Planning for Climate Change

Adaptation Progress Report

2024

United Utilities

Water for the North West

Foreword

Reliable water and wastewater services are critical to supporting the people, communities and businesses we serve. Delivering great water every day and safely treating and recycling wastewater back to the environment underpins our vision to deliver a Stronger, Greener and Healthier North West. Future proofing these services is critical to supporting economic growth and prosperity for the region.

The water industry is perhaps at the forefront of the consequences of climate change given the intrinsic links between the weather, ecosystem health and our ability to deliver water and wastewater services.

The ecosystems of the North West, from its mountains and valleys to its lakes and rivers, provides us with the raw materials to deliver reliable, affordable and essential services. These ecosystems have already been challenged by climate change and will be challenged further.

We are already seeing the effects of climate change on the region's weather. This is resulting in risks of more frequent droughts and more severe flooding events, placing pressure on the services we provide with increasing summer temperatures, wetter winters and more extreme weather events.

We forecast that the available water supply will reduce by around 265 Megalitres per day from 2026 to 2050; this is driven by the hydrological impacts of climate change, and the abstraction reduction necessary to secure sustainable resources.

We have already taken action to address some of the most acute risks including accounting for the likely effects of climate change within our strategic planning frameworks. We have also been developing long-term adaptive plans that are agile in responding to changes in climate science, customer behaviour and regulatory challenges. You can find more about these in our Long Term Delivery Strategy.

In this report, our fourth on climate change adaptation, we have evolved our understanding of climate risk by incorporating the latest climate science into our risk assessment processes. Taking a regional approach to assessing the effects of climate change, has enabled us to complete a more robust risk assessment that is context specific to the five diverse counties that make up the region we operate in.

To deliver services that are well adapted to the challenges of existing and future climate change, the whole of society needs to be engaged. This requires all the relevant responsible organisations, stakeholders, interdependent service providers, regulators, government departments and consumers to share in a common goal and ambition – we are stronger together.

Reviewing our risks and reporting progress against our actions is only a single step in this process. Embedding our improved county risk assessments into our long-term planning decisions and future business plans is the next step to securing a Stronger, Greener, and Healthier North West.

Louise Beardmore
Chief Executive

Executive Summary

In this report we set out the evolution of our approach to assessing the future impacts of climate change, how these may manifest as risks or opportunities and how we are adapting to the challenges.

Our approach to climate change adaption is embedded within our purpose as an organisation to provide great water for a stronger, greener and healthier North West.

Securing resilient services to the effects of climate change is underpinned by our strategic priorities and our core values.

In this, our fourth such report on climate change risks and adaption, we demonstrate our continuous improvement in embedding the understanding of climate related risk into our business planning. Supporting the delivery of our core purpose to provide a great water for a stronger, greener and healthier North West. We have developed our risk assessment approach to understand risks at both a regional and county level. More information on our county-based approach and findings is in Our counties- risks and opportunities.

In applying the latest research to our climate-related risk assessment and strategies, we highlight the importance of needing to be resilient to a changing climate and demonstrate the steps we are taking now and expect to need to take in the future to adapt to that change.

Through our climate-related risk assessment we identify how climate change poses a major threat to the services that we provide and the areas we must focus on to remain resilient.

Our assessment highlights shocks from the acute impacts of more frequent and severe weather extremes, as well as chronic stresses over time.

OUR PURPOSE

To provide great water for a stronger, greener and healthier North West.

Stronger
We deliver an essential service, help customers in vulnerable situations, invest in local communities, and support jobs and the economy, giving the North West resilience in a changing world.

Greener
We protect and enhance urban and rural environments, and adapt to the challenges of climate change, allowing people, wildlife and nature to thrive, making the North West a better place to live now and for the future.

Healthier
We provide great quality drinking water and safely remove and recycle used water for more than seven million customers, while taking care of the beautiful landscapes in the North West every day.

OUR STRATEGIC PRIORITIES

Our six strategic priorities enable delivery of our purpose and are aligned to the stronger, greener and healthier themes.

- Spend customers' money wisely
- Improve our rivers
- Deliver great service for all our customers
- Contribute to our communities
- Create a greener future
- Provide a safe and great place to work

OUR CORE VALUES

Our core values demonstrate the way we work, and reflect the things we believe are most important to help us deliver our purpose.

Do the right thing
As a responsible business, we want our people to always focus on doing the right thing. This means always putting safety first, delivering for the benefit of our stakeholders, championing fairness, acting with courage and integrity, and speaking up if something doesn't feel right.

Make it happen
We are focused on supporting each other and working as a team to make things happen, taking accountability and putting progress over perfection. We want to celebrate successes and learn when we don't get things right first time.

Be better
Creating a better tomorrow means encouraging our colleagues to live this value as well – being curious, ambitious, and solution-focused, seeking out new and innovative ways to deliver our services more efficiently and effectively.

We recognise the climate challenge we are already experiencing and how projections evidence the need for increasing levels of intervention into the future to maintain current service standards.

We have produced this report for Defra in line with requirements of the 2008 Climate Change Act. This report sets out the current and future predicted impacts of climate change on the organisation, and our proposals for adapting to climate change.

Climate risks

Predicting the effects of climate change is complex. We have assessed the potential implications for our key climate-related risks in 2050 and 2100 compared to today, using the latest climate research. To inform our

adaptive planning, we are considering multiple pathways and future scenarios, including both a benign (2^{o}C) and adverse (4^{o}C) future.

The key risks to our assets and services identified during this risk assessment, which are assessed as being sensitive to climate change, are physical risks. Meaning that they pose a risk to the destruction or disruption of our assets and systems. These physical risks include both acute risks, such as extreme rainfall, and chronic risks such as temperature increases.

The most significant risks, under all climate change scenarios and timescales, are associated with;

- **the security of water supplies**, in terms of both increased periods of dry weather impacting on raw water supplies and increased temperature leading to increased demand from customers and businesses, and
- **Increased volumes of water needing to be drained,** in terms of both wetter winters and more intense rain storms overwhelming sewer and treatment capacity beyond design capacity. This is exacerbated by increasing population and urbanisation.

More details on these risks can be found in this document, including how the risks differ in impact across our region of operation, and in our risk assessment Appendix E Risk assessment below.

As well as physical risks we are also exposed to transitional risks associated with the move to a low-carbon economy. For example, the transition to low carbon energy, could lead to changing national and international policies, changes in regulation and legislation and access to necessary finance as investors favour sectors with better environmental performance. For a well prepared and well-adapted business these transitional risks may present themselves as opportunities, conversely, they could also lead to increased capital and operating costs.

Over and above the risks to our own assets, processes and people from a changing climate we are also exposed to the cascade impacts on the assets, processes and people of other interdependent service providers. For example, the loss of third-party power transmission lines, disruption to supply chains and logistics and communication systems. Working together with Local Resilience Forums (LRFs), stakeholders at a local and national level and with more organisations completing climate adaptation reports we are improving our understanding of the risks of interdependencies, but more could and needs to be done.

Competing regulatory frameworks, legislation, investment timelines and standards of service (or lack of) makes trying to understand and assess risk exposure difficult. It is often only during an emergency that complex interdependencies and feedback loops of systems upon systems are uncovered and quantified.

Climate adaptation

We have already delivered significant investment in adapting to a changing North West climate and we have plans to continue to do so over the short, medium and long term.

We have accounted for future climate change impacts on our water supply and demand balance since 2004 when climate uplifts were included in our Water Resource Management Plan (WRMP). We continue to include climate change uplifts in our WRMP process ever since, with increasing complexity and integration of the impacts of climate change as the science behind the projections is better understood.

Water Resource Management Plan

In our Water Resource Management Plan (WRMP) we detail how, in the face of a growing population, pressures from climate change and greater protection of the environment we are going to secure an enhanced level of drought risk resilience by 2039 – securing resilience to a 1 in 500yr event.

We will do this by halving leakage, improving water efficiency to 110 litres per person per day, reducing abstraction from environmentally sensitive sites and developing strategic water resource options.

We have applied the same approach in our Drainage and Wastewater Management Plan (DWMP) accounting for future climate change uplifts within our wastewater systems and supporting the development of climate resilient future investment plans.

Drainage and Wastewater Management Plan

In our DWMP we detail how, in the face of a growing demand, increasing urbanisation and pressures from climate change we are going to secure an enhanced level of environment protection and customer service – securing improved pollution and flooding performance and delivering our storm overflows discharge reduction plan by 2050.

We will do this through a combination of nature-based solutions to intercept rainwater (including through increased partnership action), increasing our storm water system capacity and upgrading treatment capabilities.

Accounting for future uncertainty underpins the development of our long-term plans, this includes accounting for a range of likely future climate change scenarios as well as demographic change, technological enhancements and environmental requirements. This is the heart of our Long Term Development Strategy (LTDS), for more information please see our Long Term Delivery Strategy.

More generally we account for climate risks within our corporate management systems including the impacts of current and future climate change on business risks as well as including future scenarios in asset design.

Long Term Delivery Strategy

Long-term and adaptive planning is essential to affordable and resilient water and wastewater services. Building on our detailed understanding of the unique strengths, challenges and opportunities in the North West, our new LTDS incorporates our most advanced long-term planning to date. Our LTDS is central to how we will deliver our purpose and vision: "**to provide great water for a stronger, greener and healthier North West**" in AMP8 and over the long-term.

In our LTDS we detail our adaptive pathways to a range of likely future scenarios, including climate change, including monitoring plans and the decision and tigger points at which alternative pathways may be required.

Stronger together

To deliver a Stronger, Greener and Healthier North West, and a resilient UK that is well adapted to the challenges of existing and future climate change the whole of society needs to be engaged. This requires all the relevant responsible organisations, stakeholders, interdependent service providers, regulators, Government departments and consumers to share in a common goal and ambition.

In setting common goals and resilience standards, public, private and 3rd sector organisations can work together irrespective of the differences of asset base, investment cycles or regulatory regime. We support the call from the National Infrastructure Commission (NIC) that Government establishes a range of resilience standards, accounting for climate change, which will ensure that the whole of the UK is working towards and maintaining common levels of resilience so that organisations can plan accordingly.

Setting standards and regulatory frameworks enables companies to understand what is required and expected of them, and what they can expect from service providers, forming the basis for long-term business plans. This in turn provides the necessary framework to attract efficient finance to be able to deliver the necessary, customer supported and well evidence adaptation investment plans.

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Appendices

1. Introduction

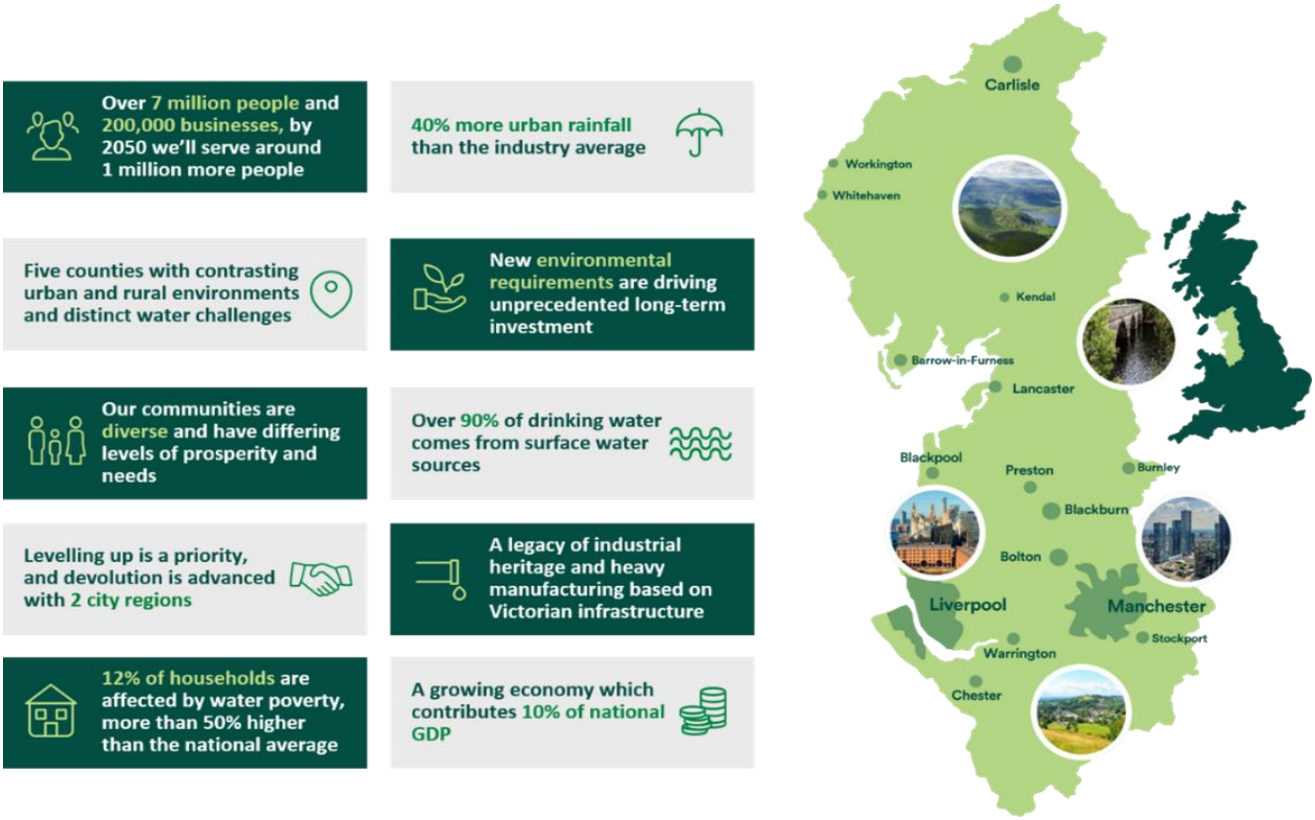
1.1 The North West region and United Utilities Water

Over seven million people and 200,000 businesses rely on United Utilities Water (UUW) every day to provide them with great water and wastewater services.

The North West is home to some of England's most beautiful landscapes. Diverse geographies, topography, land use and the weather all make the North West unique. Historically carved by glaciers forming upland lakes and over eight thousand kilometres of rivers, and today affected by some of the wettest weather in England[1]. There is widespread recognition of the importance of the North West's landscapes, both environmentally and culturally. Many areas have legally protected status, including: three World Heritage sites, three National Parks and three Areas of Outstanding Natural Beauty (AONB).

We operate in a region where levels of deprivation and economic challenges mean that a higher proportion of customers struggle financially, compared with most other UK regions. For example, 47 per cent of the most deprived neighbourhoods in England and Wales are in the North West. The degree of socio-economic challenges in the North West means more people have a greater vulnerability to climate change and have a lower adaptive capacity to the effects of climate change.

Figure 1 An overview of the North West



Weather has a fundamental impact on our services and how we deliver them. We are reliant on the environment to provide us with our raw product, water, and to receive recycled water once it has been treated. More than 94% of the water we supply comes from the lakes, rivers and reservoirs of our region, and our wastewater treatment works return clean, recycled water to our waterways.

Climate change will always be of strategic and operational importance. We are already seeing the effects of climate change on the region's weather. Our region is impacted by some of the wettest weather in England, with 40 per cent more urban rainfall than the industry average. In addition, the region has experienced numerous, and

[1] How much does it rain in the UK? - Met Office

more frequent, extreme storms in recent years, causing major disruption to communities, our infrastructure and the infrastructure of third parties that we depend on.

We are dedicated to protecting and enhancing the North West's natural environment and recognise the impact that climate change continues to have, and the need for us and the communities we serve to adapt. As the climate in our region changes, we expect our adaptability and resilience to be tested more frequently and more fiercely by wetter winters, hotter, drier summers and unpredictable extreme weather conditions becoming more common. Adapting to climate change is vital for us to deliver our purpose; to provide great water for a stronger, greener and healthier North West.

1.2 Understanding climate change

We are already seeing the effects of climate change on the region's weather, with increasing summer temperatures, wetter winters, and more extreme rainfall events. Climate change presents a systemic and often compounding risk throughout our operations and services, including impacts on other sectors who affect our operations and assets.

In the North West we are already seeing:

- Temperatures that, as an annual average, are +1°C warmer than the pre-industrial period; and,
- Twice the likelihood of a hot summer, with further seasonal changes in the North West projected to be greater than the average for England and Wales, with much wetter winters and, under some scenarios, much hotter and drier summers.

Climate change and the resulting shifts in weather patterns have the potential to significantly impact our operations, the services we provide and the broader environment. These risks can manifest in increased cost, reduced levels of service, pollution of the environment and risk to assets, property and people. We have identified some opportunities resulting from climate change, but the threats significantly outweigh the gains.

The chronic change in climate fundamentally impacts our long-term approach to reliably providing our services at a cost that is affordable and equitable to customers today and in the future. As well as the chronic shift in climate, we also assess that acute hazards such as droughts, floods, storms or heatwaves will also continue to become more frequent and more intense depending on our future climate change pathway.

Our response to climate change focuses on its two component parts:

Mitigation

We recognise that we contribute to rising greenhouse gas concentrations, and we take significant steps to minimise this through the development and delivery of our climate change mitigation strategy. Refer to Appendix D for more information.

Adaptation

We use scenario analysis in our business planning and risk management processes to ensure we identify adaptation needs that are proportionate to the risk and timely in their delivery to improve our resilience to the effects of climate change.

2. Our climate change risk assessment

2.1 Summary

We recognise that the climate has already changed, and we are planning for the unavoidable future changes that are forecast under all climate change scenarios.

Adapting to a changing climate represents one of the most significant challenges to future services and operations. In responding to this, we see substantial opportunity to deliver lasting value for customers and the North West.

Climate change is destabilising the ecosystems we rely on to provide resilient and affordable services to customers. We and others continue to act in response to these changes and recognise the need to do more over time to effectively and efficiently adapt to increasing climate impacts on the essential services we provide.

We have evolved our understanding of climate risk by incorporating the latest climate science into our risk assessment processes and embedding it within our long-term planning.

We have tested our plans against a range of climate change projections, using the latest best available information from the Met Offices UKCP18 climate change projections. More on our approach can be found in Appendix A. These projections are categorised by their Representative Concentration Pathways or RCP. Each RCP is associated with a predicted level of future greenhouse gases relative to pre-industrial levels. The relative concentrations will have different levels of consequences on average global temperatures, through a mechanism called radiative forcing. In developing our long-term adaptive plans, we have considered a range of climate change scenarios, where applicable. These include:

- benign (RCP2.6) or a 1.6°C increase in average global temperatures by 2081-2100; and
- extreme (RCP8.5) or a 4.3°C increase in average global temperatures by 2081-2100.

We have further developed our understanding of how climate change is likely to test the resilience of our services through our company-wide assessment of climate-related risks, updated cyclically with the latest evidence. This explores the risks from both the acute impacts of more frequent and severe weather events, and more chronic stresses over time from trends for drier and warmer conditions and sea level rise.

2.2 Our approach

For our first adaptation report a comprehensive risk assessment was undertaken, utilising industry best practice to assess our strategic risks. This was based on UKCP09, the most up-to-date climate projections available at that time.

Since then, UKCP18 has been published, and we have made significant progress across a range of climate related planning activities, including drought planning, improving resilience to flooding and freeze-thaw events. We have improved strategic planning for wastewater and drainage, incorporating UKCP18 into some of these plans, and this continue to evolve in future planning cycles.

We recognise that climate change impacts all areas of our business, and that the extent of this impact is ever increasing. To address this, we continued to develop our climate risk assessment and in our third adaptation report, we applied our risk assessment to over 100 climate-related risks. These risks were scored based on their likelihood, based on a 2050 horizon and impact, across our values framework.

For our fourth adaptation report, we have further advanced our risk assessment. We have promoted climate change discussions across the business, consulting subject matter experts and interested parties. We have reviewed all risks submitted at ARP3, completed a consolidation exercise, updated risk likelihoods and impacts and added any new and emerging risks. For this round of reporting, we have considered consequence and likelihood scores at both a regional and county level. These risks have been reviewed against a 2050 and 2100 time horizon, compared to today, using the latest climate research; the Met Office UK Climate Projections 2018 (UKCP18). This has four pathways to 2100 depending on concentrations of greenhouse gases in the atmosphere. For our climate change risk assessment, we have used multiple climate change scenarios. These pathways have

been used in our risk assessment as they represent the spectrum of likely future climate change. This has allowed us to establish a comprehensive insight into the risks we must continue to address.

As part of this round of reporting, we have also updated our Climate Change Adaptation Action Plan; this can be found in Appendix F Action Log and Monitoring below. All actions previously submitted at ARP3 have been reviewed, the status updated where appropriate, interdependencies with other organisations identified and any new actions have been added.

2.3 Unintended consequences on the environment

We recognise that the measures and action we put in place to adapt to climate change have consequences. These can be the intended consequence of the climate change adaptation, but sometimes there can be unintended consequences of adapting or where action has resulted in a trade-off with another sustainability priority. Where we have identified an opportunity to act against climate change, we have also documented any potential, known trade-offs with other priorities.

2.4 Identifying interdependencies

As we mature our approach to climate change resilience, we are increasingly seeing value in looking more widely, beyond our immediate control. Understanding the risks from dependent and interdependent service providers and the risks of associated cascade failure. We recognise that there are many interdependencies associated with delivering our resilience activities and the actions of others are likely to impact on our ability to manage our risks.

Since the last round of adaptation reporting, we have worked to fully appreciate the risks that are posed to our services. We have mapped our whole system, and the network of systems on which we rely and how they interact with each other; these are also commonly referred to as impact chains.

We are now building on the initial systems mapping work to focus on key system independencies and to identify risks. We are developing outputs from our systems mapping work to create a systems interrogation tool, which we can use to improve risk management to identify the most appropriate and efficient investment needs.

The tool will allow us to act on complex information in the systems maps when assessing and mitigating risks. It will allow us to be presented with elements upstream and downstream of an element of interest. Alongside this, questions will be prompted to ensure risk identification and mitigation considers system interdependencies and a broad range of mitigation measures.

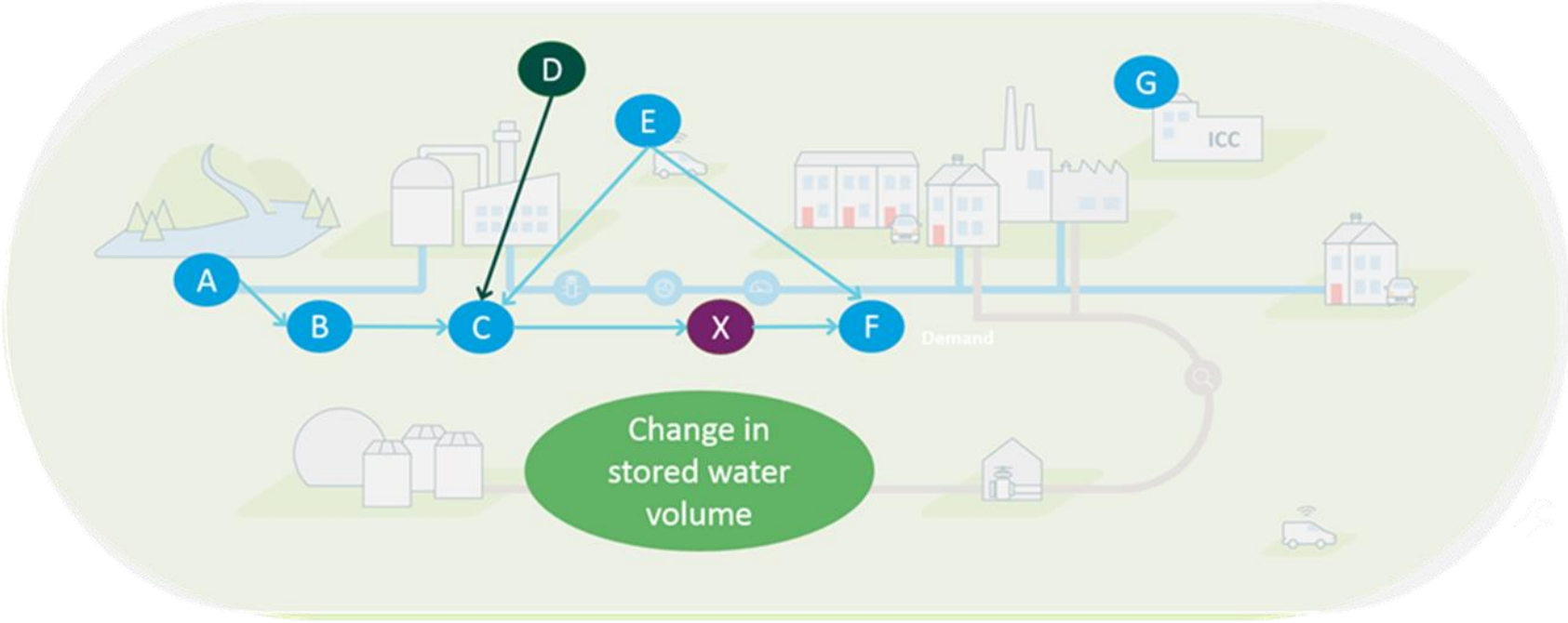
In identifying our critical interdependent and dependant impact chains we can identify and quantify the risks that are posed to us, and the cascade implications both upstream and downstream. Taking a view of the wider systems enables us to identify potential co-delivery and partnership opportunities, understanding who the most appropriate body or service provider to secure resilience is as efficiently as possible.

Figure 2**Error! Reference source not found.** shows how the complex system maps we developed have been simplified to provide useful tools for our colleagues. The maps can be used to identify the most significant up and downstream impacts of an issue and to ensure that they are appropriately considered throughout the risk management process.

In the Interdependencies and collaboration section further on in this document, we outline our interdependencies and how we are using them as opportunities to enable resilience.

Figure 2 Example systems resilience decision support tool

Worked example – considering the effects of a change in treated water storage on the United Utilities system to support decision making



Potential risk management prompt questions:

- What knock on impacts might the hazard cause?
- How can upstream elements be used to control the risk at the element of interest?
- How can upstream/downstream stakeholders help manage the risk?
- How can environmental assets be harnessed to manage the risk?

Water elements

External/environmental elements

Change/trigger

Scenario

X — Exploration of the likely cascade impacts of a change in the total volume of treated water storage

Reduction in stored water to protect water quality (turn-over concerns)

Options analysis

A — Water resources – no change in total demand for water, reduced flexibility/downstream storage means greater level of reliability needed/less resilience to transient raw water quality issues

B — Raw water transport – reduced flexibility/downstream storage means greater level of reliability needed/less resilience to outage and issues scheduling maintenance

C — Water treatment – increased reliance on treatment assets to maintain constant flow, less resilience to outage and issues scheduling maintenance

D — Supply Chain (including power and chemicals) – change in criticality of water treatment assets requires greater reliability on dependant supply chain and stockpiling of critical chemicals and materials to ensure required level of redundancy.

E — Technical resources – change in criticality of water treatment assets may require change in staffing arrangements, including 24/7 staffing and/or more rapid response to incidents

F — Change in customer resilience – under normal operation no change to service level, but increased risk of disruption due to reduction in stored water volumes to mitigate events.

G — ICC – elevated criticality of assets, requires increased monitoring and control capabilities as well as more responsive contingency plans

3. Top causal factors

Climate change poses six broad risk categories that we predict will increasingly impact our ability to deliver water and wastewater services. Refer to Appendix E Risk assessment below for full details of our climate change risks.

3.1 Hotter, drier summers

Risk summary

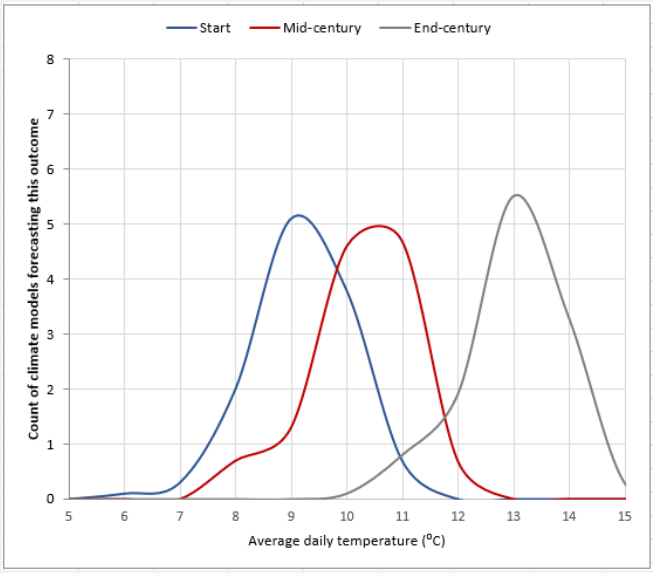
Extended periods of lower-than-average rainfall reduces the amount of water we have available to use. Since such dry weather periods usually occur during the summer months, the impact can be compounded by the demand for water, soil moisture deficits, and the loss of water to evaporation being higher. Due to climate change impacts, we expect the frequency and severity of hotter and drier summer weather to increase.

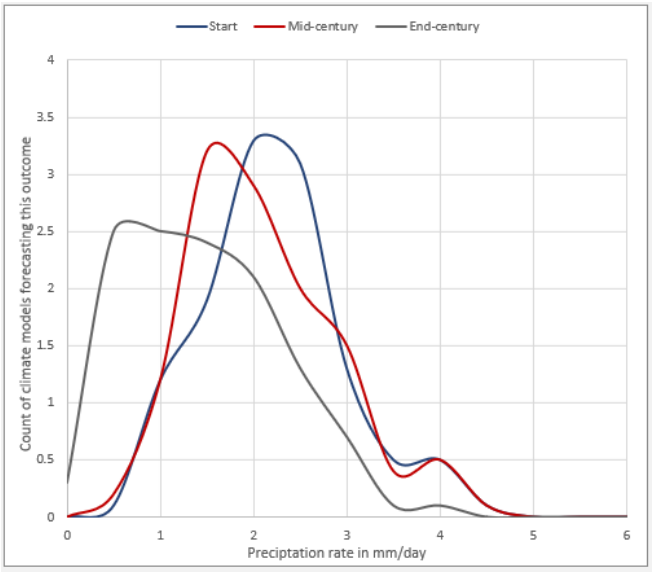
The North West is getting hotter

As can be seen in the chart to the right, under an adverse climate change scenario (RCP8.5) average daily temperatures are forecast to increase from an average of 9°C to 13°C by the end of the century.

Note that under a benign climate pathway (RCP2.6) we expect average daily temperatures to peak at 10°C by mid-century, a much smaller increase.

However, summer extremes will be more significant. We anticipate that average summer maximum temperatures could increase from 26°C to 34°C in Greater Manchester (RCP8.5 by 2100) with some Met Office models recording maximum summer temperatures above 40°C.





The North West could get drier

Average annual rainfall is not expected to materially change under both benign and adverse future climate change scenarios.

However, annual averages mask the significant reduction in summer precipitation that we expect under an adverse climate change (RCP 8.5) when.

Under a benign pathway summer precipitation is expected to remain broadly like today.

Note that there are sub-regional county differences that could have a greater significance to our operations (these are explored later in this document), but the overall trend of drier summers is seen across all counties.

The likelihood of a hot summer in the UK has doubled. We are experiencing this in the North West, where average annual temperatures are around 1.3°C higher in the 21st century compared with the last decade of the 19th century, with some monthly averages showing an increase in temperature by as much as 2.4°C. These

increasing temperatures lead to more frequent drought conditions, an increase in water use across the region and extreme temperatures threaten the reliability of assets, systems and processes.

During the summer of 2022, an extreme heatwave caused significant disruption to the UKs infrastructure, with railways, runways and roads temporarily closed because of the high heat[2]. This same heatwave threatened the reliability of our own assets, particularly operational IT systems and motors. This required the temporary deployment of emergency cooling systems to several assets. Given forecasts of increasing average and extreme temperatures we anticipate more frequent and more impactful extreme heat events in the future impacting upon the reliability of our services. Figure 3 summarises climate-related risks relating to hotter, drier summers.

Figure 3 Summary of climate-related risks relating to hotter, drier summers

Hotter, drier summers		
Reduced water resources resulting in supply interruptions	Asset deterioration of wastewater assets from increased septicity	Drying of impounding reservoir clay cores resulting in crack formation compromising resilience
Drying vegetation resulting in more severe moorland or forest fires	Lower river flows, resulting in requirement for tighter discharge permits at wastewater treatment works	Poor and unpleasant working conditions impacting workforce and customers
Shock loads of foul wastewater at first significant rainfall event, resulting in a failure to adequately treat and possible pollution events	Increased tourism, resulting in damage to land and catchments	Increased reservoir misuse, increasing the risk of accidents
Property flooding due to blockages at next significant rainfall event	Increased tourism, resulting in localised supply/demand issues for water and wastewater	Increased microbial action and gas production, increasing risk of ignition endangering staff
Flooding at first significant rainfall event due to increased soil moisture deficit	Reduced river inflow rates and raw water volumes	Impact to aquatic ecosystem, through encouraging of invasive species
Highly concentrated septic sludge volumes, causing odour issues	Higher average demand for water resources, resulting in supply interruptions	Hotter average temperatures resulting in overheating of company assets increasing risk of failure
Increased water treatment requirements due to reducing raw water source options		

Actions

- Our Drought Plan aims to manage water supplies so there is enough water available of an appropriate wholesome standard for customers across the North West during a 1 in 200-year likelihood drought condition and have stress-tested our plan under many different future scenarios;
- We have invested in our supply-side drought options to have them readily available, minimising the time it takes to bring them online during dry weather conditions and ensuring water quality is at the heart of our decision making in preparing for and during drought periods. We are investing in further supply side options and reducing demand through leakage and promoting water efficiency;
- Our Water Resources Management Plan[3] (WRMP) uses the Environment Agency Water Resources Planning Guideline on climate change. We have adopted our advanced modelling approaches to assess the impacts of the new projections. We set out our strategy to achieve a long-term, best value and sustainable plan for water supplies in the North West. It plans for an adequate supply to meet demand over the 25 years from 2025 to 2050 and beyond, delivering enhanced levels of drought risk resilience;
- Smart (Automated Metering Infrastructure) metering provides an opportunity to transform how we look at consumption and customer-side losses (leaks and plumbing losses). We have proposed a programme that is focused on the most efficient collection of the rich data on water usage once the water leaves our network. UUW's Revised WRMP and PR24 business Plan have proposed installation the of 500,000 new household

[2] Met Office 2022 heatwave report

[3] unitedutilities.com/globalassets/z_corporate-site/about-us-pdfs/wrmp-2019---2045/final-water-resources-management-plan-2019.pdf

meters, 1,000 new non-household meters, and the upgrading of 420,000 household and non-household meters to AMI (Automated Metering Infrastructure) technology. This metering will support us in business use and leakage reduction, by helping us quickly find identify customer-side leaks, and influence customers' water consumption behaviour; and

- Via Ofwat's innovation fund we have partnered with other water companies and infrastructure providers to assess the impact of extreme heat on water company assets, systems and interdependencies[4]. We have identified the need to further review the effects of extreme heat on our asset base, to inform changes to asset requirements and building standards so as to remain operational in a hotter climate.

3.2 Changes in seasonality

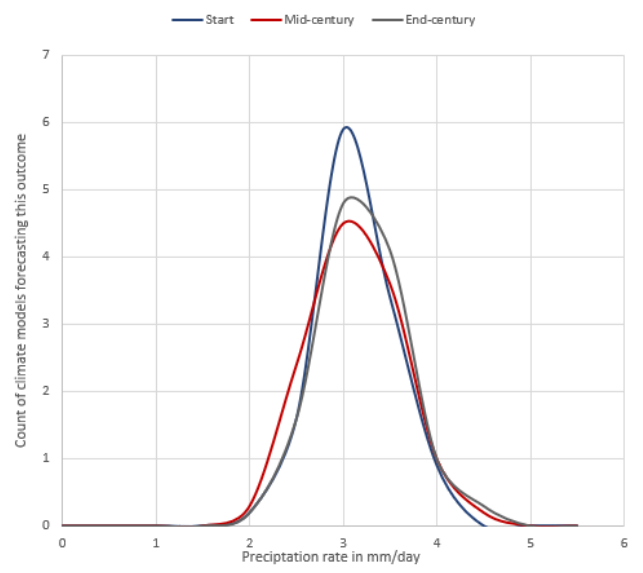
Risk Summary

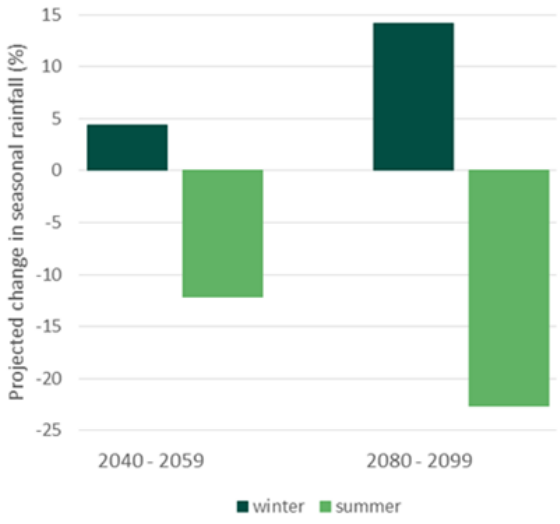
Current and predicted changing levels of rainfall and when the rain will fall, puts pressure on our wastewater services. Under all climate change projections, we can expect to need to drain and treat more surface water, increasing the risk of sewer flooding and storm overflow spills if the effects are not mitigated.

Annual rainfall volumes

Data analysis for the North West region, for a range of climate change scenarios to the end of the century shows that annual average rainfall volumes (in mm per day) are not forecast to change – suggesting that total average annual rainfall volumes will remain largely consistent with those experienced today.

Chart opposite shows the distribution plot for annual average daily rainfall volumes under an adverse climate change scenario.





Significant changes when the rain falls

While we expect annual averages to still be broadly like today, when we analyse the data over the seasons, we can see a notable difference in the expected profile of when the rain will fall.

As can be seen in the chart opposite we expect significant reductions in summer rainfall from current trends and an increase in winter rainfall.

This change in seasonality may require us to use our systems differently to today to maintain resilience of supplies.

The nature of being a water and wastewater company means that flooding and the effects of flooding are an ever-present risk. We rely on upland reservoirs and rivers for most of our water supplies, assets sited close to

[4] Climate Resilience Demonstrator (CReDo) - Extreme Heat Scenario - Ofwat Innovation Fund

these water bodies are at risk of flooding unless the risk is properly controlled or mitigated. Similarly, our wastewater collection and treatment sites run largely under gravity and need access to point of discharge into water bodies, this places them at the bottom of hills and near water. The combination of topography and weather patterns of parts of the North West also contribute to this issue. The ability for sewer networks and wastewater treatment works to operate effectively, without harm to the environment or customers, can be affected due to flooding from surface waters, rivers and the coast.

Figure 4 Summary of climate-related risks relating to changes in seasonality

Changes in seasonality		
Accelerated asset deterioration from greater soil movement	Adverse effect on supply and demand of biosolids for agriculture	Changes to agricultural practices and land use, negatively impacting catchments, devaluing assets and impacting raw water quality and quantity
Decreased renewable generation, odour issues, and temporary plant hire	Prolonged use of rising mains to adequately drain networks resulting in deterioration of asset health and leading to more frequent failures	Prolonged use of in-field biosolids stockpiling in wet weather resulting in an increased diffuse pollution
Reduced water resources, from changes in commercial activities leading to increased abstraction	Increased infiltration of groundwater into sewers, increasing sewer flooding risk	Changing discharge permits and abstraction limits to protect native species
Increased algal growth in reservoirs, resulting physical blockages of water treatment assets and negative impacts on raw water quality	Increased surface water run-off, increasing turbidity affecting raw water quality	Favourable conditions for non-native species, resulting in increased costs of treatment or restrictions on moving water
Temperature inversions in reservoirs, causing odour and taste issues	Changes to agricultural practices and land use, leading to increased demand for water, reducing water resources	

Actions

- We have developed a 25-year Drainage and Wastewater Management Plan (DWMP), which sets out our long-term approach for sustainable drainage and wastewater management across the North West and how we intend to make sure that the region thrives now and in the future. We have run a comprehensive suite of assessments across the whole of the North West to develop a robust understanding of water catchment resilient issues. The focus for this DWMP has been to assess our most significant risks, including fluvial and/or coastal flooding of wastewater treatment works and major pumping stations. To understand the risk to wastewater treatment and wastewater network assets, we have assessed their flood risk exposure; and
- As part of the DWMP methodology, we have carried out a high-level assessment to identify potential assets at high-risk and high-level costs to provide mitigation. This investigation aims to act as a signpost to indicate where we may want to invest to provide resilience to ensure that we are able to operate effectively in a fluvial or coastal flooding event.

3.3 Extreme events

Risk summary

As described above, our region is becoming hotter and wetter and seasons are changing, but also unpredictable extreme weather conditions are becoming more common. Evidence demonstrates that climate change has exacerbated and will continue to exacerbate storm events and increase the likelihood of heatwaves.

The frequency of heatwaves has been increasing, the rate at which temperatures are increasing has also been found to be accelerating. The rate of temperature increases is higher, with increases over the past 30 years being higher on average than for those over the past 50 years. These in turn are higher than those over the past 150 years. This is a pattern of acceleration that is predicted to continue without significant reduction of global greenhouse gas emissions. Heatwaves pose an additional potential risk to our company assets, increasing the risk of failure, and poor working conditions for colleagues working on sites.

Heatwaves

Analysis of maximum temperatures forecast across the North West, and at a county level, indicate that we can expect to see more days with extreme temperatures (above 35°C) with Greater Manchester and Cheshire most at risk under an adverse climate change projection.

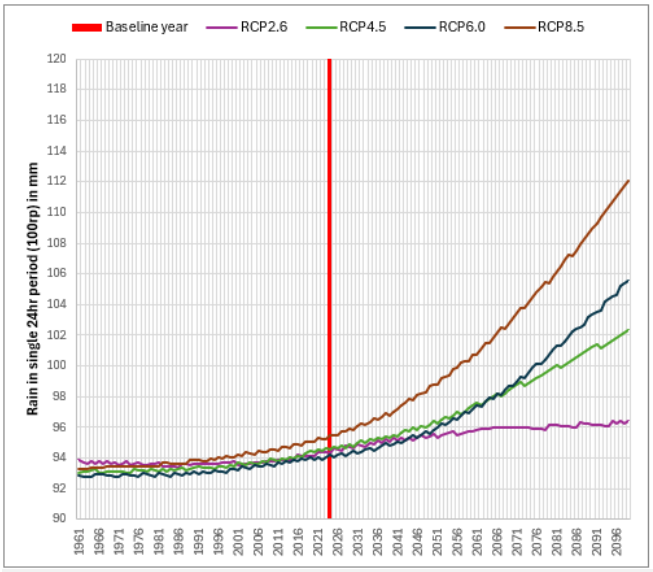
We can also expect to see the average duration of heatwaves (based on the current Met Office definitions) to increase, notably the frequency of heatwave events appears to be reducing as they merge into longer duration events.

The table opposite refers to an adverse climate change projection, under benign climate change we do not expect extreme daily temperatures to increase much above today's values, but extended heatwaves may still be a risk factor in Cheshire and Greater Manchester.

County	Time period	Average number of days above 35°C	Average heatwave duration (days)
Cumbria	2020-29	0	6
	2046-55	0	8
	2090-99	9	38
Lancashire	2020-29	0	6
	2046-55	1	11
	2090-99	14	42
Greater Manchester	2020-29	2	13
	2046-55	3	26
	2090-99	46	38
Merseyside	2020-29	0	6
	2046-55	1	12
	2090-99	13	47
Cheshire	2020-29	2	10
	2046-55	2	26
	2090-99	43	43

Predictions of more frequent, intense storms increase the likelihood of damage to overhead power lines leading to an increased risk of large-scale power outages. This highlights an interdependent risk with energy providers- see Interdependencies & Collaboration section. This risk was seen when we experienced Storm Desmond and Storm Eva in 2015, when severe adverse weather resulted in poor pressure and no water issues. This was exacerbated by power outages preventing effective communications with customers and employees. Storm Arwen in 2021 brought severe weather conditions with high wind speeds, snow and ice resulting in prolonged electricity disruption.

In our PR24 draft determination response to Ofwat we proposed a £50 million programme of investment to help mitigate the risk of future deterioration in sewer flooding performance due to climate change. A sustained programme of surface water management needs to be initiated now to protect customers and the environment from the effects of sewer flooding. If we do not invest now, flooding performance will deteriorate despite efficient investment through base expenditure due to the increased hydraulic risk our region is facing because of climate change.



Peak rainfall volumes

The chart opposite shows the amount of rain we can expect to see, in a single 24hr period, for a 1 in 100-year event probability in Manchester city centre in the summer for a range of climate change pathways from benign (RCP2.6) to adverse (RCP8.5).

The chart shows that despite an overall reduction in average summer rainfall volumes (discussed above) we can expect that when it does rain, volumes may well be higher.

The trend for increased rainfall since 1960 and into the future in a single 24hr period is observable under all climate change pathways.

Hydraulic modelling demonstrates that in the North West, regional modelled flood volumes following a 1 in 20-year event are forecast to increase by 38% (1.4 million $m^{3)}$ by 2030 due to climate change and urban creep, equivalent to 560 Olympic swimming pools. It is therefore imperative that we act now to deliver an enhanced capability above base maintenance requirements to mitigate the impact of increasing hydraulic flooding risk upon customers and communities.

We propose investment in rainwater management as identified via our optimised DWMP programme. Our proposal has prioritised six catchments that are disproportionally impacted by rainfall driven by climate change, are outside of any existing enhancement programmes and in which the DWMP optimiser identified opportunity for the implementation of rainwater management solutions. These catchments:

(1) Have experienced almost 500 cases of hydraulic flooding over the last 10 years, with hydraulic flooding accounting for 36% of total incidents recorded;

(2) Experienced two-thirds of all hydraulic flooding from severe (> 1 in 20) events, demonstrating the impacts of climate change here and now; and

(3) Collectively account for an optimised investment of £148m in rainwater management solutions as part of our DWMP, of which we propose to prioritise investment of £50m in AMP8.

Figure 5 Summary of climate-related risks relating to extreme events

Extreme events		
Increased flood risk resulting in changes to liability risk, increasing insurance premiums	Extreme rainfall resulting in run off from agricultural land increasing nutrient loads to water sources	Increased risk of erosion and/or damage causing the loss of river crossings and vulnerable assets, resulting in service interruptions
Heatwaves resulting in overheating of company assets increasing risk of failure	Extreme rainfall resulting in floods, accidents and landslips, causing a disruption to transport and supply lines	Disruptions to telephony and IT, impacting our ability to monitor sites and assets
Heatwaves causing work environments to become intolerable, having a detrimental impact on the workforce	Extreme rainfall resulting in mass transport and deposition in raw water mains, impacting quality	Extreme weather events putting pressure on our emergency response
Sewers becoming overwhelmed in extreme rainfall events, resulting in sewer flooding	Extreme rainfall resulting in adverse raw water quality impacting the treatment process and customers	Infrastructure damage and blockages, causing issues when accessing sites
Asset flooding during periods of extreme rainfall, causing failure as assets	Flooding resulting in changes to legislation, accountability and investment requirements	Increased frequency and duration of loss of power within a treatment process, resulting in service disruption
Extreme rainfall overwhelming sewers, resulting in failure to treat wastewater, and spills, polluting the environment	Extreme rainfall resulting in external pressure to use alternative methods of flood mitigation	Impact to our suppliers causing disruptions within our supply chain, resulting in service interruptions
Extreme rainfall resulting in a failure to treat wastewater as a resulting in above capacity flows	Extreme rainfall, increasing the potential for landslips, damaging land, assets, dam slopes and contaminating reservoirs	

Actions

- We have developed our energy resilience plans and recognised interdependencies between United Utilities and electricity distribution network operators (DNO). We have worked in partnership with the DNOs in our region, ENWL and SPEN, to develop an understanding of their resilience practises, and allows us to target our investment more specifically. As part of the PR24 Draft Determination Response we have proposed to invest in power resilience at sites that are currently experiencing frequent power outages; see Section 5 on Interdependencies and collaboration for further detail;
- With future heatwaves likely to exceed 30°C, we plan to review our asset standards and if they can withstand these higher extreme temperatures;
- Both our WRMP and Drought Plan have been stress tested to ensure they can withstand periods of extended dry weather. We have invested in our supply side drought options to have them always available, minimising

the time it takes to bring them online during dry weather conditions. This has enabled us to react quicker and made us more resilient during dry weather;

- The AMP8 storm overflow programme solutions have been designed to a 2050 climate scenario, demonstrating how we are building long term resilience into the solutions that we install; and
- Through our proposed investment, we will invest in rainwater management solutions to increase the storage of rainwater runoff in our priority catchments by 22,750 m^3, mitigating the impact of additional flooding from climate change by 2030, thus preventing an additional 30 sewer flooding incidents. Without this investment, forecasts indicate there would be a further 9 Olympic sized swimming pools of wastewater flooding across these towns and cities in the North West in a 1 in 20-year storm. Over the past 10 years there have been nearly 500 hydraulic incidents in the six selected catchments, where modelled flood volume in a 1 in 20-year storm is forecast to increase by 35% by 2030, relative to a 2020 baseline, which equates to an estimated additional 34 flooding incidents per annum. The options that we will deliver as part of the programme are defined through the DWMP options development process, and specifically refer to the generic options around surface water management:
  - Installation of surface control SuDS at strategic locations;
  - Strategic blue / green corridors: combination of the management of blue and green spaces in urban environments;
  - SuDS delivered through partnerships with local authorities.

3.4 Cold waves and frost

Risk summary

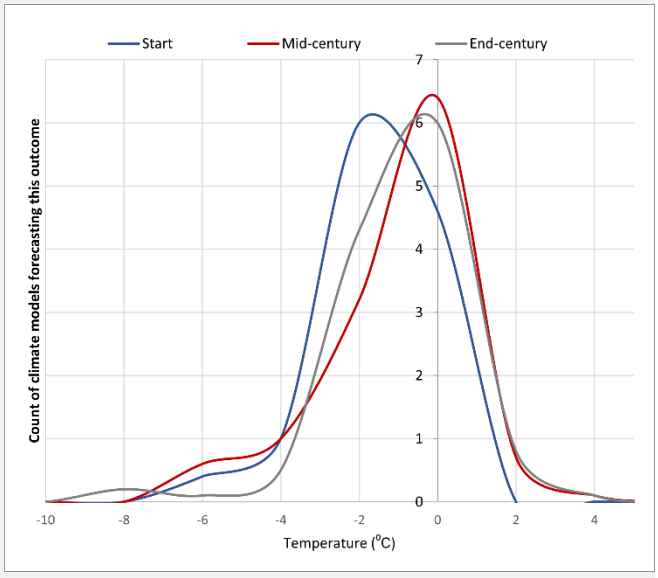
Winters, in general, are forecasted to become both warmer and wetter. The frequency of cold waves and ground frost are therefore expected to reduce under all climate change scenarios compared to historical trends. The key risk is the impact of freeze and thaw cycles on ground movement damaging buried assets and the freezing and bursting of customer supply pipes.

Cold waves are not going to disappear completely, however, and their impact could be more consequential when they do occur. Assets will be less exposed to the shocks of freezing temperatures and the effects on ground movement, potentially resulting in higher susceptibility when a cold wave does occur. Home owners and response organisations may be unprepared due to lower exposure and familiarity with contingency plans.

Warmer winters forecast

The chart opposite shows the trend in warming winters for Cumbria, the trend is observed in all other regions of the North West.

This chart is for a benign climate change scenario, showing that even by mid-century under a benign and therefore almost certain projection, that warmer temperatures can be expected across our region of operation.



County	Time period	Average number of days below -5⁰	Maximum number of days below -5⁰
Cumbria	2020-29	3	45
	2046-55	1	19
	2090-99	0	5
Lancashire	2020-29	2	46
	2046-55	1	13
	2090-99	0	0
Greater Manchester	2020-29	3	51
	2046-55	1	16
	2090-99	0	3
Merseyside	2020-29	1	40
	2046-55	0	10
	2090-99	0	0
Cheshire	2020-29	3	49
	2046-55	1	22
	2090-99	0	2

Cold waves

The table opposite, based on an adverse climate change scenario, shows the forecast dramatic reduction in days with a minimum temperature of equal to or below -5° across the 5 counties that make up our area of operation.

-5°C has been established as a critical temperature threshold by analysing our asset performance data.

-5°C air temperatures are cold enough to impact soil temperatures, inducing ground movement through freeze and thaw cycles, the longer the period of freezing and the quicker the thaw the greater the impact on buried infrastructure.

While the average number of freezing days looks to reduce from an already small number, as is indicated by the maximum number of days below -5°C there is still potential for significant freezing events until mid-century under an adverse climate change scenario.

Although, winters are forecast to become warmer, in the last decade we have experienced four notable cold snaps; in 2010, 2011, the 'Beast from the East' in 2018 and December 2022. The reduced frequency in experiencing freezing conditions may account for a lack of preparedness when they do occur, as summarised by Ofwat in their summary, "Out in the Cold"[5], of the water sectors performance during the "Beast of the East" in 2018.

Some companies were identified as not having had appropriate plans in place for this type of incident, but thanks to our continued investment in resilience systems and processes UUW was recognised as being one of the better performing companies, demonstrating resilience in our systems to increase production and move water to where it was most needed, paired with effective governance processes to manage the incident as it developed.

Figure 6 Summary of climate-related risks relating to warmer, wetter winters

Cold waves and frost		
Cold waves/frost reducing the effectiveness of wastewater treatment, leading to risk of failure to adequately treat and possible pollution events	Freeze/thaw events, resulting in ground movements and damage to water networks creating leaks contributing to supply interruptions	Cold wave/frost causing freezing of customers pipes, resulting in private leaks and/or supply interruptions and increased volumes of calls, putting strain on our emergency response capability

Actions

- Our winter readiness plans embrace all our lessons learnt from historic cold snaps. With cold weather having an observed significant impact on many of our operations, there are many aspects that need to be considered when preparing for extremes in winter weather. We consider it prudent to continually check, review and update practices and procedures for all our assets and equipment before, during and after cold snaps to prevent any unnecessary damage to our sites, assets and people.

[5] Ofwat - Out in the Cold - 2018

3.5 Rising sea levels

Risk summary

Global sea levels are rising and will continue to do so with the impact of climate change. Our coastal assets, and those on tidal waters, are likely to be at increased risk of flooding and outfall blocking. This poses a risk of damage to our company assets, but also of our workforce accessing these assets to complete remedial works.

Analysis of sea level rise shows that while the North West of England is perhaps less susceptible than the south eastern and Yorkshire coast lines there is still an increasing risk of asset inundation and damage.

Absolute sea level rise is expected to average at just less than 1m by mid-century under a benign climate change scenario (1 in 100-year event probability). With high-risk locations (mean-time sea level rise more than 1.5m for the same scenario) identified along the Solway coast line at the mouth of the River Eden.

Figure 7 Summary of climate-related risks relating to sea level rise

Rising sea levels		
Tidal blocking leading to issues with coastal discharges	Increased abstraction resulting in the intrusion of salt water into the water table, resulting in saline intrusion into groundwater and river intakes	Saline intrusion into sewers, increasing volumes requiring treatment and increasing saline corrosion of assets in both network and process
Rising sea levels resulting in coastal flooding causing damage to nearby assets	Rising sea levels resulting in coastal flooding resulting in issues accessing sites	Increased risk of erosion and/or damage from rising sea levels causing the loss of vulnerable assets in close proximity

Actions

- Through the Drainage and Wastewater Management Plan (DWMP) that was published in 2023, we have run a comprehensive suite of assessments across the whole of the North West to develop a robust understanding of water catchment resilient issues. The focus for this DWMP has been to assess our most significant risks, including fluvial and/or coastal flooding of wastewater treatment works and major pumping stations; and
- We are investing to protect Crosby pumping station from coastal erosion, in a partnership scheme led by Sefton council. The scheme will protect Crosby Northern pumping station and an adjoining 2 km length of 600 mm diameter rising main from accelerated erosion rates. The cliff edge is now only ~20 m from these assets. This will, not only secure the resilience of our own asset base, but also reduce coastal erosion risk for ~169 properties, creating intertidal habitats and enhancing the coastline.

3.6 Transitional risks

Risk summary

Transitional risks are those associated with a move to a low-carbon economy, such as evolving policies, regulation and legislation. Transitional risks result from a misalignment of economic factors with actions aimed at protecting, restoring and/ or reducing negative impacts on nature. These risks can be prompted by changes in regulation and policy, legal precedent, technology, or investor sentiment.

Figure 8 Summary of climate-related risks relating to transitional risks

Transitional risks		
Decarbonisation in energy supply causing an unstable grid resulting in power issues	Movements in policy and legislation, changing practices, resulting in the need for new infrastructure, technologies, training and competencies	Movements in policy and legislation, changing practices, resulting in changing financeability and investor sentiment.
Increased external pressures on our responsibilities requiring action on climate change mitigation	Climate change mitigation and adaptation responsibilities from third parties resulting in pressure on our supply chain	Changing and increasing climate change mitigation and adaptation responsibilities, putting pressure on affordability

Actions

- We horizon scan for changes relating to transitional risks across technology, policy and legal, markets and expectations of our stakeholders and customers. Topics include looking for technologies to measure and reduce process and fugitive emissions, government policy changes and developments, energy pricing fluctuations (of both fossil fuels and low-carbon alternatives), and the developing market (availability and cost) of alternative fuelled vehicles, batteries; and
- Carbon pricing is an important topic, and we track closely the costs of purchasable credits, offsets and energy attribute certificates. For medium and long-term risk and benefits assessments (such as our AMP8 business plan) we use the UK Government carbon values 'for use in policy appraisal' for the relevant year to convert GHG emissions to a financial value, e.g. £130 per tCO2e for 2030.

4. Our counties- risks and opportunities

4.1 The five counties

Our region is diverse and is made up of five distinct counties and some bordering areas. Each have different challenges and opportunities because of the impacts of climate change. The five distinct counties of the North West can be seen in Figure 9.

Figure 9 The five counties of the North West

Cumbria is home to a wide variety of special landscapes: two national parks, two world heritage sites, three areas of outstanding natural beauty and hundreds of designated sites of special scientific interest. It is also home to some of the wettest weather in England, water is captured in this county and this supplies over one-third of the North West with water.

Lancashire is home to some of the region's most beautiful natural features. The county is carved by many rivers drained from the Pennines, including the Ribble, Wyre and Lune, all of which drain to the west of the county, and enter the Irish Sea. A large proportion of combined sewer systems are particularly prevalent in the historic towns of East Lancashire.

Manchester is surrounded by hills to the North and East, but itself relatively low lying forming a topographical 'bowl' shape. The effect is that the area becomes inundated with rainwater from the uplands that is then slow to drain. Customers in and around Greater Manchester receive their water supply from Haweswater in the Lake District. This is supplied through the Haweswater aqueduct, a gravity fed pipe.

Of all the North West counties, Merseyside is the most predominantly urban. Such a densely urban composition can have implication on water quality. The coastal waters of Merseyside are important for the economy, in particular tourism and fisheries. However, the urbanised landscape and population size of Merseyside means that local bathing waters are increasingly at risk to storm overflow spills.

Much of Cheshire is rural, and farming and agriculture play a key role in the county's environment and economy and is important for North West food production. Many customers in and around Cheshire receive their water supply from Lake Vyrnwy in Wales. This is supplied through the Vyrnwy aqueduct.

In the following sections we have summarised the unique current and predicted climate-related impacts and risks, and the related challenges and opportunities these will bring for each of the North West's five counties. Full details of our risk assessment and actions we are taking to address these risks can be found in Appendix E Risk assessment below.

4.2 Cumbria

Cumbria is home to some of the wettest areas in England. Consequently, over one third of the North West's water supply originates in Cumbria, captured in reservoirs and transported across the region. With hotter, drier summers forecast, it is of vital importance that supplies remain resilient during dry weather events.

Warmer weather is also resulting in increasing lake and reservoir temperatures, this can increase the rates of biological activity and result in significant widespread algal blooms and eutrophication which is detrimental to biodiversity, amenity value and the quality of raw water requiring more treatment.

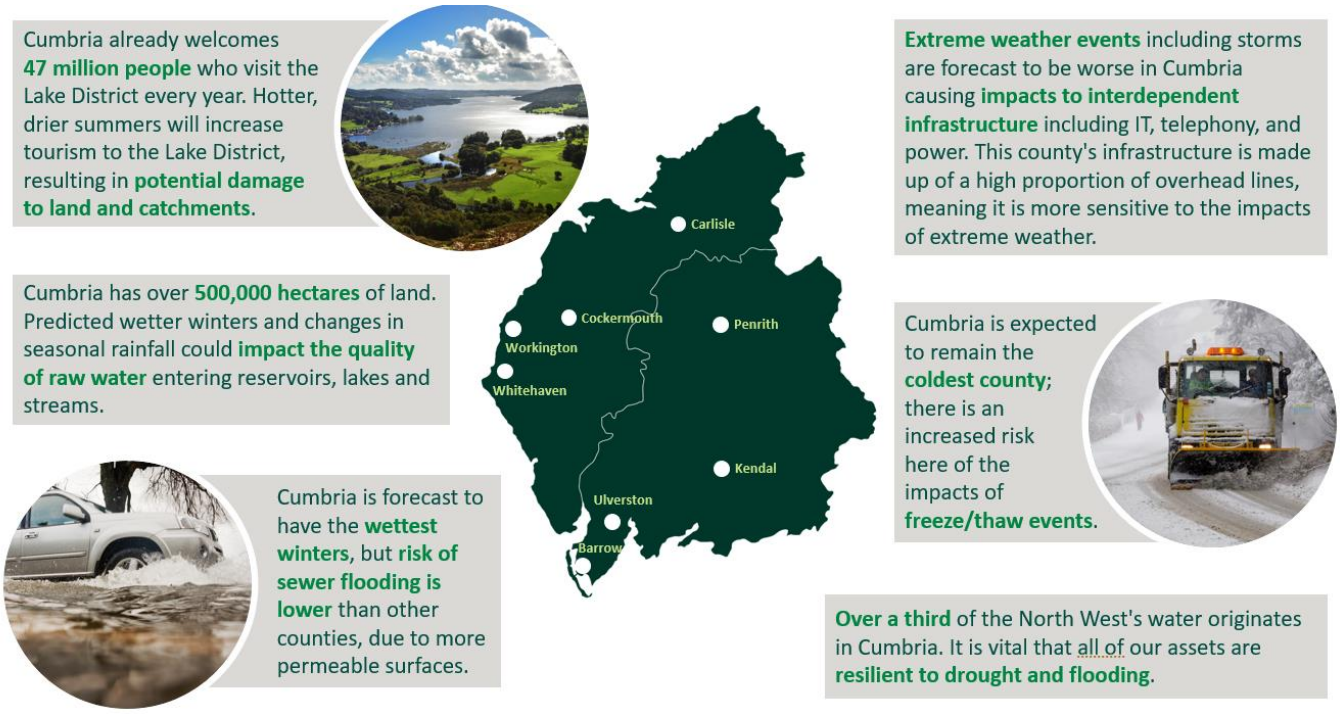
Wetter winters are expected to be most likely in Cumbria compared to any other county in the North West. However, the risk of sewer flooding, resulting in spills, here is lower as much of the rain falls on the mountains and fells that are not drained by our sewer network. However, the risk of sewer inundation and spills is still present in the areas that are drained by combined sewer systems. A relatively high-water table in Cumbria does mean that buried assets can suffer from accelerated deterioration and the sewer network is at a higher risk of infiltration from ground water.

Although temperatures are set to be warmer during winters, Cumbria will remain the coldest county in the North West and impacts of freeze/thaw, such as freezing of customer's pipes and supply interruptions, may still be seen. Extreme weather is predicted to have the highest impact in Cumbria, much of the power infrastructure is made up over overhead lines so is susceptible to storm events and their consequences.

Cumbria is home to a wide variety of special landscapes: two national parks, two world heritage sites, three areas of outstanding natural beauty and hundreds of designated sites of special scientific interest. As such, it is a tourist hotspot attracting visitors from all over the world each year. With summer temperatures and dry conditions set to rise, more tourists are predicted to visit Cumbria, increasing the likelihood and impact of damage to land, including an increased risk of wildfires.

Some of the highest sea-level rise changes are forecast to occur along the Solway coastline, at the mouth of the River Eden. This will present a higher risk to flooding to communities and assets along that stretch of coastline and potential impacts on the operation of assets such as Carlisle waste water treatment works which recycles treated water into the River Eden.

Figure 10 Top climate impacts in Cumbria



Action

- As part of future investment for AMP8 (2025-2030), our plans include investing in power resilience in water and wastewater assets in Cumbria via our Resilience Uplift business plan. We plan to address sites that are currently experiencing frequent weather-related power outages, and at sites where there is a high pollution potential should a site shut down under a loss of power;
- We plan to secure enhanced levels of flood risk resilience to critical water abstraction assets, protecting them from fluvial flooding and safeguarding supplies to a large proportion of Cumbria;
- Keeping rivers and lakes clean and beautiful is hugely important for Cumbria. We plan to invest to ensure great river water quality, protect biodiversity and contribute to achieving bathing water standards across coastal and inland bathing waters including new sites at Coniston(multiple) and Derwentwater. Beyond our own operation, we will support sustainable agricultural practices, through our work with partners to maximise benefits for river water quality;
- We plan to deliver targeted sustainable urban drainage solutions (SuDS) in areas of forecast high additional water volumes resulting from climate change;
- We are investing over £1 billion in the Haweswater aqueduct, ensuring resilient water supplies across the North West, including Cumbria;
- Investing in largescale land management and re-wilding projects to provide resilience to raw water inflows and raw water quality in our Thirlmere and Haweswater catchments, working in partnership to deliver more resilient ecosystems and protect the biodiversity and heritage of the Lake District National Park – a World Heritage Site; and
- We will continue to invest, collaborating with partners, including landowners, non-governmental organisations and community groups, to protect Cumbrian landscapes and manage our owned catchment land.

4.3 Lancashire

Lancashire has a diverse geographical landscape. The west has low-lying coastal and estuary landscapes, where tidal influences and urban areas contribute to surface water runoff. The uplands in the east have extensive areas of countryside and moorland with two designated areas of outstanding natural beauty: Forest of Bowland and Arnside and Silverdale. Like Cumbria, Lancashire is expected to be hit harder by wetter winters and changes in levels of precipitation across the seasons. However, as Lancashire is more urbanised, there is a higher risk of surface water flooding impacts.

There are also a high proportion of combined sewer systems in East Lancashire, meaning an increased risk of sewer flooding, resulting in spills, in this county particularly during extreme rainfall. Lancashire's predominately overhead line power infrastructure means they are also more likely to experience power loss, and potential supply interruptions, due to the impact of storms.

These and traditional townscapes make Lancashire a popular tourism destination. Visitor numbers are expected to increase to the area with warmer overall weather forecast, potentially increasing the risk to land and catchments.

Water sources in Lancashire are sensitive to compounds which affect the taste, smell and appearance of water; surface water runoff from future wetter weather will increase the likelihood of this risk.

There are a mix of socio-economic levels across Lancashire; those with a lower socio-economic status may be less able to personally adapt themselves to climate change or climate change adaptation may be lower on their personal priorities.

Figure 11 Top climate impacts in Lancashire

Action

- We're investing to reduce the number of storm overflow spills, improving water quality and amenity along the rivers Ribble, Lune and Wyre;
- We have recently piloted a partnership approach to Natural Flood Management (NFM) in the Wyre area. A combination of factors including climate change and population growth over a number of years has led to greater intensity and severity of flooding events – increasing flood risk to UU assets and customer property United Utilities encouraged the formation of a consortium that included Rivers Trust, Environment Agency as well as other key stakeholders and funded some innovative research to prioritise the NFM interventions and quantify the benefits they could deliver. More details can be found in section 5.2;
- We plan to deliver targeted sustainable urban drainage solutions (SuDS) in areas of forecast high added water volumes resulting from climate change; and
- We have plans are to invest in power resilience in water and wastewater assets across Lancashire, as part of our Resilience uplift future investment for AMP8 (2025-2030). We plan to address sites that are currently experiencing frequent power outages, sites where pollution can be attributed to supply side power loss should they shut down and have significant consequences should they fail. We have plans to invest in two water treatment works to ensure we can continue to deliver great water quality.

4.4 Greater Manchester

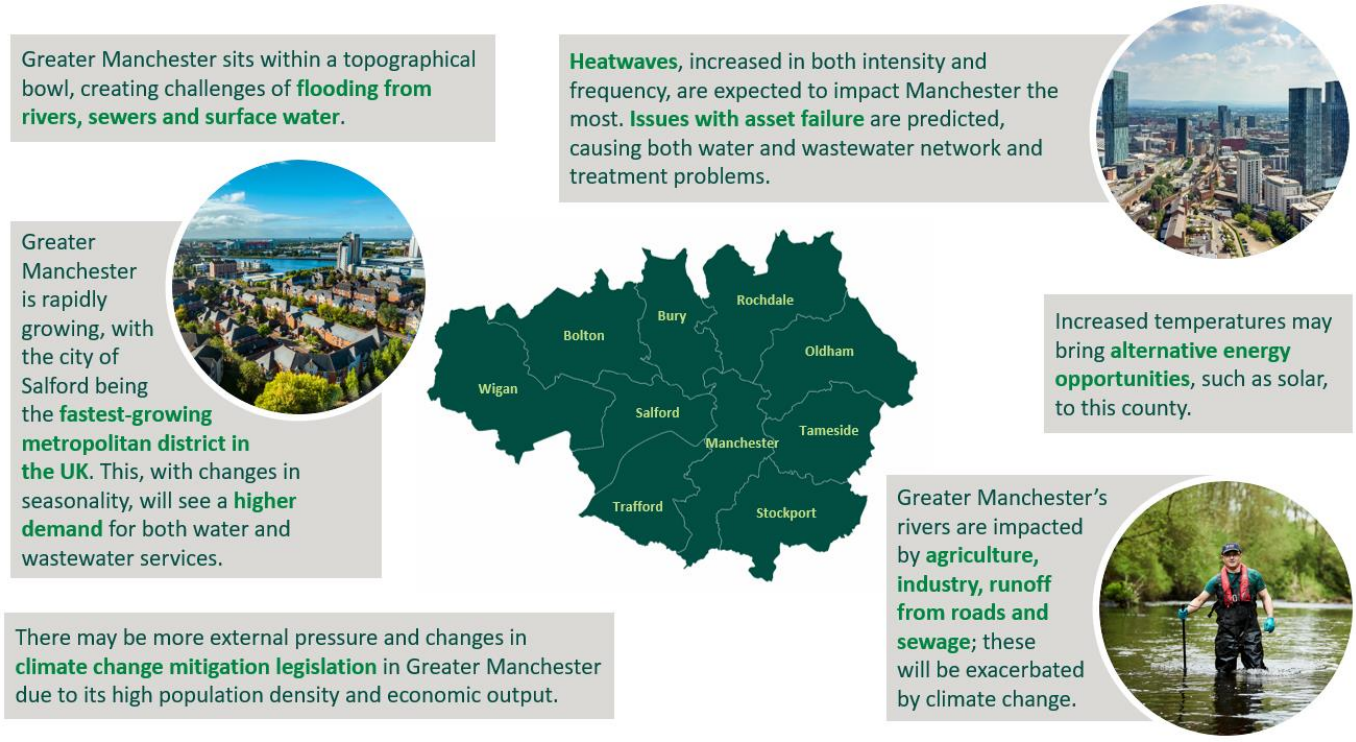
Greater Manchester sits within a topographical bowl creating challenges of flooding from rivers, sewers and surface water. The flooding risk is worsened by high rainfall, the urban rainfall in the North West is 40 per cent higher than industry average. This is compounded by Greater Manchester's rivers being affected by agriculture, industry, runoff from roads as well as sewage, with 37 per cent of the North West's combined sewer overflows situated in Greater Manchester. Wetter winters and more extreme events due to climate change are set to worsen these issues.

Hotter, drier summers and extreme heatwaves are forecast to hit Great Manchester the hardest. Customers in and around Greater Manchester receive their water supply from Haweswater in the Lake District. This is supplied

through the Haweswater aqueduct, a gravity fed pipe. Hotter temperatures increase customer demand for water, so it important that this supply stays resilient.

Our building standards ensure that assets and equipment, specifically those that generate heat as a result of their operation, are kept cool enough to remain operational. Standards require natural or forced ventilation to maintain operational temperatures when it is 30^{0}C outside. As the number of days above 30^{0}C increases we therefore may start to effects on the health and functionality of our assets in the future. However, this may also bring more opportunities for green energy such as solar.

Figure 12 Top climate impacts in Greater Manchester



Action

- We're investing over £1 billion in the Haweswater aqueduct, ensuring we sustain resilient water supplies for Greater Manchester;
- Through our trilateral partnership with Greater Manchester Combined Authority (GMCA) and the Environment Agency we have developed a collaborative Integrated Water Management Plan for Greater Manchester, a first for a UK city region. Through working with our partners to deliver integrated water management, we aim to minimise the risk of flood and disruption, through using nature-based solutions we aim to deliver more green spaces;
- Through our proposed investment, we will invest in rainwater management solutions to increase the storage of rainwater runoff in our priority catchments by 22,750 m^3, mitigating the impact of added flooding from climate change by 2030, thus preventing an additional 30 sewer flooding incidents. Without this investment, forecasts show there would be a further 9 Olympic sized swimming pools of wastewater flooding across these towns and cities in the North West in a 1 in 20-year storm. The schemes under delivery include major public realm improvements in town centres across Greater Manchester including Oldham, Bolton, Stockport, Stretford, Altrincham and Walkden. These schemes include raingardens, tree pits, permeable pocket parks and recreational parks with cycle ways to connect the access round the town centre; and
- We have plans to invest to reduce spills from storm overflows.

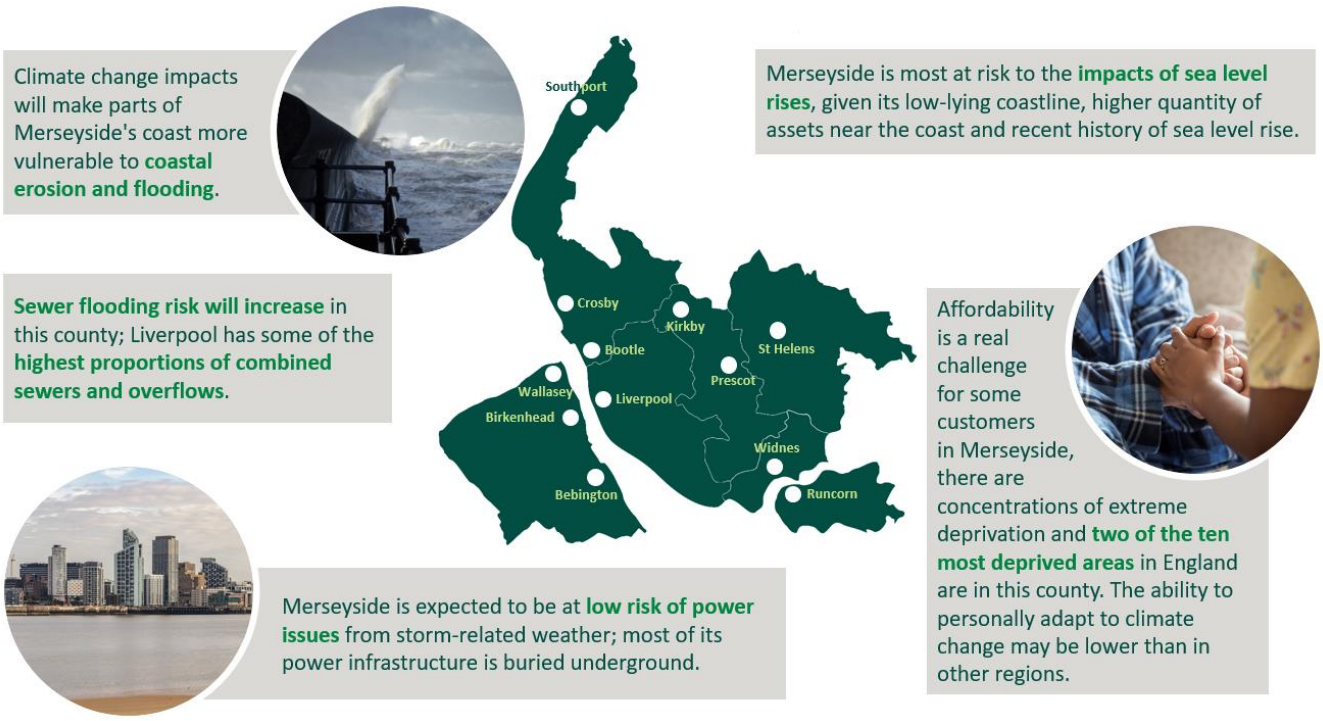
4.5 Merseyside

Merseyside has significant coastline, making parts of the coast vulnerable to coastal erosion and flooding which are forecast to become more frequent with climate change.

Liverpool has some of the highest proportions of combined sewers and so a high number of overflows. The urbanised landscape and population size of Merseyside means that local bathing waters are increasingly at risk to storm overflow spills. Wetter winters and more extreme rainfall heighten the risk of sewer flooding, leading to spills.

There are a mix of socio-economic levels across Merseyside; parts of this county have concentrations of extreme deprivation, and two of the ten most deprived areas of England are in this county. It is predicted that those with a lower socio-economic status may be less able to personally adapt themselves to climate change and that climate change adaptation may be lower in their personal priorities.

Figure 13 Top climate impacts in Merseyside



Action

- Tackling overflows requires re-plumbing the sewer system and we have a long-term plan for this. Subject to business plan approval. We have plans to resolve overflows straight away and are beginning the first phase of our Cleaner Mersey project to plan for significant separation of rainwater and sewerage systems across Liverpool;
- All the overflow investment in the AMP8 programme will be designed to a 2050 design horizon, allowing for climate change in the design. Solutions will vary depending on the size of intervention required and the opportunity (space/land) we will deliver a mix of traditional solutions, sustainable urban drainage and hybrid schemes;
- 20 sites across the River Alt are being assessed by the Mersey Rivers Trust for Natural Flood Management (NFM) measures, in potential Partnership with United Utilities. The project is currently in the feasibility stage. One proposed site is Tuebrook Wetland, adjacent to one of our Water Treatment Works. This scheme is being assessed for flood alleviation benefits in Maghull, which is a known flooding location;

- We are investing to protect Crosby pumping station and sewer from coastal erosion, in a partnership scheme led by Sefton Local Authority. The scheme will protect Crosby Northern pumping station and ~169 properties, creating intertidal habitats and enhancing the coastline;
- To support vulnerable customers in Merseyside, we will continue to offer sector leading support to customers who face difficulty when paying their water bill and have put in place extra support for vulnerable customers with additional needs; and
- With a significant population and asset base along the Merseyside coast line we will re-evaluate the risk to flooding of our assets on receipt of the latest National Flood Risk Assessment (NaFRA2).

4.6 Cheshire

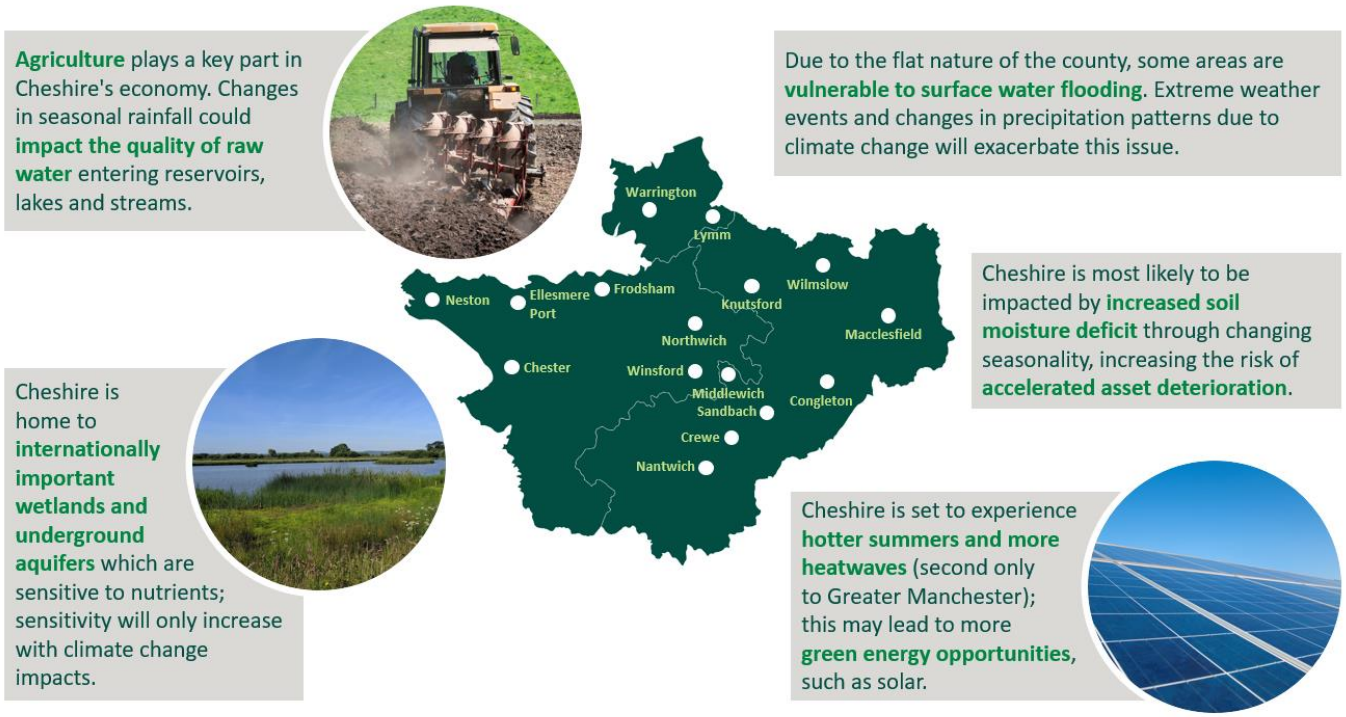
With farming a dominant industry across both the Cheshire environment and economy, it is important that we collaborate closely with local farmers to ensure practices do not impact on water quality. Predicted wetter winters and changes in seasonal rainfall increase the likelihood of surface water run-off from agricultural land impacting the quality of raw water entering water courses.

Hotter, drier summers and extreme heatwaves are forecast to impact Cheshire, second only to Greater Manchester. The lowest summer rainfall is expected in Cheshire and hotter temperatures will increase the demand for water, increasing the risk of drought.

Predicted future fluctuations of wet and dry cycles increase the likelihood of soil moisture deficit impacts which can lead to significant ground movement. As the ground dries out it can shrink, soils with a high clay content, which are present in Cheshire, are the most impacted by this mechanism. The effect of the shrinkage and subsequent swelling when it does rain results in significant ground movement which can damage buried infrastructure, especially more fragile materials.

Lower average summer rainfall also increases the likelihood of soil moisture deficit leading to greater surface water run-off potential at the first significant rainfall event, increasing the risk of flooding especially at flat areas of the county.

Figure 14 Top climate impacts in Cheshire



Cheshire, Ellesmere Port in particular, is also set to become one of the UK's centres for hydrogen production. The UK Government backed Industry Cluster (HyNet) project is set to accelerate UK hydrogen production and supply clean energy (as well as provide carbon capture and storage) for the industry in the area.

Water is a key raw material to produce hydrogen to support the UKs decarbonisation ambitions, however the water demand for HyNet and the developing hydrogen economy in the area remains uncertain. This uncertainty presents both a risk and an opportunity to UUW and the services that we provide. We are actively engaged with developers to support development, to mitigate risks to our services and maximise the potential opportunities.

Action

- We are proposing to renew 950km of water mains across the North West over the next five years. This will prioritise those with the greatest cost benefit ratio, including fragile pipes in rural Cheshire which we know are more vulnerable to ground movement during dry weather;
- We continue to employ our Catchment Systems Thinking approach, also known as CaST, to collaborate with farmers to take a joined-up and holistic approach to farming and the protecting of water quality;
- We are collaborating with farmers and partner organisations to promote sustainable farming practices across the River Dee catchment to protect drinking water quality;
- We also continue to collaborate with partners, building on our innovative Cheshire Hub partnership to identify opportunities to work collaboratively and deliver nature-based solutions to improve our rivers; and
- We have plans to invest in three water treatment works to ensure we can continue to deliver great quality water into the future, and we plan to deliver additional borehole supplies for drought resilience.

5. Interdependencies and collaboration

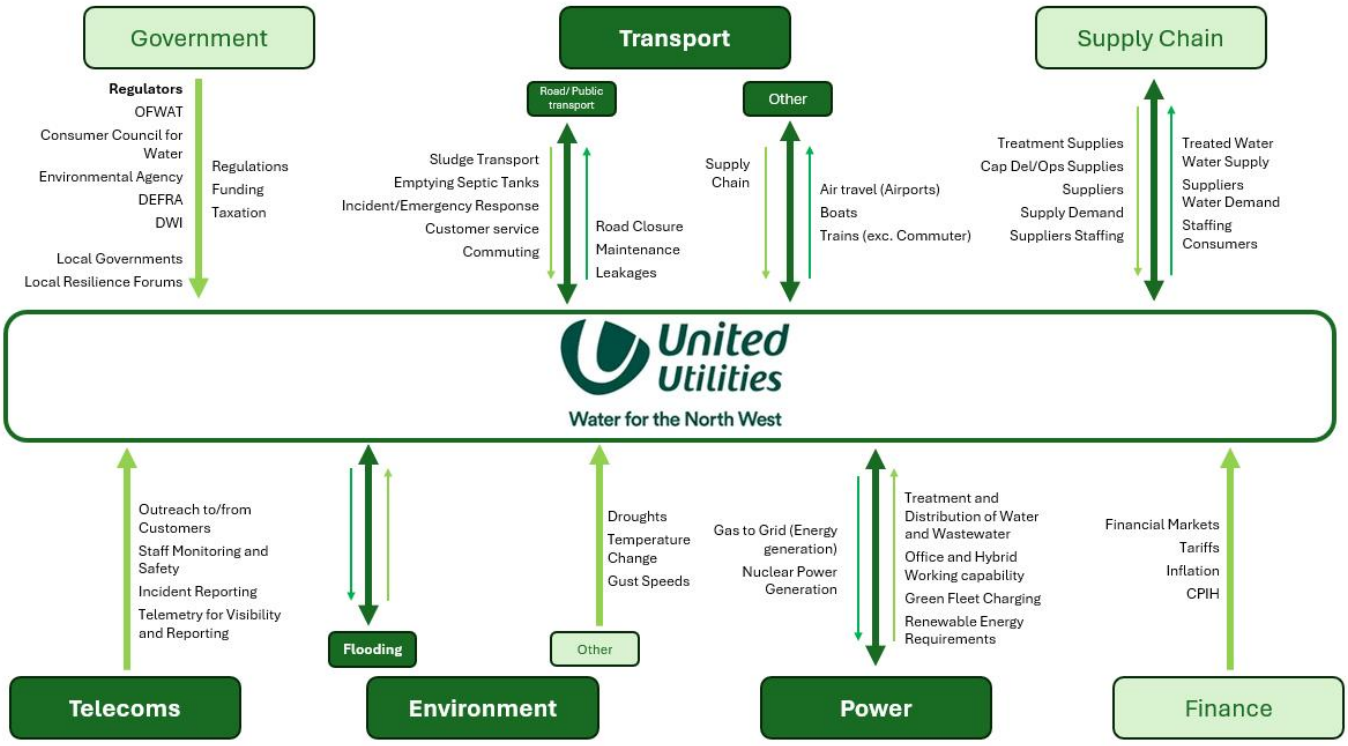
5.1 Summary

Whilst we can, and do, define the systems we use to deliver our services and the external systems we interface with; we have worked to understand the links and interdependencies between them at appropriate scales; from national to local, strategic to operational. Our approach to identifying and managing interdependencies is outlined in Section 2.4. Empowered with this knowledge, we have continued to develop processes to maintain a vertical line of sight within systems and horizontal line of sight between systems.

We are supporting the Cabinet Office's initiative for all Critical National Infrastructure (CNI) providers, for which water supply is one of 13 sectors categorised as CNI, to assess assets which meet sector specific risk thresholds for interdependencies on the other 12 CNI sectors. The anticipated outcome of this work is the discovery of critical interdependencies, and this will enable us to deliver improved situational awareness, develop appropriate response plans, and identify targeted resilience enhancements where these go beyond the risk tolerance.

We recognise that there are many interdependencies, relating to climate change, associated with delivering our resilience activities and the actions of others are likely to impact on our ability to manage our risks. We have outlined our main interdependencies below and how we are using them as opportunities to enable resilience.

Figure 15 Summary of our interdependency mapping



5.2 Flooding

We recognise that addressing the risk of flooding requires a multi-agency approach to solving this issue. United Utilities has a part to play as the drainage provider, and this approach also needs to include the Environment Agency and land drainage authorities. This is why we have joined forces to develop an Integrated Water Management Plan for Greater Manchester with the Greater Manchester Combined Authority (GMCA) and the Environment Agency, piloting this collaborative approach to the way we plan for and manage all elements of the water cycle in Greater Manchester.

To help mitigate the risk we have a significant focus on removing surface water from the sewerage system in AMP8, this includes working with Local Authorities to promote the installation of Sustainable Urban Drainage Systems (SuDS), including as part of highway developments.

We were very active in supporting the work of the National Infrastructure Commission (NIC) in their review of surface water flooding risk[6], providing evidence and expertise in their review of the risks and development of recommendations to Government.

We have conducted flooding risk assessments for all our assets at risk, this includes powered sites that are likely to be damaged in case of a flood occurrence. This includes an allowance for the likely effects of a range of future climate change scenarios on the Environment Agency's flood risk datasets. The outputs of which are included within our long-term delivery strategy submission for proposed investment targeted at the most significant risks in AMP9 onwards. We anticipate the need to review and reassess the flooding risk to sites post the release of the National Flood Risk Assessment (NaFRA2) anticipated in late 2024 / early 2025 by the Environment Agency, which we understand will be a significant step forward in modelling flood risk capabilities, including the specific impacts of climate change, topography and existing flood defences.

The Wyre Natural Flood Management Scheme

United Utilities Water (UUW) identified with partners a joint need to develop mechanisms that would enable greater applications of Natural Flood Management (NFM) interventions. A combination of factors including climate change and population growth over several years has led to greater intensity and severity of flooding events – increasing flood risk to UUW assets and customer property. It was recognised that a conventional approach to this challenge was not sustainable – both from an economic and environmental perspective - and recognised that a nature based, collaborative solution had the potential to deliver the greatest efficiencies and opportunities to maximise additional ecosystem services. This could not, however, be delivered by any one organisation alone so needed to be delivered in partnership and an innovative solution was required to facilitate this. This concept aligns with our Catchment Systems Thinking (CaST) approach, delivering multi-functional and multi-stakeholder solutions.

Through engagement with other partners, it became known that NFM opportunities were being considered by multiple organisations, however each organisation could not substantiate individual business cases and the greatest opportunity to enable NFM to be delivered was to develop an approach collaboratively. UUW encouraged the formation of a consortium that included Rivers Trust, Environment Agency as well as other key stakeholders and funded some innovative research to prioritise the NFM interventions and quantify the benefits they could deliver. Following on from this UUW, the Environment Agency, FloodRE and the Rivers Trust jointly developed a project and secured external funding from the Esme Fairbairn foundation to progress the development of a market mechanism to deliver interventions collaboratively.

Going forward, we will focus on how we can learn from the project and scale the approach – including sharing appropriate learning with applicable projects. We want to improve our understanding of NFM and look to ways of linking the catchment measures into network performance to understand what this could deliver in terms of resilience for the sewer network.

This project was a forerunner of the Environment Agencies £10 million Natural Environment Investment Readiness Fund and continues to significantly influence many of the projects funded through this route, with several attempting to replicate this across the country. As such it is shaping the national approach to driving catchment markets and we have used our experience in developing this with a lot of the other catchment activity we are driving, taking learning and adapting and improving them to the specific needs of other geographies. This success has been recognised with the project winning an Edie award for nature and biodiversity project of the year.

[6] nic.org.uk/studies-reports/reducing-the-risks-of-surface-water-flooding/

5.3 Power

In providing water and wastewater services, we have an interdependency of power supply and the effects of its failure. During FY23 we generated 205GWh, equivalent to almost a quarter of the electricity we consumed, however, as a relatively energy intensive business we will remain reliant on a continuous energy supply.

The energy industry is facing both physical and transitional climate change challenges across generation and distribution networks. Uptake of electric vehicles, distributed generation and transitioning to low carbon generation (renewables) is placing more demand on the generation and distribution system requiring much more active balancing of supply and demand as well as managing potentially intermittent power sources such as increasing amounts of wind and solar. Additionally increased physical risks of flooding to substations, storms and severe weather causing loss of supply, and increased vegetation growth along the network, all threaten the continuous service they provide.

In developing our energy resilience plans we recognise the interdependencies between United Utilities and electricity distribution network operators (DNO). We have worked in partnership with the DNOs in our region, Electricity North West (ENWL) and Scottish Power Energy Networks (SPEN), to develop an understanding of their resilience practises, allowing us to target our investment more specifically, and develop appropriate plans to determine which party is best placed to address energy resilience risks. This includes taking part in joint resilience exercises, knowledge sharing sessions and sharing key asset base information to understand vulnerability and applications for additional service protection via the Electricity Supply Emergency Code (ESEC).

This has allowed us to start developing plans to bridge the gap between current water company capability and resilience provision of the DNOs; ensuring that customer's money is spent appropriately.

We are leading activities on behalf of WaterUK (the trade association for the water industry) and Defra to develop power impact visualisation tools, sharing information across the sector.

Alongside our climate change risk assessment, we have reviewed our climate change evidence base and analysed distribution network operator performance for most of our region. Analysis of published outage data from the major supplier to our area of operations (Electricity North West) has identified an increasing trend in outages because of weather/storm events or their consequences.

As part of the PR24 business plan we have proposed to invest in power resilience at sites that are currently experiencing frequent power outages, sites where pollution can be attributed to supply side power loss should they shut down or be within the worst severed region of our operations and have significant consequences should they fail.

5.4 Digital and telecommunications

We rely on advances in technology, connected networks, and reliable communications to continue to deliver resilient services. Increased severe weather events, space weather and higher temperatures can put pressure on telecommunication assets and result in service disruptions.

In 2025, Openreach plans to switch off the Public Switched Telephone Network (PSTN). This 'switch off' will also impact ADSL and IDSN connections that rely on the copper network. We have recognised the need for UUW to replace our business-critical telemetry connections before the existing methods become obsolete. To mitigate this risk, we are making good progress replacing our PSTN connections with digital alternatives such as 4G mobile technologies. This has given us an extra layer of resilience, allowed remote monitoring and fault fixing and enabled broader situational awareness. We are targeting the completion of this project prior to the 2025 'switch off' to ensure we maintain a resilient service.

New technology and innovations create opportunities for improvements in service and efficiency, and keeping at the forefront on innovation is vital to delivering a sustainable service through a changing climate. Adopting new technology can introduce risks, however, through cyber security and changes to our ways of working. We have evolved our approach, responding to the significant increase in cyber threats, most notably following the start of

the war in Ukraine. We will continue to ensure we are taking all reasonable steps to maintain our digital resilience.

In addition to the technological updates described above, we have also launched our Digital Skills Academy, a new learning portal for employees to access digital learning content to upskill them for their roles now and in the future.

We have comprehensive IT Disaster Recovery (ITDR) arrangements across critical systems with resilience built into the underlying infrastructure where necessary. This was demonstrated during the Covid-19 pandemic, where we effectively and efficiently moved large numbers of colleagues from office working to remote working over-night. These disaster recovery arrangements differ from Business Continuity planning for loss of systems. Business Continuity planning for loss of systems details how services will be maintained during a system loss, whereas Disaster Recovery arrangements detail how, and in what order, systems will be brought back online following a loss. These two aspects of our resilience are interlinked and complimentary to each other.

5.5 Transport

While we advance our systems approach and enhance our centralised operational monitoring and control capabilities to drive efficiencies, many of our services require reliable logistics for the supply of materials, chemicals and staff to get to site and for waste and recyclables to leave site.

Road transport is classed as CNI, and we are liaising, via Defra, to raise awareness of key transport links to our CNI sites, raising dependencies of key links.

Key failure modes, because of climate change, include loss of access to company site or supply chain location because of surface water flooding, treefall due to storms and erosion damage of roads as a result of high river flows either undermining or flowing over the road surface.

Despite the variety of consequences that could come from this risk, there are many controls available to us. The possibility of having multiple access points to sites and assets greatly reduces the risk of not being able to access sites. This can range from alternate access points on the opposite side of the site, or additional manual entrances and exits.

This risk is particularly sensitive to severe weather, where disruptions to our supply chain can result in a cascade failure even if the disrupted transport route is not local. We collaborate with our suppliers to ensure that transport resilience is accounted for, and ensure we have suitable reserves to mitigate this risk.

Transport is also exposed to compound failure risks. With increased flood risk from pluvial sources from more intense rainfall, in turn placing high demands on the sewer network when highway drainage is connected, resulting in an increased risk of sewer flooding potentially compounding the flood event. This increase in non-permeable surfaces (known as urban creep) is included in our DWMP modelling to account for the additional rainfall we expect to need to drain.

Additionally, we are working with Transport for Greater Manchester (TfGM) to co-create a highway drainage manual that promotes sustainable urban drainage solutions to break the link between surface water and sewer flooding for new highway projects.

5.6 Supply chain

Having an integrated culture throughout our supply chain is fundamental to the successful delivery of our strategic aims, it is critical that we ensure our supply chain is resilient.

There are numerous ways that climate change can impact our supply chain, from extreme weather preventing access and deliveries to our sites, to chemical availability and external pressures for our supplies to adapt themselves to climate change.

Supply chain risk is considered as part of the Corporate Risk Management Framework, which follows an enterprise-wide approach to risk and is aligned to ISO 31000:2018. Our approach covers key aspects of supply

chain management that could impact the achievement of our business objectives, associated performance target and obligations as a water and wastewater company.

As part of our supply chain procurement processes, we require all potential suppliers to detail their contingency arrangements. For example, a logistics supplier will be expected to hold, and be able to demonstrate, that they have sufficient fuel reserves to remain operational should a supply chain issue arise.

We understand the source (geographic) of all our key supply chains including materials and chemicals, mapped to each site that uses that chemical. This enables us to rapidly assess the potential impacts of disrupted supply chains, for example because of disruption to the Suez Canal, conflict in eastern Europe and the middle east. This information is reviewed regularly to understand key supply chains risks.

We also, via a WaterUK working group, work together as a sector to understand key sector wide supply chain risks to enable prioritisation of material distribution across the UK should there be a significant disruption to the manufacture or supply of critical materials.

Through our United Supply Chain (USC) approach we engage suppliers on sustainable and ethical issues and performance, to ensure our supply chain is resilient to shocks and stresses. To support this into the longer term, through our partnership with the Supply Chain Sustainability School we have been able to offer both our commercial colleagues and supply chain partners free resources to learn more about the responsible sourcing principles.

5.7 People

It takes more than 5,000 of us to keep our network flowing, making us one of the largest employers in the North West. We employ, either directly and indirectly, 1 in 100 jobs in the region, supporting strong manufacturing sectors which rely on strong and stable water services. While we all do an important job, nothing we do is worth getting hurt for. Health, safety and wellbeing take precedence because our people deserve to go home safely every day. Climate change poses a risk to working conditions, whether that is more frequent, longer or hotter for teams working outdoors, or storms and site access.

We implement a proactive process of identifying and rectifying unsafe practises and reducing exposure to risks. These are identified and managed through our centralised risk identification and management process.

In recognition of our commitment to health and safety, we were awarded the Royal Society for the Prevention of Accidents (RoSPA) gold standard medal for the 12th consecutive year. In support of colleagues' wellbeing, we have again retained the Workplace Wellbeing Charter accreditation.

5.8 Nature

Ecosystem services

We rely upon the ecosystem of the North West and beyond to provide us with our core raw materials and recycling routes. We are reliant upon the environment to provide every drop of water supplied to customers and business across the North West and to receive recycled water and treated biosolids at the end of the cycle.

More than simply catching rainwater, the ecosystem collects, stores and provides the first phase of water treatment. Ensuring that there is sufficient water in the middle of summer to meet demands and that raw water is of high quality to ensure effective and efficient treatment to wholesome standards.

The ecosystem also helps to protect our assets, slowing the flow of water entering the drainage system, absorbing water to reduce flooding risk while also providing a route to recycling treated water.

We own 56,000 hectares of land across the North West for the purposes of securing this essential ecosystem service. We have been investing in restoring our catchment land for over 20 years in order to protect it and make it more resilient to climate change which in turn provides us with enhanced levels of service, such as improved raw water colour, resilience to extreme rainfall events and reduced flood downstream flood risk.

Sites of Special Scientific Interest

There is widespread recognition of the importance of the North West's landscapes, both environmentally and culturally. Many areas have legally protected status, including: three World Heritage sites, three National Parks and three Areas of Outstanding Natural Beauty (AONB). The functioning of these landscapes is fundamental to supporting the communities and economy of the North West, including essential natural processes that enable water supplies and reduce the risk of flooding.

The North West is also home to over 200 Sites of Special Scientific Interest (SSSI) and 55 Special Areas of Conservation (SAC). UUW is proud to own and collaborate in the conservation of these protected areas to protect and restore their critical functions in the water cycle and deliver many wider benefits for recreation, nature and climate regulation.

Our LTDS projects reductions in storm overflow spills to less than 10 per year, reduce internal flooding by 50 per cent and external flooding by 30 per cent. We aim to enhance the resilience of our network, for example proactively reducing sewer collapses. By 2050, we aim to reduce pollution incidents by 33 per cent. We will protect and restore catchments through our industry leading catchment systems thinking approach, including bold early action by 2030 to improve 6,987 hectares of Sites of Special Scientific Interest (SSSI) and almost 289.9 km of river. Additionally, we are investing to maintain the status of our 26 shellfish waters and 29 bathing waters

Invasive non-native species

Invasive non-native species are defined as any species introduced outside of its natural range (past or present) which may negatively impact upon the environment, the economy, or human health.

Invasive non-native species have been identified as one of the top five drivers of global biodiversity loss[7].

In Britain, they threaten the survival of native wildlife and damage our natural ecosystems by preying on or out-competing other plants and animals and spreading harmful diseases.

Defra estimate that Invasive species cost the British economy almost £2 billion a year[7], increase the risk of flooding or prevent us from enjoying recreational spaces and activities.

Climate change is a factor in the promotion of Invasive Non-Native Species (INNS) spreading. For example, increasing temperatures mean that the biological range for INNS is spreading further north and the lack of significant winter freezes means that insects more often associated with warmer climates, such as mosquitos, are surviving British winters.

While climate change is a factor in the propagation of INNS other factors also play a critical role which can make risk assessment complex. For example, river flow regimes and water quality can mean that a native species or INNS can prosper outside of its normal geographic and temperature ranges.

Typical impacts from INNS include the loss of native biodiversity and potential impact on the ecosystem that we are dependent on, but also include physical impacts such as mussels blocking raw water pipelines and vegetation growth potentially blocking filters and treatment processes.

Possibly the largest impact to UUW is the requirement to prevent the onward spreading of INNS to areas currently free from them. We run a significantly integrated water supply system, which in some locations includes the transferring of raw water from one catchment to another, and potentially different parts of the England and Wales once national water transfer schemes are in place. This risks the movement of INNS from one area to another and will require additional treatment.

Similarly, the recycling of treated biosolids to land risks the spreading of INNS, especially plant materials, which may require additional storage and distribution requirements.

[7] Invasive Species Week: threats to our native wildlife – Environment

5.9 Emergency response

United Utilities Water's response

We use the term business continuity to cover planning for loss of office accommodation, centralised business services (control room and customer service centre activities) and loss of people, for example through flu pandemic or inability to get to work due to extreme weather or fuel supplies disruption.

Our effective management of Business Continuity (BC) means we can better plan for, and respond to, incidents that could cause business disruption. Our aim, in all circumstances, is to keep our business operating at an acceptable level that safeguards the health of our employees, as well as the interests of customers and other key stakeholders, ultimately protecting our operation and reputation.

Our Business Continuity approach is aligned to ISO 22301, and our comprehensive business continuity plans will consider BCI 'Good Practice Guidance' using templates provided by the Business Continuity Adviser through our ClearView Business Continuity Management system. ClearView provides a validated, high availability and resilient system that is accessible 24/7.

Central Government's planning assumptions for a range of risks are set out in the National Security Risk Assessment (NSRA). These assumptions provide information on the common consequences of the emergency scenarios set out in the NSRA. Where relevant, these scenarios will form the basis of our Business Continuity planning and the development of specific, strategic plans, for example pandemic, fuel supply disruption, loss of national telephony.

To ensure they are up to date, we review our Business Continuity plans regularly, or at the point of any considerable changes in the business or within specific departments. We provide appropriate information, instruction, training and supervision to those involved in embedding our Business Continuity Framework, so that we have a workforce that is skilled and competent in Business Continuity Management.

The Incident Control Centre (ICC) Response Manager will assist individual departments in the management of business continuity incidents and any necessary escalation of incident management structures. Business continuity incident management teams are resourced and run by the affected business areas, supported by the ICC, and follow company good practice incident management process

Supporting emergency services

We actively support the emergency services, particularly the fire brigade. As the climate continues to warm, and summers become drier we can expect to see a significant increase in fire risk across the North West, a risk that manifested during the summer of 2022 with wildfires in London and the midlands. In July 2022, the London Fire Brigade (LFB) faced its "busiest day since World War Two"[8] because of wildfires across the capital.

The fire brigade relies upon us to provide sufficient water volumes and pressure in our network to meet firefighting requirements, we regularly liaise with regional fire brigade to ensure that performance expectations are being met.

Supporting the fire brigade is of particular importance to us, we are a significant land owner across the North West including large areas of open moorland. During extended dry periods and periods of hot sunny weather the moorland is at risk of significant wildfires like those experienced across Belmont and Saddleworth in 2018[9].

It is important to work together with the emergency services to quickly extinguish fires as there is a potential risk to the loss of assets, prolonged damage to land resulting in poor water quality and a treat to co-located CNI as was the case with the 2018 fires when a national broadcast mast was under threat of damage.

Where we can we support training and exercising of plans and provide access to water for fire fighting in these remote areas.

[8] Summer wildfires: Has London learned the lessons of 2022? | London City Hall

[9] Firefighters from seven counties fight Greater Manchester moor fires | Greater Manchester | The Guardian

Local Resilience Forums

As part of our duties under the Civil Contingencies Act, we participate fully in Local Resilience Forums (LRFs).

Participation includes the exercising of plans to reasonable worst case planning scenarios, based on the UK national risk register. This ensures that we understand what to expect from LRF partners and they know what to expect from us for a range of incidents and events. These include water distribution planning, flooding, cold weather, heatwave, power disruption, and industrial process site risks that could impact on our operations. Activities include risk assessment, multi-agency training and exercising, plan development and joint incident response

We have also taken part in national planning exercises, focused on understanding the risks and likely scenarios under a national power system failure.

6. Our approach to adaptation

6.1 Managing risk and uncertainty

Successful management of risks and uncertainties allows us to deliver on our core purpose - to provide great water for a stronger, greener and healthier North West - now and in the future, and be more resilient across our corporate, financial and operational structures.

By recognising the causes and consequences of risks through the identification, analysis and evaluation of the individual and compounded risk, and the capacity and capability of the company to manage these (our adaptive capacity), we can be proactive, prepared and prioritised.

In periods of adversity, such as during recent weather extremes, risks become more likely to materialise.

In the summers of 2020 and 2022, we experienced very dry summer weather. Intense dry weather periods are classified as a drought, and the first major drought in approximately 20 years affecting the North of England occurred during 2018. This event stressed our water resources, water production capacity and biological processes at some wastewater treatment works.

Thorough assessment of climate-related risks, with respect to projected changes in the climate, enable us to ensure our services will remain resilient through such adverse conditions as they worsen and increase in frequency.

Risk management is not just about adverse events happening, it is also about realising opportunities. Looking ahead and considering the longer term is therefore fundamental. We combine this with an ongoing review of our processes and practices to ensure their effectiveness in an ever-changing business environment.

Our risk management framework provides the foundation for the business to anticipate threats to delivering an effective service through a changing climate, and to respond and recover effectively when risks materialise. Key components of the framework include:

- An embedded company-wide risk management process which is aligned to ISO 31000:2018 Risk management guidelines;
- A board-led approach to risk appetite, based on strategic goals;
- A strong and well-established governance structure giving the board oversight of the nature and extent of risks the group faces, as well as the effectiveness of risk management processes and controls; and
- A portfolio of policies, procedures, guidance and training to enable consistent, group-wide participation by our people.

Continuous improvement is a key feature of the framework which incorporates a maturity assessment model to identify areas to enhance.

6.2 Identifying and assessing risks

We have a well-established and consistent approach to the identification and assessment of risk across the whole organisation. This includes consistent language, risk quantification and valuations with frequent review, robust governance and reporting to board level.

This is supplemented by cross-business horizon scanning forums with the aim of capturing emerging material risks and/or factors that may worsen a current risk, third party assurance and assessment of company risks to National Risk Registers to ensure appropriate risk assessment.

Each risk is event based and is sponsored by a senior manager who is responsible for the analysis of the identified corresponding causal factors, consequences and the control effectiveness, taking account of both the internal and external business environment. This process determines the likelihood of the event occurring and the full range of potential impacts from a minimum (best case) to a maximum (worst case). Comparing this position against the

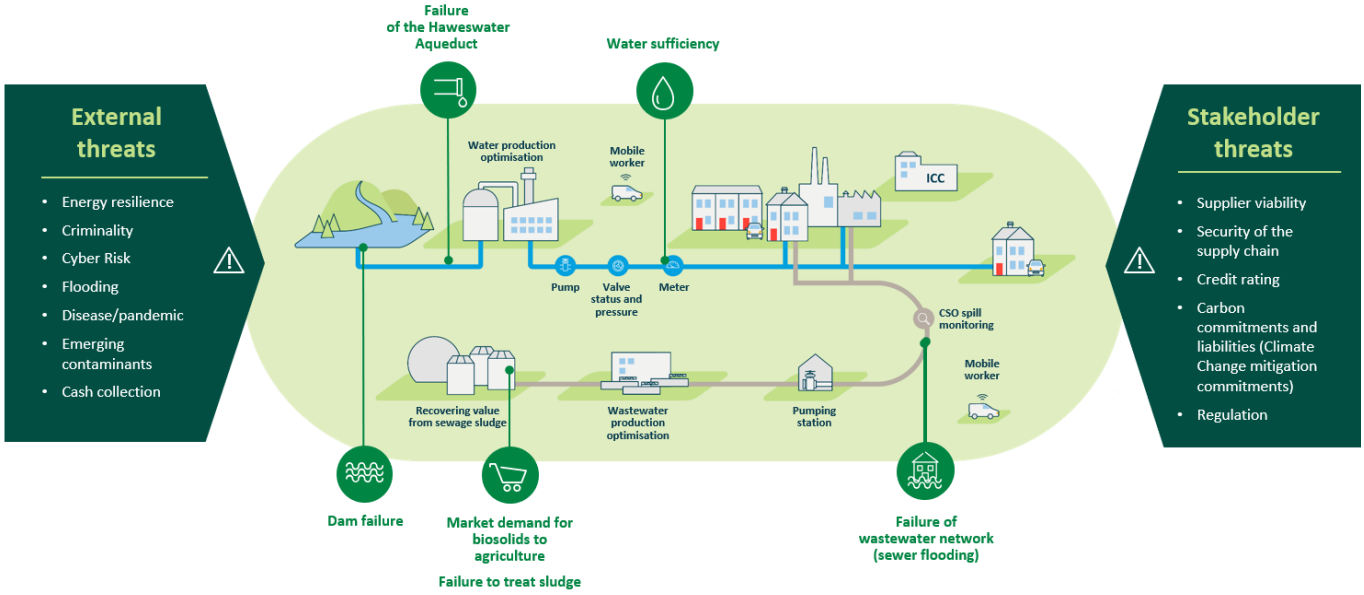
desired target state, in combination with the strengths, weaknesses and gaps of the control environment, supports the decisions for further mitigation as appropriate.

This ongoing analysis culminates in the biannual integrated risk review (IRR) which forms part of the governance and reporting process to ensure consistency of approach and a true reflection of the risk facing the company. It also serves to calibrate the most significant risks from a financial and reputational context and to assess how these relate to our risk appetite.

Our highest scored operational risks all have the potential to provide a major shock to the resilient delivery of our services. Some of these risks include an element of day-to-day performance but they all are associated with events that could lead to major disruption.

The risks portrayed in Figure 16 below, have been identified via our corporate risk management process, and are governed and reviewed annually in line with our approach to corporate resilience. This process requires risk owners to review, refresh, and report on existing and new risks at least every six months to the group board, or when a risk materially changes. This includes a review of the existing controls and mitigation and their effectiveness

Figure 16 Key risks mapped from source to tap



6.3 Resilience in the round

We routinely apply a systems approach to securing resilience in the round. We look beyond our own assets to take account of cascade failure risks and interdependent services in our decision-making. Resilience in the round means being resilient across all the component parts, operational, corporate and financial, and understanding the connections and interdependencies between them.

Operational performance is intrinsically linked to financial and corporate performance. We consider them equally impacted and ensure that they are considered alongside each other to avoid focusing on single issues. This has provided a solid basis to build greater resilience into our services, with a focus on further developing our systems-based resilience approach. Taking a long-term view in securing efficient resilience, requires us to face into the future. The impacts of climate change mean that we are increasingly managing greater levels of uncertainty than our historic performance required. We are managing for this future uncertainty by acting on the best available evidence and building long-term adaptive plans which account for the likely future scenarios. This enables us to make timely investment decisions to secure resilience

6.4 Climate-related risk management

Climate-related risks are managed and embedded within United Utilities Water through our risk management framework and across our governance and reporting processes. Our approach helps to ensure the identification, assessment and management of climate change risks, to reduce impact and likelihood, while maximising opportunities. Through our long-term adaptive plans, we have established long-term adaptive pathways, always responding to the latest evidence and innovations to secure best value, reliable services for customers.

Our mitigation metrics are aligned to the ambition of limiting global temperature rises to 1.5°C which is the global climate goal. Adaptation metrics account for the risks and uncertainties associated with this, and with higher temperature rises (for up to 4°C), as well as how the many potential variations in climate change impact the delivery of service improvements. Targets are set with risk and uncertainty included. While the most significant climate-related risks are physical risks, transition risks are also managed through our risk management framework.

6.5 Adaptive capacity

Our adaptive capacity is our ability to adapt to the impacts of climate change, take advantage of opportunities that may arise and respond to consequences. Our adaptive capacity is high; this is enabled by top management commitment to adaptation, commitment to our statutory obligations which account for climate change, and, as a business, we are continually assessing and developing our adaptive capacity.

We have created a specific organisational policy for Risk and Resilience, which includes climate change adaptation. This policy sets out key principles to provide sustainable and resilient services for all customers, which enables them to cope with and recover from disruption, anticipate trends and variability, and protects the interests of stakeholders. We forecast expected risks arising from foreseeable stresses on our business, including from climate change, and use the results to inform our long-term plans.

Our long-term plans are statutory requirements and are robust to a wide range of uncertainties including climate change.

- Our Water Resources Management Plan (WRMP) sets out our commitment and plan to deliver reliable, safe, clean and resilient water supplies to the North West over a 25-year time horizon, and accounts for potential impacts of climate change;
- Our Long-Term Delivery Strategy (LTDS) was published in October 2023 as part of our AMP8 (2025-2030) business plan to Ofwat. This outlines our strategy to meet our ambitions to 2050 and beyond. It describes the core and alternative adaptive pathways which may be required under different scenarios and demonstrates how scenario testing has informed our low-regrets, best value plan. To develop our LTDS we have built on our track record of effective long-term planning and scenario analysis for each of our service areas. This has enabled us to develop and cost new long-term plans for water, wastewater and bioresources, as well as completing detailed analysis of cross cutting priorities like climate change; and
- In 2023, we published our first Drainage and Wastewater Management Plan (DWMP)[3], this sets out our long-term approach for sustainable drainage and wastewater management across the North West, and how we intend to make sure that the region thrives now and in the future. To help us produce this plan, we looked at three key areas, flooding, environment and wastewater treatment, specifically looking at how a growing population and more extreme weather might prevent us from delivering our service. The best practice modelling techniques to assess our performance against a variety of future risks, account for climate change. This first iteration of the DWMP was not a statutory requirement, but the second, for which guidance has been received in autumn 2024, is now a legal duty under the Environment Act 2021.

UUW has put in place appropriate resources dedicated to the production and delivery of these long-term plans.

In developing and delivering our long-term strategic plans, we are adopting an adaptive pathway approach, building potential future scenarios into our planning. This allows us to remain agile as the climate changes and as the science provides us with greater understanding, while acting on changing customer and stakeholder

expectations and changes in legislation. This allows management to adapt and modify strategies and approaches in response to uncertainty and change.

Although we have a robust plan to avoid disruption and unpredictable events, incidents can happen. How quickly and effectively we respond to these events can impact the customer experience or environmental impact. Our Integrated Control Centre (ICC) is core to our response and recovery capability. The ICC provides situational awareness of how the water, wastewater and bioprocessing business streams are performing, in real time. This enables a timely and coordinated response, prioritising our resources to minimise the impacts

6.6 Engaging with stakeholders

We serve domestic and business customers throughout the counties of Cumbria, Lancashire, Greater Manchester, Merseyside and Cheshire. We strive to maintain a resilient and sustainable level of service to customers and the environment, taking climate change and both customers' and stakeholders' views into account.

Understanding what matters to stakeholders will only be achieved by building strong, constructive relationships and engaging regularly. This is important to building and maintaining trust and remaining resilient to interdependent risks resulting from climate change. These relationships are subject to robust governance to ensure the insights generated are considered in decision-making at executive and board level. The board's Environment Social Governance (ESG) committee meets three times a year, with stakeholder expectations and reputational horizon scan as one of its standing agenda items. In Figure 17, we outline our nine key stakeholder groups that we both influence and are influenced by.

Figure 17 Nine key stakeholder groups that influence our planning and activities

6.7 Engaging with customers

Understanding customer views is essential for both evaluating our long-term strategies and assuring that we have the right plan that serves the people who pay for it, now and into the future. It is critical that we talk to customers about our current and long-term plans and ambitions to gather a broad range of opinions and insight. Engaging with customers on these topics can be quite complex, a mix of quantitative research with qualitative discussion has enabled us to gain valuable insight.

When customers were asked about what they believe our strategic priorities to be, of the more discretionary investment opportunities, protecting the environment, meeting future challenges such as climate change and preventing pollution have a high combined importance. This combination makes 'current and future environmental concerns' the second most important combined priority after safe drinking water.

Through customer priorities research[10], we saw that customers see climate change as a high priority and feel a proactive approach to tackling it is needed. Customers recognised that climate change is present in the here and now, that there is a potential for a more adverse future and that future generations could bear the greatest impacts.

[10] DJS Research on behalf of United Utilities, Climate Change and Resilience, January 2021

7. Climate change governance

7.1 Board level governance

Our mature risk and resilience governance provides clear alignment and integration between decisions across the business. The alignment of our risk management processes from field to board ensures that decisions at all levels of our business help us to meet our strategic ambitions and deliver within the board-approved strategic risk appetite, enabling effective risk management across our business. Our resilience plan directly faces into the climate and affordability challenges, balancing the competing priorities for enhanced service and environmental performance, whilst acknowledging the inter-generational fairness needed when investing in our existing asset base.

We have a well-established governance and reporting structure for risk and resilience. The board has overall responsibility for establishing, maintaining and monitoring the risk management and internal control systems, with our CFO having executive responsibility for implementing the enterprise risk and resilience framework. This includes the development and roll out of the risk and resilience policy; establishing associated governance and steering groups; and employing dedicated risk and resilience teams, particularly the corporate risk team, which is responsible for the embedment of the overarching risk and resilience framework and processes.

The board undertakes a comprehensive review of the business risk profile twice a year in line with the full and half-year reporting cycle. This review considers the nature and extent of the most significant event-based risks relative to inherent risk areas new and emerging risks and any watching briefs (topics where there is currently insufficient information to assess the risk). The board also undertakes specific reviews of individual risks at each meeting. In combination, the profile review and specific review of risk by the board supports decision-making, enabling it to:

- Decide on an acceptable level of risk, relative to risk appetite and tolerance, to deliver on the group's strategy;
- Ensure appropriate controls and mitigation are in place, and test the appropriateness of plans;
- Report externally on the long-term viability of the company in an informed manner; and
- Monitor and review the effectiveness of risk management procedures and internal control systems.

Prior to the full and half-year review by the board, the executive-led Group Audit and Risk Board (GARB) provides an initial oversight of the risk environment, undertaking a 'top-down' assessment of the risk profile. Key points and themes are then fed into a number of director-led integrated risk reviews (IRRs) for the 'bottom-up' assessment of risks, controls and the determination of further mitigation. These IRRs include senior managers and subject matter experts to ensure a holistic consideration of correlating risks, the interdependency of controls, and new and emerging circumstances. The outcome is then collated by the corporate risk team and reviewed by the executive committee before escalation to the board.

For the most recent half-year risk review, and to ensure the consistency of risk awareness and estimation across the business, we have completed a high-level review of the risk profile and categorised if these risks are either sensitive, moderately sensitive, low sensitivity or not sensitive to climate change impacts. Risks have been assessed across water, wastewater, bioresources, as well as land, fleet, finance, resource, commercial and health, safety and wellbeing. For all risks that are sensitive or moderately sensitive to climate change, we have then associated a primary common causal factor, using the six causal factors identified in Section 3. Finally, we have completed an expert judgment assessment of if the climate change impacts are currently being seen and if there is a likely impact from climate change under both benign and adverse climate change scenarios in 2050.

The effectiveness of risk management and internal control systems is formally reviewed on an annual basis, in accordance with the code. The assessment, which considers relevant governance, risk management, internal control and assurance factors, is undertaken by the GARB before escalation to the audit committee, which acts on behalf of the board on this matter. The internal audit team provides periodic independent assurance on the effectiveness of risk management. This was last undertaken in 2023 for both risk management and, separately, for risk appetite and tolerance.

7.2 Alignment to adaptation standards

United Utilities Water utilised an in internal resource within the internal audit/assurance team to complete benchmarking against the stipulated adaptation standards (i.e. ISO 14090, 14091 and BS8631), as required by the Climate Adaptation Reporting (ARP) - 4th Round Guidance, received in December 2023. Benchmarking was completed by an ISO manager trained as a lead auditor in multiple ISO standards.

The Climate Change Adaptation Report, risk assessment, action planning development and processes to derive the information present were reviewed for compliance and alignment with the requirements set out within the three stated adaptation standards.

The outputs of the alignment review formed part of an existing plan to improve management systems to embed best practice.

Figure 18 Summary of alignment to adaptation standards

Standard	Alignment level
ISO 14090	***High***
ISO 14091	***High***
BS8631	***Medium***

A review was competed prior to submission and assessed alignment against the requirements within the standard. Any improvements identified were added/used to enhance the submission and revisited following this update. This formed the alignment level rating as detailed within the table above.

Adaptation standards

- ISO 14090:2019 Adaptation to climate change – Principles, requirements and guidelines;
- ISO 14091:2021 Adaptation to climate change – Guidelines on vulnerability, impacts and risk assessment (note: this product must be purchased); and
- BS8631 Adaptation to climate change – Using adaptation pathways for decision making.

Alignment Level Key

High- high degree of alignment of key requirements from evidence provided. Some changes may be deemed necessary by management to further enhance the submission. The business is exposed to negligible risk.

Medium- reasonable degree of alignment of key requirements from evidence provided. Further changes would be deemed necessary by management to further enhance the submission. The business is exposed to moderate risk.

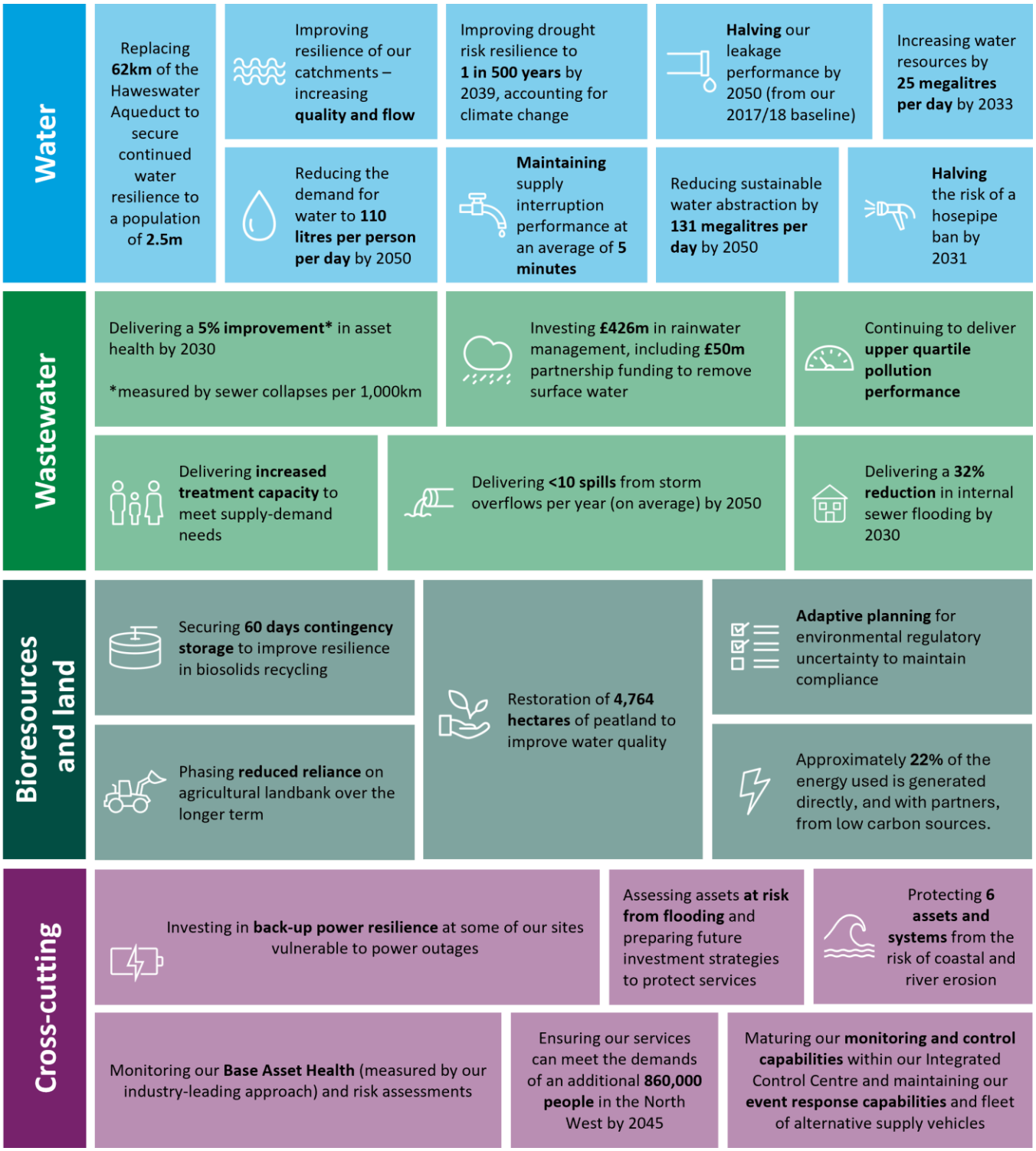
Low- low degree of alignment of key requirements from evidence provided. Further and immediate changes required by management due to absence of significant levels of requirements required within the submission. The business is exposed to high risk.

Note: - Comparable UUW versions of terminology/timescales present within the standards if observed and included as compliance.

8. An ambitious future

To support the delivery of our ambitions and objectives we have set stretching future performance targets that go beyond the traditional regulatory planning horizons, accounting for climate change projections. A summary of our future climate change related investment is shown in Figure 19 below.

Figure 19 Summary of future climate change related investment



Appendix A Source datasets and models

In this supporting technical appendix, we discuss the source models and datasets used in our analysis of climate change variables.

A.1 Source Data

The majority of source data used to produce our climate variable risk assessment has been is extracted from the Met Office climate change user interface - Welcome to UKCP (metoffice.gov.uk) – account required.

This dataset is the UK climate projection 2018 (UKCP18) – note that while the 18 refers to 2018 this was the report year and not the year the data was mastered, hence 2020 still represents a forecast position within the datasets. Also note that the release of data via the UKCP18 data portal took several years, with more general datasets being made available in 2018 but more complex high-resolution data only released in 2022 – this includes for example temporal data associated with rainfall.

We have also used data from the Meteorological Office Rainfall and Evaporation Calculation System (MORECS) to build relationship models that have allowed us to estimate the effects of changes in temperature and rainfall on soil moisture deficits.

Additional data sources, particularly for observed data used to build relationship models, was also taken from UUW internal datasets used to support the production of our Water Resource Management Plan (WRMP) and our Drainage and Wastewater Management Plan (DWMP).

A.2 Climate change products used

In retrieving climate change projections from the Met Office datasets, we have elected to use the Global (60km grid square) protections. This is because;

- The 60km grid square resolution has enabled us to extract data at a representative resolution to our 5-county organisational model – this means that we can easily look at the sub-regional effects of climate change on our region;
- Data is available as absolute values (i.e. a forecast temperature or amount of precipitation) rather than a % change which aligns to our proposed analysis methods; and
- Both RCP2.6 and RCP8.5 climate scenarios are available as outputs from this product, compared to others where only RCP8.5 is available, enabling us to risk assess against a benign level of climate change (RCP2.6) and a credible worst-case scenario (RCP8.5).

We have extracted and used all 12 of the UK regional model ensembles (each with subtly different assumptions) to account for the variability and uncertainty that is inherent in forecasting future climate change.

Appendix B Core principles and approach

In this section we briefly summarise our core approach and principles used to conduct our climate change risk assessment and outline our methodology.

Our approach to completing our climate change risk assessment is outlined in Section 2.2.

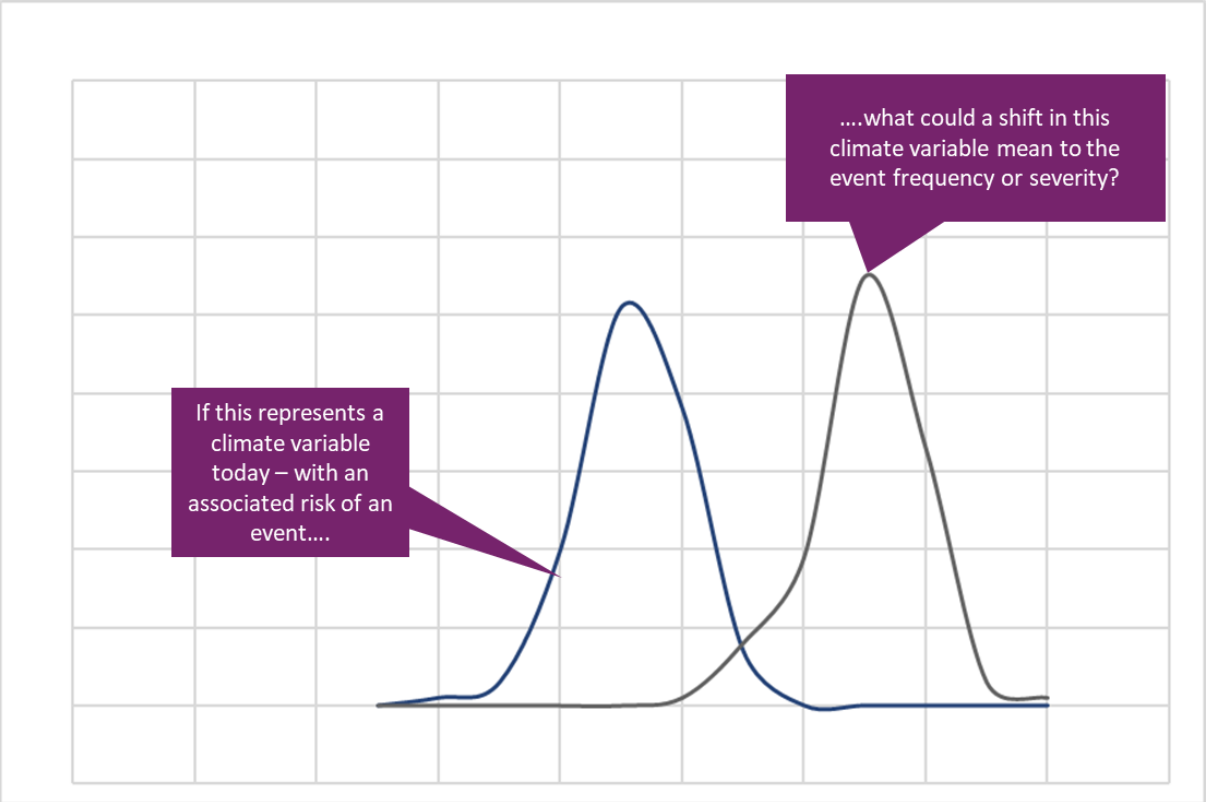
B.1 Data analysis

We have tried where possible to be data driven. Given the natural uncertainty in forecasting the future we have tried where possible to be objective and evidence led. Figure 20 outlines our core approach.

Figure 20 shows a change in climate variable (along the X axis) – on the Y axis we record the number of regional climate change models that predict this climate variable (out of a total of 12). This enables us to produce a distribution plot of the likely change in variable in absolute terms, but also to assess the level of model uncertainty – i.e. the more spread the distribution chart the greater the level of model divergence and therefore lower uncertainty.

The conceptual example shown in Figure 20 is for temperature for the North West of England administrative boundary and is sourced from the Met Office UKCP18 user interface.

Figure 20 Analysis concept used



Example of temperature change between now (current decaade) and the end of the century (2090-2100)

In generating these profiles for each climate variable and matching them to an observable impact on our services we can then use the projected changes in these variables to estimate the potential future change in impact.

For example, an increase in temperature is likely to result in an increase in demand for water, which we can then estimate given a forecast increase in that temperature, or the timing (i.e. when in the next 80yrs will this be a problem) and rate of occurrence of high temperature days which could impact the reliability of our operational assets.

B.2 Data resolution

Building on our previous climate change risk assessments for adaptation reports 1,2 and 3, but also for our statutory planning frameworks of the WRMP and DWMP, we have chosen to assess the climate change data not only at a regional level, but also on our sub-regional 5 county organisational model. This enables us to be more sensitive and to better reflect the diverse range of services and operations as well as the distinct geographies, demographics and asset bases within the counties that make up our region of operation.

We are now able to better recognise the range of risks across the region which means that we can develop area and asset specific adaption plans. Plans that not only account for the uniqueness of a region but also the forecast timing of when a climate threshold may be breached.

The example below shows how looking at the data at a higher resolution allows us to better assess and quantify the risk.

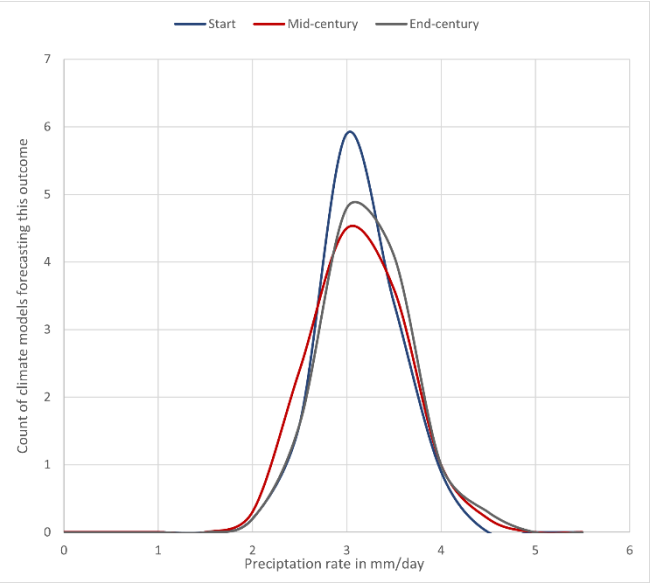
This analysis is for precipitation, measured in mm per day for now, a mid-century projection and an end of century projection. This analysis is for RCP8.5.

Note that for all the following charts the same three datasets are used.

- Start – this is the average of each climate model for the current decade (2020 – 2029);
- Mid- century – is the average of climate model for the decade (2046 – 2055); and
- End- century – is the average of climate model for the decade (2090 – 2099).

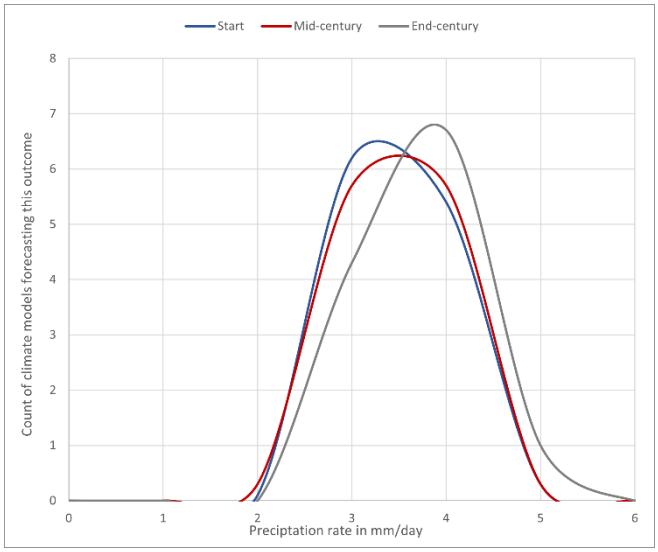
Figure 21 and Figure 22 below show how looking at the data at a higher resolution can help to identify climate risks that otherwise may go unnoticed. Figure 21 shows how the mean precipitation rate for the North West of England it likely to change for a given climate scenario (RCP8.5) at a regional level it appears that when measured as a daily average there is limited change. However, Figure 22 demonstrates that when we look at one of the five counties that make up our region, we can see that there is likely to be a change in average daily rainfall patterns for that area with an increase in average daily rain fall from the Mid-Century point onwards.

Figure 21 Regional forecast precipitation rate



Met Office UKCP18 data for the North West region

Figure 22 Sub-regional forecast precipitation rate (Cumbria)

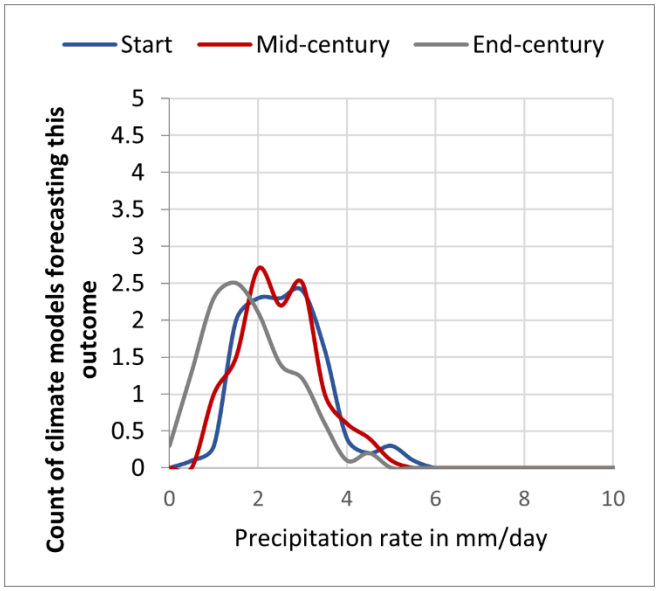


Met Office UKCP18 data for the region of Cumbria

This improvement in risk awareness as a result if increased data resolution is also true when we include temporal data. Figure 23 and Figure 24 show how when we include time information, we can pinpoint not only what the general trend in daily precipitation rates is, but also when we can anticipate seeing the greatest potential impact.

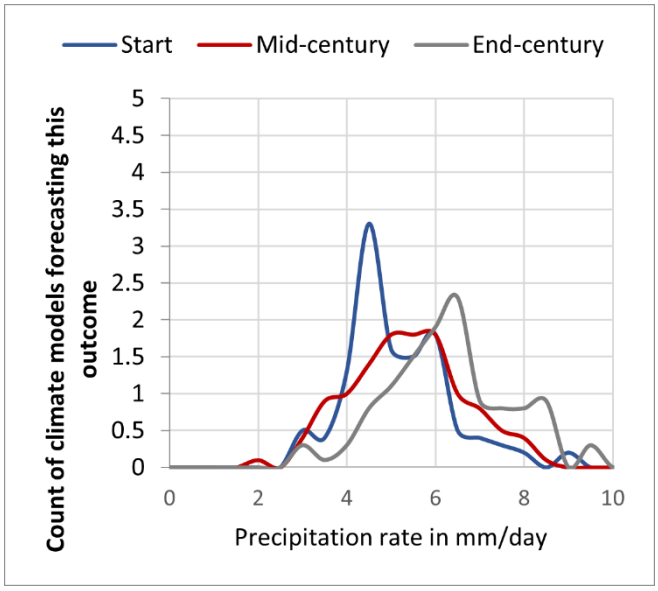
Considering that Cumbria is a business-critical region for us regarding water resources this enhanced level of information will enable us to better understand the risk. We know for example that we can anticipate the same total amount of precipitation in a year compared to now at least by the mid-century Figure 22 but when that precipitation is likely to fall will change. This may require us to change how we operate our storage assets to account for a reduction in in-flows during the summer compared to day and/or to maximise the refill volumes that we can expect to see in the winter.

Figure 23 Sub-regional forecast precipitation rate (Cumbria) Summer period



Met Office UKCP18 data for the region of Cumbria – summer season

Figure 24 Sub-regional forecast precipitation rate (Cumbria) Winter period



Met Office UKCP18 data for the region of Cumbria – winter season

B.3 Risk matrix

Our climate-related risk review looked at each risk and assessed both the likelihood and consequence of the risk occurring. The matrix used for this assessment is outlined below in Figure 25, further supporting guidance is provided in Figure 26.

Figure 25 Risk matrix used in risk assessment

Impact					
Very high	5	10	15	20	25
High	4	8	12	16	20
Medium	3	6	9	12	15
Low	2	4	6	8	10
Very Low	1	2	3	4	5
	<5%	6-20%	21-30%	31-50%	>50%
	1 in 25 years	1 in 10 years	1 in 4 years	1 in 3 years	>1 in 2 years
	Very low	Low	Medium	High	Very high
	Likelihood				

Figure 26 Risk matrix supporting guidance

Impact	
Rating	**Definition**
Very high	It would result in catastrophic events resulting in failure to deliver the organisations functions.
High	It would result in significant disuption to the organisation's functional delivery, resulkting in the need to conduct re-planning and re-estimating. In the extreme, it may result in failure of the project.
Medium	It would result in delays or additional work that would exceed existing contingencies, resulting in exceeded time scales, additional resource and/or additional budget requirements.
Low	It would result in delays or additional work that could be contained with existing contingencies.
Very low	It would result in negligible delays or disruption.

Likelihood	
Rating	**Definition**
Very high	The risk in the process of materialising and may already be under active management as an event
High	Past events have not been fully resolved, efffective mitigations not yet identified, control weakness are known and are being managed.
Medium	Past events satisfactorily resolved, mitigations are in place or are on track to be in place, control improvements are under active management
Low	Events are rare, required mitigations in place, controls are effective
Very low	No known event or if known extremely rare, extreme industry-wide scenarios

B.4 Subject matter expert review

In this section we set out how our risk assessment has been reviewed by company subject matter experts and risk owners.

The risk assessment process started with a review and consolidation of the climate-related risks submitted at the third round of climate change adaptation reporting. To support with this activity, we engaged with subject matter experts from across the business and held workshops to discuss the nature of the risk, amend any wording to reflect any risk changes and review the likelihood and consequences of the risk occurring. The risks were assessed on both a regional and five-county basis. Supporting packs with the climate change data analysis were created for consistency of this assessment. Using the risk matrix, a likelihood and consequence score was agreed at both a regional level, and county level where applicable. Where a risk has already been reviewed by the board as part of the half-year comprehensive review of significant event-based risks, the associated climate-related risks were scored in line with these existing scores.

B.5 Strengths and weakness of approach

Below we outline the strengths and weakness of the data analysis approach we have taken to support the review and completion of our climate change risk assessment.

Strengths

- Credible data source
- Consistent approach
- Allows for gap identification
- Greater awareness of adaptation plan across the business
- Documented processes for future iterations

Weaknesses

- Risk assessment open to subjectiveness
- Time consuming

Appendix C Action planning for adaptation

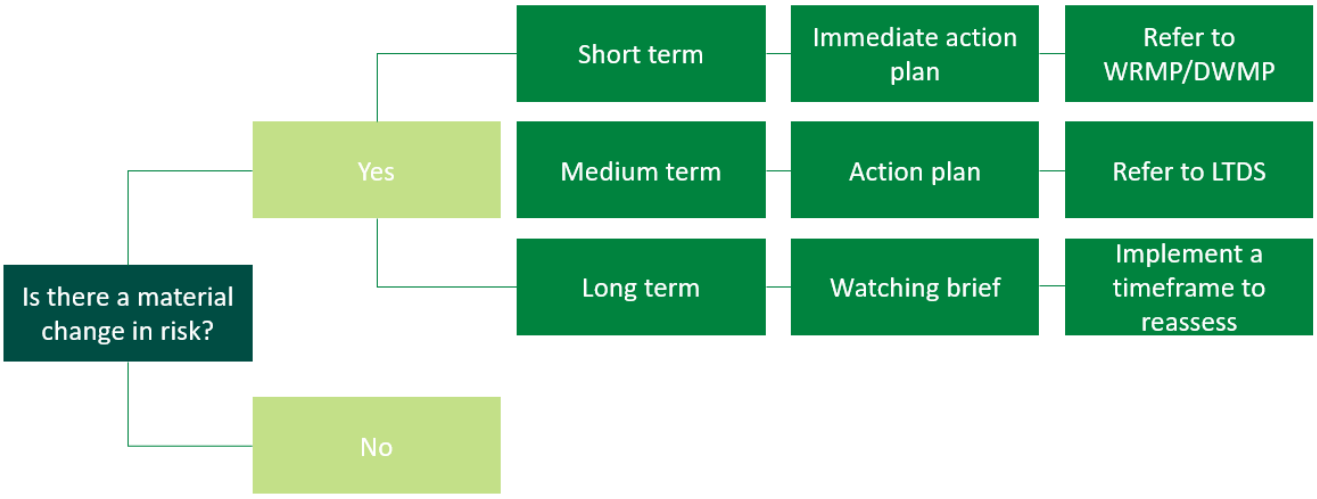
C.1 Methodology

In our third Climate Change Adaptation Report published in 2021, we submitted new actions and existing actions, along with a description of the action, timescale and status. As part of this current round of reporting, we have reviewed all the new actions that were included in the previous report to confirm these are still appropriate, update any wording where required and provide an updated status and timescale. This has been a collaborative effort across the business, engaging with any interested parties or subject matter experts that are relevant to each action. We have also included new actions for this round of reporting. Our full list of actions can be found in Appendix F below, which includes detail on:

- Actions to address risks
- Timescales and ownership
- Costs have been included where applicable
- The approach to monitoring and evaluation- what does success look like
- Where actions have been met or missed, including commentary on how well the actions addressed the risks and whether any additional action is required to meet adaptation needs and objectives
- Interdependencies with other organisations or sectors

To determine the action required for each of the risks identified in the assessment, the following decision tree has been used.

Figure 27 Decision tree used in risk assessment to determine action required



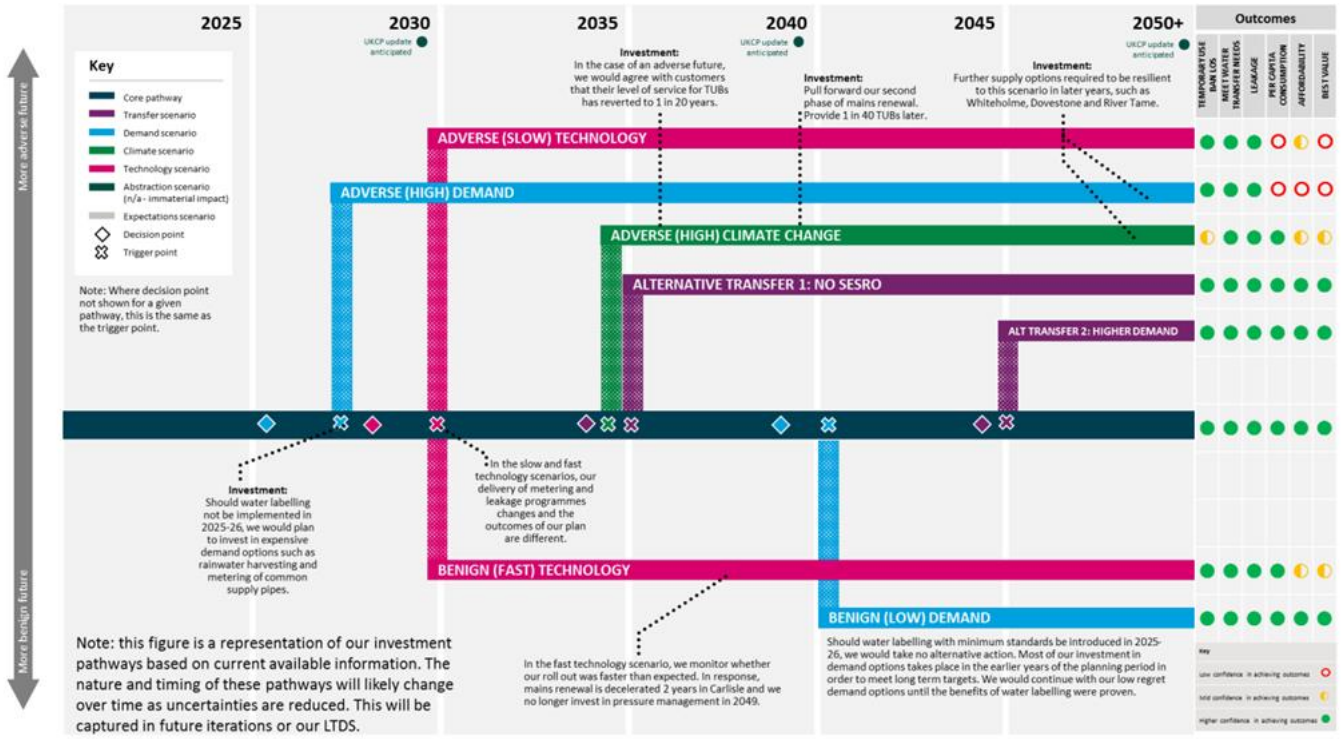
C.2 Adaptive pathways

We undertake extensive adaptive planning through our statutory WRMP, DWMP, and LTDS.

Error! Reference source not found. outlines an example of our adaptive planning; a summary of our adaptive p athways for water resources.

By testing how our plan responds to a range of future scenarios we have created the alternative pathways of investment shown. We have tested the impacts of climate change in both benign and adverse scenarios. Our alternative pathways are described by clear decision and trigger points which we will proactively monitor. Alternative pathways may be required at different points in time.

Figure 28 Example of adaptive pathways - A summary of our adaptive plan for water resources



C.3 Monitoring and evaluation

We will monitor our Climate Change Adaptation action plan through:

- Our new Long Term Delivery Strategy incorporates our most advanced long-term planning to date. As part of this, a monitoring plan has been developed to underpin the above reporting and governance measures. This plan has been designed to integrate with our existing corporate risk management process, to track how our adaptive plan is performing and when an alternative pathway may be required. The corporate risk process already provides a cyclical, holistic and integrated approach to monitoring and managing risk across the business, underpinned with formal governance arrangements that conclude with the Board, assurance and public disclosure in the annual report. Our continual improvement to long-term planning will itself strengthen our corporate risk system by further maturing its inclusion of long-term risks. The monitoring plan is found in the Long-Term Delivery Strategy and includes the metrics that will be measured, the frequency of review, and thresholds for subsequent action.
- Our quarterly Risk and Resilience Board meets to monitor and report the quality and completeness of progress against risk and resilience activities, including climate change adaptation actions. This is the forum where decisions can be made by the Directors in attendance and any risks or actions can be escalated.

Appendix D Climate Mitigation

While we focus on our adaptation to the impacts of climate change in this report, it is important to recognise how we contribute to rising greenhouse gas concentrations, and the significant steps we take to minimise that.

Our transition plan to contribute to, and prepare for, a rapid global transition towards a low-emission economy is based on our established climate change mitigation strategy, summarised in Figure 30.

Our strategy has four components:

- vision and visibility,
- ambition and commitment,
- demonstrating action; and
- beyond here and now.

Between them, these define our principles, priorities and implementation approach.

Figure 29 Our established climate change mitigation strategy

Vision and visibility: Demonstrating integrity and leadership in carbon reporting and disclosure.

Vision and visibility are the foundations of our climate change mitigation strategy and thus our net zero transition plan. We are dedicated to understanding how every aspect of our operations contributes to our emissions. Our aspiration is to ensure we consider the climate in all our operational and strategic decision-making and to influence strategy and behaviours by including emissions management in remuneration schemes and incorporating carbon pricing into our best value framework. We are also committed to reporting in an open and transparent way, aiming to be recognised as among the best in the UK.

Ambition and commitment: Playing our part to mitigate climate change and lower our greenhouse gas emissions to help make the North West a better place to live now and in the future.

An important element of our approach is to demonstrate our ambition and encourage others to contribute by making public commitments. In 2020 we made six carbon pledges, and we are making good progress to deliver these. Central to our pledges was to set science-based targets for all emission scopes. United Utilities is proud to be the first UK water company to have had near term targets approved by the Science Based Targets initiative (SBTi), a collaboration that defines and promotes global best in science-based target setting. Our four targets cover all 3 emission scopes, and the scope 1 and 2 emissions reduction target are consistent with the 1.5° ambition of the Paris Agreement. The SBTi Corporate Net-Zero Standard was launched in late 2021 and we have chosen to reinforce our support to the Business Ambition for 1.5°C campaign, with a long-term target and commitment to net zero which was approved in August 2024.

Demonstrating action: Reducing our environmental impacts through delivery of transformational strategies and culture change.

We have an action plan to achieve the long-term ambition of net zero by 2050 (in line with the UK Government targets). We are already working and delivering on actions in all themes to achieve the aims in Figure 29. Our priority in the medium term will be to reduce our absolute emissions through these actions before we use carbon units or purchase any credits to offset the residual emissions to net zero.

Figure 30 Our action plan for short, medium and long term

Action plan	Short term including recent progress	Medium term up to 2030	Long term to 2050 and beyond
Reduce consumption by careful use of resources.	• Colleague campaign 'Use Less, Save More' • Achieved ambitious targets for percentage of waste to beneficial reuse	• Optimise wastewater processes for GHG • Sensitive delivery of environment improvement programmes	• Identify and implement further efficiency opportunities • Reduce use of carbon intensive materials and techniques
Replace processes and resources with more sustainable alternatives.	◆ Renewable electricity sourcing • Substantial renewable energy generation capacity and capability • 60%+ sludge processing by lower GHG advanced digestion • Electric vehicle infrastructure	• Grow further renewables capabilities and capacity • Bioresources planning and investment to increase sludge processing capacity ◆ Electric vehicles rollout and trials for HGVs	• Eradicate use of fossil fuels, e.g. use hydrogen to fuel HGVs • Nutrient recovery initiatives • Continual stretch for sustainability informed by latest innovations
Remove GHGs from the atmosphere.	• Woodland creation – planning and first schemes planted and registered • Peatland restoration – schemes started	◆ 550ha woodland creation ◆ 1000ha peatland restoration	• Ongoing benefits of restored peatland • Benefits from growth of new woodlands • Carbon capture, use and storage
Collaborate to tackle emissions in the supply chain.	• Led water industry on task and finish group on chemicals and GHGs • Climate-related criteria in AMP8 delivery partner selection ◆ Encourage capital delivery partners to set SBTs	• Influence national approach to water environment improvements • Sustainability performance indicators for suppliers • Quantify more scope 3 emissions using product and activity data	• Collaborate to decarbonise our infrastructure programmes and wider supply chain • Drive standards reform to enable use of low emission materials and techniques • Offset residual emissions
Innovate to address current technological or market gaps.	• Carbon categories in United Utilities Innovation Labs • CEO Challenge improvement projects on energy and carbon • Identification of future research and innovation needs • Support regional transition via membership of Net Zero North West	• Explore low-carbon capital delivery options, e.g. nature-based solutions and low-carbon concrete • Process emissions monitoring • Nutrient recovery research • Research to support net zero treatment works and communities	• Transformation in water and wastewater processing towards net zero treatment works • Application of circular economy principles across the business • Utilise emerging Environment Attribute Certificates schemes

◆ Actions that directly link to our six carbon pledges or near-term science-based targets.

Beyond here and now: Innovating across processes, technology and culture.

Our strategy pillar of 'beyond here and now' encourages us to reflect on the challenge to influence emissions beyond our current inventory and existing capabilities. To deliver our net zero transition plan we will challenge standards and engage with industry peers, our supply chain, and other partners to develop markets, technologies and practices to reduce or mitigate future emissions.

Appendix E Risk assessment

This section presents a summarised extract of risks that have been identified through our climate-related risk assessment. A set of the most significant causal factors is addressed within the body of the report. Scores are given on a scale of 1 to 5, with the total risk score out of 25.

Risk Code	Causal Factor	Risk	Impact	Location	Risk narrative	ARP 4 risk score Present day scenario	Present day risk commentary	ARP 4 risk score Mid-century scenario	ARP 4 risk score End of century (+2°C or benign) scenario	ARP 4 risk score End of century (+4°C or adverse) scenario	Future risk commentary
R1	Extreme events	Extreme rainfall overwhelming sewers	Sewer flooding	Rest of the region	Extreme rainfall events (high volume over a short period of time) represent a significant shock to the wastewater drainage system. Extreme volumes can quickly overwhelm the capacity of the sewerage system and lead to flooding, surcharging of sewers and activation of combined sewer outfalls (in combined systems only).	**20**	High intensity rainfall events can happen almost anywhere in the region. The very localised impacts can quickly overwhelm most sewer systems - this risk is highest for the region of Greater Manchester due in combination to the high combined sewer proportion, local topographic factors and higher volumes of peak rainfall compared to the rest of the region.	**20**	**20**	**25**	Under a benign climate change scenario, future rainfall volumes are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future peak rainfall volumes are expected to increase (most significantly in Greater Manchester during the summer). As a result, we expect the risk of extreme short duration rainfall events overwhelming sewer capacity to increase in likelihood and consequence.
				Greater Manchester		**25**		**25**	**25**	**25**	

Risk Code	Causal Factor	Risk	Impact	Location	Risk narrative	ARP 4 risk score Present day scenario	Present day risk commentary	ARP 4 risk score Mid-century scenario	ARP 4 risk score End of century (+2°C or benign) scenario	ARP 4 risk score End of century (+4°C or adverse) scenario	Future risk commentary
R2	Extreme events	Extreme rainfall overwhelming sewers, resulting in failure to treat wastewater	Spills resulting in environmental pollution	Region wide	Increased frequency and intensity of rainfall events, beyond the capacity and asset design for the drainage network, requiring the use of combined sewer overflows to prevent sewer flooding of properties and businesses.	**16**	This is a current risk. Rainfall volumes have already increased beyond the design capacity of the drainage system. Extreme rainfall events (volume and intensity) result in spills - but this varies year to year based on number of high intensity storm events.	**20**	**20**	**25**	Under a benign climate change scenario, future rainfall volumes are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also as a result of storms. As a result, we expect this risk to increase in likelihood and consequence.
R3	Hotter, drier summers	Lower average summer rainfall reducing water resource availability, risking public supply resilience	Reduced reservoir levels during summer, necessitating increased use of supply restrictions and possible failures of the water service	Cumbria & Lancashire	Summer rainfall is expected to significantly reduce in the future, a trend we are already observing. The lack of summer rainfall to replenish reservoir levels will result in an increased likelihood of in year supply restrictions needing to be placed on public use and reductions in levels of service. In extreme circumstances this could result in localised system failure. This is a particular risk for United Utilities given our high percentage of surface water abstraction, and the relationship between surface water availability and recent rainfall.	**16**	The likelihood remains the same across the region, but this risk is more consequential in Cumbria and Lancashire as they are key water resource hubs.	**16**	**16**	**20**	Rainfall volumes and patterns are expected to remain broadly similar by mid-century and the end of century under a benign climate change (peak emissions by 2050). However, under an adverse pathway, by mid-century there are already signals that summer rainfall could on average be lower, with a material change by the end of the century, therefore the risk increases from mid-century to the end of century under an adverse climate change scenario. This risk is higher in Lancashire and Cumbria due to the significance of the raw water collected and stored in these regions.
				Rest of the region		**12**		**12**	**12**	**16**	

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R4	Changes in seasonality	Increase in annual growing days promoting increased risk of algal growth in reservoirs, resulting in physical blockages of water treatment assets	Negative impact on raw water quality	Lancashire & Greater Manchester	As the climate changes, prevailing weather conditions will also change. This has the potential to trigger changes in seasonal weather patterns, promoting extended growing seasons which increases the likelihood and potential consequences of algal blooms in reservoirs.	**12**	Algal blooms are already being observed in Lancashire and Greater Manchester, resulting in increased treatment costs and impacts on the acceptability of water with customers. While not currently a significant risk in major public water supply sources in Cumbria, due to the high proportion of raw water supplied from Cumbria the future risk could be significant.	**16**	**16**	**20**	There is already a risk in a significant part of our region today, linked in part to already experienced climate change. Further climate change, including under a benign climate change scenario, is likely to further exacerbate this risk. Under an adverse climate change scenario, this is expected to increase further in terms of both likelihood and consequence.
				Cumbria		**4**		**9**	**12**	**15**	
				Merseyside & Cheshire		**4**		**6**	**8**	**10**	
R5	Hotter, drier summers	Lower average summer rainfall, leading to low flow conditions in the sewerage network increasing likelihood of blockages in the sewage system	Property flooding	Greater Manchester	Drier weather can have significant impacts on sewer flows, especially flows of sewage in combined systems. While water consumption (for all domestic purposes) remains a largely consistent input into the sewer the lack of regular rainfall adding to flows can result in blockages developing in the distribution network. Once a blockage is formed there is an increased risk of flooding should a high intensity rainfall event (such as a summer storm) impact an area, potentially resulting in property flooding	**12**	There is a moderate risk of this occurring across the region, however this risk is more consequential in Greater Manchester due to the higher proportion of combined sewer systems. Additionally, current peak summer rainfall forecasts are of high intensity in Greater Manchester, a highly urbanised area. Cumbrian peak rainfall events are highest of all, however only a limited area is actually drained, and the county is mostly rural so impact on the sewer network is lower.	**12**	**12**	**16**	Under a benign climate change scenario, future rainfall volumes and patterns are broadly similar to those of the current climate to the end of the century. There are only small increases in peak rainfall intensity. By the end of the century, under an adverse climate change scenario the likelihood of prolonged dry weather promoting blockages in combined sewers increases as do peak rainfall volumes, resulting in more extreme flooding. This is particularly true of Greater Manchester.
				Rest of the region		**8**		**8**	**8**	**12**	

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R6	Extreme events	Extreme rainfall resulting in run off from agricultural land (including both owned and non-owned land)	Increased nutrient loads to water sources	Region wide	Intense rainfall events can lead to the mobilisation of surface materials and transport into raw water collection and storage systems. This can result in nutrient rich run-off from agricultural land being washed into water courses and reservoirs, seeding reservoirs with high nutrient loads as well as pesticides	**12**	High nutrient load in reservoirs can trigger significant algal blooms during the summer months - resulting in poor raw water quality and the requirement for more intensive treatment to meet regulatory and customer acceptability standards.	**12**	**12**	**16**	Under a benign climate change scenario, future rainfall volumes are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also as a result of storms. As a result, we expect this risk to increase in likelihood and consequence.
R7	Extreme events	Extreme rainfall, resulting in floods, accidents and landslips	Disruption to transport and supply lines	Region wide	Intense rainfall events can lead to the flooding of access routes and/or the mobilisation and transport of surface materials (in extreme events resulting in landslips) that can impact upon access routes to assets, preventing staff and supply chains from being able to access, risking the safe and effective operation of sites.	**12**	High intensity and prolonged wet weather (such as Storm Desmond / Eva in 2015) pose a risk to access to some of our sites. This is a risk today, with a medium annual likelihood assessment. For sites that are known to have issues site specific contingency plans already exist.	**12**	**12**	**16**	Under a benign climate change scenario, future rainfall volumes are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also as a result of storms. As a result, we expect this risk to increase in likelihood and consequence.

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R8	Changes in seasonality	Prolonged use of in-field biosolids stockpiling in wet weather	Increased diffuse pollution risk	Region wide	With increasing wet weather during the Autumn and Winter months this restricts the opportunity to recycle biosolids to agriculture, requiring stockpiling on land until more suitable spreading weather.	**12**	Changing weather patterns may restrict the time period within which farmers can apply biosolids to their land. This increases the likelihood that biosolids are stockpiled on farms waiting for suitable weather conditions for application to the land. This presents a risk to leaching of nutrients to water courses if not properly stored.	**12**	**12**	**16**	By mid-century, rainfall patterns are forecast to be largely consistent with present day. Under an adverse climate change scenario, by the end of the century, wetter winters and wetter springs are forecast (critical biosolids storage and spreading periods), increasing the risk scores.
R9	Hotter, drier summers	Lower average summer rainfall reducing raw water source options	Requirement to treat less favourable raw waters, increasing treatment requirements	Region wide	Under business as usual arrangements water sources are selected based on their availability, local and regional demand, and efficiency of treatment. Under drier summer weather in combination with higher demand, the need to maximise reservoir abstraction with little or no replenishment reduces. Limiting the ability to optimise raw water quality or treatability over volume requirements increasing treatment costs.	**12**	Under business as usual operations, we optimise raw water abstraction based on efficiency (availability, quality and demand). Under stress from climate change, the opportunity to optimise is reduced, incurring increased costs.	**12**	**12**	**16**	Under a benign climate change scenario, future rainfall volumes and patterns are broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario the likelihood of prolonged dry weather increases across the region.
R10	Hotter, drier summers	Lower average summer rainfall resulting in increased soil moisture deficit leading to	Flooding	Rest of the region	Drier summer weather combined with warmer temperatures combine to increase soil moisture deficient. This results in contraction of soils and effective hardening of	**9**	There is a moderate risk of this occurring across the region, however this risk is more consequential in Greater Manchester due to the higher proportion of	**9**	**9**	**12**	Under a benign climate change scenario, future rainfall volumes and patterns are broadly similar to those of the current climate to the end of the

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		compaction of soil surface resulting in greater run-off potential at first significant rainfall event		Greater Manchester	surfaces; this makes them less permeable than normal. High intensity rainfall events following prolonged dry periods cannot be intercepted by the ground like normal, which results in increased surface water run-off, increasing water to sewer systems and increasing risk of sewer flooding and CSO spills.	**12**	combined sewer systems. Additionally, current peak summer rainfall forecasts are of high intensity in Greater Manchester, a highly urbanised area. Cumbrian peak rainfall events are highest of all, however only a limited area is actually drained, and the county is mostly rural so impact on the sewer network is lower.	**12**	**12**	**15**	century. There are only small increases in peak rainfall intensity. By the end of the century, under an adverse climate change scenario the likelihood of prolonged dry and warm weather promoting high soil moisture deficits increases, combined with increases in peak rainfall volumes, resulting in more extreme flooding. This is particularly true of Greater Manchester.
R11	Hotter, drier summers	Lower average summer rainfall resulting in low flows in sewer network, increasing likelihood of highly concentrated septic sludge volumes	Odour and treatment work performance issues	Rest of the region	A risk to combined sewer systems, reduced rainfall in the summer period may result in lower flow rates in the sewer system. Resulting in longer residence time of foul sewage leading to the potential for it to become septic, which can cause treatment difficulties once it is flushed out at the treatment works following the first significant rainfall event.	**9**	This is a risk to all combined sewer systems in the region, but particularly in Greater Manchester due to the high proportional of combined sewer networks.	**9**	**9**	**12**	Under a benign climate change scenario, future rainfall volumes and patterns are broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. However, by the end of the century, under an adverse climate change scenario, summer rainfall volumes are expected to significantly reduce, increasing the likelihood of septic sewerage causing odour issues and issues with treatment works.
				Greater Manchester		**12**		**12**	**12**	**15**	
R12	Hotter, drier summers	Hotter, drier summers increasing tourism to more remote	Localised supply/demand issues for water and wastewater	Rest of the region	Hotter, drier summers increase tourism/people seeking recreation in nature or on the coast, resulting in localised	**9**	This risk is expected to be most significant in Cumbria, due to its relatively low population	**9**	**9**	**12**	Under a benign climate change scenario, future temperatures are expected to be broadly similar to

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		parts of the north west, significantly increasing temporary population above base		Cumbria	supply/demand issues in areas of usually low population where infrastructure has not been designed to supply.	**12**	density under normal operations, which means that the distribution and sewerage systems are sized accordingly.	**12**	**12**	**16**	those of the current climate to the end of the century, therefore the risk remains similar to current scoring. Under an adverse climate change scenario, we would expect the increased frequency and intensity of hotter, drier weather to be more likely to encourage more people to seek respite in spending time in nature.
R13	Changes in seasonality	Change in seasonal rainfall patterns increasing the frequency and prolonged use of rising mains to adequately drain networks	Deterioration of asset health and more frequent failures	Region wide	Under normal operation the majority of the waste water collection and transport system operates under gravity. During high rainfall events there is a greater requirement to pump waste in order to effectively drain areas and prevent sewer flooding.	**12**	Changes in seasonal rainfall, especially in combined sewer systems, will require greater pumping / use of rising mains to effectively drain areas. The increase in the cyclic use of pumps (pressurising the sewer) can result in accelerated asset deterioration beyond its initial design requirements.	**12**	**12**	**15**	Under a benign climate change scenario, future rainfall volumes are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also as a result of storms. As a result, we expect an increase in risk to asset health and more frequent rising main failures.
R14	Changes in seasonality	Increased rainfall in winter, leading to increased infiltration of	Sewer flooding	Rest of the region	Ground water levels are highly influenced by long-term rain patterns. During the winter months ground water levels are generally higher due to	**12**	Infiltration is a known risk and forms a component of the DWMP supply / demand balance for sewer networks. Increasing	**12**	**12**	**15**	Under a benign climate change scenario, future rainfall volumes are expected to be broadly similar to those of the

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		groundwater into sewers			increased rainfall. If ground water levels exceed that of the sewer system, there is a risk of infiltration into the sewer network.		infiltration volumes pose a risk to sewer flooding during intense rainfall events as they reduce the available sewer network and treatment capacity.				current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also as a result of storms. As a result, we expect increased ground water levels resulting in more infiltration, in combination with more frequent and more intense rainfall events increasing the risk to sewer flooding.
R15	Changes in seasonality	Greater extremities in wet/dry cycles leads to greater soil movement	Pipe systems move, leading to fractures and accelerated asset deterioration	Greater Manchester & Lancashire	Forecast changes in seasonality will result in greater soil moisture deficits in the summer. This is likely to result in increased ground movement resulting in movement of fixed infrastructure.	**9**	Certain soil types are more vulnerable or have greater movement when dried out under high soil moisture deficits, for example soils with high clay content. Soil types are distributed differently across the region, and so is the range of projected soil moisture deficits largely as a result of differing rainfall and temperature forecasts. We see more clay soils in Merseyside and Cheshire, hence a higher risk assessment. Conversely, we anticipate lower soil moisture deficits in Cumbria, hence a lower risk assessment.	**9**	**9**	**12**	Analysis of future soil moisture deficits resulting in potential ground movement shows that the likelihood of drying events will increase from present day. Up until mid-century and by the end of the century, under a benign climate change scenario, this increase does not result in a material change in risk category. However, under an adverse scenario by the end of the century, we expect this risk to increase across the region with the exception of Cumbria.
				Cheshire & Merseyside		**12**		**12**	**12**	**15**	
				Cumbria		**4**		**4**	**4**	**4**	

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R16	Extreme events	Extreme rainfall resulting in asset flooding	Failure of assets	Greater Manchester	Increased risk of surface water flooding and flooding from rivers as a result of increased frequency of high intensity and high volume rainfall events.	**12**	This risk is assessed as the risk of a significant, multi-area event (e.g. Storm Desmond in 2015). Due to the nature of our business a high proportion of our asset base is exposed to flooding risk, especially the waste water system which tends to be located at the low point of each drainage area. This risk is elevated in Greater Manchester due to the increased rainfall volumes and intensity compared to other counties in the region, topographical factors, and the value of the asset base.	**12**	**12**	**20**	Climate change has already increased the risk of asset flooding across the region. Under a benign climate change scenario, future rainfall volumes are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also as a result of storms. As a result, we expect this risk to increase in likelihood.
				Rest of the region		**8**		**8**	**8**	**16**	
R17	Hotter, drier summers	Lower average summer rainfall resulting in low flows in the sewer network, increasing likelihood of highly concentrated shock loads of foul wastewater impacting works capability on first significant rainfall event	Failure to adequately treat wastewater and pollution events	Rest of the region	Drier weather can have significant impacts on sewer flows, especially flows of sewage in combined systems. While water consumption (for all domestic purposes) remains a largely consistent input into the sewer the lack of rainfall adding to flows can result in blockages and the development of septic sewage in the distribution network. Significant amounts of septic sewage can adversely impact treatment capability.	**12**	Consequences across the region are similar, but the likelihood in Cumbria is reduced due to slightly higher rainfall volumes (on average) compared to the rest of the region even after climate change is accounted for and because of the smaller area served by a drainage system compared to other counties.	**12**	**12**	**16**	Under a benign climate change pathway, we anticipate summer rainfall volumes to remain broadly similar to current climate across all regions by mid and end of century. By the end of the century, under an adverse scenario we expect the likelihood of prolonged dry weather impacting upon the flow of sewage to increase across the region.
				Cumbria		**8**		**8**	**8**	**12**	
R18	Rising sea levels	Rising sea levels resulting in coastal flooding causing damage to nearby assets	Failure of assets	Rest of the region	Climate change causes sea level to rise due to a combination of melt water from glaciers and ice sheets and thermal expansion of seawater as it warms. Rising sea levels resulting in coastal	**4**	All counties in the North West have some areas of coastline, except Greater Manchester. Due to the higher proportion of coastline in Lancashire and	**6**	**6**	**8**	This risk associated with sea level rise is expected to increase by mid-century under both benign and adverse climate change scenarios, more so in the

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				Lancashire & Merseyside	flooding, resulting in damage to assets in close proximity to the coast, causing these assets to either be temporarily unavailable, damaged or fail.	**12**	Merseyside the risk failure of assets caused by coastal flooding has been assessed as higher in these counties compared to the rest of the region.	**16**	**16**	**20**	counties of Lancashire and Merseyside with their areas of significant coastline. This increase is further exacerbated by the end of the century, under an adverse climate change scenario.
R19	Rising sea levels	Rising sea levels increasing the risk of erosion	Damage or loss of vulnerable assets in close proximity	Rest of the region	Climate change causes sea level to rise due to a combination of melt water from glaciers and ice sheets and thermal expansion of seawater as it warms. Rising sea levels resulting in increased risk of erosion, resulting in damage to assets in close proximity to the coast, causing these assets to either be temporarily unavailable, damaged or fail. This is also exacerbated by extreme weather on the coast, with storms contributing to the impacts of coastal erosion.	**4**	All counties in the North West have some areas of coastline, except Greater Manchester. Due to the higher proportion of coastline in Lancashire and Merseyside the risk of loss of assets associated with coastal erosion has been assessed as higher in these counties compared to the rest of the region.	**6**	**6**	**8**	This risk associated with sea level rise is expected to increase by mid-century under both benign and adverse climate change scenarios, more so in the counties of Lancashire and Merseyside with their areas of significant coastline. This increase is further exacerbated by the end of the century, under an adverse climate change scenario.
				Lancashire & Merseyside		**12**		**16**	**16**	**20**	
R20	Extreme events	More extreme conditions (wind and flood) resulting in an increased frequency and duration of loss of power within a treatment process	Service disruption	Rest of the region	The water sector is highly dependent on reliable power systems. Water production and waste treatment are energy intensive processes. The risk is widespread, affecting large, distributed asset bases supplied via multiple energy circuits, a fault on one of these circuits could result in full system failure.	**8**	In our region the supply is one of the more reliable across the UK, and yet there are still areas of vulnerability. Particularly in Cumbria and Lancashire where the distribution network is less interconnected and therefore less resilient and significant lengths are suspended on overhead lines making them vulnerable to wind and	**8**	**8**	**12**	Under a benign climate change scenario, future rainfall volumes and wind gusts are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes and wind gusts (particularly in the
				Cumbria & Lancashire		**12**		**12**	**12**	**16**	

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							wind borne debris. Larger sub-stations have been protected against flooding, but smaller distribution sub-stations have not been protected leaving them vulnerable to flooding losses.				winter) are expected to increase. As a result, we expect increased risk to power distribution assets and disruption on our asset base.
R21	Hotter, drier summers	Hotter, drier summers resulting in drying of vegetation increasing fuel availability, stoking more severe moorland/forest fires	Loss or devaluation of company assets and negative impact on raw water quality	Cumbria	Drier weather can result in increased availability of fuel available for wildfire, increasing the consequences should a wildfire start.	**8**	Significant areas of Greater Manchester, Lancashire and parts of Cheshire (Peak District) are covered by extensive moorlands providing more opportunity for wildfire to spread. These areas are also significantly more populus, and near to major conurbations increasing likelihood of ignition during nice weather.	**8**	**8**	**12**	Up until to end of century, under benign climate change, we anticipate the likelihood of drier summers and of ignition to be similar to present day. Under adverse climate change, we expect the likelihood of extended dry weather resulting in more fuel availability and therefore more consequential fires. This is particularly acute on the moorland regions of Greater Manchester, Lancashire, and Cheshire.
				Cheshire, Lancashire & Greater Manchester		**10**		**10**	**10**	**15**	
R22	Hotter, drier summers	Increased average summer temperatures, leading to drying of impounding reservoir clay cores resulting in crack formation	Compromise to resilience	Rest of the region	The integrity of impounding reservoirs is directly related to the condition of the core, in some assets this is formed of clay, which must be kept wet to maintain its performance. Extended dry periods and reduced reservoir levels may result in the clay core potentially drying and cracking, potentially leading to leakage through the core.	**8**	Significant areas of Greater Manchester, Lancashire and parts of Cheshire (Peak District) are covered by extensive moorlands providing more opportunity for wildfire to spread. These areas are also significantly more populus, and near to major conurbations	**8**	**8**	**12**	Under a benign climate change scenario, future temperature and rainfall volumes are forecast to be comparable to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. However, under an adverse climate change scenario rainfall data suggests that most of the region is likely to become drier post mid-
				Cumbria		**10**		**10**	**10**	**15**	

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											century, particularly for extended periods in the summer. This may result in increased reservoir draw down to meet supply demand, risking clay cores drying out.
R23	Extreme events	Increased weather extremes, leading to infrastructure damage and blockages, causing issues when accessing sites (chemical deliveries, reservoir inspections, etc.)	Issues when accessing sites (e.g. chemical deliveries, reservoir inspections)	Region wide	With increasingly more frequent and more extreme storms and events there is a risk that site access across the region may be restricted or blocked due to debris / fallen trees / flood water / snow & ice.	**9**	Blocked access ways delay our ability to safely respond to incidents and events, restricting our ability to recover failed assets, conduct critical asset inspections and make key chemical and fuel deliveries.	**9**	**9**	**16**	Under a benign climate change scenario, future climate trends are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk of climate induced events is anticipated to remain broadly similar. By the end of the century, under an adverse climate change scenario, we expect that climate induced events are likely to increase as a result of more intense storms (rain and wind).
R24	Rising sea levels	Rising sea levels resulting in coastal flooding	Issues accessing sites	Rest of the region	Climate change causes sea level to rise due to a combination of melt water from glaciers and ice sheets and thermal expansion of seawater as it warms. Rising sea levels resulting in coastal flooding, resulting access restrictions for both colleagues and supply chain, threatening asset operation.	**4**	All counties in the North West have some areas of coastline, except Greater Manchester. Due to the higher proportion of coastline in Lancashire and Merseyside coastal flooding resulting in access issues to sites have been assessed as higher in these counties compared to the rest of the region.	**6**	**6**	**8**	This risk associated with sea level rise is expected to increase by mid-century under both benign and adverse climate change scenarios, more so in the counties of Lancashire and Merseyside with their areas of significant coastline. This increase is further exacerbated by the end of the century, under an adverse climate change scenario.
				Lancashire & Merseyside		**9**		**12**	**12**	**16**	

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R25	Hotter, drier summers	Increased summer temperatures, reducing relative humidity and increased sunlight, leading to increasing evapotranspiration from reservoirs and land	Reduction in river inflow rates and raw water volumes	Rest of the region	Hotter, drier summers, complete with increased sunlight and reduced relative humidity could result in more ideal conditions for evapotranspiration, resulting in increased losses from catchment land and reservoirs.	**9**	This risk prevails across the entire supply region but given lack of surface water resources in Merseyside the consequences are lower.	**9**	**9**	**16**	Under a benign climate change scenario, future temperature and sunlight forecasts are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. This risk increases in terms of both likelihood and consequence under an adverse climate change scenario by the end of the century.
				Merseyside		**3**		**3**	**3**	**3**	
R26	Changes in seasonality	Changes in weather and climate impacting agriculture	Adverse effect on supply and demand of biosolids for agriculture	Rest of the region	Reduction in available landbank for biosolids recycling and/or increased competition. This is a result of changes in agricultural practices across the North West, such as more landbank being unavailable due to changes in farming practices.	**9**	The principal outlet for biosolids (post treatment) in the North West is to recycle them to land. Not all of the available landbank is open to the reception of biosolids as soil improvers. There are restrictions in place for certain agricultural outputs that prevents the use of waste derived biosolids from being recycled to land. There is additionally competition from other sources of biosolids (e.g. animal manures) especially in areas of significant dairy pasture.	**9**	**9**	**12**	Under a benign climate change scenario, future climate trends are forecast to be comparable to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. Under an adverse climate change scenario, by the end of the century, we anticipate that there is a chance that regional agricultural practices may change to suit the new climate. This could impact upon landbank availability to recycle biosolids (there are restrictions on where biosolids can be recycled), as growing seasons in the North West change.

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R27	Extreme events	Extreme rainfall, resulting in mass transport and deposition in raw water mains	Impacting resilience and quality	Region wide	Intense rainfall events can lead to the mobilisation of surface materials and transport into raw water collection and storage systems, potentially blocking or restricting the performance of raw water collection and transport systems. This can result in lower collection and transport volumes risking water resource availability later in the year as well as asset damage and costs to recover services.	**9**	There are observed localised risks to some of our assets today, generally observed following periods of high intensity rainfall resulting in sedimentation of materials in our raw water collection and distribution assets.	**9**	**9**	**12**	Under a benign climate change scenario, future rainfall volumes are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also as a result of storms. This is likely to result in a greater potential for material transport, and increased risk of sedimentation.
R28	Extreme events	Extreme rainfall, resulting in adverse raw water quality	Impact to the treatment process and customers	Region wide	Intense rainfall events can lead to the mobilisation of surface materials and transport into raw water collection and storage systems, increasing the turbidity of raw waters adversely impacting raw water quality being presented for treatment.	**9**	Risks associated with adverse water quality resulting from intense rainfall events occur today, under extreme rainfall events. This risk occurs region wide.	**9**	**9**	**12**	Under a benign climate change scenario, future rainfall volumes and intensity are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also in terms of intensity. This is likely to result in a greater potential for material transport, and increased risk of adverse turbidity arriving at water treatment works.

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R29	Extreme events	Increased frequency and severity of flooding	Changes to legislation, accountability and investment requirements	Region wide	With increased flood risk, which is anticipated as a result of climate change, there is a risk that legislation and expectations may change, requiring water companies to increase efforts to reduce the impact of flooding events. Increasing costs and changing service priorities.	**9**	This risk has been assessed a medium risk. The accountability for addressing flood risk is well defined in legislation, but the consequences of a change in requirement or expectation could be significant.	**9**	**9**	**12**	Under a benign climate change scenario, future rainfall volumes and intensity are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also in terms of intensity. This is likely to increase the frequency and extent of flooding exposure to our sites.

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R30	Extreme events	Extreme rainfall resulting in an increased frequency of flood events	External pressure to use alternative methods of flood mitigation i.e. use of reservoirs	Region wide	With increased flood risk, which is anticipated as a result of climate change, there is a risk that reservoir owners could be expected or required to operate reservoirs differently to the way they were intended to act as flood water attenuation assets.	**9**	Defra (in their strategic priority statement for Ofwat) have already suggested that the use of reservoirs as flood protection assets should be prioritised by Ofwat. However, reservoirs are generally not set up to provide this provision and lack the control required. We already have a voluntary agreement to operate Thirlmere reservoir for the purposes of flood risk to Keswick. The greatest risk is when the same reservoir is used for public supply. If levels are lowered for flood protection purposes in the winter, this may result in water supply risks in the following spring / summer.	**9**	**9**	**12**	Under a benign climate change scenario, future rainfall volumes and intensity are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk of flooding will remain broadly similar. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also in terms of intensity. This is likely to increase the frequency and extent of flooding exposure to our sites increasing pressure to use public water supply assets to act as flood attenuation assets - increasing costs to the water companies and increasing risk of supply issues should reservoir stocks not fully recover ahead of the following summer.

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R31	Transitional risk	Movements in policy and legislation, changing practices	Changing finance ability and investor sentiment	Region wide	Changing policies, regulation and legislation to address mitigation and adaptation requirements, in response to climate change, can increase operating costs, change finance ability and in turn, investor sentiment.	**9**	This risk is region wide and has been assessed a medium risk. We have well defined climate change pledges, plans and policies, but the consequences of a change in requirement or expectation could be significant.	**9**	**9**	**12**	Under a benign climate change scenario, future climate patterns are broadly similar to those of the current climate to the end of the century, therefore pressure to take alternative or different action is expected to remain similar. By the end of the century, under an adverse climate change scenario, we expect increase pressure to take alternative/more action.
R32	Transitional risk	Changing and increasing climate change mitigation and adaptation responsibilities	Affordability pressures	Region wide	Changing policies, regulation and legislation to address mitigation and adaptation requirements, in response to climate change, can increase operating costs, putting pressure on both company and customer affordability.	**9**	This risk is region wide and has been assessed a medium risk. We have well defined climate change pledges, plans and policies, but the consequences of a change in requirement or expectation could be significant.	**9**	**9**	**12**	Under a benign climate change scenario, future climate patterns are broadly similar to those of the current climate to the end of the century, therefore pressure to take alternative or different action is expected to remain similar. By the end of the century, under an adverse climate change scenario, we expect increase pressure to take alternative/more action.
R33	Rising sea levels	Rising sea levels causing tidal blocking	Issues with coastal and tidal river discharges	Region wide	For sewerage systems to effectively work they need access to freely discharging flows to the environment. Rising sea levels beyond current discharge levels threaten to	**9**	Risks and issues associated with outfall locking have already been identified across the region, principally as a result of river levels. Sites with	**9**	**9**	**9**	While sea level rise is anticipated to increase between now and the mid-century, the vast majority of works with discharge routes to the sea is via long

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					impact this. Climate change causes sea level to rise due to a combination of melt water from glaciers and ice sheets and thermal expansion of seawater as it warms. Rising sea levels resulting in coastal flooding, resulting in damage to assets in close proximity to the coast, causing these assets to either be temporarily unavailable, damaged or fail.		coastal discharges tend to have long sea outfalls in place that overcome this risk.				sea outfall which largely mitigates the risk. However, analysis of where we can expect to see the most significant sea level rise (along the Solway coast line) we expect there to be localised issues with a small number of sites.
R34	Changes in seasonality	Changes in land use and agricultural practice	Increased demand on water resources	Region wide	Increased growing seasons as a result of changes in seasonality and warmer climates may result in changes in crop selection and length of growing season, potentially resulting in increased water consumption to meet demand.	**9**	This is a regional risk, however there are localised part of the North West that we are already experiencing high water demand to meet agricultural requirements, such as areas of Lancashire.	**9**	**9**	**12**	Under a benign climate change scenario, we anticipate growing seasons in the North West to remain broadly similar. Under an adverse climate change scenario, by the end of the century, there is a potential for longer growing seasons and alternative crop viability (crop currently not viable in the North West). However, confidence around this is low due to uncertainties in international and UK market forces and food security policy.

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R35	Transitional risk	Increased external pressures on our climate change responsibilities	Climate change mitigation action required	Region wide	Changing policies, regulation and legislation to address mitigation and adaptation requirements, in response to climate change, can increase external pressure from our stakeholders for increase our climate change mitigation action.	**9**	This risk is region wide and has been assessed a medium risk. We have well defined climate change mitigation strategy, including goals and pledges, but the consequences of a change in requirement or expectation could be significant.	**9**	**9**	**12**	Under a benign climate change scenario, future climate patterns are broadly similar to those of the current climate to the end of the century, therefore pressure to take alternative or different action is expected to remain similar. By the end of the century, under an adverse climate change scenario, we expect increase pressure to take alternative/more action.
R36	Transitional risk	Movements in policy and legislation driven by climate change	Need for new infrastructure, technologies, training and/or competencies	Region wide	Changing policies, regulation and legislation to address mitigation and adaptation requirements, in response to climate change, can increase the need to invest in new assets, infrastructure and training.	**9**	This risk is region wide and has been assessed a medium risk. We promote a culture of innovation within the business, ensuring we have effective technology, training and competencies, but the consequences of a change in requirement or expectation could be significant.	**9**	**9**	**12**	Under a benign climate change scenario, future climate patterns are broadly similar to those of the current climate to the end of the century, therefore the need for new infrastructure, technologies, training and/or competencies is expected to stay broadly the same. By the end of the century, under an adverse climate change scenario, we expect there to be a need to invest in alternative or further infrastructure, technologies, training and/or competencies.

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R37	Extreme events	River levels rising, results in outfalls being unable to discharge	Treatment works backing up	Region wide	For sewerage systems to effectively work they need access to freely discharging flows to the environment. Rising river levels during storms and winter beyond current discharge levels threaten to impact this. Climate change is expected to result in higher peak river flows, potentially resulting in assets being temporarily unavailable, damaged or to fail.	**9**	Risks and issues associated with outfall locking have already been identified across the region, principally as a result of high river levels.	**9**	**9**	**12**	Under a benign climate change scenario, future rainfall volumes and patterns are broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, the likelihood of more rainfall in the winter and greater intensity rainfall events are expected to result in higher river levels, leading to more instances of outfall locking.
R38	Extreme events	Increased severity and frequency of adverse weather events	Pressure on our emergency response	Region wide	With increasingly more frequent and more extreme storms and events our emergency response resources may be stretched.	**9**	We have assessed this as a current medium risk. There are infrequent occasions where significant bad weather events have stretched our response capabilities, especially where these impact upon multiple counties at the same time.	**9**	**9**	**12**	Under a benign climate change scenario, future climate trends are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk of climate induced emergencies is anticipated to remain broadly similar. By the end of the century, under an adverse climate change scenario, we expect that climate induced emergency responses are likely to increase as a result of more intense storms (rain and wind).
R39	Hotter, drier summers	Lower average summer rainfall, resulting in lower average flows increasing likelihood of build-	Asset deterioration	Rest of the region	A risk to combined sewer systems, reduced rainfall in the summer period may result in lower flow rates in the sewer system. Resulting in higher concentrations of sewerage and	**6**	This is a risk to all combined sewer systems in the region, but particularly in Greater Manchester due to the high proportion of combined sewer networks.	**6**	**6**	**9**	Under a benign climate change scenario, future rainfall volumes and patterns are broadly similar to those of the current climate to the end of the

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		up of hydrogen sulphide and septicity		Greater Manchester	longer residence time of foul sewage potentially accelerating asset deterioration.	**9**		**9**	**9**	**12**	century, therefore the risk remains similar to current scoring. By the end of the century, under and adverse climate change scenario, the likelihood of prolonged dry weather resulting in septic sewerage causing accelerated asset deterioration increases.
R40	Hotter, drier summers	Lower average summer rainfall, reducing volumes of sewerage requiring treatment, threatening sustainability of biological treatment	Operational issues and recirculation pumping required	Rest of the region	With lower flows in the sewerage system, as a result of reduced rainfall into combined drainage systems, lower volumes of sewerage may arrive at treatment facilities to be treated. This may increase the need for recirculation pumping of final effluents around the treatment works to keep treatment works operating correctly.	**6**	This is a risk to all sewerage systems but given the anticipated reductions in summer rainfall in Cheshire and Greater Manchester we anticipate the risks being higher in these counties.	**4**	**4**	**6**	Under a benign climate change scenario, future rainfall volumes and patterns are broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. However, by the end of the century, under an adverse climate change scenario the likelihood of prolonged dry weather increases, and therefore the risk increases.
				Cheshire & Greater Manchester		**9**		**6**	**6**	**8**	
R41	Hotter, drier summers	Lower average summer rainfall, impacting inflows to water bodies/raw water storage volumes	Failure to maintain environmental flow requirements in downstream water courses	Region wide	Environmental flows (compensation flows) are stipulated by the environment agency. Under a drier climate there is a risk that reservoir levels will be reduced, increasing the likelihood of failure to meet required flows, but also reduced river levels requiring higher compensation flows to maintain environmentally prescribed conditions.	**8**	The risk is deemed low, but the consequences could be high due to high fines and operational costs. This is a particular concern for reservoirs that provide both water for public supply and environmental compensation, where a balance between resilient supply and environmental requirements needs to be struck.	**8**	**8**	**12**	Under a benign climate change scenario, future rainfall volumes and patterns are broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario the likelihood of prolonged dry weather increases across the region.

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R42	Extreme events	Increased risk of erosion and/or damage from higher river flows causing the loss of river crossings and vulnerable assets in close proximity	Service interruptions	Region wide	With increased river flows, resulting from increased rainfall volumes and intensity, the erosion potential of rivers increases. This can threaten assets that are in close proximity to rivers, such as pipe bridges, abstraction assets and discharge points.	**8**	This is already a risk, with a majority of rivers across the North West still in an active erosion phase. A small number of pollution incidents and water supply interruptions have occurred as a direct result of river undermining assets.	**8**	**8**	**12**	Under a benign climate change scenario, future rainfall volumes and intensity are expected to be broadly similar to those of the current climate to the end of the century, therefore peak river flows are anticipated to be broadly similar to today. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also in terms of intensity. This is likely to increase peak river flows and therefore increase the risk of damage to assets in close proximity to water courses.
R43	Extreme events	Increasing likelihood of maximum daily temperatures and frequency of heatwave days,	Asset failure	Cumbria, Lancashire, Merseyside	Extreme prolonged heatwaves (days with maximum temperatures in excess of 30^{0}C) threaten the operation of plant and equipment due to	**3**	Data analysis of maximum temperatures at a county level indicates that Greater Manchester and Cheshire are expected to be hotter counties in comparison to	**3**	**3**	**8**	Under a benign climate change scenario, future maximum temperature forecasts are expected to be broadly similar to those of the current climate to

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		resulting in overheating of company assets		Cheshire & Greater Manchester	overheating, effecting reliability and production capacity.	**8**	the rest of the region. Therefore, the risk of extreme heat impacting asset reliability is higher in these counties than the rest of the region, this is likely to be associated to their inland status.	**8**	**8**	**16**	the end of the century, therefore the risk remains similar to current scoring. Data analysis of maximum temperatures at a county level indicates that Greater Manchester and Cheshire can be expected to have more frequent, extremely hot days (over 35 degrees), from mid-century onwards. Therefore, the risk to asset reliability in these counties (post mid-century) under an adverse climate change is increased.
R44	Hotter, drier summers	Hotter, drier summers resulting in lower flows in rivers and warmer receiving waters	Tighter discharge permits at Wastewater Treatment Works	Region wide	Hotter, drier summers will likely result in lower river levels and warmer waters. This will result in lower environmental capacity to receive treated effluent (based on current discharge permits), this could result in increased wastewater treatment requirements as a result of changes to environmental discharge permits.	**8**	This risk prevails across the entire region. Assessments on water temperature and river levels on discharge permits was completed at DWMP cycle one. The current risk has been assessed as moderate.	**8**	**8**	**15**	Under a benign climate change scenario, future temperature and rainfall forecasts are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. Under adverse climate change by the end of the century, we would expect increased warming and lower rainfall volumes resulting in a higher consequential cost of delivering enhancement treatment capability to more works.

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R45	Extreme events	Increased rainfall, increasing the potential for landslips, increasing the risk of damaging land, damaging assets	Contamination of reservoirs and damage to dam slopes	Region wide	Intense rainfall events (prolonged rain and increased intensity) can lead to the mobilisation of surface materials and mass transport increasing the risk of landslips. Significant landslips could result in damage to dams and contamination of raw water but also the structural integrity of the dam slopes can be threatened.	**8**	This is a risk today; this is managed through a dam safety strategy and plans.	**8**	**8**	**10**	Under a benign climate change scenario, future rainfall volumes and intensity are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk of landslip / dam slope being impacted will remain broadly similar. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also in terms of intensity. This is likely to increase the risk of significant landslip and dam slope damage.

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R46	Extreme events	Increase in likelihood and intensity of storms impacting our suppliers and causing disruptions within our supply chain	Service interruptions	Region wide	With increasingly more frequent and more extreme storms and events there is a risk that damage and site access to our supply chain partners facilities may result in shortages of key materials, expertise and chemicals. Manufacturing and storage facilities may be damaged by flooding and storms, access may be restricted or blocked due to debris / fallen trees / flood water / snow & ice.	**8**	This risk goes beyond our region of operation. While a significant part of our supply chain is from the UK some elements are international. We actively monitor our supply chain exposure, maintain strategic stock and require suppliers to have business continuity plans. This is a low likelihood risk but could be significant in consequence depending on which supply chain is impacted.	**8**	**8**	**10**	Under a benign climate change scenario, future climate trends are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk of climate induced emergencies is anticipated to remain broadly similar. However, the international nature of this risk is difficult to quantify. By the end of the century, under an adverse climate change scenario, we expect that climate induced emergencies resulting in disruption to supply chains are likely to increase as a result of more intense storms (rain and wind). Under more extreme events we expect the consequences to increase.
R47	Transitional risk	Decarbonisation in energy supply causing an unstable grid becoming common place	Power issues for our assets	Region wide	As the power generation and distribution sectors decarbonise, become more distributed and more reliant on intermittent sources there is a greater risk to disruption from changes in sources potentially resulting in service irregularities.	**8**	The risk is region wide and has been assessed as a medium risk. Power irregularities could result in failure of assets and facilities resulting in a loss of services to customers. However, there is a lot of uncertainty in this assessment given this significant shift in power generation and distribution approach and being early in the transition	**8**	**8**	**8**	The proportion of intermittent power is expected to grow over time; however, we assess this is not a climate sensitive risk, it is a transitional risk. As the technology matures to control the power quality in the grid the risk will change from one of quality to one of quantity as increased reliance is placed on intermittent generation as traditional generation sources are withdrawn.

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R48	Hotter, drier summers	Hotter, drier summers resulting in increased likelihood of reservoir misuse	Accidents	Region wide	Hotter, drier summers resulting in potentially more members of the public tempted to swim in reservoirs, resulting in accidents.	**8**	This risk already occurs in the present day and the consequences, dependent on the specific circumstances and/or severity of accident can vary.	**8**	**8**	**8**	This risk is expected to remain largely the same under all climate change scenarios and timelines; mitigating actions are already in place.
R49	Cold waves and frost	Cold waves/frost reducing the effectiveness of wastewater treatment	Failure to adequately treat wastewater and/or possible pollution events	Region wide	The incoming sewerage is generally above ambient temperatures, this is only a risk if prolonged, extreme cold weather persists.	**8**	The current risk likelihood is low, but the consequences could be significant in terms of additional cost of treatment, fines and penalties.	**8**	**8**	**4**	Under a benign pathway cold temperatures are expected to remain similar to current climates for all counties, however extreme cold waves are forecasted to reduce in frequency and duration under an adverse climate change scenario. Therefore, the risk reduces in terms of likelihood by the end of the century under an adverse climate change scenario.

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R50	Changes in seasonality	Changes in temperature causing temperature inversions in reservoirs	Taste and odour issues	Region wide	As the climate changes, prevailing weather conditions will also change. Resulting in Spring starting earlier in the year, higher summer temperatures, and later Autumns. This will result in more significant reservoir warming due to the longer time exposure. With greater warming the impact of reservoir inversion (the level of mixing) increases.	**6**	This risk is currently being observed in the present day, with inversions a risk in both Spring and Autumn as temperatures change.	**6**	**8**	**10**	The risk is expected to increase in terms of consequence by mid-century under all climate change scenarios. Lake turnover is driven largely by temperature and sunlight, as these increase under all climate change scenarios, we expect warming periods to last longer leading to more extreme stratification which could have consequences on the nutrient load and temperature distribution within the lake. This could result in poor water quality, for example more significant algal blooms and damage to the freshwater ecosystem.
R51	Hotter, drier summers	Hotter, drier summers increasing tourism on company owned land	Damage to land and catchments	Cumbria & Merseyside	With hotter and drier summers forecast we anticipate an increase in tourism numbers visiting company owned land for recreational purposes and to escape hot cities for rest bite.	**3**	The risk profile changes across the region and is informed by location and proximity to population centres. In areas of owned land with a high population in close proximity such as Cheshire, Greater Manchester and Lancashire, we expect the likelihood of land damage to be higher.	**8**	**8**	**8**	The risk is expected to increase by mid-century in terms of likelihood (number of tourists visiting), but consequences remain low.
				Cheshire, Greater Manchester & Lancashire		**4**		**10**	**10**	**10**	

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R52	Changes in seasonality	Changes in commercial activities leading to increased abstraction by other catchment users	Reduction in additional available water resources	Region wide	As the climate changes, prevailing weather conditions will also change. This has the potential to trigger different growing patterns and/or land use, for example a greater demand for agricultural irrigation. There is also a transitional risk associated with increased water demand to support hydrogen production.	**6**	Changes in seasons are forecast, with earlier springs and later winters, resulting in extended growing seasons and the potential for different land use opportunities. For example, changes in agricultural practices from pasture to agriculture.	**6**	**6**	**9**	Under a benign climate change scenario, future temperature and rainfall volumes are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, changes in seasonal weather are expected to become both more likely and more consequential.
R53	Changes in seasonality	Increased rainfall intensity and volume in winter resulting in surface run off and mobilisation of materials, risking infiltration to raw waters	Turbidity affecting raw water quality	Region wide	Intense rainfall events can lead to the mobilisation of surface materials and transport into raw water collection and storage systems. In extreme events resulting in landslips.	**6**	The risk is currently assessed as low, in part due to our activate management of catchment land to address this risk. However significant events can occur under extreme events.	**6**	**6**	**9**	Under a benign climate change scenario, future rainfall volumes are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. By the end of the century, under an adverse climate change scenario, future rainfall volumes are expected to increase, both in terms of seasonal averages in winter but also as a result of storms. As a result, we expect this risk to increase in likelihood.

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R54	Extreme events	Increases in extreme weather events, causing disruptions to telephony and IT	Impact in our ability to monitor sites and assets	Region wide	With increasingly more frequent and more extreme storms and rainfall there is a risk of disruption to communication systems as a result of loss of power, damage and flood.	**6**	The current communications networks (third party) that supply our region are generally robust to all but the most extreme events, with resilient backups available in most locations with the exception of the most rural sites. Current failures are not generally associated with climate related problems such as power disruptions associated with asset health of third party assets.	**6**	**6**	**9**	Under a benign climate change scenario, future climate trends are expected to be broadly similar to those of the current climate to the end of the century, therefore the risk of climate induced communication systems failure will remain broadly similar. By the end of the century, under an adverse climate change scenario, we expect that climate induced communications failures to increase as a result of increased storm frequency (wind and rain) impacting directly on communication system assets but also critical power supplies to these dependant assets.
R55	Changes in seasonality	Changes to agricultural practices and land use resulting from climate change negatively impacting catchments	Devaluation of assets and impact upon raw water quality and quantity	Cheshire, Cumbria & Lancashire	As a result of a changing climate, new areas of land may become viable agriculturally and existing land may be able to support more intensive agriculture. This may lead to a change in use of non-owned catchment land resulting in	**6**	There is a greater likelihood of risk in Cheshire, Cumbria and Lancashire because these are areas of greater agricultural output compared to the rest of the region. On own-catchment	**6**	**6**	**9**	Under an adverse climate change scenario, by the end of the century, the likelihood of this risk occurring increases in Cheshire, Cumbria and Lancashire. This is linked to the potential for changes in

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				Greater Manchester & Merseyside	lower quality inflows to reservoirs and use of pesticides and fertilisers, which impact raw water quality and devalue land assets.	**4**	land, this risk is largely mitigated as we are able to control agricultural practises. The greater risk is on non-owned catchment, of which the risk is higher in Greater Manchester and Cheshire, due to the large proportional of non-owned catchment land.	**4**	**4**	**4**	agricultural practises. On own-catchment land, this risk is largely mitigated as we are able to control agricultural practises. The greater risk is on non-owned catchment, of which the risk is higher in Greater Manchester and Cheshire, due to the large proportional of non-owned catchment land. Certainty is low, the introduction of ELMS may influence future agricultural direction placing more value on delivering ecosystem services rather than product,
R56	Extreme events	Increased flood risk due to higher rainfall and wet/dry cycles	Changes to liability risk, increasing insurance premiums	Region wide	Risk assessment based on company evaluation of risk exposure from the risk of flooding from rivers, sea and rainfall - dataset published by the Environment Agency	**6**	Our risk assessment is based on flood extent maps published by the Environment Agency - latest versions published from December 2023.Gross risk position is biased to wastewater assets given their proximity to water bodies and geographical positioning at the most downstream point of a drainage system.	**6**	**6**	**8**	Up until mid-century and by the end of the century, under a benign climate change scenario, there is an increase in risk but this does not result in a material change in risk category.However, under an adverse climate change scenario we can expect events to be more consequential due to forecast intensity and volumes of additional rainfall. This is a regional assessment, but there are a minority number of assets at much higher risk. Where this risk has been deemed unacceptable, mitigation action has already been deployed.

Risk Code	Causal Factor	Risk	Impact	Location	Risk narrative	ARP 4 risk score Present day scenario	Present day risk commentary	ARP 4 risk score Mid-century scenario	ARP 4 risk score End of century (+2°C or benign) scenario	ARP 4 risk score End of century (+4°C or adverse) scenario	Future risk commentary
R57	Hotter, drier summers	Lower average summer rainfall resulting in lower summer flows causing reduced aquifer recharge, leading to lower groundwater levels	Reduced source yield	Region wide	As a result of a drier climate, and with lower flows in rivers, there is a risk that aquifer systems will fail to fully recharge. Combined with a need to abstract to meet higher demands during continued dry weather, this is compounded by the ground becoming more compacted and groundwater recharge rates being further impacted.	**4**	95% of the region's supply is derived from surface water in an average year. Groundwater sources are limited; therefore, the risk is low. However areas of Cheshire are supplied by groundwater sources and given the future forecast reduction in rainfall in Cheshire, this risk is higher in this county.	**4**	**4**	**6**	C by the end of the century, under an adverse climate change scenario the likelihood of prolonged dry weather increases, increasing the risk of reduced aquifer recharge.
				Cheshire		**6**		**6**	**6**	**8**	
R58	Cold waves and frost	Cold waves/frost resulting in freeze thaw events, resulting in ground movements and damage to water networks	Leaks contributing to supply interruptions	Region wide	Freeze and then rapid thaw events can result in buried assets moving, with assets breaking and joints leaking. This can result in very high demand to be able to meet the real demand and leakage that the water production and distribution systems can be challenged to meet these demands.	**6**	Analysis of climate data (UKCP18) suggests that a similar number of very cold days (below minus 5 Celsius) can be expected across the region today. Average annual expectations are for low (less than 3 days) per year.	**6**	**6**	**4**	Climate projections indicate that there is a trend towards slightly warmer winters under a benign and adverse climate change scenario, we expect the likelihood to reduce by mid-century but not materially and stays within the same risk category. By the end of the century, with warmer winters forecasted, the likelihood reduces further. However, the consequences of these rare events could increase as assets, people, processes and systems are less frequently exposed and plans exercised.

Risk Code	Causal Factor	Risk	Impact	Location	Risk narrative	ARP 4 risk score Present day scenario	Present day risk commentary	ARP 4 risk score Mid-century scenario	ARP 4 risk score End of century (+2°C or benign) scenario	ARP 4 risk score End of century (+4°C or adverse) scenario	Future risk commentary
R59	Cold waves and frost	Cold wave/frost causing freezing of customers pipes, resulting in private leaks, supply interruptions and increased volumes of calls	Strain on our emergency response capability	Region wide	Freezing of customer supply pipes (privately owned) that tend to be shallower laid than company owned water mains, resulting in pipe bursts and blockages, causing supply interruptions and adding to high water demand. This places stresses on the supply and distribution systems and on our call centres and emergency response teams.	**6**	Analysis of climate data (UKCP18) suggests that a similar number of very cold days (below minus 5 Celsius) can be expected across the region today. Average annual expectations are for low (less than 3 days) per year.	**6**	**6**	**3**	Climate projections indicate that there is a trend towards slightly warmer winters under a benign and adverse climate change scenario, we expect the likelihood to reduce by mid-century but not materially and stays within the same risk category. By the end of the century, with warmer winters forecasted, the likelihood reduces further. However, the consequences of these rare events could increase as assets, people, processes and systems are less frequently exposed and plans exercised.
R60	Changes in seasonality	Changes in seasonal weather norms	Colleague injuries form slips, trips, and falls.	Region wide	Colleagues slips, trips and falls are observed throughout the year but are seen more frequently when the seasons are changing. For example, Autumn when leaves start to fall and become slippery after rainfall or a cold bout bringing ice/frost.	**5**	This risk has been categorised as very high likelihood but is generally very low in terms of consequences. This risk is already being observed, most accidents occur in the Autumn when personal risk perception is low.	**5**	**5**	**5**	This risk is expected to remain largely the same under all climate change scenarios and timelines. Evidence suggests that people are very quick to adjust their behaviours when their own safety is at risk.
R61	Hotter, drier summers	Increased average summer temperatures	Poor and unpleasant work environment	Region wide	Hotter, drier summers resulting in a poor and unpleasant working environment and associated impacts such as dehydration, poor concentration levels during heat increasing the risk of in accidents including when driving vehicles.	**5**	This risk has been categorised as very high likelihood but is generally very low in terms of consequences. Current practise is to issue advice to all impacted employees on how to work safely during heatwaves.	**5**	**5**	**5**	This risk is expected to remain largely the same under all climate change scenarios and timelines. Evidence suggests that seasonal campaigns are extremely effective at mitigating risks and people are effective at adjusting their behaviours when their own safety is at risk.

Risk Code	Causal Factor	Risk	Impact	Location	Risk narrative	ARP 4 risk score Present day scenario	Present day risk commentary	ARP 4 risk score Mid-century scenario	ARP 4 risk score End of century (+2°C or benign) scenario	ARP 4 risk score End of century (+4°C or adverse) scenario	Future risk commentary
R62	Extreme events	Increased severity, frequency and duration of heatwave events, causing work environments to become intolerable	Detrimental impact on the workforce	Region wide	Extreme heatwaves resulting in working conditions becoming intolerable causing a detrimental impact on the workforce, including mental health issues.	**5**	This risk has been categorised as very high likelihood but is generally very low in terms of consequences. Current practise is to issue advice to all impacted employees on how to work safely during heatwaves. Field based staff have safe systems in place to track monitor those who are lone working.	**5**	**5**	**5**	This risk is expected to remain largely the same under all climate change scenarios and timelines. Evidence suggests that seasonal campaigns are extremely effective mitigating actions.
R63	Transitional risk	Climate change mitigation and adaptation responsibilities from third parties	Pressure on our supply chain	Region wide	Changing policies, regulation and legislation to address mitigation and adaptation requirements, in response to climate change, putting pressure on our supply chain, including transport methods, access and resource availability.	**4**	This risk is region wide and relatively low risk- we have a well-established and well defined approach to engaging with suppliers, to ensure our supply chain is resilient to shocks and stresses.	**4**	**4**	**9**	Under a benign climate change scenario, future climate patterns are broadly similar to those of the current climate to the end of the century, therefore the need for third parties to take different action in relation to climate change mitigation and adaptation is expected to remain similar. By the end of the century, we expect there to be a need for third parties to act differently in their mitigation and adaptation responsibilities, so we expect this risk to increase.

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R64	Rising sea levels	Rising sea levels combined with increased abstraction resulting in the intrusion of salt water into the water table	Saline intrusion into groundwater and river intakes	Region wide	With rising sea levels and the human influence on ground water levels as a result of abstraction there is a risk that saline water may contaminate drinking water sources (ground water)	**4**	While there is a significant coast line in our region, and sea levels are forecast to increase the overall risk of contamination of ground water used for public supply is low. Ground water represents a small (<5%) of water used to supply the region.	**4**	**4**	**8**	Even under a benign climate change scenario sea levels will continue to rise, but the consequences are low due to the small amount of ground water used in the regions public supply. Under an adverse climate change scenario we could expect sea levels to rise further, increasing the likelihood of saline intrusion, especially in combination with a need to abstract more water for public supply to meet higher demands as a result of hotter and drier summers, requiring more sources of water to be developed which could be coastal aquifers.

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R65	Rising sea levels	Rising sea levels causing saline intrusion into sewers, increasing volumes requiring treatment and negatively impacting biological processes	Saline corrosion of network and process assets	Region wide	With rising sea levels and the human influence on ground water levels as a result of abstraction there is a risk that saline water may contaminate ground in which our assets are buried. Resulting in accelerated asset deterioration / corrosion and infiltration of saline water entering the waste water treatment processes which, if sufficient in volume, can inhibit microbial treatment processes.	**4**	This risk has been assessed as low risk. While we do have assets in coastal areas, we do not see significant issues reported with regard to asset health issues. Currently saline intrusion risks on waste water treatment are low	**4**	**4**	**8**	Even under a benign climate change scenario sea levels will continue to rise, but the risks to assets and infiltration are estimated to be low. Under an adverse climate change scenario we could expect sea levels to rise further, increasing the likelihood of saline intrusion (especially in combination with a need to abstract more water for public supply to meet higher demands as a result of hotter and drier summers) this will increase the risk of assets being exposed to saline environments and the potential for infiltration of saline water in sewer systems.
R66	Hotter, drier summers	Increased average summer temperatures discouraging native species and encouraging invasive species	Impact to aquatic eco-system	Region wide	Hotter summer temperatures could alter the current climatic norms from those that native species have evolved to, resulting in changes to the environmental ranges of certain species (particularly cold water species) promoting non-native species with greater environmental range.	**3**	While we may be impacted by this risk (in terms of changes to legislation), we are not the accountable organisation that directly manages this risk. There is a low confidence in this risk due to multiple compounding factors impacting upon the range of native species including water quality and flow regime of rivers, which can extend or reduced the expected range of some species.	**3**	**3**	**6**	Under a benign climate change scenario, future climate trends are forecast to be comparable to those of the current climate to the end of the century, therefore the risk remains similar to current scoring. Under an adverse climate change scenario, by the end of the century, the risk of more frequent, hotter, drier summers increases, increasing the likelihood of impacting upon the liveable ranges of native species.

Risk Code	Causal Factor	Risk	Impact	Location	Risk narrative	ARP 4 risk score Present day scenario	Present day risk commentary	ARP 4 risk score Mid-century scenario	ARP 4 risk score End of century (+2°C or benign) scenario	ARP 4 risk score End of century (+4°C or adverse) scenario	Future risk commentary
R67	Changes in seasonality	Changes in seasonality negatively impacting native species	Regulators change discharge permits/abstraction limits	Region wide	Hotter summer temperatures and altered rainfall patterns resulting in changes to environmental conditions and river flow regimes may impact the environmental ranges of certain species (land, plant, aquatic). This could result in environmental regulators enforcing changes to abstraction, compensation flows and discharge permits to as to preserve current environmental conditions.	**3**	While we may be impacted by this risk (in terms of changes to legislation), we are not the accountable organisation that directly manages this risk. There is a low confidence in this risk due to multiple compounding factors impacting upon the range of native species, resulting in uncertainty in the actual solution. The environmental regulator has already established environmental destination requirements for the water business (abstraction) which are funded via the Water Resource Management Plan.	**3**	**3**	**6**	Rainfall volumes and patterns as well as temperature trends are expected to remain broadly similar by mid-century and the end of century under a benign climate change (peak emissions by 2050). Therefore, we anticipate that the risk to native species will remain broadly similar to current risks. However, under an adverse pathway, by mid-century there are already signals that summer rainfall could on average be lower and with higher average temperatures, resulting in a material increase in risk that abstraction, compensation flows and discharge permits may be altered via regulation to protect native species.

Risk Code	Causal Factor	Risk	Impact	Location	Risk narrative	ARP 4 risk score Present day scenario	Present day risk commentary	ARP 4 risk score Mid-century scenario	ARP 4 risk score End of century (+2^{o}C or benign) scenario	ARP 4 risk score End of century (+4^{o}C or adverse) scenario	Future risk commentary
R68	Changes in seasonality	More favourable conditions for non-native species in water bodies	Increased costs of treatment and restrictions on moving 'contaminated' water from one reservoir to another	Region wide	In order to protect native species, additional treatment may be required so as to prevent cross contamination from already impacted water bodies when transferring raw water across systems.	**3**	While we may be impacted by this risk (in terms of changes to legislation), we are not the accountable organisation that directly manages this risk. For new raw water transfers the need to protect against INNS is already part of the core solution requirements.	**3**	**3**	**6**	Rainfall volumes and patterns as well as temperature trends are expected to remain broadly similar by mid-century and the end of century under a benign climate change (peak emissions by 2050). Therefore, we anticipate that the risk to the spread of non-native species will remain broadly similar to current risks (the environmental range is anticipated to remain the same as today). However, under an adverse pathway, by the end of the century we forecast that summer rainfall could on average be lower and with higher average temperatures, resulting in a change to / extension of environmental ranges that favour the spread of non-native species.

Appendix F Action Log and Monitoring

F.1 New actions

The table below is a record of the new actions committed in ARP4 and the open actions from APR3.

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	New or existing action	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced	Interdependencies with other organisations or sectors
N06	Support water trading for future UK supply demand.	We are delivering the Severn Thames Transfer (STT) Strategic Resource Options (SRO) by the Ofwat timelines, and this is included in the WRMP. This action is ongoing, it was funded as part of PR19 and commenced in 2020.	Existing (APR3)	From 2019	Current	Closer working relationship with Severn Trent. Stakeholder engagement Procurement via DPC Environmental assessments Customer acceptability Town and Country Planning process Treatment of contaminants of emerging concern (PFAS)	Severn Trent
N12	Reduce leakage by 15% reduction from PR19 performance commitment levels by 2024/25.	Met our leakage reduction target for FY2024/25, as stipulated in our Water Resources Management Plan, in line with the Environment Act 2021.	Existing (APR3)	Until 2025	Current	Reduction in leakage by 15%. Increase in supply system headroom and maintaining a positive supply/demand balance in the face of climate change and population growth.	
N19	Delivery of Wyre Natural Flood Management (NFM) project and incorporation/dissemination of lessons learnt.	ARP4 update: We are 2.5 years into 3 year delivery phase and 75% of interventions have been delivered. Performance monitoring is up and running for some of the delivered interventions and are outperforming the expected peak flow reductions ARP3 update: Agreements have been secured with all partners and the project is currently going through final contract sign off. This will then be delivered and represents a 9 year commitment to NFM in the Wyre catchment with the option of extending through to 2070. This is an innovative funding project with potential to change how this activity is delivered more broadly.	Existing (APR3)	2021-2030	Current	The project will identify the most cost-effective nature based solutions at a catchment scale, aimed at ensuring long-term flood resilience. This project has won two awards – EDIE nature and biodiversity project of the year 2023 and Water Industry Award for Natural capital project of the year 2024	Environment Agency Regional Flood & Coastal Committees (RFCC) Flood Re Wyre Borough Council Rivers Trust Wyre Rivers Trust

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	New or existing action	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced	Interdependencies with other organisations or sectors
N20	Maintain, update and deliver Natural Capital strategy with focus on delivery of greater ecosystem service benefit including climate resilience.	ARP4 update: The Natural Capital strategy in place and we are currently working to embed this. The Natural Capital corporate account has been updated and we are in the process of reviewing, including updating the Catchment Systems Thinking (CaST) strategy, which is the overarching strategy that this sits underneath. ARP3 update: Our first natural capital strategy was completed and signed off in 2020. This is currently being embedded and implemented within the business, this will be subject to regular review and development to ensure targets are met and advances in natural capital thinking are picked up and incorporated.	Existing (APR3)	2020-2050	Current	Our Natural Capital strategy has supported a better overall understanding of the key risks and opportunities for the business and has promoted a more holistic approach to managing these risks and opportunities, in a way that aligns with other organisation's needs in catchments. There is challenge being experienced as this is new, and these barriers to nature-based solutions are in our published discussion document. As part of the strategy, we are trying to break down these challenges by mainstreaming the nature based solution projects that we lead.	
AP1	Review the new (cycle 2) Drainage and Wastewater Management Plan guidance issued to understand any climate change associated requirements.	Review of the requirements of the new Drainage and Wastewater Management Plan second cycle; considering climate change and the impacts and risks posed by climate change.	New (APR4)	From 2025	Current	The Drainage and Wastewater Management Plan (DWMP) is a long-term plan, which sets out how we propose to ensure robust and resilient drainage and wastewater services for the North West. Improve understanding of the detailed impact of supply/demand changes including climate change, and influence stakeholders to support investment in preventing service deterioration.	Department for Environment, Food & Rural Affairs (DEFRA)
AP2	Convene and lead a Resilience Community of Practice event, bringing together interdependent infrastructure providers and key stakeholders in the North West.	We have an ambition to convene a Resilience Community of Practice event in 2025.	New (APR4)	2025	Current	A ‘call to arms’ to infrastructure industry leaders to encourage awareness and action of the need to adapt to climate change across the North West. To build a collective view on progress to date in adapting to climate change and our ambitious plans to increase climate resilience. To engage with key infrastructure providers, to broaden our understanding of interdependencies and to explore the potential to co-design and align projects focused on climate resilience, with the ambition of building a resilience plan for our region.	Other infrastructure providers and stakeholders based in the North West
AP3	Complete a flood risk assessment following the release of the NaFRA2 ‘Risk of flooding from rivers and sea’ and ‘Risk of flooding from surface water’ data due in Spring 2025	Identification of our assets that are at risk from flooding based on the new available data.	New (APR4)	2025-2030	Current	Understanding which of our assets are at risk of flooding and understanding the potential impact of this on the services we provide, enabling us to build targeted investment plans where applicable.	Environment Agency

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	New or existing action	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced	Interdependencies with other organisations or sectors
AP4	Track the Long Term Delivery Strategy monitoring plan	The Long Term Delivery Strategy (LTDS) is a valuable part of our integrated planning and decision making and will continually evolve. We will monitor and govern the delivery and ongoing effectiveness of our LTDS.	New (APR4)	2025-2030	Current	Adaptive and long-term planning is a continuous process that is agile and responsive to emerging developments. It is important to recognise that this monitoring plan is not exhaustive; other factors will also be considered as we review and revise our strategies. These include assumptions that do not align to particular scenarios or pathways yet influence and enable our plans.	
AP5	Review and understand the current asset standards associated with heat	Understanding the asset standards for high temperatures across our current asset base to identify potential impacts and risks.	New (APR4)	2025-2030	Current	Understanding the risk associated with heat and high temperatures and the risks to our assets.	
AP6	Improving drought resilience to 1 in 500 years by 2039, accounting for climate change	Improved drought resilience to a 1 in 500 year drought event, in line with regulatory requirements	New (APR4)	2039	Current	Subject to investment approval by regulatory bodies.	
AP7	Reducing demand for water to 110 litres per person per day by 2050	Reducing demand for water, to support water resources resilience and reduce our impact on the environment.	New (APR4)	2050	Current	Subject to investment approval by regulatory bodies.	
AP8	Increasing water resources by 25 megalitres per day by 2033	This ambition is in line with our Water Resources Management Plan 2024.	New (APR4)	2033	Current	Subject to investment approval by regulatory bodies.	

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	New or existing action	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced	Interdependencies with other organisations or sectors
AP9	Delivering <10 spills from storm overflows per year (on average) by 2050	Reduction spills from storm overflows- it is a requirement set by government for storm overflows to spill due to rainfall no more than 10 times per year on average by 2050	New (APR4)	2050	Current	Subject to investment approval by regulatory bodies.	
AP10	Delivering a 32% reduction in sewer flooding by 2030	Reducing instances of sewer flooding	New (APR4)	2030	Current	Subject to investment approval by regulatory bodies.	
AP11	Restoration of 4,764 hectares of peatland to improve water quality	Improvement of water quality currently at risk of being impacted by peatland conditions.	New (APR4)	2025-2030	Current	Subject to investment approval by regulatory bodies. We have been working hard since 2005 to improve the condition of our peatlands and our AMP8 plan targets the improvement of a further 4,764 hectares but there is still a long way to go and some of our peatland is still not in the condition we aspire it to be in.	
AP12	Investing in back-up power resilience at some of our sites vulnerable to power outages	Proactive investment against future supply issues and improved power resilience of our assets deemed to be at risk.	New (APR4)	2025-2030	Current	Subject to investment approval by regulatory bodies.	

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	New or existing action	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced	Interdependencies with other organisations or sectors
AP13	Protecting 6 assets and systems from the risk of coastal and river erosion	Protection of selected assets from coastal and river erosion	New (APR4)	2025-2030	Current	Subject to investment approval by regulatory bodies.	
AP14	Reducing sustainable abstraction by 131 megalitres per day by 2050	Reduction in sustainable abstraction	New (APR4)	2050	Current	Subject to investment approval by regulatory bodies.	
AP15	Complete the Drainage and Wastewater Management Plan second cycle and embed it into strategic planning processes	Embedment of long-term wastewater plan into strategic planning processes.	New (APR4)	From 2028	Current	Improve understanding of the detailed impact of supply/demand changes including climate change, and influence stakeholders to support investment in preventing service deterioration.	

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	New or existing action	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced	Interdependencies with other organisations or sectors
AP16	Embed the 2024 Water Resources Management Plan into strategic planning processes	Embedment of long-term water plan into strategic planning processes.	New (APR4)	From 2025	Current	Improve understanding of the detailed impact of supply/demand changes including climate change, and influence stakeholders to support investment in preventing service deterioration.	

F.2 Existing actions

The table below is a record of actions committed in previous adaptation action plans, which are now complete or embedded within company management systems.

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced
A01	Carry out 2010-2015 flood protection programme. Review flood risks for the next regulatory submission and extend to include service reservoirs.	Assets identified as 'at risk' have been protected.	2010-2015	Complete	Ensures our assets are resilient to severe flooding in the short term with emergency plans in place to prevent disruption to supply. For cost-efficiency reasons, we deferred the River Eden scheme into AMP6 to coincide with planned maintenance at this facility.
A02	Review emergency electricity supply arrangements for all key assets.	Arrangements reviewed and advice from our insurers sought with respect to implementation of additional flood mitigation measures.	2010-2015	Embedded	Ensures our assets are resilient to severe flooding in the short term with emergency plans in place to prevent disruption to supply.
A03	Carry out flood protection programme (2015 onwards) and continue resilience activities at sites at highest risk of flooding. Include service reservoirs in flood risk work and develop risk plans for all sites through asset planning.	Assessment of whether our wastewater facilities are in a flood risk zone (identified by Environment Agency flood risk maps) and as a result resilience work was identified for 5 facilities.	From 2015	Embedded	Ensures our assets are resilient to severe flooding in the short term with emergency plans in place to prevent disruption to supply. All sites categorised as at risk of flooding now have a Flood Emergency Response Plan (FERP). To safely minimize the business and environmental impact of a flood or spillage event affecting the facility and to ensure a return to normal operation as quickly as possible.
A04	Review Climate Change impact on water resources using UKCP09 and rainfall run off modelling, and review drought plan and standby sources available.	We worked with UKWIR and the Environment Agency to apply the UKCP09 projections for our WRMP14 using best-practice methods. We fully reassessed the effects of climate change on water source yields, water demand and target headroom within the revised plan. Climate change did not trigger a deficit in any of our water resource zones. Our drought plan has been reviewed and updated. It sets out actions for drought events including those significantly worse than on historic record. We are now working with UKCP18 for WRMP24.	2010-2015	Complete	Improved understanding of our climate change risk in the North West for the next WRMP. Our adaptation plan in the current WRMP, used CP02 data and focuses on utilisation of sandstone aquifer resources in the Cheshire and Merseyside area, which are generally resilient to CC. Need to review this understanding with more sophisticated methods.
A05	Reassess climate change risk on borehole Deployable Output using more sophisticated UKWIR methodology (looking at more intense rainfall events and increased evapotranspiration).	Ground water is now considered as integral part of our WRMP that uses UKCP18 data and scenarios.	2010-2015	Embedded	Improved understanding of our climate change risk in the North West for the next WRMP. Our adaptation plan in the current WRMP, used CP02 data and focuses on utilisation of sandstone aquifer resources in the Cheshire and Merseyside area, which are generally resilient to CC. Need to review this understanding with more sophisticated methods.

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced
A06	Complete 2010-2015 water treatment works (WTW) and SCaMP investment and continue to maintain WTWs and water supply catchments.	Planned water treatment quality investment and to maintain water treatment works have been completed. In addition, some water treatment works have been fitted with water quality failsafe shutdown triggers. For surface water sources these are based on a series of water quality triggers at key stages of the treatment process. For groundwater sources turbidity monitors have been installed.	2010-2015	Embedded	Improve and maintain WTW treatment processes and catchment land. Protect against future risk of increased algal growth and general low quality raw water due to higher temperatures.
A07	Understand risks for those sites without appropriate treatment capability (Algal growth and micro-organisms).	Algal blooms can necessitate the requirement for secondary treatment to reduce the occurrence of taste and odour issues. We have identified sites that have repeated circumstances of algal growth and therefore are at risk of taste and odour issues. We have installed Granular Activated Carbon (GAC) treatment at these sites, but we also use Powder Activated Carbon (PAC) as a temporary treatment option for other sites that need it on an ad hoc basis.	2010-2015	Embedded	Improve and maintain WTW treatment processes and catchment land. Protect against future risk of increased algal growth and general low quality raw water due to higher temperatures.
A08	Continue to closely monitor and review chlorine residual requirements throughout WTW to tap.	Monitoring at supply points is routinely done to meet both company and regulatory standards. A 'Site Specific Disinfection Policy' was established where chlorine treatment protocol is specified for each site, rather than having regional/catchment standards. This allows for local variations to be accounted for and titrated against. Monitoring enables appropriate treatment values to be defined and also the effectiveness to be assessed.	2010-2015	Embedded	Improve and maintain WTW treatment processes and catchment land. Protect against future risk of increased algal growth and general low quality raw water due to higher temperatures.
A09	Review risks, to identify likelihood regarding Tidal limits moving upstream and increasing salinity at intakes (e.g. constant or spring tide) and develop mitigation/adaptation measures for River Dee and River Lune intakes.	Identification of sites that have the potential to be affected by tidal intrusion.	2010-2015	Complete	Once risks of increasing tidal limits are understood mitigation and adaptation measures can be developed to ensure security of supply and prevent deterioration of raw water quality.
A10	Continue statutory 10 yearly inspections of impounding water bodies, supervising engineer reservoir inspections and maintenance programme.	Inspections have been completed as required with no significant issues arising.	2010-2015	Complete	This will improve reservoir safety and provide greater resilience to potential climate change impacts
A11	Complete programme of work to enhance spillways design to prevent damage to masonry structures during intense rainfall events.	Work to enhance spillways was completed at nine target sites.	2015-2020	Complete	This will improve reservoir safety and provide greater resilience to potential climate change impacts

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced
A12	Carry out studies on impact of climate change on increased drawdown and duration of drawdown on earth embankments. Assess measures to protect upstream face of earth dams if required.	Reviewed probability of earth slips causing overtopping. During 2015-25 we will carry out studies on the impact of climate change on increased drawdown and duration of drawdown on earth embankments and assess measures to protect upstream face of earth dams if required.	2010-2015	Complete	Improve reservoir safety if studies highlight adverse impact of climate change.
A13	Sustainable Catchment Management Programme (SCaMP) investigation into correlation between land condition and raw water quality.	The SCaMP programme includes monitoring to observe and measure the effectiveness of the intervention actions taken. Comparisons are made between locations impacted by project activity and historic data and control sites elsewhere in the region. Observed trends in colour production and delivery in stream flow are beneficial, with many SCaMP catchments showing a stationary, or else improving raw water quality, which is opposite to many untreated, un-restored upland blanket bog catchments in the UK uplands, where colour appears to be continually increasing year on year.	2010-2015	Complete	Improve and maintain WTW treatment processes. Protect against future risk of increased algal growth and general low quality raw water due to higher temperatures. Prevent issues at source through catchment management and prevent infiltration into pipelines. Maintain sufficient disinfection in the network. Seek further R&D (e.g. UKWIR)
A14	Continue to deliver catchment management activities on United Utilities owned and non-owned catchments.	During 2015-20 our focus for catchment management was on the Water Framework Directive safeguard zones which are designated areas to be carefully managed to prevent pollution and deterioration of raw water. We utilise knowledge from pilots to work in partnership on non-owned catchments to work with the variety of different stakeholders.	2010-2015	Embedded	Improve and maintain WTW treatment processes. Protect against future risk of increased algal growth and general low quality raw water due to higher temperatures. Prevent issues at source through catchment management and prevent infiltration into pipelines. Maintain sufficient disinfection in the network. Seek further R&D (e.g. UKWIR)
A15	Increase use of turbidity monitors for sites at risk of elevated turbidity as a surrogate for adverse water quality.	Turbidity adversely impacts the effectiveness of chlorine treatment with the potential consequence of residual pathogens. Turbidity measurements can therefore be correlated to water quality challenges and can be used to titrate chemical dosing for instance of coagulants.	2010-2015	Embedded	Improve and maintain WTW treatment processes. Protect against future risk of increased algal growth and general low quality raw water due to higher temperatures. Prevent issues at source through catchment management and prevent infiltration into pipelines. Maintain sufficient disinfection in the network. Seek further R&D (e.g. UKWIR)
A16	Deliver Climate Change Investment (supply and demand actions) including West-East Link pipeline and South Egremont Boreholes.	Construction of the 50km West-East Link pipeline was completed and South Egremont boreholes have been constructed.	2010-2015	Complete	Ensuring a more resilient and adaptable water supply network with integrated resources to balance supply risks arising from climate change to maintain level of service for water supply for our customers.

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced
A17	Reduce leakage by 28.4Ml/d and demand by 16Ml/d through demand management activities such as the water efficiency programme and customer metering.	We implemented a wide range of activities to encourage our customers to be more water efficient and exceeded the water efficiency targets set by Ofwat of 1 litre per property per day saving each year between 2010 & 2015. In West Cumbria where there is an urgent need to promote water efficiency, we launched a bespoke water efficiency campaign called 'Watertight.' We have maintained an extensive programme of leakage control actions and met or outperformed our regulatory target every year since 2007. We also took to the skies to in an award winning project using aerial surveys to detect leaks on rural large diameter pipes in West Cumbria.	2010-2035	Superseded	This has been superseded by the Environment Act 2021, environmental targets, which require larger reductions. Ensuring a more resilient and adaptable water supply network with integrated resources to balance supply risks arising from climate change to maintain level of service for water supply for our customers.
A18	Review WTW treatment capabilities for sites where ground water and surface water sources are blended during droughts.	Our Drought Plan sets out the actions we will take to protect water supplies should a severe drought occur. Customer acceptability of water is a fundamental consideration where blending or change of source is required.	2010-2015	Embedded	Protects against future risk of drinking water quality problems, ensuring we continue to meet drinking water standards and the aesthetic quality of drinking water expected by our customers.
A19	Continue to upsize priority sections of sewer (increase sewer network capacity) to alleviate hydraulic inadequacy and provide mitigation to customers.	We have been delivering our hydraulic flooding and unsatisfactory intermittent discharge programme 2010-15 which includes increased capacity to alleviate hydraulic inadequacy. To date we have delivered 107 DG5 flooding projects (benefitting 520 properties) at a cost of £119m. The programme for 2015-20 plans to further reduce sewer flooding. One way in which this is being implemented is by including in all projects allow for an additional 10% storm rainfall volume specifically for climate change. In PR19 we developed the Hydraulic Flood Risk Resilience measure around which we have developed a programme of interventions in AMP7 aimed at reducing flood risk at repeat flooding properties as well as conducting a review of our mitigation programme to maximise effectiveness.	2010-2015	Complete	Provide an agreed level of protection to properties against sewer flooding
A20	Investigation to enhance network models (coverage and capability). Prioritise wastewater treatment works (WwTWs) and drainage networks according to their relative exposure to the impact of climate change.	We continue to develop and maintain our regional models. Future design requirements and climate forecasting are factored into our models for long term resilience.Development of these models has continued and is being used as part of the DWMP scenario modelling, of which climate change is a key part and the Risk of Flooding in a Storm measure which tracks the percentage of the region at risk of flooding in a 1 in 50 year storm.	2010-2015	Embedded	Improve understanding of the detailed impact of supply/demand changes including climate change, and influence stakeholders to support investment in preventing service deterioration.

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced
A21	Joint working with the Environment Agency and Local Authorities on surface water management issues.	We have initiated flood partnership meetings across our region with local authorities and the Environment Agency representatives. Jointly funded solutions were considered in priority areas (for delivery in 2015-20) where it is cost effective to do so. We attend Local Resilience Forums (LRFs) with response partners including the Environment Agency, local authorities and emergency services. We developed a fully integrated hydraulic model of the entire drainage system with in the with Liverpool City Council area and worked with them to assess the interaction with our drainage systems in the catchment. We are supporting Defra working groups advising on the implementation of the Flood and Water Management Act 2010, and the encouragement of using Sustainable Drainage Systems (SuDS) on new developments now being implemented though changes to national planning guidance.	2010-2015	Embedded	Establish a framework to share data, skills and expertise.
A22	Continue with our Integrated Asset Planning (IAP) approach.	Development of our IAP with specific methodologies for identifying integrated solutions for network and treatment assets which includes the impact of climate change.	2010-2015	Embedded	Integrated Asset Planning was a new way of working within United Utilities and it can be a challenge to change. Address spatial variation in changes in rainfall patterns by targeting investment needs. Ensure holistic and sustainable solutions are progressed. Identification of integrated solution for network and treatment assets taking climate change and the risks/impacts associated into account.
A23	Sustainable drainage demonstration project.	The SuDS retrofitting demonstration project has been completed and we assessed 4 sites for possible SuDS solutions.	2010-2015	Complete	Integrated Urban Drainage (IUD) in the longer term (by 2035).
A24	Implement recommendations from the sustainable drainage demonstration project.	Creation of a £9m programme for the installation of SuDS and NFM as part of our Green Recovery submission.	2015-2020	Complete	Significantly reduce the impact of changes in storm intensity on the sewerage system. Enhancement of our systems, tools and processes when delivering BGI in partnership. An example of this, the SuDS studio tool has been further developed and to better understand future opportunities. Other schemes are our partnership with the RHS, the Ignition Project and SuDS for Schools programme.

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced
A25	Use UKCP09 scenarios to review climate change risk assessment and adaptation plans as part of on-going wastewater asset planning.	UKCP09 has been compared with the Climate Modelling Inter-comparison Project (CMIP5) published in 2014. There are differences in the model outputs in relation to summer rainfall patterns but broadly they are consistent and UKCP09 is still considered to still to provide the most a valid UK climate predictions.	2015-2020	Complete	Ensure that adaptation activities address the appropriate risks of climate change. The plan is flexible to respond in changing circumstances and formalise our actions when better information is available.
A26	Improved sewer monitoring and targeting of intervention on network to reduce service failure.	Our Wastewater network management Project considered different activities to improve how the network performs examples include sewer monitoring, remote control capability, improving asset records, and using models with accurate forecasting.	2015-2020	Embedded	Improved understanding of asset operation in response to changes in precipitation. This will inform future adaptation plans. The objectives of the project were to improve decision making as the data is available and consistent, enabling interventions at the right time and place as a result of monitoring and performance analysis and to build scenario and fact based response plans to reduce the impact on our customers if an incident occurs. In addition to our Wastewater network management our Sewerage Management Planning (SMP) modelling allows us to identify places at particular risk of flooding and enable preventive and mitigation actions. The learning from these activities has now led to the development of DNM and fed in to the DWMP.
A27	Identify sewer monitoring investment requirements for 2015-2020.	The roll out of a wider programme of in sewer monitoring in prioritised areas; This includes monitoring on Combined Sewer Overflows.	2015-2020	Complete	We have installed spill monitoring on 239 named intermittent discharges by March 2018. These discharges impact on high amenity water bodies. An additional 1800 storm discharges were fitted with event duration monitors (EDMs) by 2020.
A28	Integrated Catchment Modelling (ICM) work with the Environment Agency to identify future water quality improvements required by legislation.	Completion of ICM modelling for all high priority catchments	2015-2020	Embedded	Improved understanding of asset operation in response to changes in precipitation. Identify investment needs for 2015-2020 to achieve regulatory compliance with water quality legislation, manage the risk of reduced base flows and ensure a sustainable outcome. Surface water management activities may remove the need for CSOs. Embedded the outputs into our Integrated Asset Planning approach and Sewerage Management Plans Able and to used outcomes to inform investment plans for future water quality improvements.

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A29	Long-term surface water management activities.	We are actively involved in pursuing a more sustainable approach to surface water drainage at many levels; involvement with Defra/Department for Communities and Local Government (DCLG) on SuDS implementation, working with the Regional Flood and Coastal Committee, liaison with the Lead Local Flood Authorities and local partnerships with LAs and the Environment Agency.	2015-2020	Embedded	Support the achievement of Integrated Urban Drainage (IUD) in the longer term (by 2035). Significantly reduce the impact of changes in storm intensity on the sewerage system.
A30	Short-term surface water management activities.	We have an appropriate maintenance operating regime to ensure customer service does not deteriorate. All asset failures are logged for input to our common framework tool enabling us to predict the expected long term performance of our assets. Consequences are reviewed based on failures to obtain an updated consequences model to feed back into the system.	2015-2020	Embedded	Provide an agreed level of protection against water quality deterioration.
A31	Changes to asset design standards to - Accommodate changed usage profile; - Accommodate or withstand corrosion; and - Remove the need for recirculation.	We will continue to maintain our assets and review asset standards taking account of climate change impacts when planning over the next 25 years for instance to account for increased rainfall. Asset standards will be amended if appropriate. Asset design standards have been updated to take account of future hydraulic conditions. Appropriate hydraulic assessments are also undertaken to take account of current and future inflow compared to pumping capacity.	2015-2020	Embedded	Protect existing assets against corrosion. Ensure future design standards take account of climate change
A32	Review asset design standards against CP09 scenarios to identify unsustainable practices and amend for 2015-2020.	The network modelling team have reviewed the UKCP09 scenarios and amended asset design standards against them. We have uplifted the rainfall intensities over 25 years as projected which is in line with Environment Agency/Defra guidance.	2015-2020	Embedded	Revised asset standards have been updated to take account of climate change.
A33	Short term – increase chemical dosing into sewers and at WwTWs to prevent gas creation.	The use of chemical dosing where it is appropriate to do so.	From 2011	Embedded	Continuation of the use of chemical dosing where it is appropriate to do so.

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A34	Involvement in national work on the management of flooding from sewer to land under the Waste Regulations.	Wastewater escaping from the sewerage network is classed as controlled waste under the EU Waste Framework Directive. We have been involved in Defra working groups to advise implementation of the Flood and Water Management Act 2010 and with the Environment Agency and other parties on SuDS implementation. We continually influence implementation of the SuDS hierarchy contained in planning policy guidance yet find no right or recourse or escalation where an LPA/LLFA are non-compliant. We continue to experience numerous opportunities missed due to developer pressure and local authority apathy and can provide examples on request. It is currently envisaged that schedule 3 of FWMA 2010 may be enacted in England through the forthcoming environment bill. We continue to explore SuDS opportunities through retrofit or initiatives such as SuDS for Schools, IGNITION and the green roof pilot in Manchester.	2015-2020	Embedded	Agreement on the framework for regulating sewer discharges to land.
A35	Work with our energy supplier to identify critical sites and develop a plan to manage the risk of outages and service failure.	We work closely with Electricity North West's (ENW) to support independent resilience. We are delivering more self-generation of renewable energy. This will reduce our reliance on the grid in order to build resilience to power outages. We also have contracts set up with back-up generator suppliers for critical sites. Energy management plans for each area aim to reduce energy consumption through site specific initiatives.	2015-2020	Embedded	The benefit of this approach is that as well as reducing our carbon footprint it also supports the Governments objective to increase renewable energy generation. The challenge with our energy supply strategy is consideration of the government policy and incentives and striking a balance between affordability (need to reduce imports), reducing carbon emissions and increasing renewable generation. Reduced reliance upon continuous grid power supply builds resilience
A36	Piston effect study to investigate solutions to relieve the impact of rapid variation in inflows/dilution to WwTWs.	The piston effect is a theoretical steep increase in load caused by a "first flush" increased flow in a storm. This higher concentration may not be treatable causing permits to be exceeded. Studies on a sample of works gave mixed results. The observed piston effect varied according to site, but it was typically lower than previously estimated. Further investigation revealed that investment was not economically viable though recirculation will continue to be considered as an option for the future. In the meantime, the effect will be managed at site level.	2015-2020	Embedded	Recommendations which could mitigate risk have been identified; however, these haven't proved economically viable

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A37	Implement the investment identified by the piston effect study.	No viable investment identified.	2015-2020	Complete	No viable investment identified.
A38	Implement the investment identified by Integrated Catchment Modelling (ICM) and carryout further modelling to identify future water quality improvements in light of better information on climate impacts on base flows.	We have an evolving programme of work identified in the National Environment Programme based on the modelling outputs to deliver Water Framework Directive requirements.	2015-2020	Embedded	Should new climate predictions be issued we will review the need for further modelling on the new forecast river base flows.
A39	Short-term approach to addressing lower average peak flows.	Business as usual practice is to manage and monitor, in real-time where appropriate.	2010- 2015	Embedded	Protect existing assets against corrosion. Ensure future design standards take account of climate change.
A40	Produce an odour management plan for all sites using a risk based approach. Identify sites where there is a case for investment.	Odour management plans are in place for all appropriate wastewater treatment sites. These individual plans vary in scale and complexity, depending on the nature of the site.	2015-2020	Embedded	Manage the health, safety, environmental and customer impact of odour according to the local risk presented.
A41	Implement the investment identified by odour management plans. Review the plans and identify further investment required.	At the highest priority sites, odour control investments were delivered as part of our business plans for 2015-2020.	2010-2015	Embedded	Manage the health, safety, environmental and customer impact of odour according to the local risk presented.
A42	Continue involvement in national Research & Development work regarding changes in domestic waste disposal practices impacting dry weather flow pollutants.	In 2011 it was expected that use of domestic macerators would increasingly cause additional network issues (e.g. blockages) and nutrient load challenges. Since then, local authorities have dramatically extended their door to door food waste recycling reducing the shift towards domestic maceration. Domestic Maceration is still at a low level.	2010-2015	Embedded	Although we do not promote maceration, we recognise that there may be some benefit gained through an increase in energy production from the waste at the treatment works. However more research is required by the industry to fully understand this potential and whether the benefits outweigh the risks.
A43	Investigation/trial UV treatment of storm discharges.	A study has been undertaken on UV storm treatment of discharges however this method will not be taken forward as the Environment Agency had concerns regarding this method of treatment.	2010- 2015	Complete	Address potential septicity, odour, treatment and water quality issues resulting from increased volumes of storm water

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A44	Identify investment required in 2015-2020 for UV trial.	No longer applicable.	2015-2020	Complete	No longer applicable.
A45	Implement the investment identified by the UV trial.	Additional capacity has been delivered through developments at Shell Green and Davyhulme facilities	2015-2020	Complete	Additional capacity has been delivered through developments at Shell Green and Davyhulme facilities
A46	Produce detailed action plan identifying alternative biosolids disposal routes.	Additional incineration capacity plant was provided an alternative disposal route but has since been superseded. Detailed planning was achieved through rollout of the Regional Sludge Operational Management programme (RSOM).	2015-2020	Embedded	As Shell Green incinerator stream 3 is always operational (except for maintenance) the intake into the stream can be increased quickly should an event occur. Maintenance on the stream could become more efficient to maximise operational time.
A47	Carry out modelling work to identify land areas for sludge recycling at risk from flooding.	The land bank has been mapped against the Environment Agency Flood Map. A report was produced on flood risk, implications for the land bank and mitigation measures should flooding take place. Any loss in land bank can be absorbed and mitigated against by disposing of sludge to non-flooded areas, supported by RSOM.	2010- 2015	Embedded	Provides an alternative means of sludge disposal should the land bank for recycling be unavailable due to the impact of climate
A48	Review the type and number of insurance claims to inform work to reduce or remove the risk where appropriate.	We have continued to monitor the claims numbers and values across our assets and public liability. As our exposure through 2010 to 2014 had not increased, and this suggests our exposure had not increased. We produced 21 ‘facility resilience assessments’ for our insurers based on our high value/high risk sites from climate change impacts. These document the risk of the sites flooding.	2010- 2015	Embedded	Our action helped in making representations to the insurance market and the “watching” brief continues to keep us focused on this issue. Because of the recent floods in other areas, there may be an impact on our premiums but to date this has not been evident.
A49	Work with suppliers to help them adapt to the impacts of climate change.	We have requested carbon reduction plans from key suppliers, prioritising Network Maintenance suppliers first as they are larger contributors based on analysis of available data. In addition, we are acting to further explore with some of our key suppliers in 2022.	2010- 2015	Embedded	We do not expect a ‘one size fits all’ approach and will enter into dialogue with signatories to understand which areas of the charter apply most to them.

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A50	Identify lessons learned from previous emergency events and put measures and actions in place.	Business Continuity Plans produced for each business area stipulate arrangements for severe weather/emergency situations. Severe weather arrangements are also put in place during winter. Teams are also advised to cross-skill and document procedures and for office based staff there is now increased provision for remote working including on own devices.	2010- 2015	Embedded	Although plans are put in place it is down to each business area to a certain extent to how well they keep information up to date and have appropriate cross-skilling capacity.
A51	Work with operational delivery partners to identify potential resources for emergency events.	Business Continuity Plans are in place for each business area and stipulate arrangements for severe weather/emergency situations. These include reprioritising work, including that done by partner organisations, so that resources are effectively utilised in the circumstances.	2010- 2015	Embedded	Ensuring plans are in place for each part of the business in the event of arrangements for severe weather/emergency situations.
A52	Use study by NHS to inform actions.	The latest heat wave plans for England are obtained and advice is used to inform actions in the event of a heat wave.	2010- 2015	Embedded	Ensure colleagues are well informed around what action to take to keep themselves safe and well during a heat wave.
A53	Continue to monitor and implement health and safety policies related to hot weather risks.	UU has a belief for health and safety which aims to make UU a safer place to work; “Nothing we do is worth getting hurt for.” This applies to all of our business regardless of the nature of the work or the particular risk entailed.	2010- 2015	Embedded	Making UU a safer place to work.
A54	Minimise the impact of flooding by providing mitigation to customers.	Delivery of local bespoke solutions such as non-return valves, flood gates and doors, sump and pumps, ground re-profiling, waterproof coating and smart air bricks.	2015-2020	Embedded	Reduction of the impact of flooding.
A55	Establish Integrated Control Centre ICC.	Since 2013, we have established the Integrated Control Centre to centrally monitor, control and report on performance for both water and wastewater sides of our wholesale activities. As the wastewater network management pilots deliver enhanced monitoring and control of our wastewater system outputs will, where possible, be integrated into the ICC. The centralisation of this capability allows efficient interventions to be undertaken either remotely or efficiently scheduled in a consistent manner.	2015-2020	Embedded	The implementation of enhanced monitoring is central to our wastewater operating model.

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A56	Investigate further opportunities for Sludge treatment and use.	The land bank has been mapped against the EA Flood Map, zones 2 and 3. A report has been produced on flood risk, implications for the land bank and mitigation measures should flooding take place.	2015-2020	Complete	Flooding / saturated ground prevents access to fields
A57	Develop framework for implementation and maintenance of SuDS for new developments.	Development of framework for implementation and maintenance of SuDS for new developments.	2015-2020	Embedded	Delivery of environmental benefits and improve sewer health by slowing down rainwater run-off and mimicking natural drainage.
A58	Reduce impact of freeze/thaw events.	Installation of more insulation to water treatment works to prevent freezing (Implemented following 2010-11 winter which was the coldest since 1890).	2015	Complete	Reduction of the impact of freeze/thaw events including recovery time and minimising impact to customers.
N01	Development and delivery of our Rainwater Strategy and supporting analytics.	Promotion of alternative drainage options, and development our understanding of the effectiveness and cost implications of alternative solution across a values framework.	From 2022	Complete	Our new rainwater strategy has been developed to support our ability to manage hydraulic issues (e.g. flooding and spills) and further risks posed by climate change.
N02	Assess the impact that climate change will have on sewer flooding risk in high priority catchments.	Catchments identified through Risk Based Catchment Screening (RBCS) were assessed as part of the Baseline Risk and Vulnerability Assessments (BRAVA). Assessments were run for 2020, 2030 and 2050. Rainfall uplifts were applied for climate change for 2030 and 2050 assessments in line with 2017 UK Water Industry Research (UKWIR) uplift report which uses findings of Met Office UK Climate Projections 2009 (UKCP09) medium emissions scenario.	From 2019	Complete	Identification of the impact that climate change will have on sewer flooding risk in high priority catchments.
N03	Inclusion of latest updated climate change projections and resilience assessments into our 2019 Water Resource Management Plan (WRMP19).	We worked with UKWIR and the Environment Agency to apply the UKCP09 projections for our WRMP19 using best-practice methods. We fully reassessed the effects of climate change on water source yields, water demand and target headroom within the revised plan. Climate change did not trigger a deficit in any of our water resource zones.Our drought plan has been reviewed and updated. It sets out actions for drought events including those significantly worse than on historic record.	From 2019	Complete	Inclusion of the most up to date climate science in the Water Resources Management Plan (2019).

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N04	Inclusion of latest updated climate change projections and resilience assessments into WRMP24.	We worked with UKWIR and the Environment Agency to apply the UKCP18 projections for our WRMP24 using best-practice methods. We fully reassessed the effects of climate change on water source yields, water demand and target headroom within the revised plan. Climate change did not trigger a deficit in any of our water resource zones.	From 2024	Complete	Inclusion of the most up to date climate science in the Water Resources Management Plan (2024).
N05	Ensure drought plan is kept up to date.	Elements of the drought plan are reviewed every year through the WRMP, and drought plan annual review, and make more substantial changes in response to material change.	Annually	Embedded	Our drought plan is reviewed and updated periodically with the most up to date information.
N07	Investigation into algae DNA to develop insight into taste and odour compound formation.	Established collaborative project led by Dwr Cymru Welsh Water and Cardiff University to develop testing of environmental DNA with the aim of identifying species responsible for taste and odour compounds.	2020-2025	Complete	This is included in the Water Industry National Environment Programme (WINEP).
N10	Continue to deliver catchment management activities on United Utilities owned and non-owned catchments.	During 2020-2025 our focus for catchment management continues to be the Water Framework Directive safeguard zones which are designated areas to be carefully managed to prevent pollution and deterioration of raw water. We will build on our knowledge and experience of working in partnership on non-owned catchments to work with the variety of different stakeholders.	2020-2025	Embedded	Prevent pollution and deterioration of raw water.
N11	Pledge to restore 1000 hectares of peatland by 2030 as part of our net zero commitment.	We have carried out peatland restoration activities across the North West building on the 2,000 hectares improved through our 2005–15 SCaMP projects. By autumn 2024 over 1400 hectares were under restoration towards meeting this pledge and also the 2025 long term incentive plan target. As the result of recent surveys, we have identified a further 2,800 hectares that may be improved or protected, subject to detailed suitability assessments.	2020-2030	Complete	Climate regulation through net reduction in atmospheric greenhouse gas emissions with addition benefits to raw water quality, flood risk and biodiversity.

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N13	Influence and deliver sustainable growth and development in Greater Manchester through a trilateral partnership with the GMCA and the Environment Agency.	Formation and development of trilateral partnership, to improve flood risk resilience, enhance the environment, drive circular economy approaches and support regeneration through a series of subgroups covering: Place Based Planning; Sustainable consumption; Sustainable production/low carbon; Enhancing Natural Capital; and Resilience to climate change.	From 2021	Embedded	Improve flood risk resilience, enhance the environment, drive circular economy approaches and support regeneration.
N14	Ensure that the impact of climate change is considered in the development of the Drainage and Wastewater Management Plan (DWMP).	A number of assessments have been carried out as part of DWMP development to understand the potential risks posed by climate change. These include BRAVA of flooding and overflow performance and various resilience assessments. As part of the resilience BRAVA an assessment was carried out to understand the impact of climate change on future receiving water quality and the impact that might have on end of pipe permits.	From 2023	Embedded	Our long-term wastewater plan now considers climate change and the impacts and risks posed by climate change.
N15	Integrate climate change within the DWMP.	Climate change accounted for in Cycle 1 of our Drainage and Wastewater Management Plan. We have considered climate change within the BRAVA storm overflow performance assessment using UKCP09.	From 2023	Complete	Our long-term wastewater plan now considers climate change and the impacts and risks posed by climate change.
N16	Pilot our Dynamic Network Management approach to develop an intelligent wastewater network using artificial intelligence and machine learning.	Neural networks have been applied to vast amounts of data across the region, covering sewers, outfalls and pumping stations. The new platform identifies any deviation in expected flow, level and asset performance in correlation to the rainfall conditions. Generating alerts for performance teams when those changes are likely to cause any impact on our customers or the environment.	From 2021	Complete	This innovative monitoring approach has been developed to enable us to be more proactive in managing our drainage system.
N17	Actions to address risks (including ARP1-3 actions)	We have evolved our water demand forecasting capability utilising enriched data sources and new technology. We have worked collaboratively with the Met Office to refine and continually improve our short term data model and develop longer term forecasting, enabling us to deliver a 10-day weather dependent demand forecast.	From 2021	Complete	We have an early indicator of very short term demand, enabling us to prepare for pending high demand situations.

Risk code	Actions to address risks (including ARP1-3 actions)	Monitoring and evaluation	Implementation timetable	Status of actions	Benefits/ challenges / barriers experienced
N18	Develop our Freeze Thaw service.	In development with the Met Office, we have a Freeze Thaw model that aids our decision making process around possible outbreaks in demand as a result of the Freeze Thaw Process.	From 2021	Embedded	The model predicts out to 14 days and uses a complex scoring matrix to determine the level of risk to our business. Promotes rapid restoration of services following a freeze thaw event and limits impacts to customers.
N21	Supporting IGNITION project to develop financing mechanisms to deliver climate adaptation.	Identifying and developing new financing mechanisms for delivery of climate adaptation measures focusing on flooding and heat island. This seeks to drive far greater delivery of green infrastructure such as sustainable drainage to support climate adaptation in Greater Manchester.	2018-2020	Complete	Working with partners across Greater Manchester to develop a business model which enables investment in large scale environmental projects which delivers urban resilience to climate change.

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