by the works would lose supplies within 20 minutes of any kind of outage. A supply interruption affecting such a large population in a rural area would be beyond our ability to respond well to under the SEMD regulations.

Options considered
We have used the recommendations of the North Suffolk Zonal Study (2012) as the basis for understanding our resilience risks and the options for the areas. We are proposing to deliver two interventions which were recommended by the study:

- A new service reservoir and pumping station to support transfers and provide storage for customers with no protection against supply limitations or outages at Barsham WTW: and
- Mains reinforcements to improve transfer capacity across the area.

Our optioneering looks at whether we should deliver one or both of these recommendations in the period 2020-25. We also looked at the capacity of the storage requirement. Our conclusion is that both of the original recommendations should be taken forward to delivery.

These schemes were collectively tested with customers and achieved 96% acceptance. The information shared with customers during research included illustrative costs and we were also clear that all our customers will pay for enhancements even if they do not directly benefit due to where they live.

Need for enhancement

This group of schemes aim to address a number of risks identified through:

- The North Suffolk Zonal Study 2012;
- Resilience Planning; and
- Operational insight on emerging issues.

Primary risk
The primary risk we are seeking to address relates to Barsham WTW. Barsham WTW abstracts from two sources. A series of boreholes typically abstract 56% of the total flow from groundwater with the other 44% being taken from the River Waveney, but under peak demand conditions the surface water abstraction must

flex and can increase to meet as much as 60% of demand. The River Waveney abstraction is a point of vulnerability because we have no bank side raw water storage to allow for changes in raw water quality. If a threat arises then abstraction from the river must be suspended and the treatment works must depend solely on the borehole supplies for a period. This could lead to a shortfall in supply. A further vulnerability surrounding Barsham is that the customers who are supplied by the works have very limited protection, in the form of treated water storage, from any outage that may occur. Some do not have access to any storage at all and would lose supply in the event of an outage within 20 minutes. This means a supply interruption could last as long as three days. Outages at treatment works can take 24 hours to resolve depending on the cause. It may take a further 48 hours to fully recharge the network and restore supplies to all affected properties.

Water quality risks are also a factor with a treatment works that lacks final water storage. Maintaining water quality standards for our customers with a process that is constantly having to react to demand is very difficult and we frequently have to manage flow changes across the treatment process in a 24 hour period to match the supply/demand profile of the network. The level of flow fluctuation creates a pulsing effect through the works that increases the risk of water quality failures. Our operational teams are constantly having to intervene manually to balance the treatment processes.

Wider context

It is also important to note the wider context in the northern Suffolk area. Suffolk is affected by significant seasonal demand variation because it is a popular holiday destination. It is also a water stressed area. This means there is the potential for unprecedented peaks in demand to arise and coincide with periods where water resources are at their lowest.

Ormesby WTW's abstraction from the Ormesby Broad is a significant risk at present. The works abstracts from two main sources: the Broad and the River Bure via Belaugh raw water pumping station. Both of these sources have abstraction license restrictions under drought conditions. Our Ormesby Broad abstraction licence had a cessation clause added on 1 April 2017 which we expect could be applied within the next five year period. As the Ormesby broad provides 40% of the total abstraction this would create a supply shortfall for the 43,570 properties which Ormesby supplies. A cessation clause could be in place for a matter of weeks or even months. For this reason, we are delivering a new link into the north Suffolk area with the Lound to Gorleston main which will be completed by 2020. This main will provide an alternative source of supply to allow for the cessation of abstraction from Ormesby broad.

The knock on effect of the Lound to Gorleston pipeline scheme will be to reduce resilience in the Barsham supply area which has vulnerabilities already, as described above. Barsham works will be needed to provide for the increased demand that we are expecting from the Lound to Gorleston link which means that during periods of drought the number of our customers that will be supplied from Barsham WTWs will increase, amplifying the resilience risks and potential impact of an outage. In addition, the lack of strategic storage will limit our ability to respond quickly with support from Barsham in an emergency situation, as there is no supply of treated water readily available to make significant transfers. There are also limits placed on transfer capability by hydraulic restrictions in the network.

3.3.3 SUFFOLK RESILIENCE

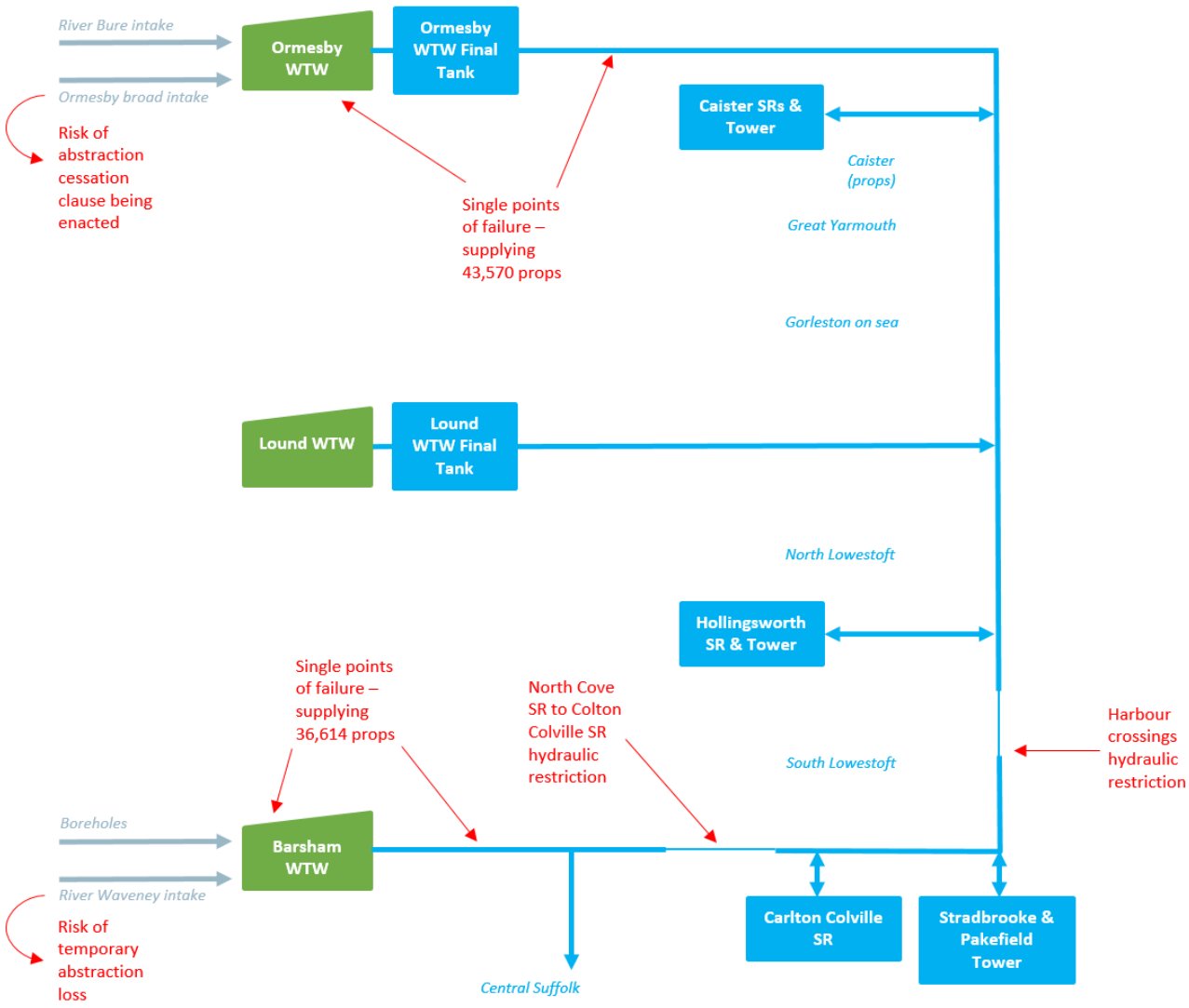

Figure 1: North Suffolk zone schematic highlighting issues

The existing mid- to long-term asset strategy for the area (as outlined in the North Suffolk Zonal Study of 2012) is for Barsham WTW to become a central 'hub' works, with improved linkages between Lound and Ormesby WTWs in order to improve flexibility in moving water around the system and address critical points of failure from a resilience perspective.

Although this needs case is connected with Unplanned Outage, the risk is a resilience issue of critical dependency on a single source. The solution we put forward to reduce the risk will not in any way influence our performance on the measure Unplanned Outage.

Failure mode

A number of failure modes could lead to service impact in North Suffolk. The primary risk relates to a lack of resilience in the chain of supply from Barsham WTW to its 36,614 customer properties and the potential for outages to lead to significant customer impact. These could be caused by factors beyond management control – specifically raw water quality deterioration in the River Waveney. The river water quality is and will always be vulnerable to rapid changes due to the nature of the catchment, river flows, and the presence agricultural pollutants along with occasional accidental pollution incidents as we have seen in the past. At

times, the water is treatable when blended with the bores process on site. When quality deteriorates beyond that point the process is run to waste, sometimes for days at a time until it becomes useable again. When this occurs the bores process is then pushed to its upper limit of capability for both filtrate quality and flow capability, increasing risk of failing either on water quality or supply capacity.

Our current Water Safety Plan for the 'River Waveney and catchment' highlights a number of key hazards which are recorded as only partially manageable. DWI code F 'Partial Mitigation' means "The control measures we have in place provide some mitigation, but to fully mitigate the risk we need additional control measures". The following hazards are scored as having a residual risk (remaining risk after control measures applied) of 8 or higher:

Table 1 – River Waveney catchment hazards from the Water Safety Plan

Hazardous Event	Hazard description	Control measures implemented by NWG	Control measures implemented by regulator
Algal bloom	A range of algal species that are known challenges for treatment processes. Taste and odour Chlorophyll	Catchment Management activities by Catchment Advisor (engagement, guidance, advice, events, campaigns, initiatives). Water quality monitoring. Abstraction Management.	Environment Agency - NVZ; DEFRA Cross Compliance - Standards of Good Agricultural Practice and Environmental Condition; DEFRA Cross Compliance - Statutory Management Requirements.
Application of fertiliser to land in catchment	Ammonium Nitrate Turbidity		
Livestock, wildlife, and animals	Ammonium Cryptosporidium Bacteria Nitrate		
Natural organic matter	Colour Total Organic Carbon Turbidity		
River/ lake/ reservoir dredging	Cryptosporidium Total Organic Carbon Turbidity		
Run-off from agricultural land	Ammonium Nitrate Total Pesticides		

Hazardous Event	Hazard description	Control measures implemented by NWG	Control measures implemented by regulator
	Individual pesticides, most problematic being Metaldehyde which is widely used in the catchment in autumn/winter and which cannot be removed with conventional treatment processes; other notables include Propyzamide, Bentazone, Carbetamide, Clopyralid. Total Organic Carbon Turbidity		
Run-off from farmyard hard-standings, silage clamps and/or manure stores	Ammonium Bacteria Cryptosporidium Nitrate Total Pesticides Individual pesticides, most problematic being Metaldehyde which cannot be removed with conventional treatment processes; other notables include Propyzamide, Bentazone, Carbetamide, Clopyralid. Turbidity		

Likelihood of failure

It is reasonable that we invest to be better prepared for raw water quality events to occur in future in light of the likelihood of failures occuring. There have been two incidents of pollution in the River Waveney in recent years:

1. An Environment Agency barge hydraulic hose burst. We stopped abstracting while the pollution was cleared up / passed our abstraction intake.
2. A chemical spill on Broome Beck, a tributary of the River Waveney. We were contacted by the EA and we ceased abstraction while the pollution was cleared up.

The increasing impacts of climate change have been visible in Suffolk for many years. Since April 2017 we have already been close to having to implement the Ormesby Broad cessation clause. This would apply if the water level reduced to -0.44mAOD, established using the lowest level reached in Suffolk's worst historic drought period from the end of 1996/97 to the start of 1997/98. It is likely that it will be implemented over the next five years.

3.3.3 SUFFOLK RESILIENCE

Defra wrote in their letter of approval for the ESW Water Resource Management Plan that "The prolonged dry weather in 2018 highlighted the ongoing resilience issues with the Ormesby Broad and associated abstractions".[1] Defra requires that we undertake a drought assessment for these sources in time for the first annual review of its WRMP.

Why mitigation against failure is beyond management control

We are currently undertaking a number of management control actions to ensure our customers supplied from Barsham WTW and in the wider area of northern Suffolk do not experience a loss of supply or an enforced supply restriction. These include:

- The production, every five years, of a Water Resource Management Plan to ensure we plan and invest to secure and store sufficient raw water to meet current and future demand from customers;
- The delivery of a new pipeline from Lound to Gorleston to mitigate temporary reductions to supply from Ormesby WTW;
- Proactive catchment management alongside local land owners and users to reduce their impact on raw water quality and quantity as much as possible;
- Annual planned and preventative maintenance (PPM) activity on our assets such as pumps, filters, clairifiers, dosing and control systems, isolation valves etc. Frequency of PPM is determined by the type of asset and the risk it presents to disruption of service if it fails or performance deteriorates;
- A further zonal study of the Suffolk system, expected to be concluded in 2021, is exploring opportunities that deliver a more sustainable and resilient network into the future.

None of these management controls fully address the risks surrounding Barsham WTW and the wider area.

Impact on customer service

The consequences of losing part of the supply capability at Barsham WTW could be very serious – whatever the cause. A large number of customer properties (36,614) would be affected. Customers in this supply area are not well protected with stored water and so the impact could be especially prolonged, lasting for up to three days. It would be necessary to enforce stringent restrictions on customer consumption and it is likely that supply interruptions would occur intermittently due to water shortages. There would be a risk of localised depressurisation of the water distribution network, leading to subsequent water quality risks such as ingress. Customers could experience discolouration, aeration and taste and odour issues and even be subject to a 'do not use' notice if ingress was identified. Our customers tell us this is the worst possible service impact they could experience, after sewer flooding in the home.

Why the consequences of failure would be beyond management control

We have Strategic Outage plans for our water treatment works which detail how we will respond in the event of losing supply. However, these relate to short term outages. This business case relates to the potential for more sustained supply impacts which would be very difficult to manage. We may be forced to turn to enforcing supply restrictions to prevent intermittent supply interruptions or network depressurisation. This would represent a level of service failure in itself, but it also could not guarantee avoided supply interruptions or water quality issues.

If a more temporary supply interruption was occurring our management control would rely on our ability to provide customers with an alternative water supply as per the SEMD regulations. The number of properties supplied by Barsham WTW is well in excess of our current and future alternative water supplies capability as such we would struggle to cope with interruption events of this scale in such rural locations. It's highly probable we would be required to seek support via mutual aid from other water companies and governmental agencies.

[1] Defra, Letter of approval of ESW Water Resource Management Plan, July 2019.

Customer and stakeholder expectation

Customer engagement

Our discretionary enhancements package has been developed in participation with 3,297 household and non-household customers and stakeholders and reflects their priorities and tolerance of risk. We explain this process in some detail in our document 'Our approach to identifying discretionary enhancements'.

The schemes in this business case, to address the supply risk resulting from large populations' dependence on single treatment sources in northern Suffolk, have been prioritised through our conversation with customers over a period of several years of planning for PR19.

In our initial engagement with customers about resilience for PR19 planning ('Resilience' research project, 2016) our customers identified the worst water service failings they could experience from a pre-defined list of potential service impacts we provided. The worst service impact they identified was "sewer flooding inside your home following a period of heavy rainfall". After this, the next worst impacts identified by our customers were "a 'do not use' water notice as there is a risk to your health if water is touched for five days", and "an unexpected interruption to the water supply to your home for more than six days."

Although customers accept that supply interruptions may occur, it is clear that extended supply interruptions lasting several days would not be acceptable and could lead to a loss of trust. *Explain* summarised this in their report: "Prolonged interruptions and severe issues such as flooding in the home were felt to indicate a fundamental failure in [the] system which could cause customers and stakeholders to lose confidence." Some participants commented that following an unexpected interruption they would expect us to restore their water supply within 24 hours. We are introducing a measure of supply interruptions over 12 hours from 2020 as an indicator of resilience and we would count anything longer than this as being an 'extended interruption'. Our start point for resilience planning was that we should look to prevent such incidents from ever occurring.

We have looked at our asset systems from source to tap and identified weaknesses which could lead to extended supply interruptions or 'do not use' notices being required. In northern Suffolk there are two treatment works which are absolutely critical to the populations they supply as they cannot be supported by alternative treatment sources.

Dependency on a single source of supply - particularly a single treatment source - has been a recurring theme in our conversations with customers on the subject of resilience. In the 2016 'Resilience' project our customers assumed that alternative sources of supply would already be available for emergency situations. We engaged with customers on the subject of 'Resilience, asset health and long-term affordability' in early 2018 and shared a number of resilience scenarios to understand customer expectations around resilience planning. In one scenario we said that over 60,000 properties could be impacted by a long duration supply interruption. Our customers' response was that such incidents should never be 'allowed' to occur. Our customers were shocked to find that a community of this size would 'only' be supported by one source of supply.

This research also included the question of whether customers would be willing to pay for improvements to asset health and resilience, if it was a case of taking a smaller reduction to bills than the 10% we were planning to make as a minimum. Two thirds of customers were in favour of waiving the full 10% of our planned bill reduction for investment in resilience and asset health. We took this as a strong indication that customers would be willing to fund a discretionary package of prioritised enhancements to strengthen resilience.

In March 2018 we conducted four deliberative workshops in our Essex and Suffolk operating regions to explore participants' acceptability of a shortlist of specific discretionary enhancement schemes. The schemes were presented in the context of a commitment from us that by 2020 customers' bills would be reduced by 10% and that the schemes could be funded by making the 10% reduction smaller.

The schemes we tested included a new main between Barsham and Lound, a new service reservoir in Barsham and relocation of a water pumping station at Barsham water treatment works. Participants were told that:

> *~60,000 properties in Great Yarmouth receive their water from Ormesby water treatment works. If this works failed Essex & Suffolk water would be unable to supply these properties with water.*
>
> *~30,000 properties which receive their water from Barsham water treatment works would lose their supply of water if this works failed. Some of these properties would be without their supply within 20 minutes.*

We told participants that the work we proposed to do would decrease the likelihood of half of the ~60,000 properties in Great Yarmouth experiencing a loss of supply if Ormesby WTWs failed and would provide an alternative supply to ~30,000 properties for up to three days if Barsham WTWs failed.

Participants were asked whether or not they accepted funding these schemes in return for taking 0.5% less of the 10% bill decrease we had committed to giving. They were told that this would be equivalent to £1.24 per year. This scheme achieved 100% acceptance from customers.

We presented this result to the Enhancement Sub Group of the Water Forums on 19 April 2018. Members agreed that the overall customer engagement approach and rigour was good and noted that they were not surprised at the high levels of acceptance for all water schemes as they are very specific with specific benefits.

All our enhancements were presented back to participants at our PR19 Acceptability Research deliberative workshops. They were available on request to the quantitative research participants. In overall acceptability research, Our Plan was supported by 91% of customers.

Regulatory expectations

On 09 August 2018, Defra, the Environment Agency, the Drinking Water Inspectorate and Ofwat wrote to the water sector companies to set out expectations to build resilience in water resources management in England.

Ofwat stated in 2017 that “resilience should be at the core of how the sector plans to deliver its services to customers”[2], highlighting the importance of resilience to business planning and its potential to bring benefits to customers. Investments in resilience generally have multi-faceted benefits that range from reducing the risk of events with low probabilities and high consequences to being able to manage our networks in a more flexible way.

(2) Ofwat (2017), Resilience in the round https://www.ofwat.gov.uk/wp-content/uploads/2017/09/Resilience-in-the-Round-report.pdf

Our track record - Service delivery and expenditure prior to AMP7

We consider resilience as the ability of assets, networks and systems to anticipate, absorb, adapt to and/or rapidly recover from disruptive events. The UK government sets out that there are different ways in which resilience provision can be delivered. These are categorised as:

Redundancy	avoiding dependencies on single assets
Resistance	proofing the system so that it is resistant to known risks – for example, flood defences or access procedures
Reliability	a system that operates effectively irrespective of whether or not risks materialise – for example, design standards
Response/recovery	the ability to recover quickly so that service is not unduly impacted – that is, tested procedures and appropriate resources

We have shown strong resilience in our service provision, in particular around the response and recovery aspects of resilience. In 2018 the 'beast from the east' caused major impacts to services and widespread travel disruption. There was also an impact on water services across the UK and Ofwat completed a review after the event to identify strengths and shortcomings to identify how the industry should improve. Through that review process we were able to evidence our very strong performance through that particular resilience challenge and highlight some of the activities undertaken. The actions that underpin our strong response and recovery capability include:

- Optimisation of our assets and resources to provide maximum value and resilience for our customers. Examples include our water supply planning processes; our operational risk assessment (coordination planning) process; and the outage plans developed for each water treatment works.
- Training and companywide processes. Examples include calm networks operational training; and we were one of the first two companies awarded the new competent operator framework by EU Skills.

Our asset base is also resilient. For example, most of our water treatment works have some level of redundancy through duplicated chemical dosing systems and two or more treatment streams, allowing some water supply provision to continue to be made in the event of an outage, asset failure or maintenance. Our assets also feature strong resistance through appropriately graded security covers, doors and monitoring/control and alarm systems. These are all supported by operational procedures which are tested through simulated and real circumstances.

Our approach to resilience planning is highlighted in the document 'Our approach to identifying discretionary enhancements'. Through this robust process we have identified our highest resilience risks and then developed solutions which will greatly reduce these risks by lessening the severity and/or likelihood of the impact on customers.

We are confident that we can deliver major projects in the 2020-25 period. We have an excellent track record in delivering major expenditure commitments. Some examples include:

- The Abberton reservoir 58% increase in capacity from 25,500 to 41,500Ml.
- The Acceptability of Drinking Water programme, cleaning in excess of 380km of trunk mains, including 16km duplication of a key trunk main on Tyneside.
- The development of new treatment works assets at Horsley WTW (2006), Wear Valley WTW (2003), Lound WTW DAF (2004).
- The Section 19 mains rehabilitation programme replacing circa 1020km of small diameter distribution mains.

Forward looking analysis

Preparing better for the impacts of climate change is key strand to the UK government's policy for the water industry, which identifies resilience as a key priority. It considers it to be an issue which is not only urgent in the present but also developing into an even greater challenge for the future:

> *Resilience is vital to current and future customers. The water sector faces serious resilience challenges including climate change and population growth, which present real threats to the resilience of assets, water resources and services to customers. The combination of these threats and changes in people's expectations – including about how we treat the environment itself – makes tackling these resilience challenges urgent.*

Our Water Resources Management Plan for Essex and Suffolk states that whilst our water resource zones are all in surplus across the planning horizon, our supply zones are located within some of the driest areas of the country and as such face particular challenges including growing demand, uncertainty from climate change and a general lack of new intrinsic water resources. These challenges are already being felt by us as a result of climate change and population growth. Our customers' expectations are simultaneously rising and they expect us to plan ahead so that they do not bear the consequences of our inaction to mitigate the effects of climate change. In northern Suffolk we lack the ability to transfer treated water and manage localised supply issues which is why we are delivering the Lound to Gorleston main. Further investment is needed in AMP7 to address resilience risks connected with Barsham WTW and its supply area.

Options considered

The North Suffolk Zonal Study was completed in 2012 and a series of recommendations were developed from that study. We are already delivering one of the recommended interventions, the Lound to Gorleston main, in AMP6.

For this PR19 submission we have identified a number of further recommendations to improve resilience and prevent the service failings that our customers have identified as their top priorities.

As part of its PR19 Final Methodology, Ofwat has noted that it will assess the robustness and efficiency of all enhancement costs to ensure that any enhancement options put forward by the water companies represent the best options for customers. We have used CBA in order to support a significant number of enhancement investment proposals. A common CBA model was applied across all schemes which ensured consistency in our assumptions and approach to analysis.

The following sections describe the options considered, our approach to costing, and then our cost-benefit analysis.

Overview of options considered

The North Suffolk Zonal Study 2012 is NWG's overarching strategy for delivering improvements in the North Suffolk area in response to identified issues in terms of both risks to supply and predicted future growth in the area. The study identified the requirement to increase storage and network connectivity in the area for the purposes of resilience. In formulating the strategy the study considered current and emerging service risks in the system, before specifically considering appropriate solutions.

Table 2 shows the list of resilience projects recommended in the study. The majority of the recommendations have now been delivered. We propose to deliver the three remaining resilience schemes this AMP.

3.3.3 SUFFOLK RESILIENCE

Table 2 – North Suffolk Zonal Study (2012) resilience projects

Scheme	Description	Priority	Status
Lound to Bradwell Main	3.5km x 600mm main – possibly via Beacon Park development + 1.3km x 450mm main	High	AMP6 project
Lound to Gorleston Pumping Plant	Duty / Standby plant – nominal duty 18 Ml/day @ approx. 45m lift (needs to derive outlet head of 55m)	High	AMP6 project
North Cove to Carlton	3.75km x 600mm extension to existing main	High	PR19
South Lowestoft Reinforcement	0.6km x 450mm extension to existing main	High	PR19
Lowestoft Harbour Crossing	Reinstatement of damaged crossing	High	Completed
Barsham Reservoir and Pumping Station	New 20 Ml Reservoir and replacement of all pumping plant	Med	PR19
Shadingfield to Alder Carr	10.4km x 300mm duplicate main	High	Completed
Barsham to Shadingfield	5.5km x 300mm duplicate main	Low	Completed

The schematic below demonstrates where and how the proposed solutions would be implemented.

3.3.3 SUFFOLK RESILIENCE

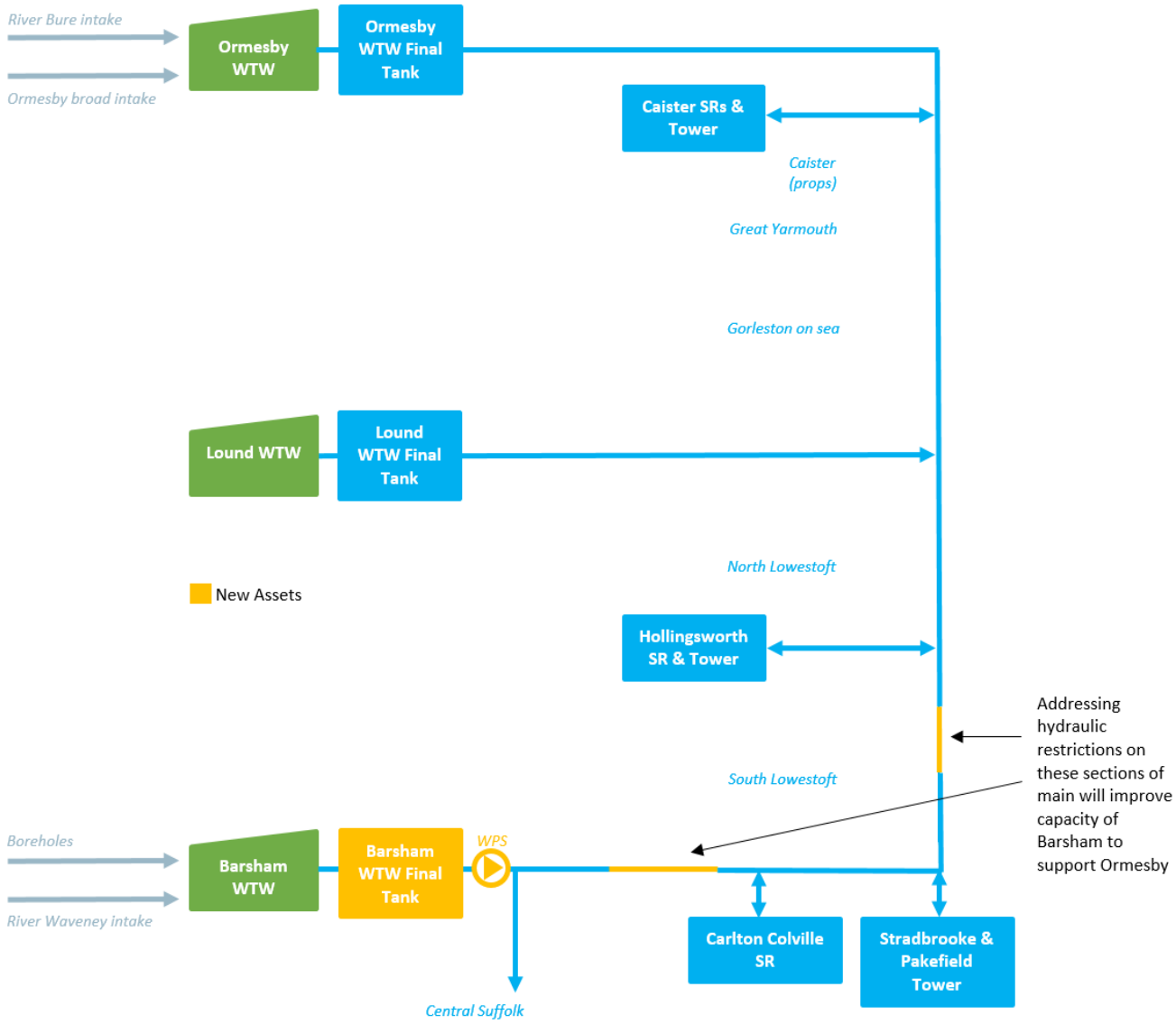

Figure 2: North Suffolk zone schematic highlighting proposed solution

Given that our zonal study had already recommended schemes for delivery to resolve the identified resilience risks, our optioneering for PR19 was more focused around whether to deliver either or both of the two component parts of this business case that remained on the list of recommendations. We could not identify any alternative to the mains reinforcement schemes that would be worth comparing with this low cost, high value intervention. We have, however, considered an alternative sizing of the reservoir at Barsham.

Option 0: Do nothing

Doing nothing in AMP7 would leave large numbers of customers, in relatively isolated locations, at risk of significant resilience-scale service failures. The introduction of the cessation clause at Ormesby Broad is an important recent development which increases the importance of Barsham WTW in the future. The current risks associated with the lack of storage both before and after treatment, together with the experience of drought in 2018, lead us to the view that we must intervene to address resilience risks in North Suffolk in the period 2020-25.

Option 1: Deliver mains reinforcements and improve transfer capability

Capex £4.1m

Lay 4.3 km of strategic main to address hydraulic restrictions which currently restrict the transfer capability between Barsham, Lound and Ormesby WTWs.

The risk of loss of ~40% capacity at Ormesby WTW will soon be manageable upon completion of the Lound to Gorleston pipeline project. By reinforcing sections of the mains from North Cove to Carlton and at Lowestoft Harbour, the capacity to transfer supplies up into the more resource constrained part of north Suffolk will be strengthened. This will further reduce the risk of the supplies of 43,570 properties in Great Yarmouth and the surrounding area being impacted by any supply restrictions at Ormesby WTW.

This option would help to address the wider context in north Suffolk but the primary risk at Barsham would not be addressed by this solution, leaving 36,614 properties at risk of protracted supply disruption which could last up to 3 days.

Option 2: Deliver new 20 Ml service reservoir and water pumping station at Barsham WTW

Capex £10.44m

Constructing a new 20 Ml service reservoir and relocating an existing water pumping station at Barsham WTW will provide 24 hours of storage for 36,614 properties served by Barsham WTW and significantly reduce the risk of a large loss of supply event – avoiding any impact from an outage that lasted up to 24 hours. In the worst case scenario of an incident lasting more than 24 hours some customers may be impacted but on a shorter term basis and at a scale which would be more manageable.

The presence of storage would also make better provision for unprecedented peaks in demand further north which Barsham treatment works may not be able to respond to at present, although hydraulic restrictions would still apply and limit the benefits for customers in these areas.

Option 3: Deliver new 30 Ml service reservoir and water pumping station at Barsham WTW

Capex £12.01m

As an outage at Barsham could last up to 3 days and this could coincide with a period of unprecedented high demand, we have considered going beyond the recommended 20 Ml reservoir capacity to make allowance for these factors. This option would go further than option 3 in addressing the primary risks, but as with option 2 the wider transfer benefits would not be achieved.

Option 4: Deliver mains reinforcements and new 20 Ml service reservoir and water pumping station at Barsham WTW

Capex £14.54m

Delivery of both the mains reinforcements and the new storage and pumping station in combination will bring the best overall risk reduction and ensure the maximum benefit from the scheme. This will provide a source of treated water which can be instantaneously drawn upon to meet significant changes in demand on Barsham works without impacting on supplies. The mains reinforcement project will simultaneously enable us to realise the full benefits of the new service reservoir and pumping station at Barsham by extending its reach.

Option 5: Deliver mains reinforcements and new 30 Ml service reservoir and water pumping station at Barsham WTW

Capex £16.11m

This option is offers the best resilience benefit of all, with additional storage capacity to allow for unprecedented periods of demand, or an outage that lasted over 24 hours, or allows for water to be transferred north without depleting storage levels to a point that may leave those properties which are supplied by Barsham at risk.

Costing of options

NWG has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives. The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third party assurance provided by Mott Macdonald in July 20183.

In June 2019, NWG commissioned a shadow pricing exercise by our contractor partners and commercial consultants for preferred option costs for each of the enhancement projects. The purpose of this exercise was to benchmark the costs produced by NWG's iMOD system against the market. The result of this exercise showed that NWG's cost estimates were on average 15% lower than the cost estimates returned by our contractor partners and 7% higher than the cost estimates returned by our commercial consultants Turner & Townsend. This gives confidence that the cost estimates produce by the iMOD system for the enhancement projects are efficient.

Cost-benefit analysis

We have undertaken our cost-benefit assessment on the basis of the avoided risk of long supply interruptions. This is one of the major benefits from the scheme that can be quantified and we have a customer valuation for interruptions greater than 12 hours from our customer valuation research conducted collaboratively with Explain, Frontier Economics and Supercharge4.

The valuation result from the research was that customers value 12-hour supply interruptions at £6,599 per property. There is a reduced risk of supply interruptions to the 80,184 properties that are reliant on Barsham WTW.

This approach has limitations as it does not value the full scale of the benefits. For example, benefits such as avoided discoloration or odour contacts are not included. Nevertheless, it provides a clear valuation for the key change in service level that results from our investment.

Based on our approach to CBA and risk reduction, we are able to calculate the benefit to customers for each option considered. These can be compared by their benefit cost ratio (BCR) and risk reduction for each intervention, analysed through NWL's risk reduction AMPS system. Both the BCR and the risk reductions for the interventions are presented in the table below.

[3] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

[4] NWG PR19 Research Tool, Striking the right balance between delivering business plan insights and cognitively valid results, January 2018.

Table 2: Risk reduction and benefit cost ratio (BCR) for the individual projects

Project number	Customers benefitting (Nr Properties)	Totex (£m)	£ per customer benefitted	Risk Score - Before	Risk Score - After	Risk Reduction delivered	BCR
Option 1	43,570	4.10	£94.10	70.70	35.35	35.35	39.42
Option 2	36,614	10.44	£285.14	58.83	5.88	52.95	16.16
Option 3	36,614	12.01	£328.02	58.83	2.35	56.48	15.57
Option 4	80,184	14.54	£181.33	128.87	2.58	126.29	30.09
Option 5	80,184	16.11	£200.91	128.87	0.26	128.61	28.27

The cost benefit analysis shows that Option 1 provides the highest BCR but this simply reflects the way this intervention offers a highly cost beneficial enhancement. It does not address the primary risks at Barsham WTW, which is why we have selected Option 4 which is the most beneficial option for the largest number of customers.

We estimate total customer benefits of £513m. This is likely to be a conservative estimate as it only includes the benefits from avoiding long supply interruption but does not capture any other benefits.

Lastly, we estimate the benefit-cost ratio based on the present value of the total costs set out above. Assuming a discount rate of 3.5%, these costs amount to £17.047m, and implies a benefit cost ratio (BCR) of 30.09. Therefore, the implied benefit to customers exceeds the costs that they would incur from supporting the enhancement.

We acknowledge that this BCR is relatively high, which is driven by the customer valuation in our research. We have estimated that the investment would be cost-beneficial as long as the valuation of individual supply interruptions is higher than £218. A comparative review of PR19 willingness-to-pay estimates prepared by Accent and PJM Economics shows that the average willingness to pay[5] to avoid unplanned supply interruptions of up to 24 hours is £553. This valuation implies a BCR of 2.53, indicating that customer benefits would exceed costs by 153% even when this more conservative value is used.

Our preferred plan/option

Our approach to defining the preferred option was established through analysis of the risk reduction, £ benefit per customer, CBA and importantly through engagement sessions with customers. We propose to deliver Option 4 as delivering the network and storage schemes in combination will maximise the benefit for customers. We have chosen not to go beyond the original recommended capacity for the proposed service reservoir at Barsham (Option 5). The resilience of the zone will be under review in the short term as we deliver another zonal study and the drought assessment required by Defra, so we will await the outputs of these activities before considering further resilience enhancements.

[5] This is based on three independent willingness to pay estimates for unplanned supply interruptions ranging up to 24 hours.

3.3.3 SUFFOLK RESILIENCE

Summary of totex

This proposed investment is included in table WS2 line 14: Resilience. We are resubmitting this table on 30/08/2019 with our response to the draft determination, as required.

Below we provide Table 3 summarising breakdown of our resilience package including how it has changed between our business plan resubmission on 01/04/2019 and the package we are proposing as part of our draft determination response on 30/08/2019.

Table 3: Breakdown of table WS2 line 14

Region	Scheme	April 2019 Totex (£m)	August 2019 Totex (£m)
Essex	Abberton to Hanningfield raw water transfer via Langford	20.350	20.350
Northumbrian	Cross connection C60/C60a	0.210	0.210
Northumbrian	Duplicate Chirton SR outlet main (315m of 700mm)	0.400	0.400
Essex	Herongate SR (30m of 900mm main)	0.230	0.230
Northumbrian	Replace 37.5km 600mm with 800mm main	14.08	0.000
Northumbrian	Whorley to Shildon main (16km of 800mm)	19.200	19.200
Northumbrian	Carr Hill link main to Springwell SR (1.5km of 600mm)	3.000	3.000
Northumbrian	Springwell SR to Pikes Hole main + EOV (7km of 1000mm)	14.860	14.860
Northumbrian	Heworth to Pikes Hole main + EOV (4km of 1000mm)	8.520	0.000
Northumbrian	Shildon SR WPS (55Ml)	3.160	3.160
Northumbrian	Maltby SR inlet/outlet arrangement	5.400	0.000
Northumbrian	Ormesby WPS modifications and SR abandonment	0.700	0.000
Suffolk	North Cove and South Lowestoft flow restriction removal	4.100	4.100
Suffolk	Barsham WTW treated water storage and WPS	10.140	10.140
Northumbrian	Springwell SR 62Ml size	16.200	16.200
All	Too critical to fail	8.340	4.690
Totals		**128.89**	**96.54**

Affordability

The impact of these enhancement investments on customer bills are shown below with this scheme costing customers a one off cost of £0.43 on their bill between 2020 and 20256.

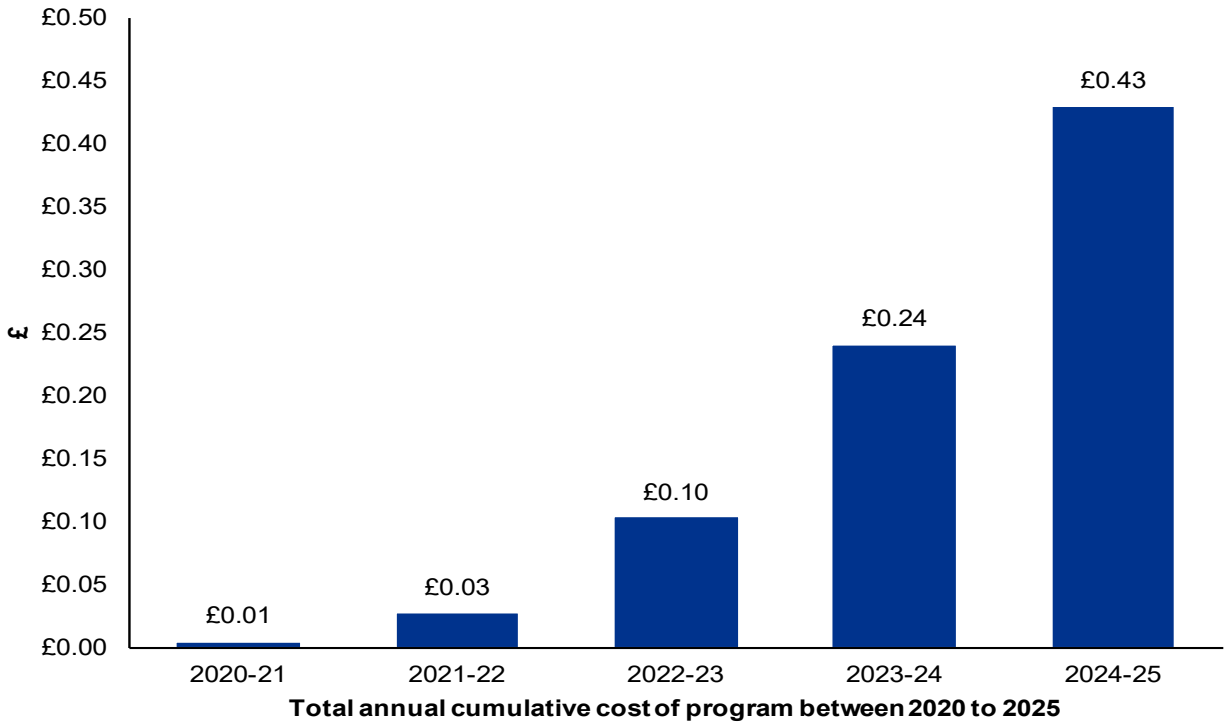

Figure: Impact of enhancements on customer bills.

We shared details of our plans with customers at two phases of discretionary enhancement research with 193 customers. Participants were asked if they would be willing to return a portion of the 10% bill decrease we had committed to giving to fund this and other enhancements.

Our final plan includes an overall reduction in bills of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum 7 driving significant improvements to average customer affordability. For the Business Plan, Northumbrian Water commissioned Economic Insight to forecast the Relative Price Effects adjustment for capex enhancements. This was assessed at around 1% pa over 2020-25. We separately set ourselves an annual efficiency target for capex enhancements of 1% pa.

We recognise that affordability will remain a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most

[6] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

[7] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

vulnerable customers including specific proposals to eradicate water poverty by 20308 and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Alignment with stakeholder needs

Regulators and other stakeholders
In our PR14 WRMP, we committed to completing the Lound to Gorleston Transfer main. In our PR19 WRMP, we confirmed progress with laying the main and stated that the pumping station will be commissioned in 2020 demonstrating good progress with our plan for this region.

Option 4 (Deliver mains reinforcements and new 20 Ml service reservoir and water pumping station at Barsham WTW) above, is designed to meet customers' needs in a safe, resilient and efficient way, while protecting the environment and respecting good supply practice and the needs of other water users.

Customer protection
Details of how we propose to incentivise delivery of our proposed enhancement schemes and to protect customers from non-delivery are included in section 4 of the April 2019 business plan.

Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases9.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers[10].

[8] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

[9] For further detail on how the Board has challenged our enhancement cases and the response from management please see our 'Board engagement on enhancement cases document'

[10] See Board Assurance Statement