Climate Adaptation Report

December 2021

NWG
living water

Contents

The River Tees, Barnard Castle, County Durham

Executive summary

Climate change: Why it's such a big deal

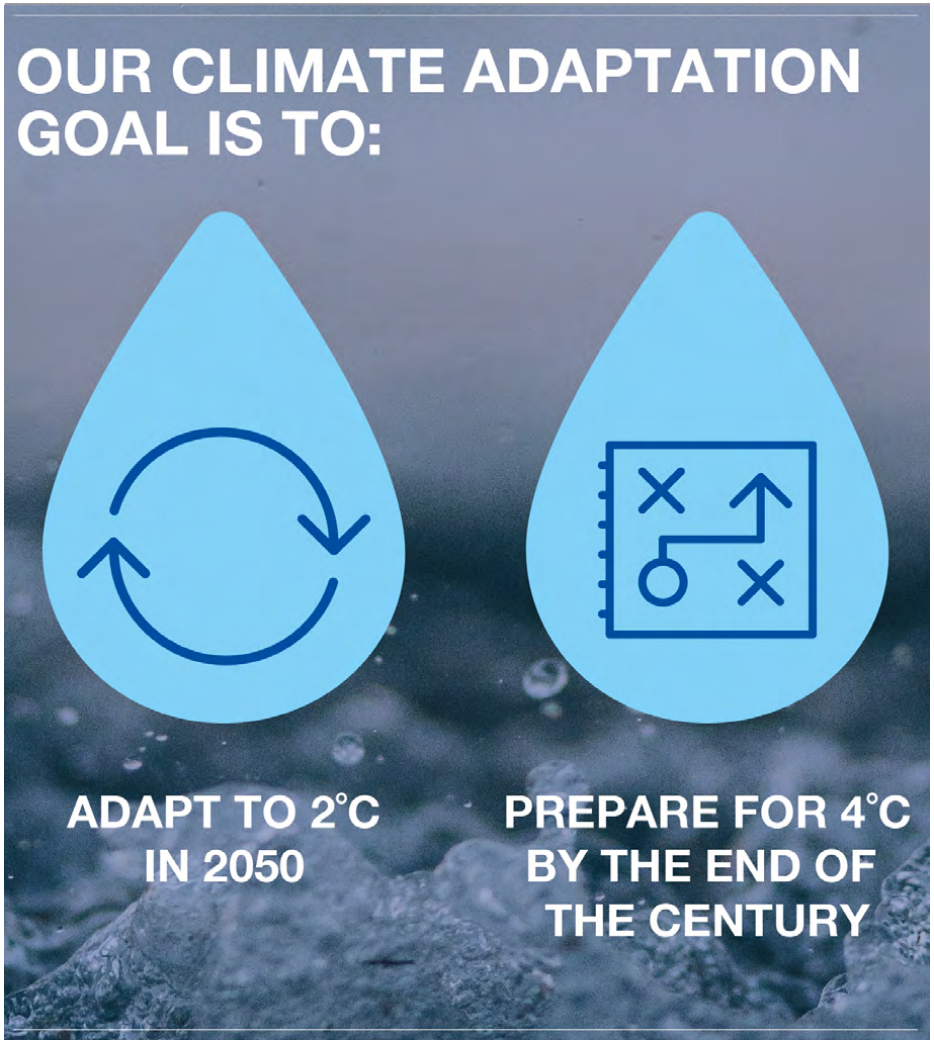
Global warming is disrupting our climate.

Affecting weather patterns. Causing serious challenges to the world's water supply. Our infrastructure is ageing. Clean, clear water is an essential need of our communities and the environment now, and for generations to come. That's why the work needs to happen now. The investment needs to happen now. The time. The effort. Preparing for, and responding to, climate change had to become a core part of our work.

Thunderstorms. Drought. Extreme temperatures. Flash floods. The water industry is so susceptible to these climate hazards. Our customers recognise this too. They've told us that investing now for the future to prepare for severe weather is important to them, and we're listening.

Our goal is to adapt to a world that is 2ºC warmer in 2050. At the same time, we will assess the risks and plan for the effects of more extreme warming by the end of the century. This way, we will be able to prepare for projects that take a long time to implement.

We will use this goal as the basis to plan and decide on investment in water resources and drainage for the long term.



Our key climate risks

Climate change increases the likelihood of climate hazards such as drought, flooding, extreme temperatures, and sea level rise in the UK. We've assessed our key climate risks to understand how they will change, looking towards the end of the century, for our communities in the north east and south east of England.

KEY CLIMATE RISK AND CLIMATE METRIC	RCP 4.5 - 2050S (ADAPT TO 2°C) HAZARD TREND	RCP 8.5 - 2090S (PREPARE FOR 4°C) HAZARD TREND
FLOODING		
Mean winter precipitation (% change) median projection	↑ 6%	↑ 21%
Local sea level rise (NE England)	0.07 to 0.23m	0.25 to 0.76m
Local sea level rise (SE England)	0.18 to 0.35m	0.46 to 0.97m
DROUGHT		
Mean summer precipitation change (% change) median projection (NE England)	↑ -10%	↑ -25%
Mean summer precipitation change (% change) median projection (SE England)	-15%	-37%
Hot spells	→ Minimal change	↑ 4 or more hot spells per year
EXTREME TEMPERATURES		
Daily maximum temperatures, 50 year return period (NE England)	→ Minimal change	↑ 32°C to 39°C
Daily maximum temperatures, 50 year return period (SE England)	→ Minimal change	↑ 37°C to 45°C

N.B. Hazard trend highlights which of our risks are most pressing, those with icon: ↑ indicates a high-priority area with the hazard increasing, the icon → indicates limited changes so are less pressing issues

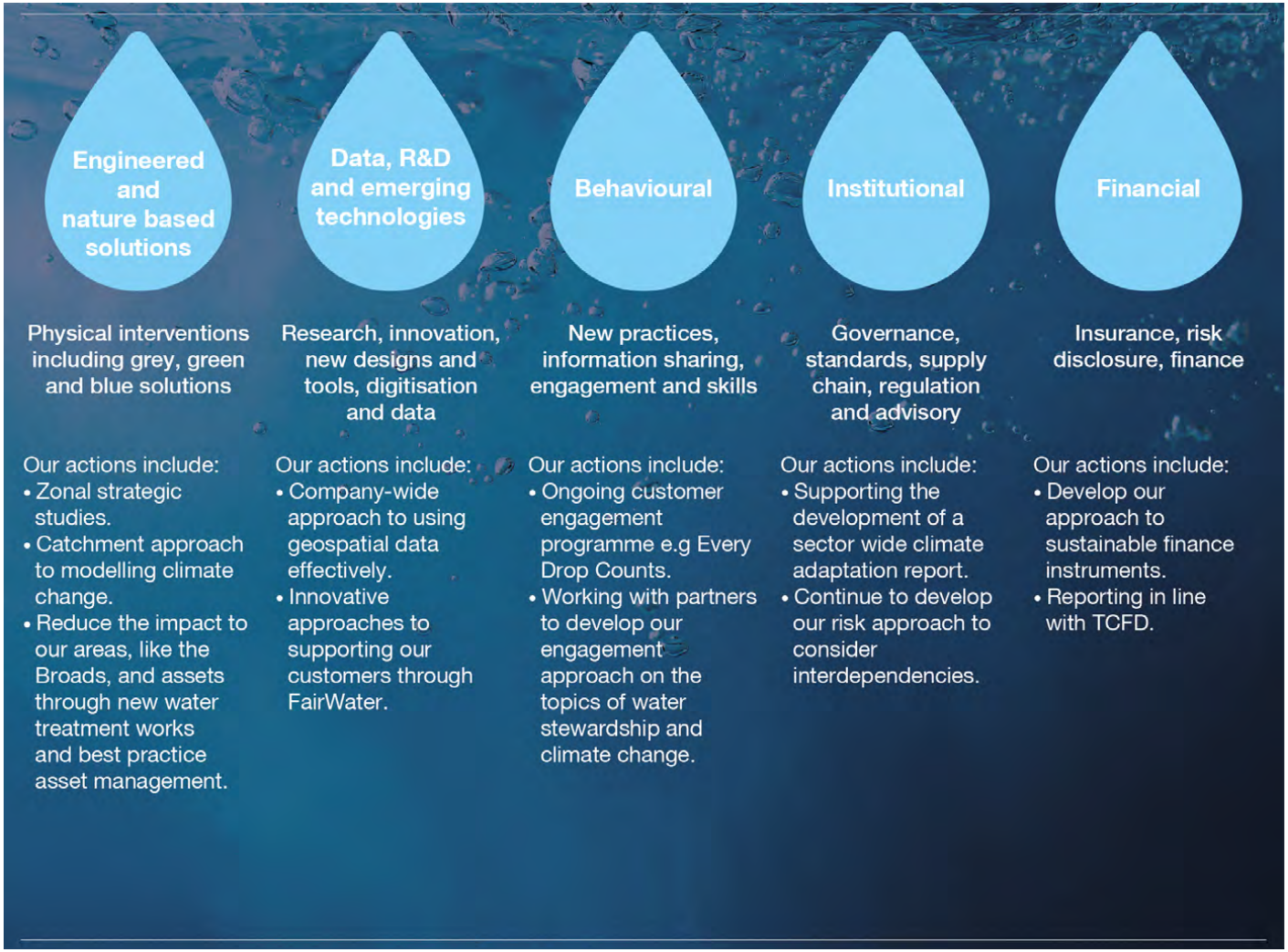
Our ability to provide customers with a reliable and resilient service is based on NWL's complex interdependent systems and assets, on which climate hazards can have direct or indirect impacts. We have considered these interdependencies in our climate adaptation planning. We're also starting to consider compound events (when multiple hazards occur at the same time). Our Water Resource Management Plans (WRMPs) and Drainage and Wastewater Management Plan (DWMP) assess these risks in detail.

We have assessed these risks and are responding to them.

Our five action areas

We believe that diverse climate action is key to addressing climate risk. We are already carrying out climate action but we know we need to do more. To make sure we're ready for the future climate, we need to continue to work across our business in its entirety, from our physical assets to our people and strategies.

We have five key action areas, developed based on the action areas in the Climate Change Committee's third Climate Change Risk Assessment (CCRA3)[1].



[1]https://www.ukclimaterisk.org/independent-assessment-ccra3/technical-report/

Opportunities to benefit our customers

Adapting successfully for one of our biggest challenges, climate change, will support our customers in a number of ways:

Our strategic themes	Customer	Environment	Competitiveness	People	Communities
Key linked performance commitments	• Water supply interruptions • Event risk • Internal sewer flooding	• Pollution incidents • River water quality • Storm overflows and discharge compliance	• Water supply interruptions • Leakage		• Event risk • Water supply interruptions • Per capita consumption (PCC)
Opportunities to increase the value to our customers	Investing in climate adaptation now will allow us to grow our resilience to severe weather events, making sure we provide the best service to customers.	Investing in climate adaptation now will help us to protect the environment over the longer term, reducing the risk of pollution and improve river water quality. This may have additional benefits of supporting a thriving environment and improving biodiversity.	Investing in climate adaptation now will make us more resilient to climate hazards. This will minimise the reactive costs of dealing with more frequent events and the damage and service interruptions they would cause.	Investing in climate adaptation now will mean that our people are ready and prepared to deal with the impacts of climate change to make sure our customers experience minimal service interruptions.	Investing in climate adaptation now will reduce the impact climate change will have on our communities. Working in partnership and achieving key behaviour changes will mean that our communities and the environment will always have sufficient water.

Our call to action

We aim to become a truly climate resilient water and wastewater service provider, both now and for future generations. To achieve this, we need to work as an industry to be climate ready.

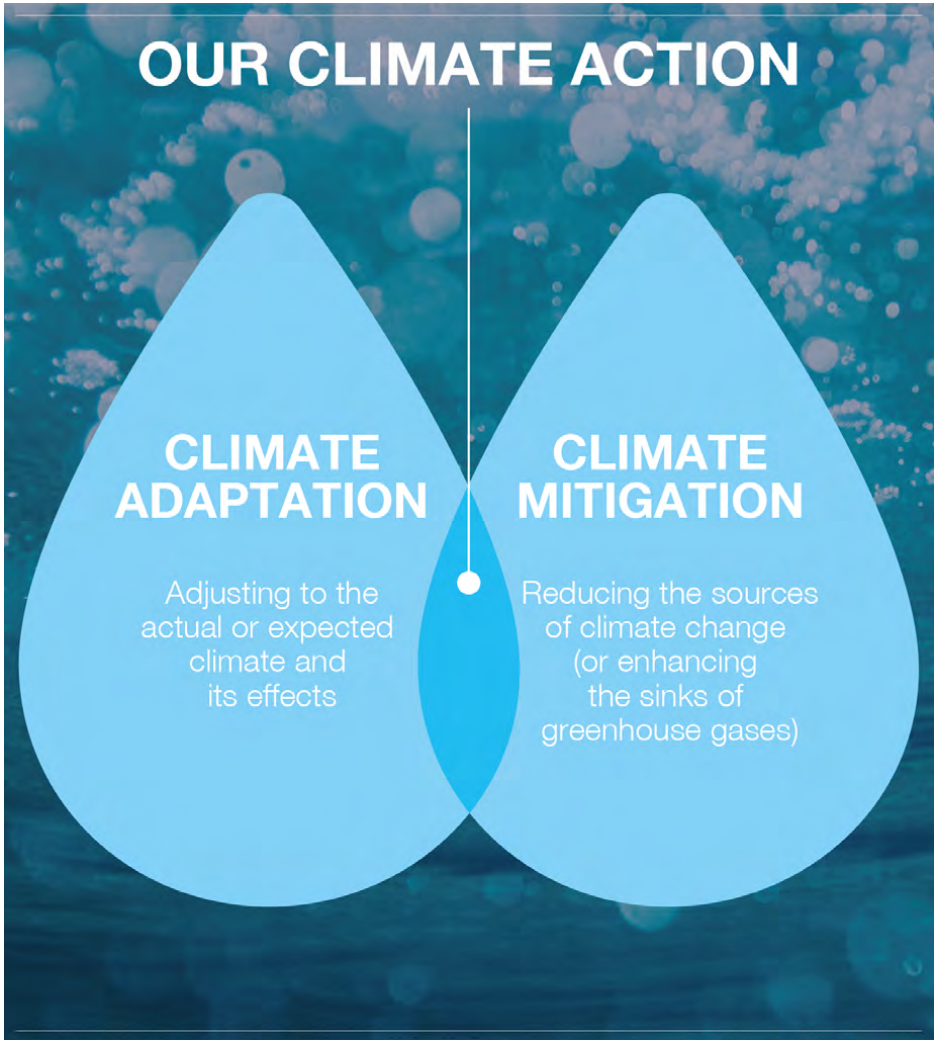
We cannot adapt alone. We want to work in partnership with regulators, customers and stakeholders to develop and deliver climate change adaptation solutions.

Our approach to climate change will be aligned to global commitments in the Paris Agreement and Glasgow Climate Pact goal of 1.5ºC.

Our goal is to be net zero by 2027, and we aim to adapt for 2ºC and prepare for 4ºC.

Preparing for climate hazards and future climate uncertainty now will provide our customers with the most reliable and robust service possible. This will reduce the likelihood of service interruptions in future.

Improving our resilience to climate hazards will also provide benefits to our environment by reducing the likelihood of pollution and maintaining raw water quality.



Who we are

We are responsible for providing the best water and sewerage services possible to our customers in several regions across the UK.

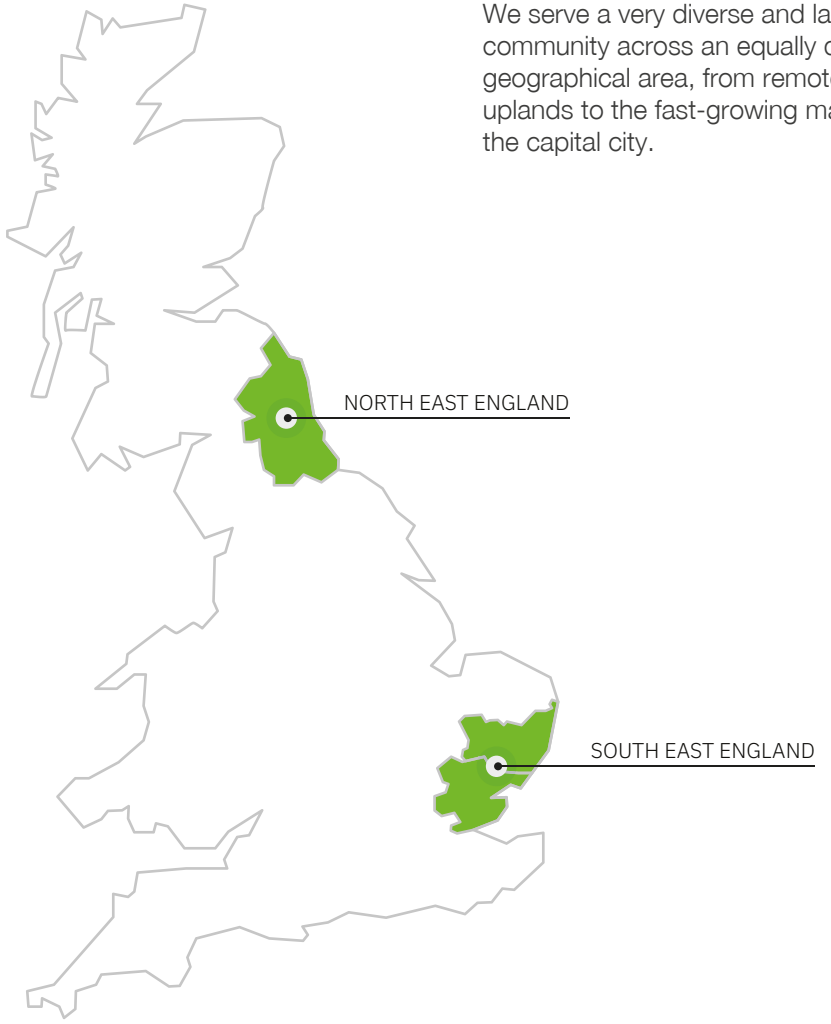
In the north east of England, trading as Northumbrian Water, we supply potable and raw water and collect, treat, and dispose of sewage and sewage sludge for 2.7 million people. In the south east of England, trading as Essex & Suffolk Water, we provide water services to 1.5 million people in Essex and 0.3 million people in Suffolk[2]. Most of our water is sourced from rivers and reservoirs. However, three of our resource zones (Berwick, Blyth, and Hartismere) are 100% groundwater[3].

We employ just under 3,000 people and operate:

- **Over 50** water treatment works.
- **Just under 400** water pumping stations.
- **Almost 350** water service reservoirs.
- **Over 26,000km** water mains.
- **Over 400** sewage treatment works.
- **Over 1,000** sewage pumping stations.
- **Over 30,000km** sewers[4].

Our regions

We serve a very diverse and large community across an equally diverse geographical area, from remote rural uplands to the fast-growing margins of the capital city.



[2]nw-draft-pr19-wrmp-report.pdf (nwg.co.uk) [3]ESW PR19 WRMP Report -Revised Draft - V1.docx (nwg.co.uk) [4]Our operating area (nwg.co.uk)

North east England

In the north east of England, the major population centres we serve include Tyneside, Wearside and Teesside. We also serve large rural areas, such as Northumberland and County Durham. In terms of gross value added (GVA), this area is the poorest of England's nine regions, meaning that supporting vulnerable customers and communities is particularly vital here[5].

Geography of the area

This area of England is generally hilly and features the Pennines, which rise over 600m and have a maximum altitude of 893m. The region also contains several other uplands such as the Cheviots and North York Moors which have an altitude of over 400m.

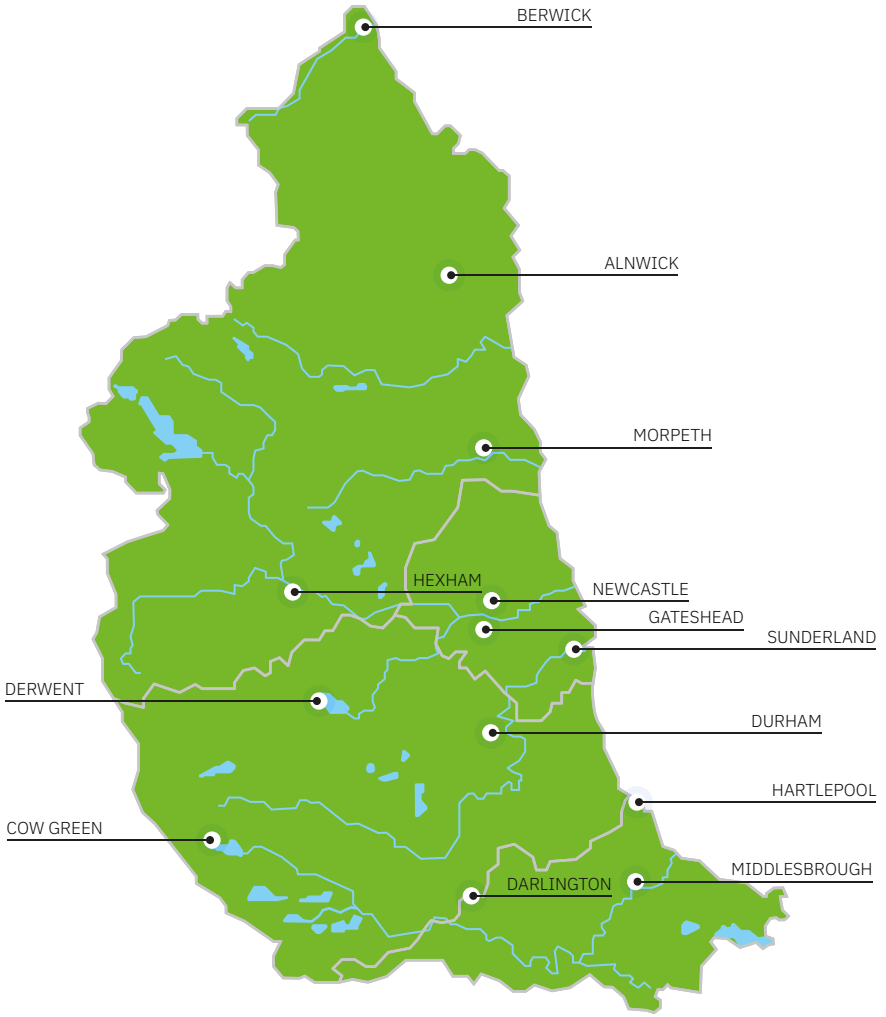
Current regional climate

The climate in this region is a marine west coast climate with mild summers and winters. The varied altitude of the landscape produces diverse rainfall patterns; there is significant rainfall in the Pennines, with the average annual rainfall exceeding 1500mm in the highest regions, while the east coast is one of the driest parts of the UK with less than 600mm of rain annually[6].

Rainfall in this region displays seasonal variation with most rain in autumn due to greater Atlantic depressions. The region's population is consistently increasing year-on-year, though at a lower rate than the England and Wales average; it is expected to increase by 2.3% by 2028[7].

North East Rainfall:
1500mm to 600mm

Rainfall national average:
1142mm[1]



[5]Regional gross value added (income approach), UK - Office for National Statistics (ons.gov.uk) [6]north-east-england_-climate---met-office.pdf (metoffice.gov.uk) [7]Subnational population projections for England - Office for National Statistics [1]UK climate averages - Met Office

South east England

Our Essex area is part rural and part urban with the main areas of population being in Chelmsford, Southend and the London Boroughs of Barking and Dagenham, Havering and Redbridge. Our Suffolk area is mainly rural with the biggest towns being Great Yarmouth and Lowestoft[8].

Geography of the area

The south east of England is generally low-lying, with an altitude of less than 60m for much of the area. It encompasses large regions of downlands, wetlands, and significant stretches of coastline. Founded on sand and clay rocks, the coast is suffering rapid erosion. The county of Essex has the longest coastline in the UK due to deep estuaries. Furthermore, the region is mostly flat, with large-scale farming operations. This increases the volume and speed of water run-off in the area and impacts the quality of both groundwater and surface water. In Suffolk our surface water abstractions are from the Broad or Broadland rivers. Since these sources are at, or below, sea level, they are at risk from tidal surges and coastal breaching.

Current regional climate

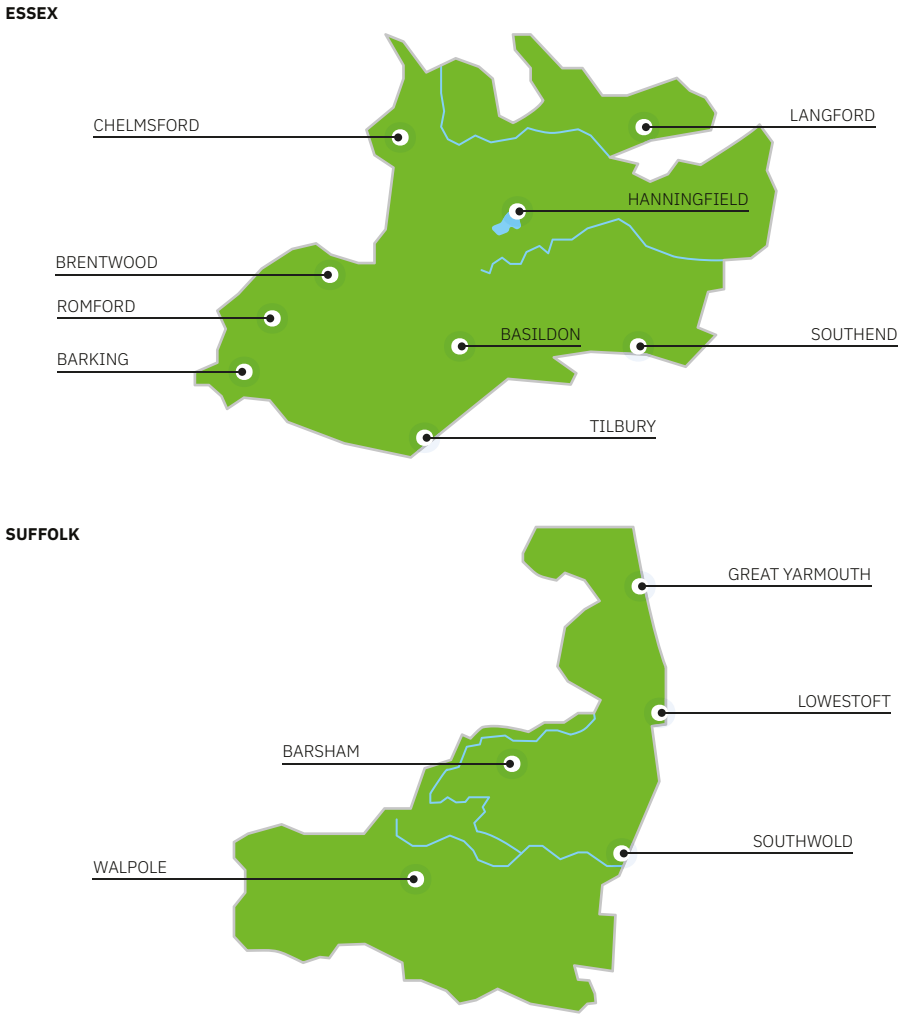
The south east is one of the driest regions in the UK, with an average of less than 700mm of rainfall per year, and thus is susceptible to droughts and water shortages[9].

This region's population is also increasing, at a similar rate to the England and Wales average. The population is expected to increase by 4.4% by 2028, resulting in over 400,000 more people living in the area, and consequently the demand for water will increase over the coming decades[10].

Providing water and wastewater services to these regions poses significant challenges in the near and long-term future since they are highly susceptible to the impacts of climate change; flooding risk from sea level rise and increased rainfall combined with increased risk of droughts from rising temperatures pose threats across the seasons. With increasing populations, these challenges are augmented, thus climate adaptation is a critical focus for our company.

South East Rainfall:
700mm

Rainfall national average:
1142mm [1]



[8]Our operating area (nwg.co.uk) [9]eastern-england_-climate---met-office.pdf (metoffice.gov.uk) [10]Subnational population projections for England - Office for National Statistics [1]UK climate averages - Met Office

Delivering for future generations

Planning for the long term

In the face of a changing climate, we recognise that we need to invest now to provide the best service to current customers and for future generations.

Our long-term strategy for improving and maintaining our services will help us to deliver our vision to be the national leader in the provision of sustainable water and wastewater services.

To achieve this, we are investing in digital solutions such as artificial intelligence and data science to develop a deeper understanding of our customer base. By implementing innovative technologies such as voice-based digital assistants or bot technologies, we make sure our customers have a wide array of convenient ways to engage with us.

Indeed, maintaining transparency and accountability is an area of focus that we are committed to - through initiatives such as Innovation Street - working openly with innovative suppliers and manufacturers, and by publishing company performance regularly.

We have developed a Resilience Framework to identify our critical assets and to prioritise investment so that we can continue to deliver reliable and resilient services to customers. This framework examines resilience in general, identifying climate change as one contributing stressor that we must develop resilience against. The framework is shown in **figure 1**, illustrating how weather and climate resilience fits into our wider resilience approach[11].

Our PR19 (Business Plan for 2020-25) modelling reflected that our water supply is 100% secure, and our long-term water resource management plan extends to 2060, including plans to create a fully potable water grid in the north east of England by 2045[12].

However, our new PR24 (Business Plan for 2025-2030) modelling has forecasted significant supply deficits from 2025 in all Essex and Suffolk water resource zones, indicating that we will need to prepare for worsening droughts through demand management, long-term storage reservoirs, and supply-side schemes. Almost all our groundwater sources are resilient to climate change. Partnerships with other water companies through Water Resources East and Water Resources North, further support the resilience of our future water supply. A long-term wastewater and drainage framework is being developed through Water UK's 21st Century Drainage programme, incorporating all current approaches and extending the current sustainable urban drainage systems. Mass market campaigns such as Bin the Wipe support us, and the rest of the UK, to keep existing assets performing at their intended capacity[13].

Providing reliable and resilient services for our customers is one of six key themes that we have assembled to allow us to deliver outcomes to our customers[14].

Customer feedback has identified four resilience outcomes that they care about and would like to see:

- Clean drinking water and effective sewerage services now and for the future.
- A reliable supply of water.
- Drinking water that is clean, clear and tastes good.
- Sewerage services that deals with sewage and heavy rainfall effectively[15].

We are engaged in the UK Government's 25-year Plan for the environment, through local planning and effective partnerships. Employing a catchment-based approach to planning and service delivery allows us to work with local communities and the agriculture sector to develop environmental improvements; these include improving biodiversity, reducing flood risks through natural flood management, reducing the environmental impact of discharges, and improving raw water quality.

[11]www.nwgourplan.co.uk/pdfs/NWG_PR19_Interactive_FINAL.pdf [12]https://www.nwg.co.uk/globalassets/corporate/long-term-strategy.pdf [13]Bin the wipe (nwl.co.uk) [14]www.nwgourplan.co.uk/pdfs/NWG_PR19_Interactive_FINAL.pdf [15]www.nwgourplan.co.uk/pdfs/NWG_PR19_Interactive_FINAL.pdf

Our future scenarios and strategies

We are building on this long-term strategy by carrying out further analysis of future scenarios and extending our long-term business strategy and our long-term water and wastewater strategies to 2050. Our Climate Adaptation Plan will feed into our future scenarios and our updated strategies.

Our long-term approach builds on the work we carried out to develop our ARP1 report 'Adapting to climate change' in 2011. This report highlighted the need to improve our understanding of risk and our risk management approaches, as well as the need to develop a focus on water supply. We recognised that climate risk should be incorporated into our over-arching risk management strategy, rather than being considered in isolation[16].

We also found that these climate-related risks should be quantified for more robust analysis and should be periodically reviewed in line with our risk management processes. The key focus areas identified were security of supply in our Essex region and flood risks in the Northumbrian region[17].

We have built resilience into our previous strategies, for example into our PR19 plans, despite some resistance from regulators. We continue our work to help government and regulators embrace an approach to dealing with future uncertainty.

Listening to our customers

Working closely with our customers and communities is essential. For example, our educational programme, The Ripple Effect, involves encouraging school children to learn about water, and about how the community can work together to protect their local water supply. We have also helped communities through the COVID-19 pandemic by donating laptops for children's online schooling in our operating areas and contributing to the vaccination rollout in Durham and Darlington[18].

We highly value our customers' opinions on make sure our business plans reflect what is important to them and we aim to engage 2 million customers by 2025[19].

Our customers told us that investing in assets for the future to prepare for severe weather and changing future demand is key. They deemed investing to reduce flooding as especially important; 68% of our customers prioritised future investment in reducing internal, external, and repeat flooding.

Customers also believed that we should be doing all that we can to reduce the risk of cutting off water supply.

We recently carried out a survey to understand our customers' views on climate change. This identified that most of our customers rate climate change as very important. It also highlighted that our customers recognise that climate change will impact them and their communities in their lifetime (67%) - with severe weather, rising sea levels and water scarcity being key events linked to climate change[20].

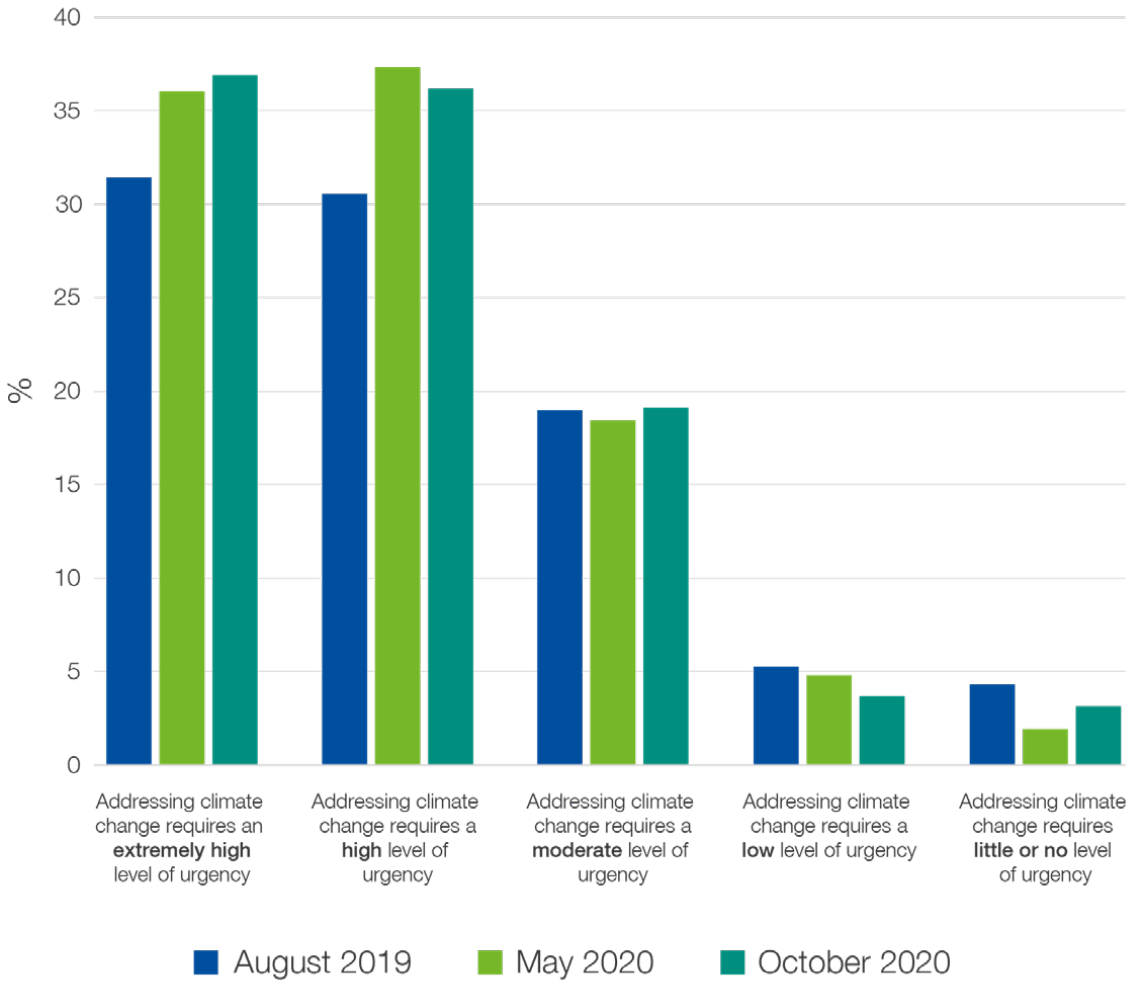
Overwhelmingly our customers believe that we need to act on climate change immediately (84%) and that this is the responsibility of many; from the individual, to water companies, to the government[21].

Interviews identified that the environment was of great importance to household customers, who thought it should be a high priority for us.

[16]Adapting to climate change 2011 [17]Climate Change Asset Impact 2012 Update Report [18]Our Purpose 2021 [19]nwg.co.uk/globalassets/corporate/long-term-strategy.pdf [20]Customer Sentiment Insights [21]Customer engagement summaries for PR19

Listening to our customers

National data shows us that the public's concern about climate change has been growing. The table below shows that this level of concern has risen through the COVID-19 pandemic[22].



Our customers have told us that sustainable approaches are the preferred solution where possible, though reflecting that traditional approaches are still required in some instances. Indeed, environmental activities were placed at the top of the list of customer priorities for investment out of environment, leakage, and rare events. They also told us that our environment goals were ambitious. Providing a reliable and resilient water and wastewater service was seen to be an important aspect of service delivery and an area in which our customers expected to see stretching performance[23].

Overall, customers welcomed our plan to be a leading, efficient, and innovative company, and recognised the link between these values and improvements to efficiency, expertise, and performance.

[22]Centre for Climate Change and Social Transformations, December 2020

[23]Microsoft Word - 2.4 PR19 Acceptability Research

Retail customers identified ‘providing reliable and resilient services’ as the most important section of the business plan, since this would also affect their own customers.

We found that our customers believe that we should pay particular attention to water-related environmental activities, and that these should be approached in collaboration with partner organisations.

From this extensive engagement, we recognise that climate adaptation, and supporting future generations, is critical to what we do.

Figure 1: NWL Resilience Framework

Our story so far

In our previous adaptation plan we set out some key points of focus, which we have built on in this plan.

Key points from previous adaptation reports	Our progress
Short-term risks included performance of the sewer system, in particular the risks of sewer discharge and flooding in extreme events.	We have committed to an ambitious goal of eradicating sewer flooding in the home and have delivered a 60% reduction in repeat sewer flooding between 2015 and 2017. We are industry leaders in the deployment of sewer level monitoring (SLM) which enable us to detect and resolve problems before they cause an issue. Since 2012, we have alerted operators and enabled them to attend and clear a problem before any overflow occurred. We also use monitoring data, together with other service information (such as blockages), in proactively investigating high frequency spilling combined sewer overflows resolving maintenance issues that are found to be the cause, and taking forward hydraulic capacity problems. This activity forms part of the water industry national environment programme (WINEP), under the 21st Century Drainage Storm Overflow Assessment Framework. Since 2020, we have been committed to undertaking extensive investigations for frequently spilling CSOs. We are developing our Drainage and Wastewater Management Plans, which focus on improving the resilience of our wastewater systems to key pressures like climate change and extreme events.
Include climate change in our risk management approaches and service policy development and carry out periodic reviews of the specific risks that climate change presents to make sure our response is increasingly robust as the impacts grow.	We have considered climate change in our risk registers, which are reviewed on a monthly basis (and annually at Board level) and we carry out reviews of the risk that climate change poses.
Balancing water demand with the availability of supply.	We have carried out detailed Water Resource Planning to achieve this balance, including regional integration of supply. This is currently being updated with the latest climate data and our modelling, which suggests that we need to develop new supply schemes and demand reduction from 2025-30 for our Essex and Suffolk customers to improve our resilience. We are continuing this work and we have an aim to limit per capita consumption of water to 118 litres per person per day by 2040. This is through our existing Water's worth saving initiative and whole town approach to scale up our industry-leading water efficiency work to a level of activity that is five times greater than currently.
Development of improved understanding of these risks is a central focus of our current and planned actions in moving towards mitigation of the long-term impacts of the changing climate.	We understand our climate risks better, have carried out interdependencies mapping of our key climate risks and have included climate adaptation within our value framework to support us to invest in climate adaptation going forward.
Ongoing development of Abberton Reservoir will address the immediate risk in relation to the supply of water in Essex and improve resilience to climate change.	We completed this work which provides us with a more resilient supply of water for customers in Essex.

Key climate risks

We want to be ready for current and future climate risks.

Our climate adaptation aim is to adapt to 2ºC for 2050 and prepare for 4ºC by the end of the century.

The world's climate is changing, and the UK's average annual temperature is already about 1.2°C warmer than the pre-industrial period. Currently, the globe's emissions trajectory, even accounting for current ambition and commitments, is likely to result in global warming of approximately 2°C to 4°C by the end of this century.

This change will result in unfamiliar local weather patterns, making some types of extreme events more likely, and it will result in rising sea levels. The changing climate affects the profile of risk due to increasing likelihood of extreme temperatures, precipitation, and sea level rise. We focus on five key hazards in this chapter.

Our commitment to net zero by 2027 and our climate mitigation actions are supporting the aim of the Paris Agreement goal of 1.5º. However, to prepare for the potential consequences of climate change, our climate adaptation actions need to prepare for global warming of at least 2ºC by 2100.

In keeping with one of the CCRA's principles for good adaptation (Adapt to 2°C, assess the hazards for 4°C), our climate adaptation aim is to: 'Adapt to 2ºC for 2050 and prepare for 4ºC by the end of the century.' Our climate adaptation goal is to:

- adapt to 2ºC for 2050 and
- prepare for 4ºC by the end of the century.

Using UKCP18, we present five key climate hazards in both short- and long-term timeframes, and under different scenarios[24, 25].

Given the criticality of the knock-on impacts of climate change, we also provide an assessment of interdependencies and the potential of cascading hazards.

We already do considerable detailed work to understand and mitigate our water resource risks through our Water Resource Management Plan. We are developing our Drainage and Wastewater Management Plan, which aims to make sure these systems are resilient to pressures including climate change.

Climate vulnerability

We understand what makes our service, networks, and assets vulnerable. To assess the vulnerability of an exposed system we follow the ISO14090:2019 approach:

- The hazard (e.g., flooding or drought).
- The exposure of the system to a hazard.
- The sensitivity of the system to the hazard.
- The climate change impact (i.e. the risk with adaptation).
- The risk with adaptation in the future.

[24]These are dependent on future greenhouse gas (GHG) assumptions modelled in Representative Concentration Pathway (RCP). RCPs are plausible future scenarios used by the Intergovernmental Panel on Climate Change's latest 5th assessment report and describe total radiative forcing (cumulative measure of human emissions of greenhouse gas emissions from all sources expressed in Watts per square meter). In the shorter timeframe, until 2050, different scenarios all result in between 1.5 and 2 °C of warming. However, after 2050, they diverge, with the high emissions scenario (RCP 8.5) approaching 4 °C of warming. We thus consider the middle emission scenario (RCP 4.5) as a representation of 2°C, and the high emission scenario (RCP 8.5) as a representation of 4°C.
[25]Climate hazard information is drawn from 3 UKCP18 products.

Key climate hazards

Climate change will increase the likelihood of climate hazards such as drought, flooding, extreme temperatures, and sea level rise in the UK. In 2021 we already experienced climate events predicted for a 2ºC future. Different geographical areas of the UK will be differently impacted, both by the different extent of changes associated with climate hazards, and by different levels of vulnerability.

In this section we provide an overview of our key climate hazards and how these may change in the future, changing the level of climate risk for NWL. We also provide a narrative around any key geographical differences between our north east and south east operating areas. The hazards we consider are:

- Flooding.
- Drought.
- Extreme high temperature.
- Extreme low temperatures.
- Sea level rise.

Where available, we consider how these hazards are likely to change in a 2ºC world by 2050 and a 4ºC world by 2100.

In the following section we refer the middle emission scenario, RCP 4.5, and the high emission scenario RCP 8.5 to reflect these two worlds. Our key climate risks align with those set out in CCRA3. Our key climate risks align with those set out in CCRA34. The infographic to the right sets out how our key climate hazards are projected to change over time.

Key climate risks

The key climate risks to the continuation of our service provision are aligned with those set out in the CCRA3[26], which are:

1. Risk to our assets from river, surface, groundwater and coastal flooding.
2. Risks to our systems and networks from subsidence.
3. Reduced water availability, risking public water supplies.
4. Risks of poor water quality and supply interruptions.
5. Risk to our network from cascading failures.
6. Risks to aquifers from sea level risk and saltwater intrusion.

KEY CLIMATE RISK AND CLIMATE METRIC	RCP 4.5 - 2050S (ADAPT TO 2˚C) HAZARD TREND	RCP 8.5 - 2090S (PREPARE FOR 4˚C) HAZARD TREND
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Mean winter precipitation (% change) median projection	↑ 6%	↑ 21%
Local sea level rise (NE England)	0.07 to 0.23m	0.25 to 0.76m
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Hot spells	→ Minimal change	↑ 4 or more hot spells per year
EXTREME TEMPERATURES		
Daily maximum temperatures, 50 year return period (NE England)	→ Minimal change	↑ 32˚C to 39˚C
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N.B. Hazard trend highlights which of our risks are most pressing, those with icon: ↑ indicates a high-priority area with the hazard increasing, the icon → indicates limited changes so are less pressing issues

[26]CCC, 2021, Water sector briefing.

Flooding

The risk of flooding mainly increases in the autumn and winter months. The risk of sewer flooding is worse in the spring, associated with heavy precipitation[27].

Mean summer precipitation is more likely than not to decrease across both our operating areas. The mean winter precipitation is projected to increase in both of our operating areas. The median projection for 2050 is an increase of 6% in RCP 4.5. Towards the end of the century, the median projection is an increase of 21%, for RCP 8.5. We can now be more certain that the increases in the mean precipitation in winter are due to an increase in both wet day frequency and wet day intensity in winter. In our 'prepare for 4°C' scenario, wet day intensity increases approximately to 15 to 30mm per hour, and 40 to 80mm per day[28] by the end of the century. The north east can expect higher daily figures, while the south east can expect higher hourly figures.

Although increases in precipitation are more likely to be driven by increases in the intensity of wet days in the autumn and winter months, projections don't exclude the plausibility that climate change will result in higher mean summer precipitation as well. The plausibility of these large increases in summer precipitation is more relevant to the south east of England, while the trend towards drier summers is stronger and more certain in the north east.

Therefore, while the general trend is towards warmer and wetter winters, and hotter, drier summers, increases in mean summer precipitation should continue to be treated as plausible. The increases would be driven by an increase in the intensity of wet days, rather than the frequency of wet days.

Our water infrastructure such as pipelines, reservoirs and treatment plants is at risk from increased flooding and flooding intensity. Flooding can place great stress on water and wastewater networks by overloading pipes and stormwater storage beyond capacity.

River Wear, Durham City Centre

[27]Climate hazard information is drawn from 3 UKCP18 products.

[28]50 year return period

Drought

Mean summer precipitation is more likely than not to decrease across both our operating areas, increasing the risk of drought.

The south east of England is likely to be more greatly affected than the north east. Greater changes are projected in the RCP 8.5 scenarios compared to the 4.5 scenarios, and the impact of the RCP scenarios is more pronounced in later decades.

By the 2050s, the median projection of decrease in mean summer precipitation is -15% for RCP4.5 in the south east of England. In the north east, the median projection is -10% for RCP 4.5.

By the end of the century, the median projection of decrease in mean summer precipitation is -31% for the south east of England for RCP 8.5. In the north east, the median projection is -22% for RCP 8.5.

Surface water supply sources in the summer are therefore likely to become more at risk in the future than they are today and, with parts of the south east of England already water stressed, decreases in summer precipitation will increase the likelihood of periods of water scarcity.

Changes in soil water content and the associated swelling and shrinking of soils cause subsidence on engineered slopes and foundations, damaging infrastructure and increasing the levels of leakages and bursts in water pipes. Nitrate concentrations are very high following droughts. The duration of this peak is dependent on when the first flush occurs and the amount of rainfall.

Farmland, Suffolk

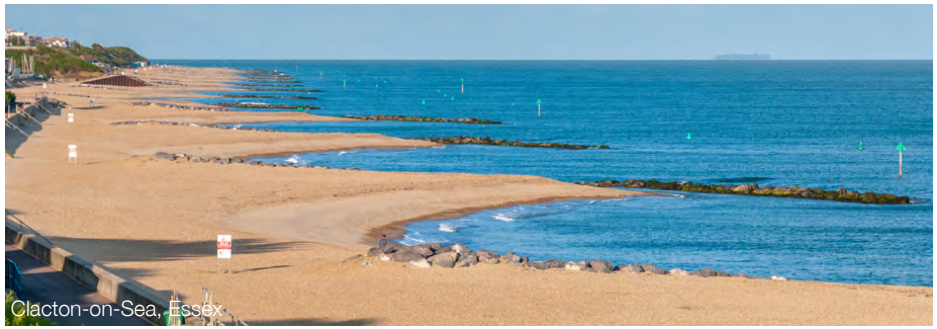
Extreme high temperatures

Climate change will increase the mean temperature everywhere and in all seasons. Future increases are greater in summer than in winter. Furthermore, climate change will increase daily maximum temperatures, across the UK.

Mean winter and summer temperature will increase more in the south east of England than in the north east. Daily maximum surface air temperatures are also projected to increase with climate change.

Towards the end of the century, in the RCP 8.5 scenario, the 50-year return period of extreme high temperatures is between 37 and 45°C for the south east, and between 32 and 39°C for the north east (10th to 90th percentiles).

Hot spells (two consecutive days over 30°C) are projected to become more frequent in the future. Southern UK is projected to have four hot spell events per year, four more than the reference time. Extreme high temperatures may impact water treatment requirements by increasing the release of pollutants, such as soil nutrients, into water courses and reducing water quality[29]. Water treatment works also work at lower efficiencies during extreme temperature changes. In general, higher temperatures are linked to greater demand on the water supply system due to higher consumption by the public. Heat waves have also been linked to harmful algal blooms, though these events are driven by a number human activities, including climate change, at local, regional, and global scales[30].



Clacton-on-Sea, Essex

Hot spells are projected to be more frequent in the future

Extreme low temperatures

The likelihood of extreme low temperatures will decrease.

Climate change will decrease the likelihood of extreme low temperatures across all the UK, in all seasons. Towards the end of the century, in the RCP 8.5 scenario, over the northern part of the UK there will be on average 0.33 cold events per year. This marks a decrease of three events compared to the reference period.

Sea level rise

The mean sea level is projected to increase throughout the century, regardless of which emissions scenario we follow, to at least 0.2m by 2100 relative to the 1981 - 2000 average with the potential of up to 1m of sea level rise by 2100.

Essex and Suffolk will experience greater local sea level rise (SLR) than coastal areas in the north east, due to a combination of local effects including Glacial Isostatic rebound. The range of uncertainty in future projections is also generally larger in the south east than it is in the north east.

By the middle of the century, for RCP 4.5, local SLR in the north east is expected to be between 0.07 and 0.23m, while in the south east it is expected to be between 0.18 to 0.35m.

Towards the end of the century, for RCP 8.5, local SLR in the north is expected to be between 0.25 and 0.76m, while in the south it is expected to be between 0.46 to 0.97m.

[29]Welsh Water. Welsh Water 2050

[30]Gobler C J (2020), Climate Change and Harmful Algal Blooms: Insights and perspective

Implications for coastal flooding

Changes in extreme coastal water levels are dominated by the mean sea level rise referenced above. There is potential for an additional contribution due to atmospheric storminess changes over the 21st century, although this is uncertain.

An illustrative high-end projection is given in UKCP18. At the Edinburgh (Leith) tide gauge, increases in atmospheric storminess could increase the 200-year return level of skew surge by 2.77mm year.

The risks from SLR and coastal flooding are generally higher in the south east, with coastal flood and erosion risk increasing for water infrastructure located in our Essex & Suffolk Water operating area.

Saltwater intrusion to freshwater aquifers can make them unsuitable for water supply to both households and agriculture.

Assessing our climate risk

We are already carrying out considerable detailed modelling to consider climate hazards in our Water Resources and Drainage and Wastewater Management Plans.

We model the impacts of climate hazards in our Water Resource Management Plans (WRMPs) and Drainage and Wastewater Management Plans (DWMPs).

Traditionally, climate change allowances have been used to inform these plans.

We are carrying out updated probabilistic modelling for our WRMP24 (WRMP for 2025-2030), looking at a high and medium emission scenario (RCP8.5 and RCP6.0). These relate to 4°C and 1.9°C warming, so generally align with our overarching climate adaptation goal.

We are currently transitioning from UKCP09 data to UKCP18 data to inform our WRMP, which is highlighting that we have reduced deployable outputs in some regions.

This update to our WRMP24 supply and demand forecasts have forecast supply deficits in our Essex and Suffolk water resource zones, which we will look to address.

Regarding drainage management planning, we continue to use uplift factors on design rainfall events and use UKWIR's RedUp tool to assess Tropical Storm Risk.

We manage these risks through our risk registers. These all ultimately feed into our strategic risk register (which focuses on longer-term risks with significant uncertainty) and our corporate risk register (which focuses on risk with lower levels of uncertainty).

Consideration of compound events

Multiple climate hazards can occur in the same location and/or time, which can lead to a more significant impact than a single hazard alone. For example, in Hurricane Sandy in 2012, the compounding effects of pluvial flooding, high wind speeds, storm surge, and waves exacerbated the impact of the event.

Traditional risk assessments often only consider one hazard at a time. However, the underestimation of these compound risks can impact the understanding of high-impact events[31].

[31] Zscheischler et al, 2018

Kielder Water Resource Zone deployable outputs for climate change scenarios

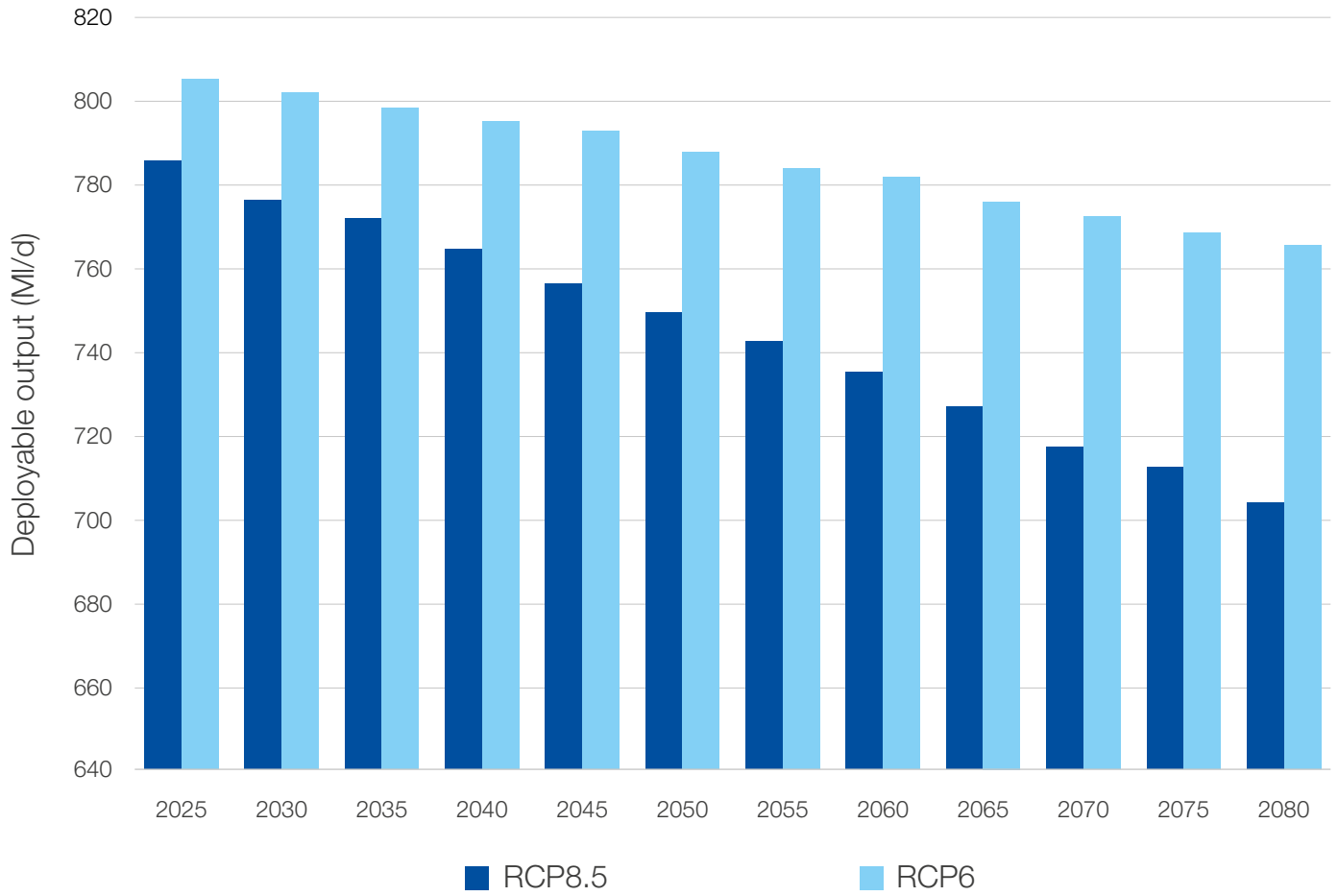


Figure 2: We already are in the process of undertaking probabilistic modelling for our WRMP. The chart shown here and on the next page show the difference in impact of the two climate scenarios modelled.

Essex Water Resource Zone deployable outputs for climate change scenarios

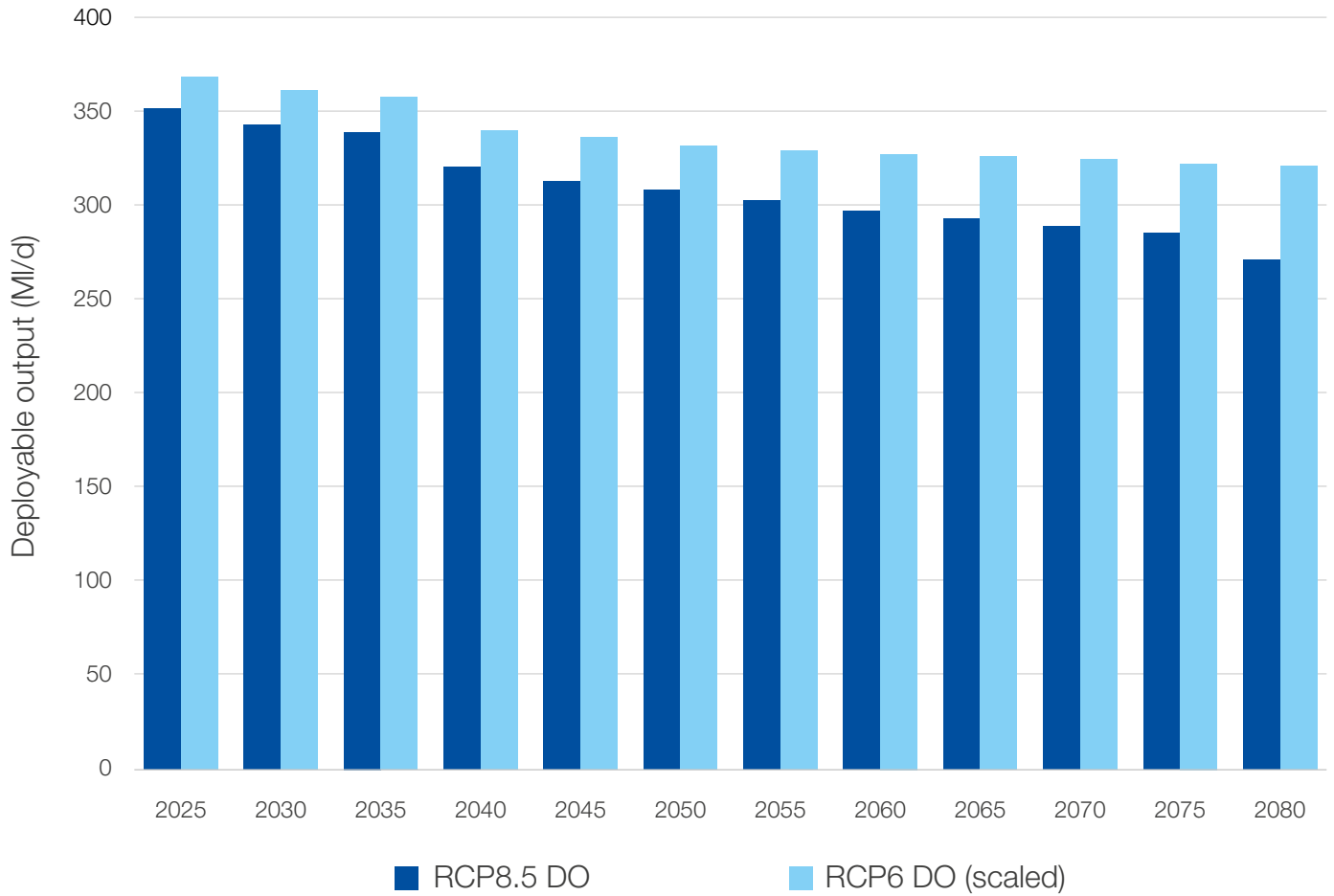


Figure 2: We already are in the process of undertaking probabilistic modelling for our WRMP. The chart shown here and on the previous page show the difference in impact of the two climate scenarios modelled.

The complexity of the risks we face

We recognise our ability to provide customers with a robust and reliable service is based on complex interdependent systems on which climate hazards can have direct or indirect impacts. Therefore, we have considered these interdependencies in our climate adaptation planning.

Understanding interdependencies is key to our approach to climate resilience as it supports our analysis of climate impacts and allows us to understand cascading risks. There are several types of interdependencies to consider[32]:

- **Functional:** when systems are connected and rely on each other to operate.
- **Physical:** when systems interact through physical processes.
- **Geographical:** When geographical properties, like proximity, impact systems.
- **Economic and financial:** when systems may be impacted by market results or budgetary constraints.
- **Institutional and policy:** when agencies control systems though policy, legal, or regulatory means.
- **Social:** When individuals and organisations interact with systems.

Cascading risks

The water infrastructure network represents a significant part of the interconnected energy, transport, technology, and water infrastructure network. If any failures occur in these systems due to climate hazards, there may be knock-on impacts on our ability to provide a reliable service.

Vulnerabilities in one of these networks can have cascading consequences. For example, in the recent Storm Arwen high winds bringing down trees caused both power outages and limited access to many sites. This caused service interruptions across multiple water and wastewater sites in our Northern region. The lack of access to sites also hampered our recovery and use of standby power options. This is turn has knock on health and wellbeing implications for our customers.

Additionally, flooding which causes disruption to the road transport network might make it impossible for operatives to address issues or conduct maintenance on our water treatment and water supply assets, resulting in poorer water quality or supply outcomes.

These cascading risks may extend beyond climate hazards in the UK. Extreme weather events globally can spread impacts across sectors[33].

Supply chains are international, and some of our supply chains rely on countries more vulnerable to climate change[34]. Climate migration is another indirect climate stressor that is linked to this and may fundamentally impact supply chains, resource availability, and our workforce.

[32]Set out in the UK Climate Risk Interacting risk report [33]CCRA3 [34]CCC2017: Committee on Climate Change, UK Climate Risk Assessment 2017, Evidence report.

The route forward

Our climate adaptation plans

We believe that diverse climate action is key to addressing climate risk, adapting to future changes, and achieving a resilience dividend. We have developed our climate action plan around five key action areas.

We have been actively assessing risks posed by climate change and taking action to adapt for many years.

We last presented an adaptation report to Defra in 2011. Making allowances for climate change has been key in developing robust Water Resources Management Plans (WRMPs) and our Drainage and Wastewater Management Plans (DWMPs).

From 2020-25 we are carrying out many schemes as part of our enhancement program that support adaptation for climate change including in the north: Howdon resilience, Teesside resilience; and in the south: Abberton to Hanningfield raw water pipeline and Layer Water treatment works additional treatment. We are preparing our WRMP24 (for 2025-30) with the latest products from UKCP18 and have a capability to report up to 2080. We have carried out critical asset assessments utilising static fluvial flood risk mapping from the Environment Agency, are currently carrying out zonal strategic studies to understand system-level pinch points, and are developing capital schemes to improve resilience in both our service areas.

While we're already taking action across our business, we want to do more. We recognise that, to make sure we are fit for the future climate, we need to continue our work across our business, from our physical assets to our people and strategies.

Therefore, we have identified five key areas for adaptation action:

- Engineered and nature-based solutions.
- Data, research and development (R&D), and emerging technologies.
- Behavioural.
- Institutional.
- Financial.

These areas align with the action areas set out in the CCRA3 report.

These actions all help to support us to prepare for 2°C and better understand the implications of a 4°C world in the long term.

This will enable us to deliver many of our performance commitments both now and in the future across water and wastewater; especially on water supply interruptions, water quality, event risk, internal sewer flooding, PCC, leakage, pollution incidents, river water quality and storm overflows discharge compliance.

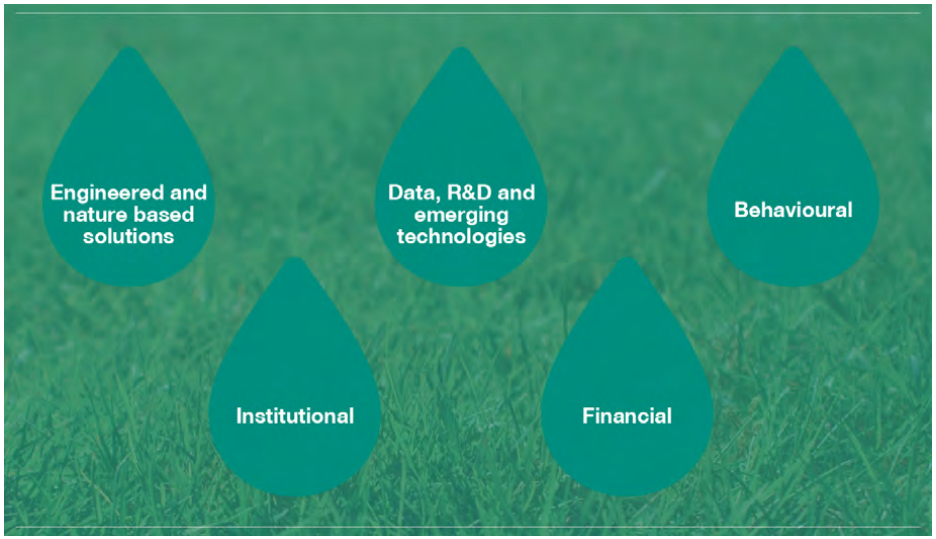


Figure 3: Our five action areas

Our climate adaptation plans
(continued)

AMP7 performance commitment	PC description	Reference	AMP6 target (2015-16)	Beginning AMP7	End of AMP 7 target	Flood	Drought	High temp	Low temp	Sea level rise
Water quality compliance (CRI)	DWI's Compliance Risk Index (CRI)	COM03	N/A	0	0	x	x	x		x
Water supply interruptions	Average supply interruption greater than three hours (minutes per property)	COM04	6 minutes 50 seconds (definition not common)	6 minutes 30 seconds	5 minutes	x	x	x	x	x
Leakage (NW region)	Leakage in megalitres per day (Ml/d), three-year average	COM05	139 mld	1%	12%				x	
Leakage (ESW region)	Leakage in megalitres per day (Ml/d), three-year average	COM06	66 mld	1.3%	14.1%			x	x	
Per capita consumption	Average amount of water used by each person that lives in a household property (litres per head per day) expressed as a three year average.	COM07	N/A	0.80%	5.30%		x	x		
Internal sewer flooding	The number of internal flooding incidents per 10,000 wastewater connections per year.	COM08	262 (public) / 228 (transferred) (properties not incidents)	1.68	1.34	x				
Pollution incidents	Category 1 - 3 pollution incidents per 10,000km of sewerage network, as reported to the Environment Agency.	COM09	115 (Cat 3 Only)	24.51	19.5	x	x			

Our climate adaptation plans
(continued)

AMP7 performance commitment	PC description:	Reference:	AMP6 target (2015-16)	Beginning AMP7	End of AMP 7 target	Flood	Drought	High temp	Low temp	Sea level rise
Risk of sewer flooding in a storm	Resilience is the ability to cope with, and recover from, disruption, and anticipated trends and variability in order	COM11	N/A	32.30%	22%	x				
Mains repairs	Mains repairs per 1,000km	COM12	4586 bursts	141.9 (3720 repairs)	123.4 (3309 repairs)	x		x	x	
Unplanned outage	Unplanned outage is a temporary loss of maximum production capacity.	COM13	N/A	6.37%	2.34%					
Sewer collapses	Sewer collapses per 1,000km	COM14	58 (public sewers only) / 84 (transferred) – different methodology across AMPS	10.69 (322 collapses)	8.13% (246 collapses)					
Treatment works compliance	Environment Agency Environmental Performance Assessment Methodology - % of treatment works complying with discharge permits	COM15	0 (different metric format)	100%	100%	x		x		

Our climate adaptation plans
(continued)

We are determined to continue taking proactive action to plan and adapt to climate change in our operating areas. We have developed a suite of actions, from empowering our customers to practise good water stewardship, continuing our innovation activities and R&D, utilising green finance opportunities, and embedding adaptive decision-making into our core business decisions.
We have considered actions that need to occur in the short term (up to 2025), medium term (up to 2040) and long term (beyond 2040).

Our key barriers to climate adaptation

There are some key barriers across the water sector to implementing climate adaptation. Some of those are internal and shorter-term challenges- like access to information, improving data, developing training on climate change, planning and managing for uncertainty, and investing in collaborative projects with third parties. We also recognise that that we need to increase our capabilities in business continuity and modify our risk approaches to adapt best for future climate change.
We aim to address these barriers through actions under each of these five action areas.

Support we need from others

There are long-term external systemic issues that will take longer to address, such as a focus on short-term issues, inadequate financial resources to invest in the long term, and lack of consistent and clear policy guidelines from Government. Therefore, our key long-term challenges are:

- **Investment to address climate challenges.** In order to address the challenges posed by climate change we need to invest sufficiently in our assets, people and processes now to implement solutions for the longer term. It is vital that this is supported by our regulatory frameworks. It also important that the water sector remains attractive to private capital investment.
- **Providing affordability for customers in the face of the investment required to address climate change.** Providing the best value service to our customers and making sure that our services are affordable for our customers both now and in the future. We have committed to eradicating water poverty by 2030[35].
- **The need for regulation to evolve to have a longer-term focus.** Regulation needs to adapt to support us to achieve our adaptation aims. Funding cycles have been identified as a key barrier to implementing climate action; therefore we would like regulators to be more flexible and long-term in their thinking to support action in this area. This is reflected in key sector-wide discussions such as those around how environmental regulations need to adapt for the future and accept more risk. There are discussions around evolving key areas of work such as WINEP[36] to enhance resilience rather than merely deliver statutory requirements[37]. This is already recognised by some of our regulators. For example, the Environment Agency (EA) has highlighted that 'regulation is not yet ready for a changing climate' and often does not allow a quick response to hazards or adapt to future hazards.

[35]nwg.co.uk/our-purpose/public-interest-commitment/northumbrian-water-group-leads-the-way-on-affordability-with-commitment-to-eradicate-water-poverty-by-2030 [36]Water Industry National Environment Programme
[37]ofwat.gov.uk/wp-content/uploads/2021/01/UUW-WINEP-review-discussion-paper.pdf

Engineered and nature-based solutions

As a water and wastewater provider, it is essential that we use bespoke engineering solutions to mitigate flood risks, ensure a secure supply, and sustainably manage our waterways.

Engineered and nature-based solutions are critical to respond to our key risks around flooding and drought. Examples of these solutions include implementing flood defence barriers or piping water between abundant and stressed zones to make sure communities are protected and supplied. Our detailed modelling of water resources and drainage through our WRMP and DWMP will provide us with more detailed requirements as to specific schemes that we need to deliver.

Considering how we impact habitats and nature when putting climate adaptation solutions into practice is important to us. Using nature-based solutions to manage water flow is an important way in which we can work together with our environment. These solutions are essential for reducing flooding from rivers and coastal areas, such as by reducing peak river levels, and increasing community resilience.

For example, slowing the flow of heavy rainfall allows communities to have more time to prepare for the effects of flooding. Nature-based solutions also help to improve biodiversity and water quality in our catchments.

Employing these in conjunction with more traditional engineering solutions means we can ensure a high level of resilience against extreme weather patterns and a changing climate in the future.

By understanding asset performance through the data we collect, how we analyse it and having whole life asset plans for both our engineered and nature-based assets, we can make sure that our assets perform as they should. This is an essential part of preparing for the impacts of climate change.

Collaborative working is essential in our projects. We work in partnership with other water companies through Water Resources East and Water Resources North, further supporting the resilience of our future water supply.

Jaywick, Essex

Engineered and nature-based solutions
(continued)

Our key action areas

We believe that we need to act now to make sure our service remains reliable for our customers. We have identified key areas for action:

- Develop a catchment approach to sustainable urban drainage.
- Align our approaches to modelling climate change across the business to make sure all our systems are prepared for future climate events.
- Carry out a review of company design standards for different asset types to make sure they incorporate climate resilience.
- Build on existing critical asset assessments. We will continue our work on zonal strategic studies to help understand strategic, system-level pinch-points in the water system and extend this to new systems.
- Continue to feed into developing the resilience of the Broads.
- Use innovation to reduce the impact of climate change on our assets. For example, the addition of a new front-end DAF process at Layer WTW during AMP7, to reduce algal loading onto the primary filters and therefore improve the deployable output of the Works. Algae has been increasingly problematic, and research suggests this could increase further with climate change.
- Implement key projects to improve the resilience of our systems, such as our project to connect Abberton reservoir to Hanningfield WTW to improve raw water transfer capability and the supply resilience in the Essex region.
- Implement best practice asset management to make sure that our assets continue to perform effectively and provide us with resilience to future climate hazards. We also aim to work with other asset owners and managers to make sure that their assets, which we rely on, are also well managed.

Key areas of research

To develop our approach in the longer term, we recognise that we need to explore some key topics, which are set out in detail in our climate adaptation action plan. These include:

- We propose research into how we can apply the circular economy approach within our business.
- We plan to continue our work in close collaboration with others such as through Innovate East and Water Resources North.
- We propose to better understand the risks and opportunities associated with nature-based solutions, with the view to increase the number of nature-based solutions proposed for AMP8.
- We plan to develop our approach to whole life asset management plans for nature-based solutions.

Brunton Park sustainable drainage solutions

This project applied sustainable drainage solutions to manage rainwater in the Brunton Park residential area, reducing highway, external, and internal property flooding. The project was the result of new collaboration between Northumbrian Water, the EA and Newcastle City Council, and residents were engaged to make sure the approach was sustainable in the long-term. The scheme involved upsizing and constructing sewers, construction of flood defences, re-alignment of the Ouseburn River, and the creation of 0.5ha of new water-dependent habitat. This combination of engineered and nature-based solutions, as well as innovative partnerships, allowed the adaptation plan to be successful, resulting in more than 100 properties no longer being at risk of flooding.

Engineered and nature-based solutions
(continued)

Wetlands trail project

We have been exploring the opportunity for Integrated Constructed Wetlands (ICWs) to provide enhanced phosphorus (P) removal at sewage treatment works. As nature-based solutions, ICWs potentially provide many environmental and social benefits, including improved water quality, enhanced biodiversity, carbon sequestration, and blue spaces for communities to enjoy. However, their effectiveness as an alternative to traditional end-of-pipe solutions is uncertain, with only a few examples globally from which to learn.

Our innovation funds have supported a feasibility project investigating the potential application of ICWs to solve future AMP8 challenges, and to identify a location for an early trial site, which would provide a test platform that wastewater managers could use to understand the effectiveness of an ICW under certain flow and treatment scenarios.

The study has identified eight locations in the Wear and Tees which we believe would be suitable for ICWs as alternative solutions for P removal, and has produced outline designs which could be included as nature-based solutions within our 2025-30 Business Plan.

The project has also produced a design concept for a 2ha trial wetland, which could be progressed ahead of 2025.

This site in the mid Wear is close to other areas of wetland restoration, which would bring big ecological benefits linking to the ambitions of the catchment partnership. This project would be located on our own land, which would enable the trial to progress quickly under our management, so that we, and others, could learn more about ICWs and contribute to the wider catchment ambitions.

Wetland ©Arup

Learning from elsewhere: Augustenberg Urban Stormwater Management, Malmö, Sweden

During the 1980s and 1990s, the neighbourhood of Augustenborg in Malmö was an area of social and economic decline and was frequently flooded from an overflowing drainage system. Between 1998 and 2002, the area was regenerated through a large-scale stakeholder-led process.

The physical changes in infrastructure included the creation of sustainable urban drainage systems (SUDS), including 6km of water channels and ten retention ponds.

Green Roof ©Arup

Engineered and nature-based solutions
(continued)

Learning from elsewhere: Urban water retention, Italy

In the Altovicentino area in Italy, a region vulnerable to floods and landslides, local authorities implemented several water retention methods to reduce flood risk.

These were a mix of natural and mechanical measures: rain gardens, green spaces, swales, fascines, underdrain bioretention, detention basins, infiltration trenches, and rainwater harvesting systems.

The Santorso municipality implemented multiple measures:

- Rain gardens and underdrain bioretention in urban areas that flood frequently.
- Swales, fascines, and a bioretention area built onto a hillside, enabling water accumulation and infiltration.
- A detention basin - surface water flowing along Via Volti is collected by a sewer equipped with pumps that brings the water into a detention basin. The detention basin is split into three sub-basins; the first one to be always left inundated. A green recreational area was created around the basin.
- Rainwater harvesting systems.
- Infiltration trenches.

Most water management efforts have focused on capital-intensive hydraulic works, which work but don't provide the wider range of benefits associated with natural water retention.

Data, R&D, and emerging technologies

We acknowledge that our changing climate and increasing extreme weather patterns will require the development of new technologies to allow us to mitigate the associated risks. These new technologies will also allow us to seize the new opportunities afforded by these changes in the natural environment.

We have detailed modelling for drought through our WRMP and drainage through our DWMP. We are looking to develop our data and the information available for key climate risks like increasing high temperatures. We are also developing our future approaches to identify and manage new and emerging risks

For our company to make sound decisions, we need robust and reliable data. It is also important that this data can be shared across the business to form a common data strategy.

Ongoing R&D facilitates innovation in our existing processes and fosters an environment in which new, pioneering processes and practices can be developed.

We can utilise data, R&D, and emerging technologies to their maximum potential to implement adaptation strategies in the most efficient and beneficial ways. For example, data may be used to predict local water demand or shortages, and therefore we can mitigate the effects of these issues through measures such as storage in advance or moving resources between differently affected areas.

Data, R&D, and emerging technologies

(continued)

Our key action areas

We have two focused research and development efforts. BE:WISE is an innovative test centre for wastewater treatment technologies. Aquadvanced is an energy optimisation software system which helps anticipate water demand in real time across our supply zones, enabling us to schedule trunk mains maintenance whilst minimising disruption.

Some key actions we are focusing on include:

- Testing and developing more effective and sustainable water and energy solutions for people's homes – including those on low-incomes, the elderly and vulnerable – to find tailored solutions to reducing carbon through energy and water efficiency. We've been awarded funding from the Ofwat Innovation Fund for this project.
- Reviewing our company-wide approach to using geospatial data effectively, making sure we have the right skills and the right data, as well as a consistent and coherent company-wide geospatial data ecosystem. The geospatial data will be combined with consumer behaviour data, asset performance data, and climate and weather data. We will use this improved data ecosystem to support our identification of risks and vulnerabilities, which will enable us to embed this into our risk management approaches.

Key areas of research

To develop our approach in the longer term we recognise that we need to explore some key topics, which are set out in detail in our climate adaptation action plan. These include:

- Continuing with PhD funding through partnerships with Exeter and Newcastle universities, focusing on the resilience of groundwater resources under different scenarios of climate change.
- Developing an evidence base of asset performance across different temperature profiles.
- Continuing research on interdependencies and the risk associated with supply chains.
- Developing an app to help us to understand individual asset risk and resilience.

Fair Water Project

The Fair Water Project, a four-year collaboration with Northern Gas Networks, Newcastle University, National Energy Action, and Procter & Gamble, aims to test, develop, and evaluate integrated water and energy solutions for households, including those on low incomes and the elderly. The project will focus on both behavioural and technical innovations that are affordable and tailored to specific housing typologies and customer habits, with minimal disruption to our customers. The products and services developed during this partnership will be evaluated and rolled out at scale across England and Wales to help customers reduce their water and energy footprint. It will also help to save money on their water bills. This project is only made possible through collaboration, drawing on the expertise of multiple sectors and academia.

Behavioural

As a critical infrastructure service provider, we work as part of a wider network, and we shouldn't choose to adapt to the impacts of climate change in isolation without considering our wider system impacts and the impacts of the wider system on us.

The risk of key climate hazards, like drought and flooding can be exacerbated through current behaviours. Promoting and encouraging behavioural change among actors in this wider system in how we use and consume water is an important component of our toolkit of adaptation measures.

Behaviour change is critical to reduce water demand (reducing per capita consumption) and to protect our assets from damaging behaviours, through campaigns like the Bin the Wipe.

Our key action areas

One of the most impactful and cost-effective strategies we have is to use our platform to leverage wider change in water use habits and water stewardship among our customers. While we have a strong track record in the behaviour change space with marketing and communication campaigns promoting water saving, we would like tto continue to develop our customer engagement approaches to further promote the responsible and sustainable use of water.

Key areas of research

- We deliver several customer engagement and communication campaigns with a focus on water saving, such as Water's Worth Saving, supporting climate adaptation and resilience.
- We have a new company-wide community investment strategy with aims to protect the water environment and leave a positive impact on local communities. We will work to deliver our climate actions in collaboration and co-deliver solutions with multiple stakeholders.
- A key area of focus going forward is to work with Water UK, the Government, and other leading water and wastewater services providers. We aim to develop an increasingly high-profile campaign promoting water stewardship and responsible water use to positively influence customer behaviour.
- To develop our approach in the longer term we recognise that we need to explore some key topics:
- We want to further engage with our customers, specifically on climate change.
- Our individual water saving campaigns, although relevant to climate adaptation and resilience, are not framed as such. We want to make sure our engagement campaigns continue to have strong results. Currently, it is unknown whether shifting the framing of our campaigns in this way would resonate with our customers more strongly and deliver our campaign objectives more effectively. Therefore, further customer research is needed.
- We use innovative techniques to carry out strategic customer
- research. We will also get back to speaking to our customers face to face again at focus groups
- and through Flo, our customer engagement vehicle, which is used to gain authentic customer insight while also raising awareness
- of key campaign messaging.

Behavioural
(continued)

Community SuDS innovation

Community SuDS innovation
We were a main delivery partner for an innovative, multi-stakeholder project to develop a new approach to designing, delivering, and monitoring Sustainable Urban Drainage Systems (SuDS) that are scalable, adaptive, led by the community, and make best use of available technologies.

The project placed the South Stanley community at the heart of the SuDS process by putting residents' needs, desires, and abilities at the centre of the design process. Community participants were directly involved in identifying and developing iterative SuDS solutions. This stakeholder engagement and co-creation of solutions directly fed into the design-thinking approach that governed the project.

The project enhanced resilience to urban surface water flooding within the study area by encouraging more rapid and efficient identification, design, and implementation of SuDS interventions. It better protected places from urban flooding.

The approach saw communities as partners in flood management, meaning they are better able to plan for, protect against, and respond to flooding events when they occur.

This is an excellent example of how driving innovation in the institutional structures that typically deliver flood risk management schemes can also positively impact our ambitions for promoting behavioural change among our customers. Shifting from the expert-led flooding-focused approach to a community partnership boosts engagement and awareness, as well as acceptance of long-term adoption of critical interventions.

We are looking to develop our community approaches to green spaces further in Stanley South. At our 2021 Innovation Festival we held a sprint to develop our approach and identified potential work around developing 'the store' community hub to share knowledge and develop ongoing communications with our communities. This may focus on flooding resilience, greenspace and wellbeing and education and training.

Learning from elsewhere: Zaragoza - A behaviour change success story

After suffering droughts in the 1990s, Zaragoza, a city in Spain, launched a water-saving behavioural change campaign. This used an advertising media campaign, education (aimed at reducing domestic consumption), financial incentives (through cutting the cost of water-saving products), and good practice guides for businesses. Features included:

- **Education**: 168 educational establishments, 428 teachers and 70,000 students directly participated in the campaign's educational programme.
- **Developing best practice for business**: they offered free water audits to businesses with water (and cost) saving recommendations. They then created a handbook and approached similar businesses in industries where there had been large savings.
- **Financial incentives**: they changed the billing methods so customers could see local averages and month-to-month changes. They increased prices where there was excessive consumption.

They achieved a cut in per capita use from 150 litres per day in 1997 to 99 litres per day in 2012. This amounts to 1,176 000m^3 per year. A water saving culture was established, as the drop in PCC has persisted after intervention. They have now created 'Zinnae', the European Cluster Collaboration Platform, which works to offer solutions to water security challenges in order to build a sustainable and resilient future, working under the principles of the circular economy and intelligent society.

Institutional

While the physical interventions we plan for in the future to build resilience in our assets and wider business might be the headline adaptation actions, institutional adaptation remains important. Institutional adaptation describes how we adapt the governance of our business, business processes, and relationships with partners and customers.

Our governance and decision making supports us to address key climate hazards, like flooding, drought and high temperatures, by supporting us to understand, plan for, invest in and implement mitigation measures.

Examples of institutional adaptation actions include our continued support of the Water Hub and Innovate East, our business continuity plans, and investment optimisation decision analytics tools.

Our key action areas

We recognise that we need to update our processes, governance and how we work with others to support our climate adaptation in the long term. We have identified some key areas for action going forward, which are:

- We are contributing to the UKWIR research project to develop a common framework for climate adaptation in the water sector, in combination with representatives from across the UK and Ireland. This aims to address the barrier that there was no common goal across the sector for climate adaptation.
- We will continue to develop and improve our risk approach and identify how we translate our strategic and corporate risk registers into planning and decision making. This will include consideration of interdependencies and will be embedded in the way our Risk and Compliance committee looks at risk.
- We aim to improve our asset resilience to make sure we are climate ready. This will include a systems analysis of risk and understanding of the vulnerabilities across our asset base. We aim to do this in part by combining key data sets on consumer behaviour, weather, land use, oceans, and our asset base to understand how these interact.
- We will explore participatory sustainable urban drainage and water use, engaging with developers, communities, and other stakeholders to improve stormwater flooding outcomes.

Key areas of research

Key areas of research to support our ongoing work are set out in detail in our climate adaptation action plan. These include:

- Developing sector-wide thinking on investing in climate adaptation, by working with our regulators to develop the best approaches to consider and invest in the long term.
- Engaging with academia and wider industry to understand how we can use the best tools, methods, and approaches to embed adaptation decision making into the business.

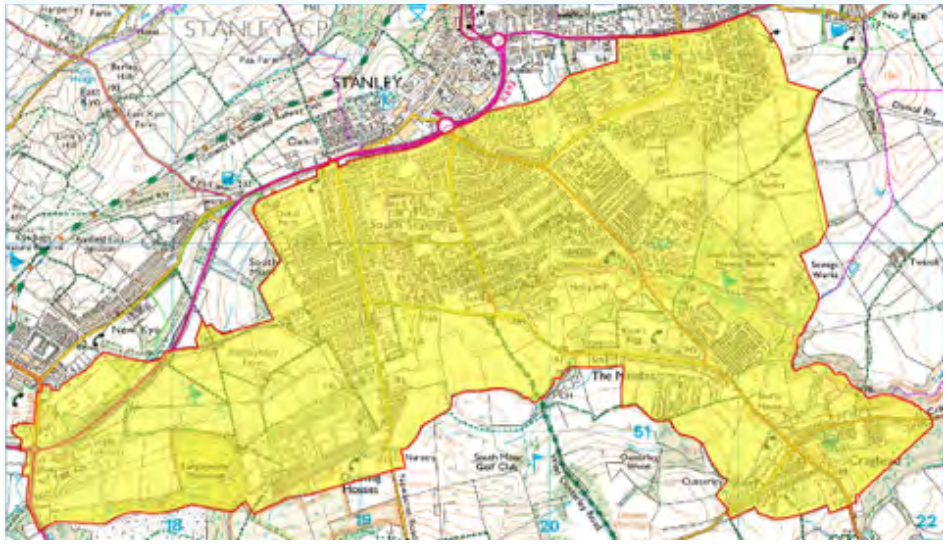
Institutional
(continued)

Northumbrian Integrated Drainage Partnership.

We are an integral part of the Northumbrian Integrated Drainage Partnership (NIDP), an award-winning, multi-agency approach to developing flood risk reduction schemes across the region.

The NIDP brings together stakeholders to collaboratively manage flooding from sewers, rivers, and surface water, and aims to promote wider benefits including habitat creation and water quality improvements.

Recent catchment improvement projects delivered through the NIDP include Killingworth and Longbenton, a £6m flood risk reduction and biodiversity enhancement scheme completed in partnership with North Tyneside Council and the Environment Agency during AMP6.



Learning from elsewhere: National Grid- TCFD Physical Climate Risk

National Grid has carried out a group-wide scenario-based assessment of physical climate change risks to electricity and gas infrastructure across its UK and US businesses to support strategic decision-making. Two scenarios were used to consider impacts from different degrees of warming.

Geospatial analysis of climate hazards (using UKCP18 data in the UK), was combined with vulnerability assessment by asset type, to produce the full risk assessment.

An interactive visualisation allows users from different National Grid business functions to explore and interrogate the richness of information available in the full risk assessment in response to their needs, such as by asset type or geographical area of interest.

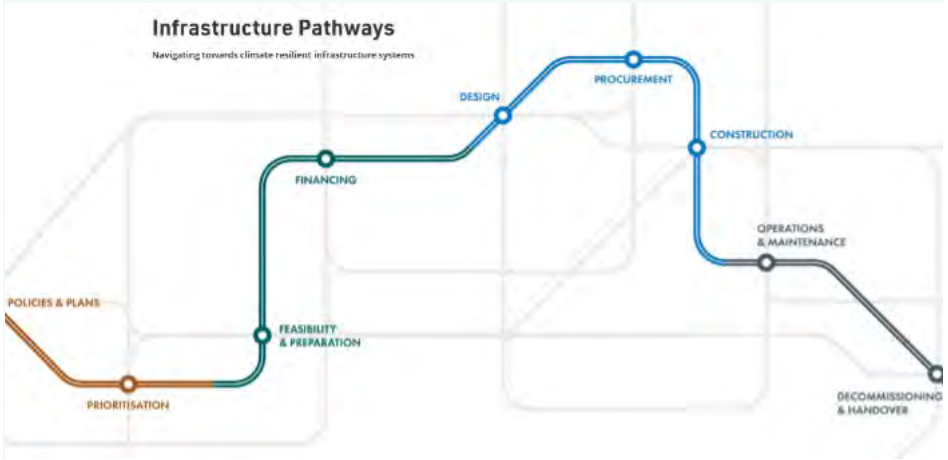
The assessment contributes to National Grid's ongoing work aligned with the recommendations of the Task Force on Climate-related Financial Disclosures.

Institutional
(continued)

Learning from elsewhere: Infrastructure Pathways, the Resilience Shift

Infrastructure Pathways is a new multi-stakeholder initiative by the International Coalition for Sustainable Infrastructure (ICSI), led by The Resilience Shift and in partnership with Arup. It aims to bring together existing guidance on resilience planning to provide a line of sight across the entire project life cycle, to embed climate resilience and deliver safe, sustainable, and resilient infrastructure for all.

It aims to set out the role of key stakeholders and communicate the resilience value at different stages across a project's life cycle. We recognise that learning from developing best practice on resilience planning will support our own long-term planning.



Learning from elsewhere: Thames Estuary 2100 Plan

The Thames Estuary 2100 plan is the Environment Agency's response to increased flood risk due to climate change, sea level rise, and increasing population. The plan is adjustable to different rates of sea level rise, preparing for the uncertainty around the impacts of climate change. The main manifestation of this approach is the fact a decision on how to replace the Thames Barrier will not be taken until around 2040, when more will be known about the impacts of climate change on the Thames Estuary.

Taking a 'precautionary' approach, where a single major investment that would protect from flooding for this century is made, would be very expensive and environmentally damaging, and could risk becoming useless if the climate projections the decision is based on turn out to be inaccurate.

To avoid this, the Environment Agency has developed a suite of different options that can be implemented based on how climate change impacts the estuary and rate of flood risk.

We aim to learn from this adaptive planning approach in our future investment planning to allow us to make 'no-regrets' decisions and prevent lock-in.

Financial

The way we finance our business and the way we report our current and future expected financial performance can be another important component of our climate adaptation toolkit. In order to prepare for key climate hazards, like flooding, drought and high temperatures, we need sufficient funds to invest in key solutions.

We are providing essential water and wastewater services and have legal obligations to do this. If we do not prepare and adapt for climate change, we risk failing to fulfil these obligations. Our customers care about climate change and trust us to support and invest in work on adaptation.

Financial institutions are increasingly considering environment, social and governance (ESG) issues in their decisions to release capital. This both provides a focus for our approach to climate change adaptation and also creates opportunities to further strengthen our approach to adaptation.

Our key action areas

There are new financing methods which are being adopted by the sector. Therefore, a key part of our future work is to adapt and develop our current approaches to financing climate adaptation actions. Some key actions we are focusing on include:

- Developing our approach to using sustainable finance instruments, such as green bonds, to finance our business.
- Reporting our climate risks for NWL and NWL's pension fund in line with Task Force on Climate-Related Financial Disclosures (TCFD) recommendations.

Key areas of research

Key areas of research to support our ongoing work include the development of comprehensive accounts of the organisation's natural capital in line with the latest guidance.

Learning from elsewhere: Best practice financial stability

We have consulted the Climate Disclosure Standards Board (CDSB) and the Sustainability Accounting Standards Board (SASB) TCFD good practice handbook, supplementary information on the use of scenario analysis, and the WWF water risk filter to identify best practice for understanding and disclosing climate risk in the water sector and to identify the benefits of using this approach.

Disclosing to TCFD recommendations presents to the market the steps we are taking in our risk management processes to deal with the associated climate risks. Using or adapting methodologies utilised in the water risk tool could give a deeper understanding of water specific climate risk. However, transition risk scenarios are not as well developed as physical risk scenarios and are generally focused on the energy sector. Therefore, disclosing to TCFD recommendations, particularly on transition risk scenarios, is likely to be iterative, year on year.

Learning from elsewhere: Sovereign Green Bonds, Sweden

We want to learn from new ways to invest in key projects. Green bonds may be an opportunity to do this. In 2015, the Swedish Parliament set out a goal to create sustainable financial markets that enable the financial system to contribute to climate adaptation and mitigation. In 2019, the Swedish Government tasked the Swedish National Debt Office with implementing an issue of Swedish sovereign green bonds. The aim is to finance a portfolio of expenditures that meet environmental and climate goals. As well as the climate goals, there are 16 environmental objectives that are monitored annually and in depth every four years. Several are relevant to water management, including:

- Flourishing lakes and streams.
- Good quality groundwater.
- Balanced marine environment.
- Thriving wetlands.

The journey map

The key sector-wide risks across water, as set out in the CCRA3 will also impact our service provision going forward. The actions set out in this chapter are enabling actions to prepare for 2°C and better understand the implications of a 4°C world. Some of the actions to specifically address these sector risks are set out below.

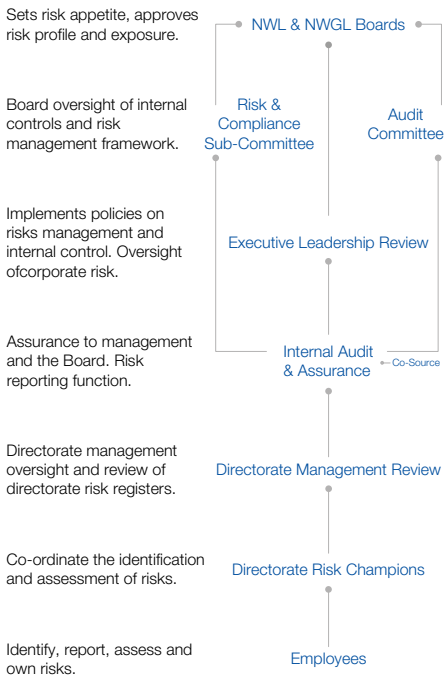
Key sector wide risks	How do our actions work to address these risks?
Risk to our assets from river, surface, groundwater, and coastal flooding	• We aim to develop a catchment approach to sustainable urban drainage. • We will continue to feed into developing the resilience of the Broads.
Risks to our systems and networks from subsidence	• We aim to carry out a review of company design standards for different asset types to make sure they incorporate climate resilience. • We will develop an evidence base of asset performance across different temperature profiles and are developing an app to help us to understand individual asset risk and resilience.
Reduced water availability, risking public water supplies	• We will implement key projects to improve our supply resilience with a new connection to Abberton Reservoir. • We have been awarded funding from the Ofwat Innovation Fund for a project that aims to test and develop more effective and sustainable water and energy solutions for people's homes. • We deliver several customer engagement campaigns with a focus on water saving, such as Water's Worth Saving. These support our customers to reduce water use, supporting climate adaptation and resilience.
Risks of poor water quality and supply interruptions	• We aim to build on existing critical asset assessments. We will continue our work on zonal strategic studies to help understand strategic, system-level pinch-points in the water system and extend this to new systems. • We are developing new innovations to reduce the impact of climate change on our assets; e.g. to reduce algal loading on our water treatment works.
Risk to our network from cascading failures	• We aim to improve our asset resilience to make sure they are climate ready. We aim for this to include a systems analysis of risk and understanding of the vulnerabilities across our asset base. • We will continue to align our approaches to modelling climate change across the business to make sure all our systems are prepared for future climate events. • We will continue research on interdependencies and the risk associated with supply chains.
Risks to aquifers from sea level rise and saltwater intrusion	• We continue to assess the impact of sea level rise, with our main risk from overtopping of sea defences, which could salinate shallow unconfined aquifers. The aquifers that are at risk from this either already have stopped being used or can be if required and there will be minimal water resource impacts. We are also looking at saline incursion for the Sunderland sources and have a current WINEP investigation into this.

An adaptive approach

Our governance approaches to climate risk

We have clear and robust governance processes for monitoring and managing climate risk.

We have strong tactical risk management, with a robust and clear process to identify, communicate, and manage risk. The graphic below provides an overview of the Group's approach to risk management.



We capture risk on two types of risk register: a strategic risk register and a corporate risk register.

- **Our strategic risk register** identifies and monitors risk with a significant level of uncertainty.
- **Our corporate risk register** identifies and monitors risk with relatively low levels of uncertainty, for which magnitude and likelihood of risks can be reasonably well understood.

These registers capture the levels of these risks and potential mitigation interventions. They support us to keep track of our risk and progress on addressing these risks. Our risk appetite is reviewed annually, or more frequently if there are any significant changes to the risk environment. We generally do not have an appetite for high-risk exposure. However, to deliver some of our objectives, some degree of risk-taking will be required provided there are appropriate benefits and mitigation.

We are developing this approach to transition to a resilience-based risk approach and to improve the connection between the business's bottom-up, tactical risk management processes and its horizon-scanning and strategic risk management processes. In particular, the business is putting in place an updated approach to developing and updating strategies based on horizon-scanning.

We are looking to further develop our understanding of system risk, understand the vulnerabilities of our assets to climate hazards at scale, and are looking to identify key trigger issues that we need to monitor better. Our resilience approach is building in multiple hazard assessment, systems interdependency and capitals valuation of risk. As well as this, we will report our climate risks for NWL and NWL's pension fund in line with TCFD recommendations.

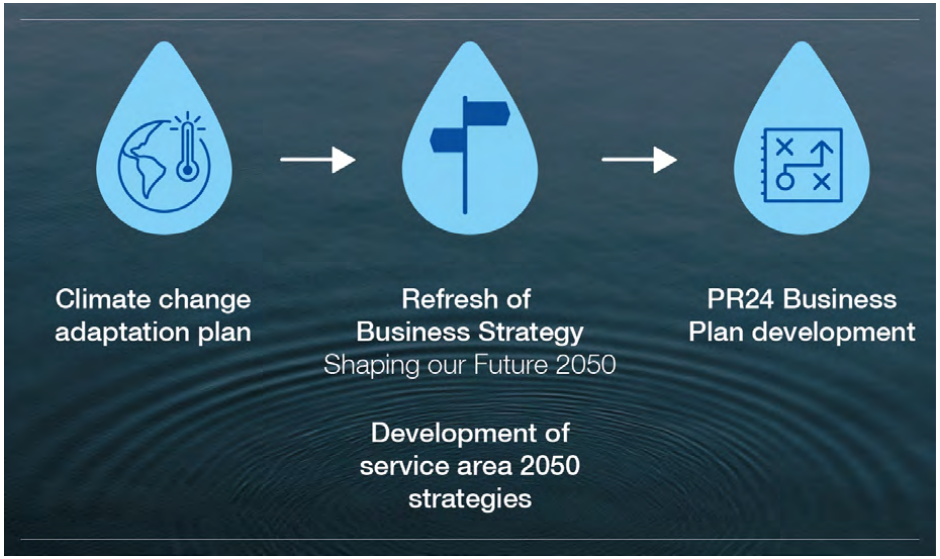
How adaptation will feed into our business

This adaptation plan is underpinned by a more detailed Climate Adaptation Action Plan, which will remain a live document. This will capture our plans for climate adaptation across the business and set out action owners, interdependencies, and timeframes for action.

This Climate Adaptation Action Plan will form part of our Long Term Strategy for the business, along with the development of our service area 2050 strategies.

This will then be the foundation of our PR24 (2025-30) Business Plan development.

This is the five-year plan that sets out our short-term steps in our overarching long-term plans to 2050.



Monitoring and continual review

The Climate Adaptation Action Plan mentioned above sets out our adaptation actions in the short, medium, and long term. This will be a live document that we will continue to update.
We will review our progress through our monthly risk management approach, and our Risk and Compliance Committee will annually review our progress.

Call to action

Our purpose: Caring for the essential needs of our communities and the environment, now and for generations to come

We do this by providing reliable and affordable water and wastewater services for our customers.

We make a positive difference by operating efficiently and investing prudently, to maintain a sustainable and resilient business.

We aim to become a truly climate resilient water and wastewater service provider both now and for future generations. To achieve this, we need to work with others across the sector to be climate ready.

Climate hazards are one of our key risks both now and in the future. We will continue to develop and deliver actions that support our climate adaptation.

This plan sets out our next steps to achieve this but is a snapshot of our future climate risk, so we will continue our work to develop our understanding of these risks to enable us to adapt to future events.

As always we will look for opportunities to deliver research and innovation to support the implementation of this in the long term. Working in partnership to deliver our work remains key and we continue to look for opportunities to deepen our collaboration with others. Our approach to climate change will be aligned to global commitments in the Paris Agreement and Glasgow Climate Pact goal of 1.5°C. Our goal is to be net zero by 2027, and we aim to adapt for 2°C and prepare for 4°C. We will consider both in tandem.

We cannot adapt alone. This is our rallying call to partners from across the sector. Let's join together with our regulators, our customers, communities and citizens and other stakeholders to develop and deliver climate adaptation solutions.

To our regulators: we want to work collaboratively to identify key opportunities to invest in our climate resilience in the long-term.

To our customers and communities: we want to engage directly on climate adaptation and to identify community partnership opportunities.

To our stakeholders: we want to look for opportunities to co-create and co-deliver key climate adaptation projects across our communities.

Look out for Climate Change as a key theme in our engagement with you.

Contact us at **haveyoursay@nwl.co.uk** if you would like to discuss specific opportunities.

Spittal Beach, Berwick

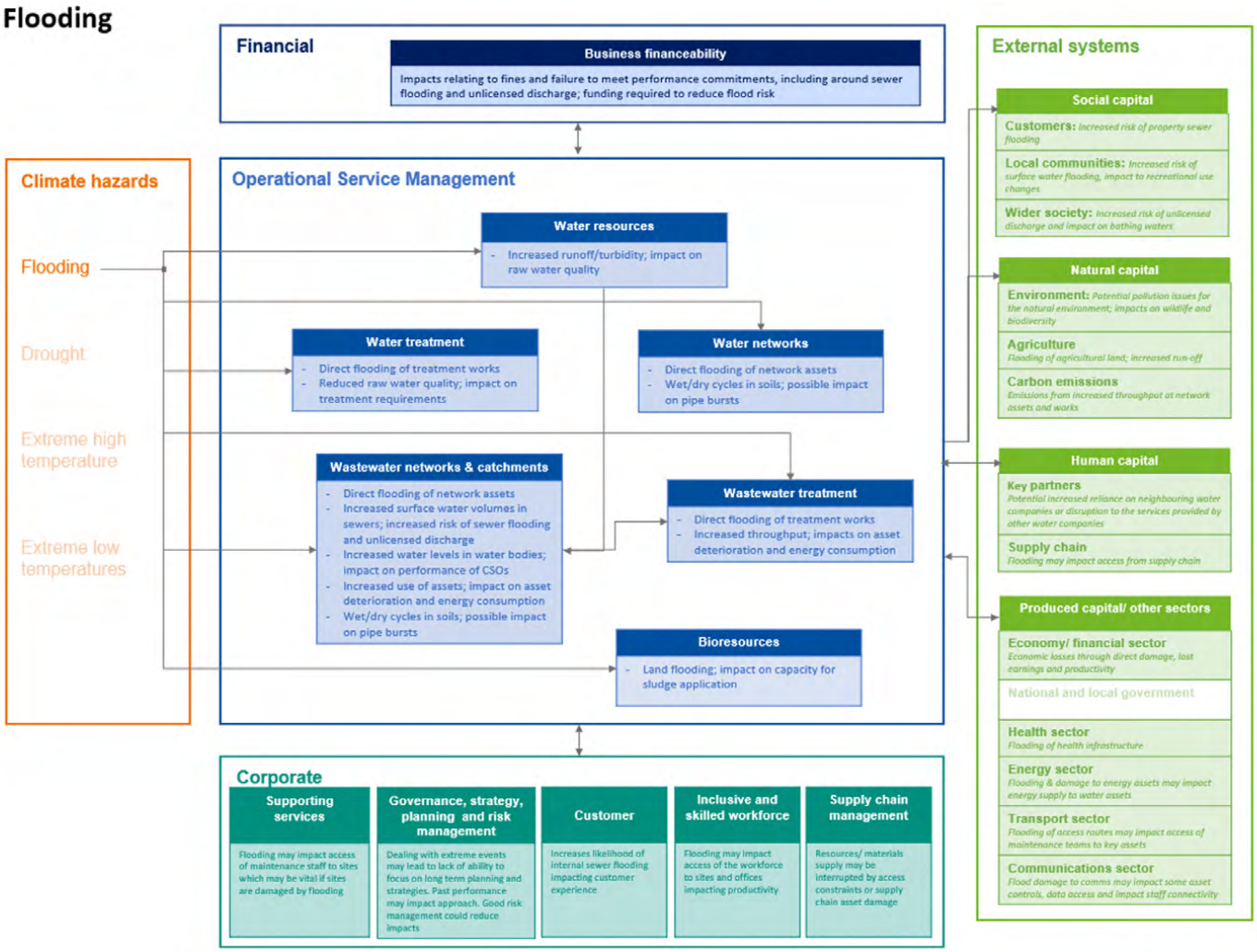
Appendix 1
Our system interdependencies

We have carried out a mapping exercise to understand how our systems are impacted by climate risk, how this impacts our other systems (operation, financial and corporate) and the interaction these systems have with external systems. This has been undertaken in four maps for:

- Flooding (including sea level rise).
- Drought.
- High temperatures
- Low temperatures.

The risk of flooding is projected to significantly increase between 2050 and 2090, both due to rising levels of winter rainfall and changing patterns of summer rainfall.

We have mapped how flooding is likely to impact our internal and external systems.

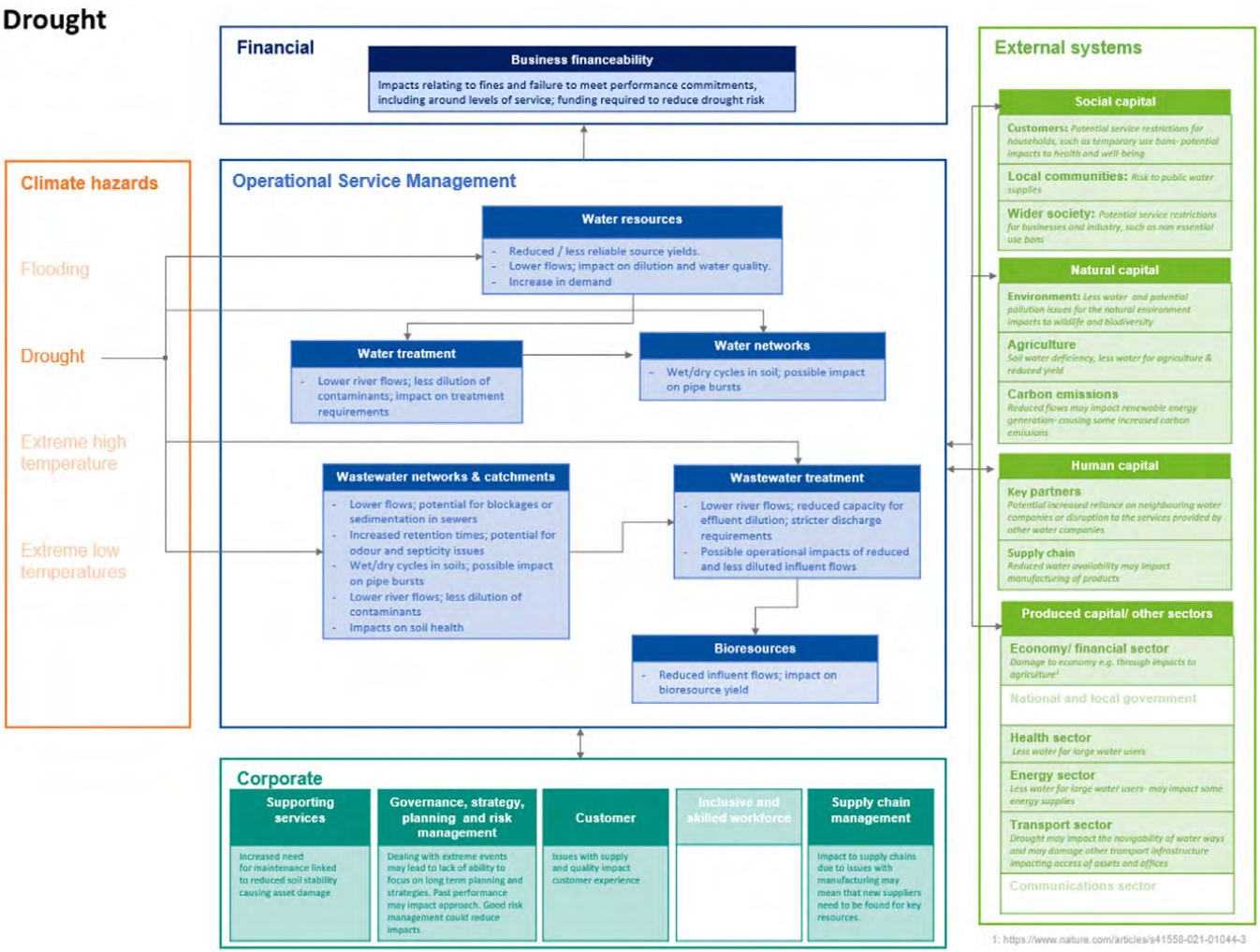


The risk of drought is increasing in 2050 and 2090. Summer rainfall will likely decrease across all our operating areas, increasing the risk of drought. This will particularly impact our customers in Essex & Suffolk.

We have mapped how drought is likely to impact our internal and external systems.

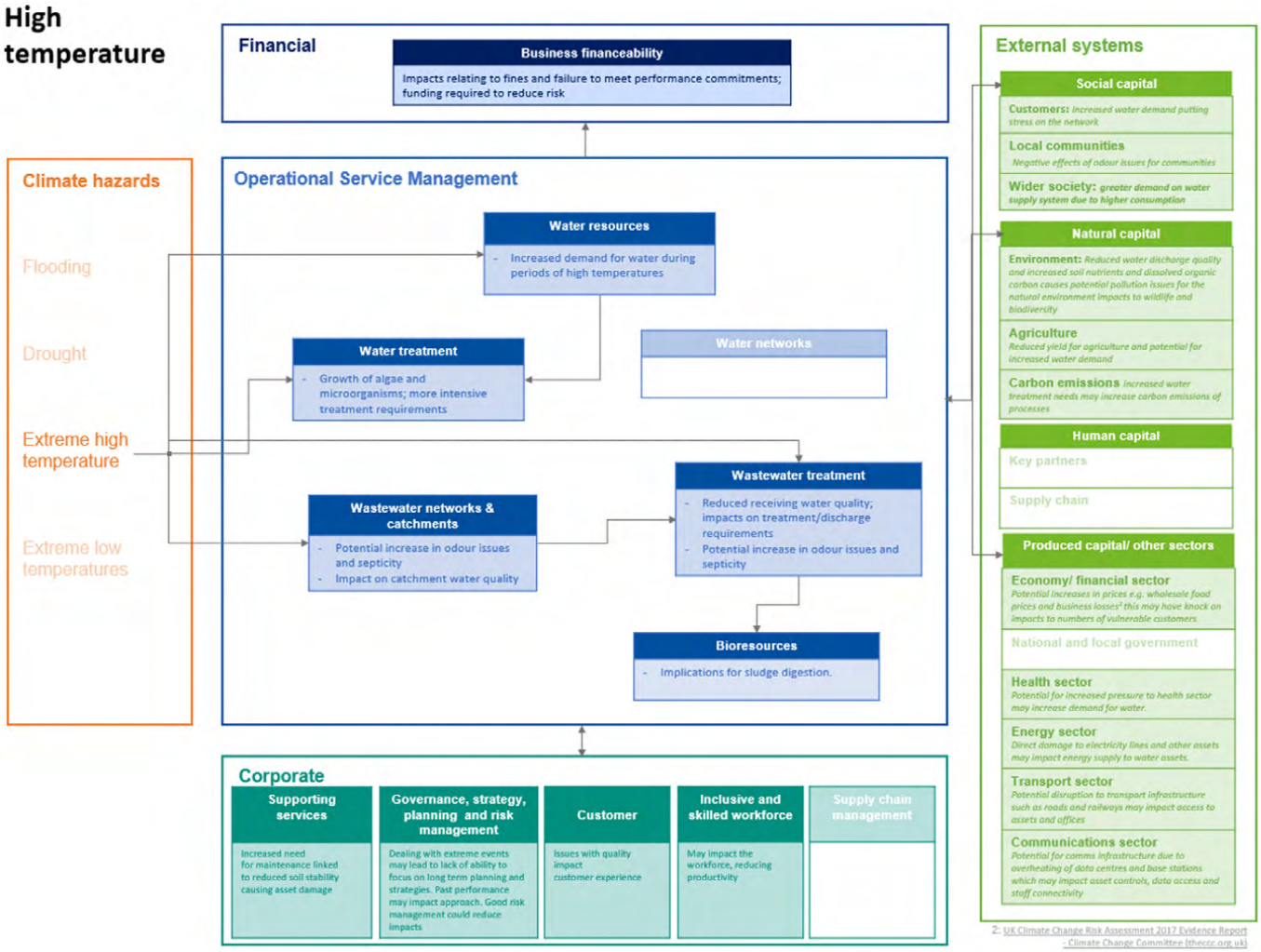
Climate change will increase the mean temperature everywhere and in all seasons. There in an increasing risk of of high temperatures particularly in 2090.

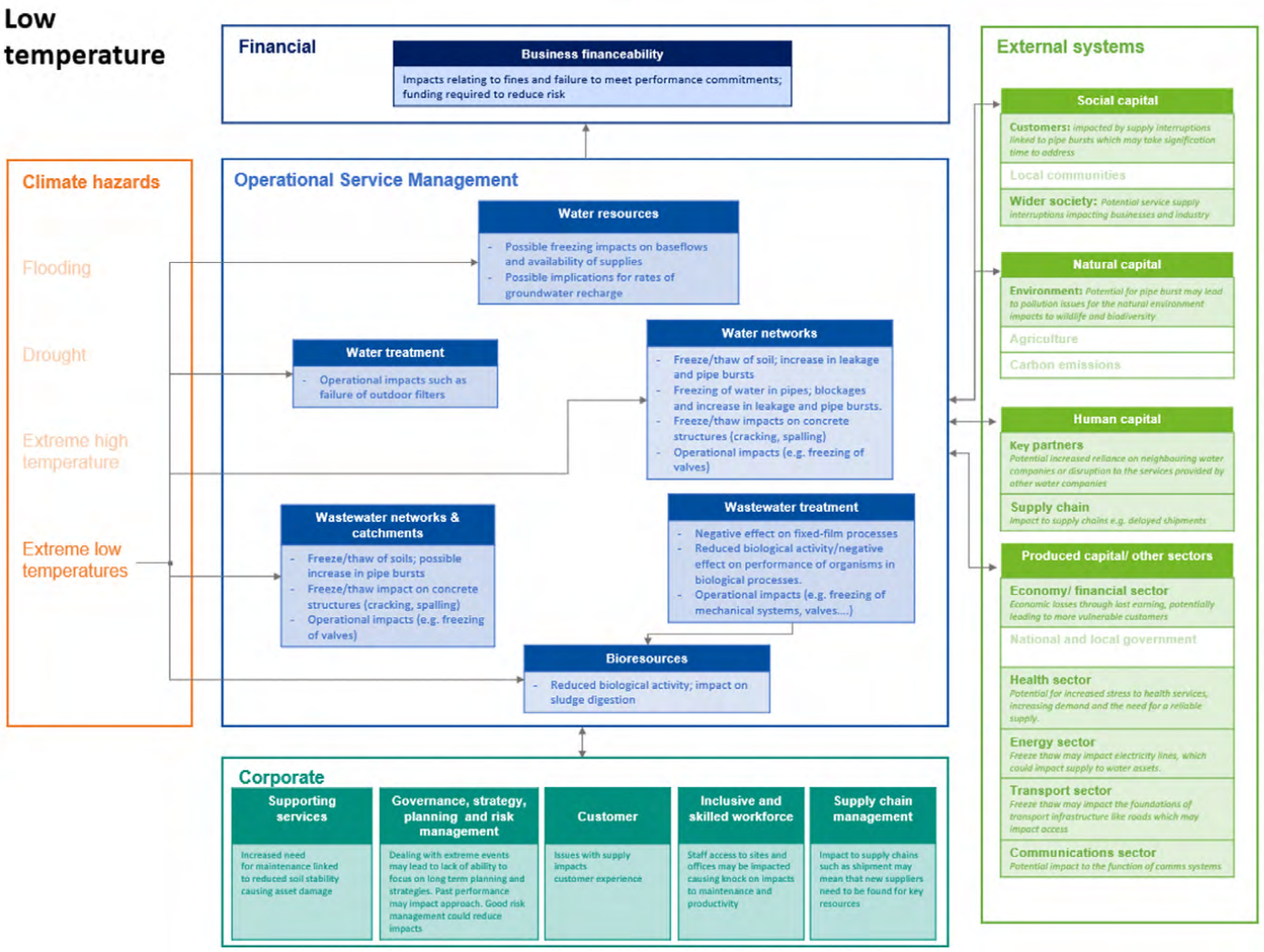
We have mapped how high temperature is likely to impact our internal and external systems.



The likelihood of extreme low temperatures will decrease over time (in 2050 and 2090) but we are still susceptible to extreme cold events.

We have mapped how low temperature is likely to impact our internal and external systems.




Low temperature
Financial
Business financeability
Impacts relating to fines and failure to meet performance commitments; funding required to reduce risk
Climate hazards
Flooding
Drought
Extreme high temperature
Extreme low temperatures
Operational Service Management
Water resources
- Possible freezing impacts on baseflows and availability of supplies
- Possible implications for rates of groundwater recharge
Water treatment
- Operational impacts such as failure of outdoor filters
Water networks
- Freeze/thaw of soil; increase in leakage and pipe bursts
- Freezing of water in pipes; blockages and increase in leakage and pipe bursts.
- Freeze/thaw impacts on concrete structures (cracking, spalling)
- Operational impacts (e.g. freezing of valves)
Wastewater networks & catchments
- Freeze/thaw of soils; possible increase in pipe bursts
- Freeze/thaw impact on concrete structures (cracking, spalling)
- Operational impacts (e.g. freezing of valves)
Wastewater treatment
- Negative effect on fixed-film processes
- Reduced biological activity/negative effect on performance of organisms in biological processes.
- Operational impacts (e.g. freezing of mechanical systems, valves....)
Bioresources
- Reduced biological activity; impact on sludge digestion
Corporate
Supporting services
Increased need for maintenance linked to reduced soil stability causing asset damage
Governance, strategy, planning and risk management
Dealing with extreme events may lead to lack of ability to focus on long term planning and strategies. Past performance may impact approach. Good risk management could reduce impacts
Customer
Issues with supply impacts customer experience
Inclusive and skilled workforce
Staff access to sites and offices may be impacted causing knock on impacts to maintenance and productivity
Supply chain management
Impact to supply chains such as shipment may mean that new suppliers need to be found for key resources
External systems
Social capital
Customers: impacted by supply interruptions linked to pipe bursts which may take signification time to address
Local communities
Wider society: Potential service supply interruptions impacting businesses and industry
Natural capital
Environment: Potential for pipe burst may lead to pollution issues for the natural environment impacts to wildlife and biodiversity
Agriculture
Carbon emissions
Human capital
Key partners
Potential increased reliance on neighbouring water companies or disruption to the services provided by other water companies
Supply chain
Impact to supply chains e.g. delayed shipments
Produced capital/ other sectors
Economy/ financial sector
Economic losses through lost earning, potentially leading to more vulnerable customers
National and local government
Health sector
Potential for increased stress to health services, increasing demand and the need for a reliable supply.
Energy sector
Freeze thaw may impact electricity lines, which could impact supply to water assets.
Transport sector
Freeze thaw may impact the foundations of transport infrastructure like roads which may impact access
Communications sector
Potential impact to the function of comms systems

Appendix 2
Glossary

Adaptation
In human systems, the process of adjustment to actual or expected climate and its effects, to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate[38].

Asset
An individual infrastructure object with georeferenced location and attributed to an asset class. Exposure means the degree to which an asset is in contact with a climate indicator of at least “low” hazard level.

Climate indicator
A selected parameter of a climate variable used to describe an aspect of change in a physical event or trend (e.g., number of days above 35°C and average summer temperature).

Climate variables
Characteristics of the climate used to describe the Earth’s climate system. Examples of climate variables are temperature, precipitation, wind, humidity etc.

Cascading hazard
If there is a failure in the water infrastructure network due to climate hazard, the knock-on effects of this cause a cascading hazard on other infrastructure or assets down the line.

Catchment
An area that collects and drains precipitation[39].

Compound event
When there is more than one climate hazard affecting a region or system at one time, leading to more significant impacts than a single hazard.

Exposure
The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected[39].

Extreme event
The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as ‘climate extremes[39].

Hazard
The Intergovernmental Panel on Climate Change (IPCC) defines hazard as the potential occurrence of a physical event or trend that may cause harm (e.g. damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources).

Hazard level
For the purposes of the assessment framework, we have defined fixed ranges for each hazard, based on values of the occurrence of climate indicators, as e.g. “High” “Medium” or “Low” hazard levels.

Impacts
Effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health status, ecosystems, economic, social, and cultural assets, services (including environmental), and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes[39].

Interdependencies
Systems that depend on one another such that when climate hazards impact one, the other will be impacted directly or indirectly due to the interaction between these systems other external systems.

Mitigation
A human intervention to reduce the sources or enhance the sinks of greenhouse gases[39].

[38]Annex II - Glossary [39]anglianwater.co.uk/siteassets/household/environment/net-zero-2030-strategy-2021.pdf

Nature-based solutions
Interventions that utilise the inherent properties of natural systems to deliver outcomes, these can either replace or be complementary to typical engineered solutions[39].

Opportunity
The potential for a beneficial consequence, because of a changing climate (the propensity to be beneficially affected)[40].

Resilience
The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation[39].

Resilience dividend
The net benefits associated with the absorption of shocks and stressors, the recovery path following a shock, and any co-benefits that accrue from a project, even in the absence of a shock[41].

Risk
The potential for a climate hazard to result in harm to an asset considering the hazard level (potential occurrence of event); the exposure of that object; and the vulnerability of that asset type.

Sensitivity
The extent to which a system reacts to an external pressure, such as a climate hazard. Higher sensitivity means the system will be more greatly affected by the hazard.

Vulnerability
The degree to which an asset class may be affected when exposed to a change in a particular climate indicator.

[39] anglianwater.co.uk/siteassets/household/environment/net-zero-2030-strategy-2021.pdf [40] Technical-Report-The-Third-Climate-Change-Risk-Assessment.pdf (ukclimaterisk.org) [41] Resilience Dividend Valuation Model: Framework Development and Initial Case Studies | RAND

Appendix 3
Acronyms

CCRA
Climate Change Risk Assessment.
A five-year UK-wide assessment that assesses the risks for the United Kingdom from the current and predicted impacts of climate change[42].

DEFRA
Department of Environment, Food, and Rural Affairs.
The UK government department responsible for improving and protecting the environment[43].

DWMP
Drainage and Wastewater Management Plan.
A long-term strategic plan that will set out how wastewater systems, and the drainage networks that impact them, are to be extended, improved and maintained to ensure they are robust and resilient to future pressures[44].

EA
Environment Agency.
An executive non-departmental public body, sponsored by the Department for Environment, Food & Rural Affairs[45].

RCP
Representative Concentration Pathways.
Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008).

TCFD
Taskforce for Climate-related Financial Disclosures.
A framework to help public companies and other organisations more effectively disclose climate-related risks and opportunities through their existing reporting processes[46].

UKCP
UK Climate Projections.
A climate analysis tool that forms part of the Met Office Hadley Centre Climate Programme[47].

UKWIR
UK Water Industry Research.
Organisation responsible for facilitating the shaping of the water industry's research agenda, developing the research programme, procuring, and managing the research and disseminating the findings[40].

WRMP
Water Resources Management Plan.
Five-yearly plans produced by all water companies to forecast supply and demand and set out how they will provide secure supplies of water to homes and businesses[40].

[40]Technical-Report-The-Third-Climate-Change-Risk-Assessment.pdf (ukclimaterisk.org) [42]Introduction to the CCRA - Climate Change Committee (theccc.org.uk) [43]DEFRA [44]Working_Together_an_overview_of_Drainage_and_Wastewater_Management_Plans.pdf
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