CLIMATE CHANGE ADAPTATION REPORT 2015

THE QUEEN'S AWARDS FOR ENTERPRISE: SUSTAINABLE DEVELOPMENT 2015

love every drop.
anglianwater

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1 Foreword

1.1 Our climate change adaptation report comes as we embark on our new Business Plan for 2015-20. This plan has been endorsed by our customers, who also recognise that our region is vulnerable to climate change. They want us to provide services that are resilient to weather and other threats. Our report sets out what we have done to understand and address the impacts of climate change by undertaking research, investing in resilience measures and working with others in the region and beyond.

1.2 We are pleased with our adaptation progress since our first report in 2011. For example, we have invested in flood resilience at 20 water sites, reducing the risk of a loss of water supply for nearly 1.5m customers. However, many challenges remain and as this report will explain, more needs to be done to continue to adapt and ensure the resilience of the services we provide for customers and the environment:

- Continued climate science and applied research is vital, and we must understand in increasing detail how to adapt our assets to cope with future weather. This will support our capital and operational investment decision-making
- We rely on our regulators supporting the imperative to adapt to climate change and ensuring mechanisms are in place to do so. Ofwat's new Resilience Duty will help
- We have to work with others. Local Authorities and other stakeholders must have the skills and capacity to engage on matters of shared interest
- Our customers have a crucial role to play, especially in becoming ever more water efficient.

1.3 To ensure we are best placed to maintain momentum on adapting to climate change, we have refreshed our internal governance structures and updated our Climate Change Charter. We have placed an emphasis on collaboration and innovation in order to transform our business and we are challenging current thinking on, amongst other things, the future of water resource planning and abstraction reform.

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1.4 Climate change is one of the drivers behind our sustainability strategy, Love Every Drop. It's hard-wired into everything we do and how we work with customers. It helps us support growth and protect the environment. We are immensely proud to have been awarded the Queen's Award for Enterprise in the Sustainable Development category, which recognises the progress we have made in embedding sustainability in every part of our operations.

Peter Simpson, Managing Director

2 Executive summary

About us and our customers

2.1 We provide water and water recycling services to 6.3m domestic and business customers, supplying approximately 1.2 billion litres of water a day. Our area covers 27,500km^2 of mostly rural landscape in the Eastern region, nearly 20% of the land in England and Wales. As a leading company we provide excellent service to our customers, support economic growth and protect the environment.

2.2 Climate change and growth are the two biggest risks we face. We have organised ourselves to plan for and manage these risks to ensure we remain a leading company throughout the 21st Century. We are challenging the current way of delivering our essential services by seeking to innovate in partnership with others in the sector and beyond. Core to this is the delivery of our sustainability strategy called Love Every Drop.

2.3 This strategy runs throughout our Business Plan for 2015-20 which is also underpinned by the most comprehensive customer engagement work we have ever undertaken. Our plan has the highest customer approval rating of any in the country and our customers share our view that we must have long-term plans, invest in resilience to climate change impacts and that they have a vital role to play by becoming ever more water efficient. This is reflected in one of our 10 Business Plan Outcomes and one of the supporting Goals;

- **Outcome**: 'Resilient Services - Our services cope with the effect of disruptive events, in particular increasingly severe weather events. We plan ahead for the impacts of our changing climate'
- **Goal:** 'Lead and champion the effective management of the impact of growth and climate change'.

Understanding risk

2.4 We occupy a flat, low-lying region with slow moving rivers, many internationally important wetlands and 1,238km of soft coastline. These and a low rainfall make it vulnerable to the effects of climate change.

2.5 Since publishing our first adaptation report (ARP1) we have increased our understanding of the risk posed by climate change, particularly for water resource planning, flood risk, network impacts and treatment processes.

2.6 As well as developing our robust water resources plan we have undertaken collaborative research to shape the future of water resource planning across East Anglia. This is innovative in its cross-sector focus and use of Robust Decision Making (RDM).

2.7 Identifying thresholds beyond which asset performance changes remains difficult. This is partly due to a lack of relevant, good quality asset performance data that can be causally linked to weather events. Both we and UKWIR are undertaking projects to help overcome the lack of data that is holding back threshold identification. We will start an asset monitoring EngD project in late 2015.

2.8 Research has facilitated investment. Innovative sewer modelling enabled us to invest in reducing hydrogen sulphide attack in and odour from, our networks, see Case study 2.

Understanding assumptions, barriers and uncertainties

2.9 The main changes in assumptions, barriers and uncertainties have been the recent developments in the regulatory framework, for example:

- Ofwat's Resilience Duty, which will help us prepare for the impacts of climate change
- Abstraction reform, which we believe is needed to help mitigate the impacts of climate change.

2.10 Done well abstraction reform should benefit the whole of society. To help inform the UK debate we visited Australia to understand how it is implemented there, see Case study 3.

2.11 Some uncertainties will never be completely eliminated, for example the pace of climate change and the pace and location of growth. We are dealing with these uncertainties by working with stakeholders, undertaking research, developing responses for multiple scenarios and identifying no/low regret solutions.

2.12 Our ambition to invest in adaptation measures must be balanced with our other priorities and our customers' willingness to pay (WTP). In ARP1 we saw public scepticism of climate change as a barrier but this is no longer the case. While some of our customers question the validity of climate change most believe we should be taking action to enhance resilience.

2.13 Our strategic planning is based on a number of assumptions:

- We will continue to provide world-class services despite increasingly variable and extreme weather
- The Climate Change Act and other national and international commitments will remain in force
- Our customers will not accept declining levels of service or steep increases in bills
- Abstraction and discharge limits will further tighten to protect the environment
- The financing framework enables us to invest in the long-term success of the business
- Growth in the region will remain strong.

Addressing interdependencies

2.14 Interdependencies are complex to address and various factors can hinder progress, however there are also many benefits to be gained such as better preparedness and enhanced staff expertise. Some examples include:

- Investing in third party assets can deliver more cost effective adaptation solutions, see Case study 7
- Working with Local Resilience Forums (LRFs) which enhances our ability to respond and recover from incidents.

2.15 Since ARP1 our interdependencies have not changed markedly. The only significant new interdependency is the shale gas industry which we discuss in 7.

Climate Change Adaptation Report 2015
Executive summary

Adaptation action

2.16 AMP5 saw considerable adaptation progress including:

- Enhancing our water network resilience to three dry winter droughts
- Reducing the number of customers relying on a single water source by approximately 162,000
- Leading the industry by reducing leakage to 192 Ml/d, down by 19 Ml/d
- Increasing domestic water meter penetration to 77%
- Reducing Per Capita Consumption (PCC) by 12 l/d to 133 l/d
- Giving 20 water sites flood protection, benefiting nearly 1.5m customers.

Looking forward

2.17 Building on the progress we have made during AMP5, our AMP6 business plan provides for more investment in adaptation as well as work to influence abstraction reform and the future of water resource planning. For example:

- We will mitigate the risk of water supply loss for approximately 627,000 people
- We will investigate the costs and risks of a transfer from the River Trent during extended periods of dry weather
- We will continue our innovative and collaborative Water Resources East Anglia (WREA) Project
- We will actively contribute to the debate on abstraction reform to secure benefits for our customers, other stakeholders and the environment
- By the end of AMP6 we will reduce our leakage by 20 Ml/d to 172 Ml/d, which is 15% of our distribution input
- We aim to have 95% of domestic properties metered and 88% of customers with metered bills
- Our water efficiency activities will contribute to a target of reducing Per Property Consumption (PPC) of 7 l/d
- We will continue to reduce the risk of property flooding from sewers
- We will be mitigating flood risk at 12 water and 23 water recycling sites protecting service to 800,000 properties.

3 Introduction

Introduction

3.1 Our services are at the heart of every single family and community in our region, with 6.3m domestic and business customers relying on our effective and efficient services. We borrow water from the environment and treat it to world-class standards to supply 1.2 billion litres of safe drinking water every day.

3.2 Our customers return around 1 billion litres of used water to us, flushed down toilets and drains into our sewerage network. This is collected, treated and recycled to the environment through rivers and coastal outlets. Our domestic and commercial customers rely on us to safeguard their health and protect the environment in which we all live and work.

3.3 Our region covers 27,500km^2, equivalent to nearly 20% of England and Wales. It is a flat, low-lying landscape with significant areas below sea level and 1,238km of soft coastline vulnerable to erosion. This makes coastal and river flooding a significant threat.

3.4 With only two thirds of the average rainfall for England and Wales, our region is the driest in the UK. This and the presence of many nationally and internationally important wetlands makes securing future water resources a significant challenge. Climate change and growth will increase this challenge and are the biggest risks we face. We recognised these risks a long time ago and have been including climate change projections in our water resources planning for over 20 years.

3.5 Between ARP1 and this report we have seen a wide variety of extreme weather events. Many long standing records were challenged or broken including:

- December 2010 was the coldest for 100 years and the 2011-12 and 2012-13 winters were also unusually cold
- April 2010 - March 2012 was the equal driest two year period since 1910
- 2012 saw a drought and hosepipe ban by April followed immediately by exceptional rainfall from April to July
- April 2012 - July 2012 was the wettest such period in England and Wales since 1766
- In 2013 the UK experienced the third warmest July on record
- October 2013 saw extreme storms that were in the top ten most severe autumn storms to affect southern England in the last 40 years
- Between December 2013 and February 2014 there were 12 storms making this the stormiest period in 20 years
- At 372.2mm the South East and Central Southern England rainfall was the wettest two months since 1910, it was the wettest winter in England and Wales since 1766
- The period was also exceptionally mild with fewer air frosts than any winter since 1961.

3.6 Our region also saw two storm surges including the worst since 1954. Coastal erosion and damage to sea defences was widespread with significant areas of Lincolnshire and Norfolk being flooded.

3.7 Attributing weather events to climate change is an emerging science, but trend analysis shows that in line with climate projections certain weather event types are becoming more common in this country. Addressing climate change is not something we can defer to future generations. Our customers want us to plan ahead, taking action now to build resilience.

The Adaptation Reporting Power

3.8 This report broadly follows the Defra December 2013 guidance to repeat reporters and includes:

- An update on actions stated in ARP1
- Other actions that we have taken in the period 2011-15
- Work that we intend to undertake in AMP6.

3.9 To set the context for our action on climate change we have added a chapter on customer engagement, our commitment to sustainability and our approach to governance. We have also illustrated our adaptation action with case studies on:

- Stakeholder engagement
- Sewer modelling
- Abstraction reform
- Power resilience
- Integrated Drainage Strategy (IDS)
- An east coast tidal surge
- Coastal defence partnership funding.

3.10 We hope that the information in this report will make a useful contribution to the next UK Climate Change Risk Assessment (CCRA) and National Adaptation Programme (NAP).

Case study 1

Stakeholder engagement - flooding

We are a Risk Management Authority (RMA) under the Flood and Water Management Act (FWMA) 2010 and have flooding duties under the Water Industry Act 1991 (as amended). However we cannot adapt to flooding alone. Reducing its effects on us and our customers requires considerable stakeholder engagement.

Lead Local Flood Authorities

The 22 Lead Local Flood Authorities (LLFA) in our region have developed Local Flood Risk Management Strategies to reduce flood risk to their communities. We helped generate and implement these through Flood Risk Management Partnerships which include the Highways Agency, the Environment Agency (EA) and Local Authorities (LA).

We have proactively engaged with the LLFAs to identify flood and erosion defence partnership funding opportunities as they enable us to deliver our RMA duties cost effectively for our customers. We have an AMP6 partnership investment programme to reduce flood risk and combined sewer overflow events, accounting for growth.

In AMP5 we also contributed to the Anglian Flood Risk Management Plan, bringing together our region's flood risk management work and 39 Surface Water Management Plans (SWMPs). These improve a local community's and stakeholders' flood risk understanding and outline management strategies. They also inform the Surface Water Flood Maps produced by the EA in 2013, as required by the Flood Risk Regulations 2009. SWMPs are continually reviewed and we will contribute to 36 in AMP6.

Water Cycle Studies

We have contributed to those Water Cycle Studies (WCS) that our LAs have created. These are continually reviewed and we have performed a gap analysis and data validation on 50 of them. We will liaise with the LAs over the results and highlight how useful WCSs are as support for their local plans.

Drainage Strategy Framework

This joint EA and Ofwat document aims to ensure better drainage network management. We will deliver this through our catchment based IDS, Sewerage Management Plans (SMPs) and Water Recycling Centre (WRC) Asset Plans. This will require stakeholder engagement to understand the relationships between our assets and others'.

Sustainable Urban Drainage Systems

We have been deeply involved in developing national Sustainable Drainage Strategy (SuDS) standards and have produced a guide for developers and LAs. We will adopt SuDS that meet the standards set out in the guide, which requires the inclusion of climate change and flood exceedance routes in designs and calculations. We remain engaged in the debate to ensure that appropriate SuDS mechanisms are developed.

4 Governance

Introduction

4.1 To meet the demands of the 21st century we need to be forward thinking and challenge current ways working. Collaboration will be important to achieve goals we share with our customers, suppliers, regulators, emergency services, LAs and others. This will help address interdependencies, enhance customer service, and create efficiencies.

4.2 This chapter describes some of the important context for our adaptation actions. We talk about our customers and their expectations, derived from the largest consultation we have ever undertaken. Then we describe our sustainability strategy, Love Every Drop, which includes action on climate change adaptation and mitigation. Lastly we describe how we have organised ourselves internally to oversee and embed adaptation action.

Putting customers at the heart of our business

4.3 In 2012 we started our most extensive and innovative stakeholder engagement programme to understand our customers', regulators' and other stakeholders' priorities and concerns. Over 100,000 customers were emailed invitations to join the conversation and many responded, for example:

- 7,150 customers were involved in WTP research
- Over 4,800 customers responded to our Discuss, Discover, Decide consultation
- 1,000s of customers contributed to online conversations, including polls and the My 2020 Water View budget simulator.

4.4 Additional focused face to face sessions were also held. These allowed us to have detailed discussions about key issues such as climate change, growth, environmental regulation, service levels and competition.

4.5 A range of views about climate change were expressed, with concerns raised about anticipated changes in weather conditions and the likely consequences for water resources and the supply network. Some customers recommended demand reduction work to reduce pressure on dwindling water resources, such as smart-metering, community engagement to raise awareness or increasing prices to more accurately reflect the future scarcity of water. Others suggested supply resilience work such as increasing underground water storage or creating inter-regional networks to allow the sharing of UK water resources.

4.6 A few customers questioned the scientific basis for climate change and the likelihood of significant effects in the UK. Others suggested that reducing our carbon footprint will have “no measurable impact” on total emissions, advising us to concentrate instead on drought and flooding mitigation to safeguard our supply system from climate change impacts. Several customers raised concerns about our resilience without questioning the effectiveness of carbon neutral policies. Others sought reassurance about our resilience because they felt that climate change is likely to make extreme weather events more frequent. They agreed that we must prepare for more pronounced flood and drought cycles and suggested that collaborating with other regional water suppliers, energy companies and Local Planning Authorities (LPA) would help us ensure that water supply meets future demands.

4.7 Our customer engagement work was scrutinised by an independent Customer Engagement Forum (CEF). This was established in response to Ofwat's requirement for the industry to establish Customer Challenge Groups. It ensured that the development of our 2015-20 Business Plan and long-term business strategy placed our customers' and stakeholders' views and priorities at the heart of our activities.

4.8 The CEF is wholly independent from us and its membership represents the interests of household and business customers, communities, the environment and the economy. Members include representatives from the EA, Natural England (NE), Drinking Water Inspectorate (DWI) and the Consumer Council for Water (CCW). During the creation of the Business Plan the independent Chair of the CEF was Dame Yve Buckland.

4.9 The CEF established four Independent Advisory Panels to assess our understanding and implementation of our customers' and stakeholders' views in more detail. One was the Environment and Climate Change Panel which included representatives from 12 separate organisations and was chaired by Craig Bennett of the Cambridge Programme for Sustainability Leadership (CPSL).

4.10 The CEF gave its support to our Business Plan in its December 2013 report to Ofwat. This included an assurance letter from the EA which stated; *"Anglian Water has provided evidence through its Customer Engagement Forum which provides confidence in its approach to understanding the long term impacts of climate change. It has also provided details of its approach to capital maintenance. We are also reassured that an independent review has identified both these areas as being robust and leading within the water industry."*

4.11 Our Business Plan had the highest level of customer acceptability in the industry and Ofwat called our customer and stakeholder engagement "extremely good". Throughout AMP6 progress against the commitments made in our Business Plan will be monitored by the CEF.

4.12 Our customers' and the CEF's views, combined with other influences on our company, (regulator, socio-economic, environmental) helped create our 10 Business Plan Outcomes.

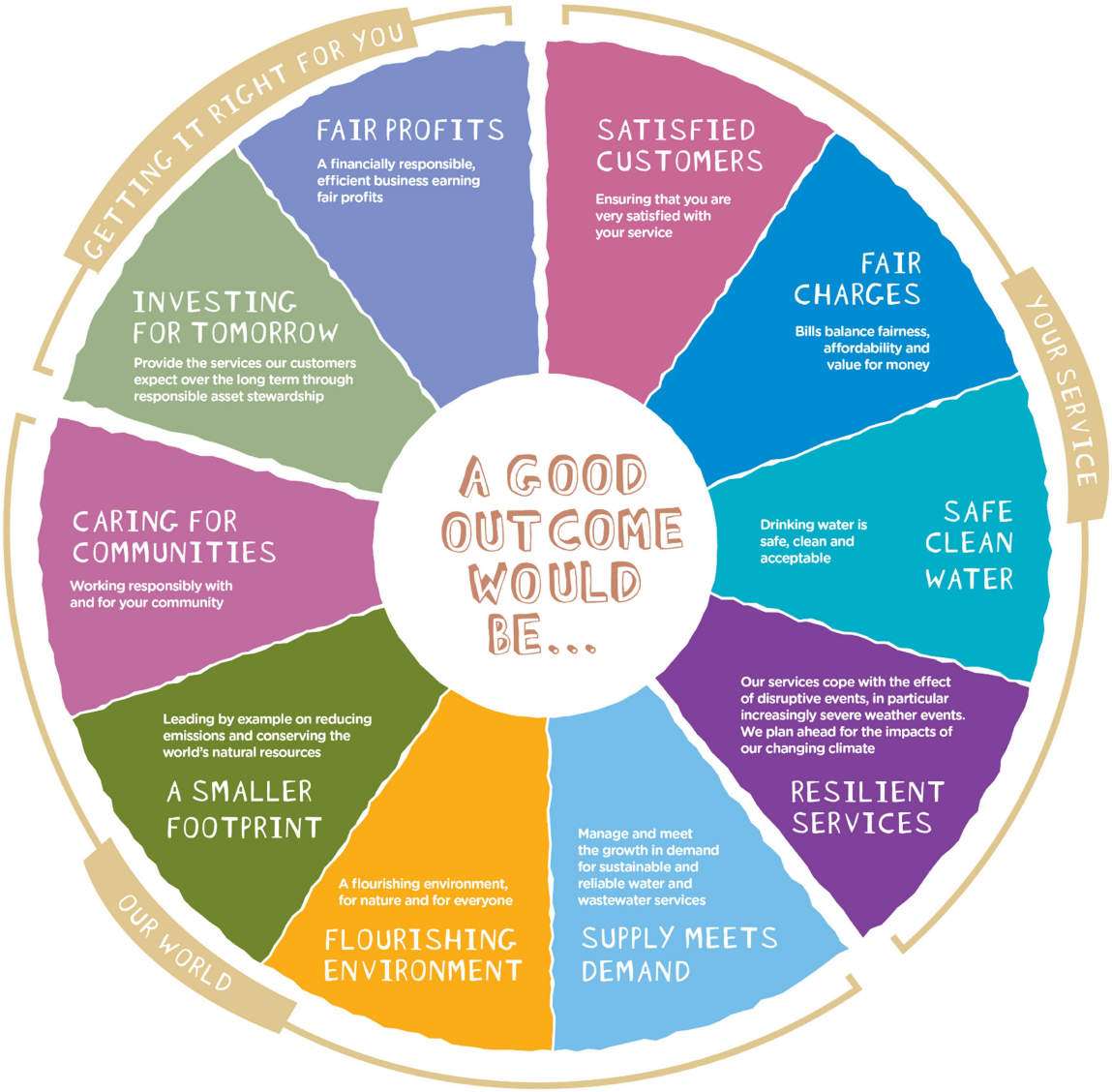
4.13 Climate change influences many of our Outcomes, but it is particularly linked to:

- Supply Meets Demand - Manage and meet the growth in demand for sustainable and reliable water and water recycling services
- Resilient Services - Our services cope with the effect of disruptive events, in particular increasingly severe weather events. We plan ahead for the impacts of our changing climate
- A Smaller Footprint - Leading by example on reducing emissions and conserving the world's natural resources.

4.14 To monitor the delivery of our Outcomes we have agreed new performance measures with Ofwat called Outcome Delivery Incentives (ODIs). We have 32 ODIs which carry financial and reputational benefits and penalties depending on our performance. They will influence how we manage the business and we are ensuring that they are used to further improve customer service and enhance the environment. 27 of these relate to climate change and 21 have the potential to be affected by its impacts.

4.15 We have also moved to considering whole-life capital and operational costs in asset management investment decisions. This is an improvement that will better enable us to make sustainable long-term investment decisions in the interests of our customers and the environment.

Picture 4.1 Our Outcomes



Love Every Drop

4.16 In 2010 we saw the need for a new kind of strategy to reshape our business for a fast-changing world. It required a global perspective which placed communities, the environment and the economy at the heart of our thinking and planning. We dispensed with traditional, introverted and incremental ways of managing our business in favour of a set of bold and far-reaching Goals. We called our new sustainability strategy Love Every Drop.

4.17 The basics of our business have not changed; providing safe, clean drinking water, protecting our environment and giving world-class customer service remain paramount. However, since 2010 Love Every Drop has fundamentally changed how we operate. It has enabled us to set even higher standards for our performance and improved our reputation. Embracing activities and campaigns involving our customers, community leaders, young people and other stakeholders has led to a better understanding of water's true value and how it supports a growing economy, flourishing environment and vibrant communities.

4.18 Before AMP6 we reviewed the Goals to ensure they are aligned with our Outcomes. Five Goals were retained in their original form, five were made more aspirational and two new ones were added. These Goals will guide the delivery of our Business Plan Outcomes, while our culture of Innovation, Collaboration and Transformation provides the solid foundation on which we will build our future.

4.19 Three of the Goals relate directly to our climate change activities and they have been made more aspirational. In line with our wish to be leading on climate change adaptation the related Goal now states that we will:

- Lead and champion the effective management of the impact of growth and climate change.

4.20 In April 2015 we were awarded the prestigious Queen's Award for Enterprise, the UK's highest accolade for business success. Our award was one of just twelve given in 2015 for Sustainable Development. It recognises the progress we have made in bringing to life our commitment to sustainability, which is at the heart of our Love Every Drop strategy.

Picture 4.2 Our Love Every Drop Goals

Climate Change Steering Group

4.21 Our Climate Change Steering Group (CCSG), formed in 2010, consists of senior staff from across the business. Its aim is to drive climate change adaptation by:

- Influencing government and the regulatory agenda
- Ensuring relevant national guidance is incorporated into our policy
- Championing the understanding of, commitment to and action on climate change
- Deriving business benefits from climate change adaptation
- Preparing us for the risks and opportunities presented by climate change
- Ensuring the incorporation of climate change adaptation into investment plans.

4.22 In 2014 we undertook a review of our organisational approach to climate change adaptation. The CCSG will now focus solely on strategic issues whilst detailed issues will be delegated to a new Technical Group. Our Regulation Director will continue to chair the CCSG, providing assurance to our management board on our adaptation progress.

4.23 Details of the action currently underway or completed can be found in Chapter 8.

Climate Change Adaptation Plan

4.24 Published in 2013 our Climate Change Adaptation Plan draws from our risk assessments, ARP1 and the water sector actions in the NAP. Delivery of the plan is overseen by the Climate Change Manager and Climate Change Advisor, with regular review by the CCSG. Its themes are:

- Embedding adaptation in decision making
- Identifying and filling gaps/uncertainties in knowledge
- Investing in adaptation
- Engagement internally, in the region and beyond.

Climate Change Charter

4.25 Our Climate Change Charter is a statement of our commitment to take action on climate change so we can continue to provide essential services to our customers, support growth and protect the environment. The charter will be relaunched in summer 2015.

Climate Change Charter

Anglian Water - leading on climate change

The services we provide and the region in which we operate will be significantly affected by climate change. Anglian Water promises to:

- Secure essential water and recycled water services, further embedding climate change mitigation and adaptation in our investment planning, capital delivery and operating strategies
- Exceed a seven percent reduction in real terms in gross operational carbon by 2020 from a 2015 baseline
- Deliver a 70% reduction in capital carbon by 2030 from a 2010 baseline
- Become the most water efficient region in the UK. We aim to reduce leakage from 195 Ml/d in 2014 to 172 Ml/d and to have 95% of homes fitted with meters by 2020. We're the first water company to achieve the Carbon Trust's Water Standard, showing our commitment to sustainably supply water to our customers
- Encourage our customers to take action on climate change. Ofwat recognised us as the industry leader in customer service (2014). We work with our 6.3m customers to encourage them to be water efficient, save energy and reduce their carbon footprint
- Maintain safe and secure water supplies to support growth in a changing climate. Between 2015 and 2020, we'll spend almost £5 billion to look after our customers' water and water recycling services, enable growth, protect the environment, and adapt to climate change. We will continue to support the Water Resources East Anglia project
- Take a leading role in understanding the benefits of and implementing water footprinting by 2020
- Work with our staff to encourage them to reduce their carbon emissions at home and at work. The fuel efficiency of vehicles fitted with telematic technology improved by 13% by mid-2014 compared to the 2013 average
- Continue to influence our supply chain to gain certification in carbon measurement, reduction and reporting
- Take a catchment management based approach in priority areas, working with farmers and other key stakeholders to improve water quality from catchment to coast and create landscapes more resilient to the impacts of climate change
- Play our part to protect and enhance species and habitats across our region. A healthy natural environment makes wildlife more resilient to climate change and can help maintain water quality. We are pledged to lead the way in managing our Sites of Special Scientific Interest (SSSIs) to ensure they are in favourable condition.

5 Understanding climate risk

Introduction

5.1 One of the challenges in adapting to climate change is a lack of understanding of the impacts of future weather on assets and processes. We started addressing this a decade ago with qualitative risk assessments undertaken by experts in the business, then moving to more objective assessments based on modelling. Our knowledge has grown, especially in areas such as flood risk, impacts on the sewerage network and implications for treatment processes. Improving our understanding of the climate risk has enabled us to include adaptation measures in our 2015-20 Business Plan. Nevertheless, as this chapter shows, continued research is necessary to inform future investment in asset resilience.

5.2 One of our priorities is to identify impact thresholds by correlating asset performance and weather data. This will enable us to identify the degree to which our treatment processes may be vulnerable to future weather.

5.3 Collaboration with others to undertake novel research and apply learning is vital to enhancing our understanding of climate risk, especially where our own risks and dependencies are impacted by others' actions.

Research

5.4 A key theme in our ARP1 was the need to understand and quantify weather and climate impacts on water industry assets. We reported on the large amount of research that we were involved in, highlighted the progress made in addressing knowledge gaps and quantifying our risks and detailed where it had influenced our adaptation work. We also noted that:

- Gaps in knowledge persist
- Assumptions remain about how climate change will occur, its impacts on assets and the identification of performance thresholds.

5.5 Research has matured, from qualitative assessments of impacts to quantifying the links between asset performance and the impacts of current and future weather.

5.6 Summarised below is a selection of projects illustrating the research direction and progress. A full list of on-going, planned and completed research can be seen in Table 11.1.

UKWIR

Climate change implications for water treatment and waste water treatment

5.7 In 2010-11 two parallel UKWIR projects were completed:

- 'Climate Change Implications for Water Treatment'. This assessed the impacts on catchment water quality, the implications for Water Treatment Works (WTW) processes and developed a framework for adaptation
- 'Climate Change Implications for Wastewater Treatment'. This assessed the climate change impacts on the quantity and quality of wastewater in networks and at WRCs, the effect on treatment processes and identified options for adaptation.

5.8 Both projects made best use of real-world weather-related asset performance data, existing models and climate change scenarios to provide current asset performance responses, asset design thresholds and performance tipping points. These were then used to generate a quantified framework for 'no or low-regrets' sustainable asset adaptation.

5.9 These projects were a significant step forward in our understanding of the impacts of climate change on our assets.

Practical methodologies for monitoring and responding to the impacts of climate change on industry treatment processes

5.10 Building on the work outlined above, this project helped the industry understand what asset data it should collect. Its aim was to provide a mechanism by which critical climate-sensitive treatment process thresholds may be established, monitored, assessed and used for investment planning. It reviewed existing asset monitoring data, identified parameters to measure, identified monitoring options and locations, sought to describe trends and provided information to allow the development of critical asset performance thresholds.

5.11 The key parameters recommended for monitoring were:

- Water treatment (primary parameters) - river flows for abstractions, raw water quality (organic carbon, colour, turbidity, Chlorophyll a and conductivity) and final water quality
- Water treatment (secondary parameters) - coagulant usage, backwash frequency, chlorine usage and trihalomethanes
- Water recycling (primary parameters) - flow (network and arriving at a treatment works), temperature (ambient) and receiving water flows (quantity)
- Water recycling (secondary parameters) - sulphide concentration, spill events and duration, screening overload events, primary sludge production, activated sludge plant blower energy demand and effluent quality.

5.12 We now have a good understanding of the asset data we have and the asset data gaps we need to fill. This knowledge underpins our asset monitoring project (see below).

Planning for, and responding to, the mean and extremes of weather

5.13 Starting in 2014 and finishing in June 2015 this project gained a better understanding of how the impacts of average and extreme weather could be measured. It established weather/asset performance relationships using current and historic weather data.

5.14 The project's objectives were to:

- Establish quantifiable links between extreme weather events and their impact on operations and assets
- Establish hypotheses for causal relationships between measured performance and current and/or antecedent weather
- Test hypotheses and produce algorithms to predict how weather will impact performance.

5.15 These causal relationships can be used to develop a better understanding of how weather affects our work, allowing the use of short-term weather forecast predictions in the planning of routine operational activities.

Our projects

5.16 In addition to the valuable work done through UKWIR we have also carried out our own research, focusing on issues that are of particular importance to us.

Septicity project

5.17 As our region is very rural and low-lying we have long retention times for used water in our sewerage network. It can become septic, producing odour, corroding pipes and affecting WRC performance, a problem that UKWIR research predicts will worsen. This project enhanced our ability to predict and resolve septicity problems. Case study 2 outlines the project and shows how modelling led to capital investment to improve our network.

Weather impacts on networks

5.18 We worked with the Met Office to understand how weather impacted sewer flooding during 2012-13. In that period parts of our region saw up to 200% more monthly rainfall than recorded since 1912. Analysis showed that antecedent rainfall, leading to waterlogged soils, was a significant factor in the majority of sewer flooding incidents in this period.

5.19 These findings have given us valuable new insights into how our sewerage networks and their catchments operate in exceptional weather conditions. The knowledge supports our new catchment based, partnership-led approach to sewerage network planning. Our IDS and the associated SMPs and sewerage supply/demand work will be able to use this information to design strategies and solutions for dealing with customer and environmental flooding. Details on these processes can be seen in Chapter 8.

5.20 We also researched the impact of weather on water main bursts. We knew these could be caused when soils freeze in winter but we found a new correlation with soil moisture deficit and soil wetting in autumn. The main peak of bursts is usually in winter, with a secondary peak in autumn. however due to the extreme weather of recent years the autumn peaks for 2008-12 were greater than the winter peaks of 2005-8.

5.21 This has improved our leakage investment planning and repair response. We are better able to analyse the failure risks of our water mains due to the soil type that they are laid in and to be more proactive in scheduling staff for leakage detection and reactive repair.

Asset monitoring project

5.22 This project is subject to a STREAM funding application with a planned start in the 2015-16 academic year. It will draw on UKWIR research and our risk assessments to build on the outputs from the UKWIR mean and extreme project. It will:

- Design and carry out monitoring strategies for weather-impacted assets which we deem a high investment priority
- Establish quantifiable links between extreme weather events and their impact on operations and assets
- Establish hypotheses for causal relationships between measured performance and current and/or antecedent weather
- Test hypotheses and produce algorithms to predict how weather will impact performance
- Make adaptation recommendations where appropriate.

Case study 2

WATS modelling for managing septic conditions in sewerage networks

Septicity in sewers and at our WRCs causes problems including odour and reduced efficiency of the treatment processes. This can affect our services to our customers, result in odour abatement notices and can require costly investment solutions.

Our 2010 climate change risk analysis identified that septic conditions in sewers could worsen significantly under the temperature and rainfall scenarios for our region. In response our Climate Change Advisor and Innovation Team developed an investigation proposal and work with Aalborg University (Denmark) began in January 2013.

Current weather and system performance data (including sulphide concentration) was used to build a detailed baseline model of the Wisbech sewerage network and West Walton WRC which could predict the location and severity of septic conditions.

Model runs were also carried out using flow and temperature data derived from the UKCP09 Low, Medium and High emission scenarios to project future network performance. The baseline and projected septicity data scenarios were then run though existing odour modelling software (Odalog) providing us with maps of current and future odour footprints. Examples of these outputs can be seen in Picture 4.2.

The baseline model and projected scenarios give us the ability to test and optimise strategies to address the current septicity and odour issues, whilst allowing us to ensure that investment solutions have the flexibility to deal with climate change.

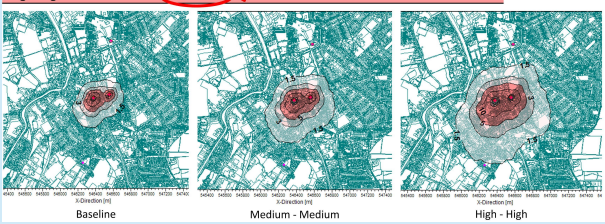
Picture 5.1 Example climate scenario outputs

Odour dispersal for climate scenarios

Climate scenario	Area (m^2)	Perimeter (m)
Baseline	58041	1021
Medium-Medium	109595	1273
High-High	197337	1664

+88%

+240%



Baseline | Medium - Medium | High - High

Pipe Corrosion for climate scenarios

	As is	Low-Low	Medium-medium	High-high
> 1 % of wall thickness per year	891 m	1,130 m	1,444 m	1,830 m
> 2 % of wall thickness per year	437 m	541 m	719 m	942 m
> 4 % of wall thickness per year	121 m	209 m	285 m	410 m

+21% +38% +51%

Construction of this model has demonstrated the concepts and techniques. The model was not available in time to influence our AMP6 Business Plan, however its outputs were used to influence two AMP5 odour reduction investments in the Wisbech catchment.

The next step will be to implement the WATS model approach on three further septicity-prone catchments. This will allow us to judge its wider applicability, develop in house expertise and better assess and seek improvements in its cost/benefit.

Protecting our biodiversity

5.23 We are responsible for 47 SSSIs covering nearly 3000Ha of land. Using NE's National Biodiversity Climate Change Vulnerability Model we assessed the ways in which our sites are vulnerable to climate change. The most vulnerable sites were ones threatened by sea-level rise. Fragmentation is also an important factor for some sites such as Pitsford Reservoir SSSI and Grafham Reservoir SSSI.

5.24 We will use NE's Climate Change Adaptation Manual (CCAM) to develop strategies for adapting our SSSIs to climate change. We will do this in consultation with local stakeholders this year when we refresh our Biodiversity Action Plan to align it with Biodiversity 2020.

Water resources

Water Resources Management Plan 2015

5.25 Rainfall in most of our supply area is significantly lower than the national average. We are classed as an area of severe water stress and our region has a large number of sites of national and international importance for wildlife, many of which are wetlands. There is concern about our ability to secure water in the long-term to supply a growing population whilst continuing to protect the environment.

5.26 The objectives of our Water Resources Management Plan 2015 (WRMP15) are to maintain the balance between supply and demand over the next 25 years while dealing with the challenges of population growth, climate change and environmental needs. The plan followed EA, Defra and Ofwat guidelines which state that, for climate change, a range of UKCP09 scenarios should be used to:

- Assess the impacts on the supply/demand balance
- Include a direct assessment of impact on both sources and demand
- Take account of the uncertainties associated with estimating the impacts on supply and demand when assessing headroom uncertainty.

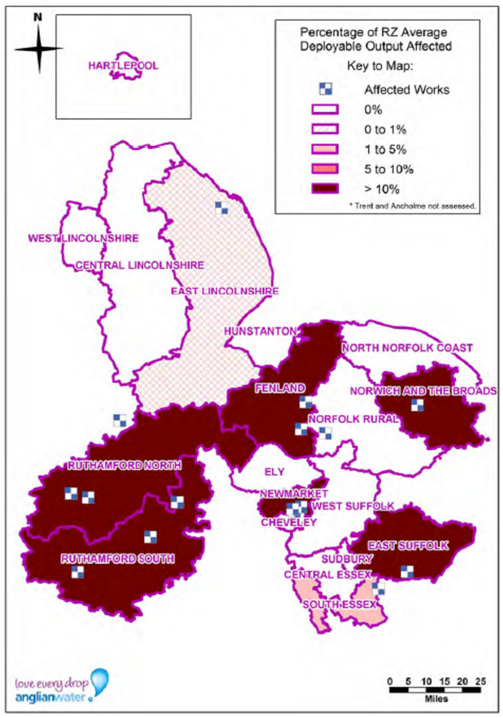
5.27 In line with the guidance our assessment had three stages. First we defined resource zones as having low, medium or high vulnerability to climate impacts. This then determined what further assessments any resource zone should have. We decided to exceed the guidance by carrying out comprehensive climate change assessments of all sources.

5.28 The next step of our assessment included a review of the UKCP09 projections by HR Wallingford. A sub-set of 100 monthly climate change perturbation factors were produced for precipitation and temperature for the 2030's. The indications were that the future will be drier, with a general decrease in precipitation and increase in potential evapotranspiration.

5.29 The perturbation factors generated were then used in stage three of the assessment which involved detailed modelling to determine the impact on yield for all of our sources. This indicated that:

- Groundwater resources are predicted to be highly resilient to climate change
- Reservoirs and direct supply intakes show greater vulnerability to climate change with consequential impacts on yield
- The most likely reduction in deployable output in 2039-40 is 12.7 Ml/d (154 Ml/d worst case) in WRMP10 it was 0 M/l/d (117 Ml/d worst case)
- The impact on demand by 2039-40 will be around +1% for household and +2% for non-household demand.

Picture 5.2 Worst case impact



5.30 When the impacts of climate change are combined with the impacts of growth and changing environmental needs, driven by the Water Framework Directive (WFD) and Habitats Directive, the impact over the period out to 2040 gives a worst case reduction of 567 Ml/d. This is roughly 50% of the water we put into supply in 2012-13. In addition we will have to manage risks from drought, deteriorating raw water quality and the impacts of cold and dry weather on our distribution system and customer supply pipes.

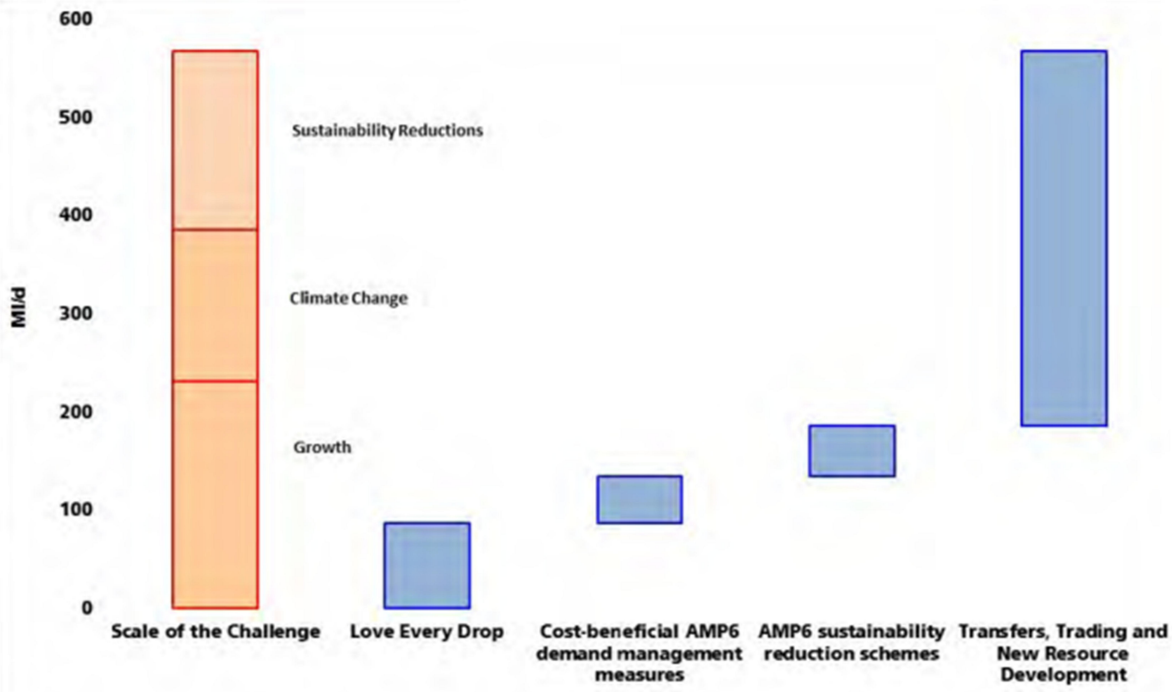
5.31 Whilst our customers recognise these challenges they have told us that they do not expect to see any severe restrictions on supplies and that they are willing to pay to avoid them. They think that we should be planning ahead, taking action now to build resilience and prevent problems in the future.

5.32 To address this our WRMP15 is flexible and adaptive, committing us to reduce leakage and consumption by at least 139 Ml/d, increase the volume of water we trade and transfer resources from areas of surplus to areas of deficit. All of the preferred options included in WRMP15 were subjected to a climate change vulnerability assessment and details of these can be seen in our WMRP15 at www.anglianwater.co.uk.

Water Resources East Anglia project

5.33 Detailed modelling in our WRMP15 gave us confidence that we can meet our customers needs, support growth and protect the environment. However, there is still a residual risk of not meeting our long-term future supply/demand needs. To manage this we are undertaking the innovative Water Resources East Anglia (WREA) project running across AMP5-6. It aims to develop a reliable, sustainable and affordable supply system in our region that is resilient to the effects of multi-season drought despite deep uncertainty in climate change and population growth scenarios. It follows work with the National Drought Management Group and projects with the Cambridge Institute for Sustainability Leadership. WREA is highly collaborative bringing together water companies, the EA, NE and others. We believe that future water resource planning must be cross-sectoral, working with other stakeholders is vital.

Picture 5.3 Defecit reduction strategy



5.34 We will examine climate change and population forecasts in the 2080s and use innovative approaches to supply/demand planning, including multi-criteria search and RDM[1]. These and other planning tools will help develop flexible and adaptive plans that perform robustly in most plausible future scenarios, rather than optimally in a few.

5.35 WREA recommendations could include winter storage reservoirs, aquifer storage and recovery, water reuse and strategic raw or treated water transfers. Together with our commitment to manage demand and increase water trading, this will deliver a sustainable and affordable balance between the future needs of customers and the environment.

5.36 Where opportunities exist for water companies and others to pool supply/demand risk, we should move from company-only Water Resources Management Plans (WRMP) and Drought Plans. Multi-company/sector strategies and plans could allow costs and benefits to be shared. Changes in the wider water sector are likely to be needed so we will work with regulators to improve current WRMP legislation and guidance.

Drought planning

5.37 There have been four major droughts since privatisation; 1988-92, 1995-97, 2005-06 and 2011-12. During this period we invested £160m to make our services more resilient to droughts, including transfer schemes to improve distribution system connectivity, additional treatment capacity and new boreholes helping maximise the use of existing abstraction licences. ARP1 detailed £63m of this as planned AMP5 investment, see Chapter 8.

5.38 Since AMP4 we have been exploring the consequences of a third successive dry winter and investing in mitigation measures. The 2011-12 drought highlighted the importance of this work. We are building on the experience and lessons learned from this drought, and in particular we are challenging current thinking on drought resilience, including on the risks

1 RDM is an alternative to traditional predict and provide decision-making processes for situations with deep uncertainty. It is used to find the best possible strategy to fit a range of plausible future scenarios.

associated with three dry winters. To understand the impacts of long-term, multi-season droughts on our water supply system, two projects were undertaken in AMP5 to assess the vulnerability of water resources in our region.

5.39 Building on previous work with the EA and United Utilities, the Severe Drought Project used hindcasting regression methods to compile rainfall records across the region for the last 200 years. Time series of river flows and groundwater levels at various locations were then synthesised. The results showed a decrease in mean long-term summer rainfall and an increase in winter rainfall over time, with significant drought events in some parts of our region in the early part of the 19th century. More work is planned for AMP6 to determine the significance of these results.

5.40 Yield assessments of our groundwater and surface water sources for WRMP15 showed that the future climate will be drier, with a general decrease in precipitation and an increase in potential evapotranspiration. Surface water yields show a decreasing trend for reservoirs and direct intakes. The latter has a larger range in yield results due to the lack of storage in the system. A sub-sample of 20 UKCP09 scenarios was generated for groundwater, using recharge indicators and adjusted climate series. We worked with the EA using their regional groundwater model to assess the impacts of each scenario. Only five drought vulnerable groundwater sources in Norfolk and Suffolk showed a loss of deployable output.

5.41 The conclusions of these projects and the WRMP15 and WREA project work show that there is still more to do on building resilience to a three dry winter drought. In AMP6 we will invest in further research and supply/demand solutions including the option to carry out further assessment of the Trent to Ruthamford transfer scheme detailed in our WRMP15. AMP6 investment details can be seen in Chapter 8 and Table 11.5.

Innovative plans

5.42 In addition to the WREA project there are a number of other projects that we have initiated over the last five years to help us develop more flexible water resource management systems. These include:

- A right to water, February 2011 - A review of abstraction regime reform options to make it more flexible and better suited for dealing with the short, medium and long-term needs of all abstractors
- Institute of Grocery Distributors drought crisis scenario workshop, April 2012 - We worked with regulators and stakeholders from the food and drink sector to develop strategies for mitigating the impact of the 2011-12 drought
- Global water challenge, thought leadership workshop, May 2012 - We hosted this to share strategic thinking and best practice for the future management of water resources in our region. A key objective was to develop ideas to achieve long-term behaviour and attitude change
- Research into water allocation through effective water trading, December 2012 - Development and testing of a pilot market based multi-sector water resource trading approach for the upper Ouse catchment. This was a collaboration with the CPSL and involved extensive stakeholder engagement
- Sink or swim: a multi-sector collaboration on water asset investment, June 2014 - The report examines new water strategies recognising the value of water to different sectors. Working collectively with other sectors to finance new water infrastructure is the most efficient way to reduce both short and long-term risks to water security. This was a collaboration with the CPSL

- Markets, water shares and drought: lessons from Australia, December 2014 - Research into how the Abstraction Reform in Australia has affected public water suppliers, see Case study 3
- The Wissey catchment multi-sector water resource planning pilot, ongoing - This follows on from the above project working with abstractors in the Wissey catchment to develop a framework for using the catchment's resources more effectively. It aims to examine trading opportunities, the infrastructure to support these and the costs and benefits of demand management measures, additional storage and supply-side capacity
- The Suffolk holistic water management pilot project, ongoing - With a wider scope than the above pilot this will examine the opportunities for developing WRMPs that meet supply/demand, water quality and flood related needs. Its stakeholders include ourselves, Essex and Suffolk Water, LAs, the EA, Internal Drainage Boards (IDB), wildlife groups and local abstractors.

Case study 3

Abstraction reform

Climate change and population growth raises concerns over future water scarcity in the UK. Modelling by the EA shows that by 2050 there may be insufficient water to fulfil licenced demands and meet environmental requirements. The current abstraction management system is not sufficiently flexible to cope in an increasingly challenging future when efficient water allocation will be critical.

In designing reform options, Defra has drawn on Australian abstraction reform experiences, including the introduction of water markets which permit trading between abstractors. There is, however, very little research describing how the Australian reforms have affected Public Water Supply (PWS) and how it operates within a shares-based system (different abstractors taking a proportion of the water available instead of a right to a fixed volume).

To contribute to the reform debate, our Strategy and Policy Analyst spent a month in Australia working with public water suppliers, government departments, regulators and others to understand experiences and impacts of reform from a PWS perspective. The findings were published in *Markets, water shares and drought: lessons from Australia* and shared with water companies, Ofwat, Defra, businesses and agricultural leaders.

Successful reform of the current allocation system will benefit society, whilst failure to reform could result in environmental degradation and act as a barrier to economic growth. Reform will be especially important in our region which, as one of the driest and fastest growing in the UK, is particularly vulnerable to climate change impacts.

The report's recommendations to create a more sustainable and responsible water abstraction regime include:

- Ensuring the EA has sufficient catchment monitoring and metering of abstractions in place prior to implementing reform
- The current system of abstraction management should be reformed proactively in anticipation of reduced water availability in the future
- Reform options should be designed to facilitate trading
- While no sector should be prioritised during ‘normal’ conditions, water for essential domestic use should continue to be prioritised during an emergency situation
- Reform options should be trialled carefully prior to implementation
- Abstractors should be engaged in the transition to the new system through catchment-based committees.

6 Understanding assumptions, barriers and uncertainties

Introduction

6.1 Barriers to adaptation include gaps in knowledge that require research, and uncertainties where a lack of precision hampers decision making. Both of these require us to make assumptions in order to make progress. Over time our knowledge has grown and the focus has shifted from gaining a broad understanding of climate change and raising awareness, within and beyond our company, to understanding specific climate change impacts on assets and processes in increasing detail.

6.2 In ARP1 a table highlighted a number of assumptions, barriers and uncertainties that were affecting or could affect our ability to deliver successful adaptation to climate change. For this report we have updated and simplified the table by:

- Removing the subdivision of the issues into external and internal knowledge gaps and regulatory and societal issues
- Showing actions taken or planned for previously listed issues
- Adding lines for new issues identified over the last five years.

6.3 The following sections give more detail on certain key issues and our current progress on addressing them. A full summary of our action for all of the assumptions, barriers and uncertainties that we have identified can be seen in Table 11.2.

Regulatory change

6.4 In ARP1 we made the assumption that the regulatory regime in place at the time would continue to be so. However as we knew that this would not be the case we highlighted a number of the more significant issues in the report and ensured that our plans and governance and review processes retained the flexibility to accommodate them if necessary.

6.5 For this report we have taken the same approach and the following sections give some detail on recent and proposed regulatory changes that we believe have the potential to influence our adaptation aspirations.

Ofwat Resilience Duty

6.6 The Government made an explicit commitment in the Water White Paper to ensuring that the long-term priorities for the water sector and the water environment are properly reflected in regulatory decision-making. The Water Act 2014 gave Ofwat a primary duty 'to secure the long-term resilience of water undertakers' supply systems and sewerage undertakers' sewerage systems as regards environmental pressures, population growth and changes in consumer behaviour'. The intention is for the duty to have a broad scope, based on the Government's view that a healthy and sustainable water environment is absolutely essential to the long-term resilience of water and sewerage services.

6.7 The Resilience Duty was drafted to ensure that the environmental pressures driven by a changing climate, coupled with population growth and behaviour change, are explicitly reflected in regulatory policies and decisions. It will support existing guidance, for example on water resources planning.

6.8 Ofwat has established a Resilience Task Force, which includes our Regulation Director amongst others from the sector and beyond, to help shape the Resilience Duty.

Market reform and competition

6.9 Market reform and increased competition were mentioned in our ARP1 as having the potential to have significant impact on the regulatory landscape within which we operate, particularly the incentives for and focus on addressing the risks of climate change. We are now further down the route and competition in the water industry continues to develop as does our understanding of its potential influences.

6.10 Currently the two primary sources of competition are those that were in place during the period of ARP1; new appointments and variations and the Water Supply Licensing regime. However in December 2011, Defra published its Water White Paper which set out the Government's reform proposals for the water industry in England and Wales. These proposals included extending retail competition to cover all eligible business customers and both water and sewerage retail services.

6.11 In 2014 Ofwat's Price Review and the Water Act revisions provided a platform for major changes in AMP7-8 to enable competition to emerge in various elements of the supply chain. The market for the provision of retail services to business customers will open in April 2017 and is expected to function similarly to the business retail market for water and sewerage services which has operated in Scotland since 2008.

6.12 The Water Act has also introduced provisions for upstream competition, which could lead to new entrants entering the market to provide new sources of water. It is also intended to facilitate the trading of water between water companies. This is expected to be put in place after 2019 alongside changes to the abstraction regime.

6.13 These two new elements of competition, along with abstraction reform, will affect all water companies in the UK. We have therefore been very active in engaging with our regulators and other stakeholders to understand and contribute to the debate on the most appropriate format for this to take. Some of the key issues being discussed are:

- Which elements of the upstream market are most likely to be opened up to competition?
- How may a "system operator" or "single buyer" model evolve?
- The risk of asset stranding
- What access pricing frameworks may look like
- Impacts of different approaches to abstraction reform on water supply
- The possibility of multi-stakeholder financing for assets.

Abstraction reform

6.14 The government is committed to reforming the abstraction regime, because there is concern that it is not able to cope with the pressures that climate change and population growth are expected to put on water resource availability. The aims are to:

- Promote resilient economic growth while protecting the environment in a manner which is fair and adaptable to future uncertainty at a reasonable cost
- Provide greater certainty for abstractors, by defining upfront what would happen if there is a decline in the aggregate water available for abstraction.

6.15 In their consultation[1] Defra proposed two reform options. The first evolves the current system of water licences (Current System Plus). The the second (Water Shares) is a more significant change, redefining water rights as a share of the water available for abstraction, as opposed to a maximum volumetric quantity. Both systems include measures to encourage permanent and temporary water trading, but Water Shares would make more trades possible. More recently, Defra has committed to consider a potential 'hybrid' of these options.

6.16 We support abstraction reform and believe that done correctly, it will enhance supply-side resilience to the benefit of all water users. Case study 3 on the experience of reform in Australia is one example of how we are engaging and informing the debate.

Evidence base

6.17 The probabilistic nature of the climate projections and gaps in the available weather and asset performance datasets pose a challenge when it comes to developing business cases for adaptation investment.

6.18 As indicated in our ARP1 natural climate variability, modelling uncertainty and the future emissions path continue to hinder decision making. However our ability to accommodate these factors has been improved by a number of research projects over the last five years as has the adoption of tools such as scenario planning and RDM.

6.19 It is primarily the absence of and gaps in datasets about weather-related asset performance that are impeding adaptation work. Much work is being done to overcome this issue, but data and research-related issues remain. Details are in Chapter 5, Table 11.1 and Table 11.2.

1 Making the Most of Every Drop

7 Addressing interdependencies

Introduction

7.1 We cannot successfully adapt to climate change in isolation. We are dependent on the performance of others to enable us to deliver resilient services. Likewise many organisations are dependent on our services for their functions. Such organisations were characterised as our interdependencies in our ARP1.

7.2 Our interdependencies include a wide range of organisations and activities, for example:

- Power companies - we need reliable power, they need a reliable water supply and water recycling services
- Other water companies - we are co-dependent on each other for water transfers and mutual aid agreements
- Suppliers - for example we need reliable chemical supplies, they need a reliable water supply (including process water) and water recycling services
- Regulators - we need a regime that allows appropriate investment in our services, they need data and a reliable water supply and water recycling services. We are co-dependent for flood defence and the provision of drainage services.

7.3 Our interdependencies list from ARP1 has remained largely unaltered with only two additions, the shale gas industry and the emergency services.

7.4 Shale gas exploitation in our region poses a number of challenges. It will require large amounts of water, thus increasing pressure on water resources. Drilling locations and methods must prevent groundwater contamination. Used process water will need treatment before its return to the environment and we may be asked to provide this service. The Infrastructure Act made water companies statutory consultees for shale gas proposals allowing us early awareness of plans and greater influence during planning application assessment.

7.5 We work with the emergency services on resilience planning and emergency response. As members of LRFs we work together to formulate, test and deliver multi-agency responses to emergencies. It is important we understand the members' roles and responsibilities to ensure that we can depend on each other when needed.

7.6 New dependencies have also been added, mostly due to a deeper understanding of previously identified relationships. For a full list of our interdependencies see Table 11.3.

Picture 7.1 Working with others to enhance our resilience

Progress

7.7 The nature of interdependencies is such that a significant failure on either side could lead to cascade effects producing deeper and more widespread impacts. This makes the addressing of interdependencies critical to the success of our adaptation efforts.

7.8 Interdependencies are complex to address, as much of the action necessary needs to be taken by or with stakeholders. Working collaboratively with other organisations can prove to be a challenge as adaptation action can be hindered if there are mis-matches in organisational priorities, staff capacity, finance, expertise and regulatory frameworks.

7.9 Collaboration can however deliver significant benefits including:

- Shared costs, as can be seen in Case study 7
- Better understanding of specific risks, such as our power resilience (Case study 4)
- Enhanced in-house expertise through working with other sectors
- Greater preparedness through, for example, joint planning exercises with LRFs
- More influence on regulation, policy and strategy creation, for example our WREA work (Chapter 5).

7.10 We are very active in effectively managing our interdependencies as it is a key area of adaptation. Actions include AMP5-6 asset resilience investment, delivering our sustainability strategy, collaborative research and development and customer engagement.

7.11 The paragraphs below detail some of the key actions that we have taken to address a number of our most important interdependencies. Further detail on actions taken to deal with stakeholder-specific dependencies can be seen in Table 11.3.

7.12 One of our most significant interdependencies is our need for power to provide our services. In Case study 4 we describe how we worked with the power distribution companies to enhance our understanding of our power resilience and how this work will support future investment.

7.13 We are dependent on third party flood defences to protect our assets. In the past we were unable to provide funding to maintain third party assets that we rely on, even if this was the most cost-effective solution. This changed during AMP5 and as a result we have allocated resources to fund third party defences during AMP6, including £3m for coastal defences at Clacton-on-Sea (see Case study 7).

7.14 As a RMA we play a significant role, alongside others, in protecting homes and businesses from flooding. Flood management is particularly complex requiring close coordination of all stakeholders (see Case study 1). We have supported efforts to secure partnership funding, allocated over £8m of investment to reduce flood risk and combined sewer overflow events, and have helped develop national standards for SuDS.

7.15 It has become increasingly apparent that farmers and other land managers play an important role in protecting water resources to deliver WFD compliance and to protect natural capital. Consequently our capacity to deliver catchment management work by influencing them has grown accordingly.

Regulators

7.16 Ofwat is our economic regulator and through the price review process has considerable influence on our ability to invest in adaptation. The most recent price review introduced an outcome-based and whole-life cost approach to regulation. In addition Oftwat now has a primary duty to secure resilience in the water sector. It is imperative that these regulatory changes facilitate appropriate cost-beneficial climate change adaptation investment.

7.17 The EA regulates our abstraction licences and our permits to discharge back to the environment. Their environmental monitoring and modelling is vital to generate the evidence which guides the regulatory framework. They also play a significant role in flood risk management upon which we depend.

Addressing interdependencies

7.18 NE has been active in furthering our understanding of the risks of climate change to the natural environment. In 2014 it published its CCAM and a GIS-based climate change vulnerability model. We have used these to begin to understand the impacts of climate change on our 47 SSSIs. We also sit on the National Adaptation Programme Biodiversity and Ecosystems Working Group to provide a link between the water sector and other stakeholders.

7.19 Natural capital and ecosystem services have become areas of significant interest with the potential to affect how we are regulated. As a sector we are undertaking research to grow our understanding and as a company we are represented on the Prince's Accounting for Sustainability Project which includes work on natural capital valuation. This will help us engage with our regulators and influence policy.

Case study 4

Improving our power resilience

We have always recognised the need for a reliable power supply to our water treatment, water recycling and support processes. It is vital to the provision of the excellent services that our customers expect and rely on.

To understand our customers' attitude to power resilience we included the issue of power supply reliability in our AMP6 Business Plan stakeholder research and engagement. This showed that householders and businesses understood that a stable power supply is core to the reliable delivery of our services, and that they believed that we should act to ensure its security. There was support for preventative action, long-term planning to build resilience and working in partnership with the power sector to ensure the continued delivery of our services to a high standard while keeping bills affordable.

We therefore undertook work to assess the resilience of our internal and external power supplies and the resilience measures already in place. Working with Ofgem, National Grid and the Distribution Network Operators (DNOs) we improved our understanding of power failure risks. Ofgem provided information on the level of risk posed by an inability to balance supply and demand, National Grid informed us of risks to the high voltage transmission network and DNOs did the same for the local distribution network. The DNOs took part in joint emergency planning exercises and helped us to understand the physical supply routes to our sites, the failure modes and risks and how to mitigate these. All data was validated against our data and by experts in the utility industries.

At the time of this project we had over 6,500 sites and we experienced about 100 electricity supply failures a month. Most of these were of short duration and due to the design of our sites there were no impacts on customers or the environment. Although interruptions lasting more than a few hours are rare they can have a significant impact if a back-up supply is not available.

Using Ofwat's nine principles and the risk-based resilience planning approach in UKWIR's Good Practice Guide the project assessed all of the sites across our Anglian and Hartlepool regions. This identified sites particularly vulnerable to longer duration interruptions with a more detailed resilience assessment being carried out for those without sufficient back-up generation.

This vital work will support power resilience investment in AMP6 and beyond. In line with the ‘all-hazards approach' on site investment will also be given protection against flooding where appropriate.

8 Adaptation action

Introduction

8.1 Our AMP5 Business Plan considered climate change more than any before it. It was incorporated into water resources and water supply/demand investment business cases and there were a number of investment programmes directly aimed at improving the climate resilience of our services.

8.2 We went further for AMP6 by ensuring that climate change adaptation consideration was an integral part of the governance and business case creation process. Over 200 business cases were reviewed to gauge their relevance to adaptation, resulting in 30 that explicitly considered climate change adaptation within their planning and solution selection.

8.3 This section covers the they key adaptation investment that we have made since ARP1 and our aims for the AMP6 period. It contains information on:

- Key investments made as part of our AMP5 programme
- Significant items of preparatory work for AMP6
- Key actions planned for AMP6
- Important work undertaken outside of the AMP programme.

8.4 More detail on our actions can be seen in Table 11.4 and Table 11.5.

Water supply/demand

Supply resilience

8.5 AMP5 modelling showed that some customer supplies could be at risk if a WTW were to fail catastrophically and some cases supply could be lost for unacceptable lengths of time. During AMP5 we undertook investment to improve the resilience of supply zones served by single WTWs with dependent populations of 50,000 or more. As a result schemes for Barrow and West Pinchbeck WTWs have benefited around 162,000 customers. A further scheme for Grafham WTW has been started, but the benefits to more than 450,000 customers will not be delivered until 2016-17 in AMP6.

8.6 In addition to our AMP5 funded resilience work a response to the 2010-12 drought was to start constructing an eight Ml/d transfer from the Lincoln supply system to Saltersford WTW. This will be completed in AMP6 increasing the resilience of supplies for over 25,000 customers in Grantham.

8.7 Although the AMP5 Final Determination did not approve funding for the Newton WTW resilience scheme it did grant it for a new Hall WTW to meet growth in demand. We are now assessing how to integrate this with our future resilience needs.

8.8 The drought, along with concerns about the impacts of climate change and population growth, increased the industry's and the Government's focus on:

- Promoting supply-system connectivity to increase resilience and more flexible and efficient use of available water resources
- Integrating water resource, drought and resilience planning.

8.9 A key objective of Ofwat's market reform proposals (see Chapter 6) is a more flexible and efficient use of water resources and their work shows that this will require increased connectivity.

8.10 Market reform will necessitate greater cross-company and cross-sector integration of water resource planning and drought planning to deliver long-term outcomes. This may increase the cost/benefit of individual schemes enabling us to make our water resources and our supply system more resilient.

8.11 In the run up to AMP6 our customers stated that they are willing to pay to avoid severe water restrictions in their lifetime and that they expect us to build resilience in our system.

8.12 Our AMP6 Business Plan commits us to increase the resilience of our supply system for around 627,000 customers. This will comprise the 476,000 customers from the Saltersford and Grafham schemes as well as approximately 151,000 more from schemes to be identified in AMP6.

8.13 All together our AMP5 and AMP6 work will protect more than 789,000 customers.

Drought

8.14 In AMP5 we spent £63m on schemes to mitigate supply/demand risk from the 2010-12 drought. Key investments included securing new groundwater sources, a river augmentation main and booster pumps, Rutland Water refill schemes and network pressure management. In addition a new central Lincolnshire trunk main was also installed and we spent £29m on enhancing leakage detection and reduction. Work is continuing on installing a link main between Hannington and Pitsford and improving the drought resilience of the Marham and Stoke Ferry surface water sources and the Postwick and Pulloxhill groundwater sources.

8.15 Our drought resilience investment to date has helped ensure the security of the majority of our customers' supplies. Groundwater sources (approximately 50% of our supply) are secure against a multi-season drought, but our surface water resources still require additional resilience planning and investment.

8.16 The drought ended with heavy rainfall in spring 2012. However, contingency planning showed that a continued drought would have led to a 150-200 Ml/d supply shortfall. Approximately 685,000 households in our Ruthamford resource zone would have had a non-essential use ban with a high risk of rota cuts and stand-pipes.

8.17 We recognise that our customers regard extreme supply restrictions as unacceptable. A review of our emergency plans also showed that their widespread use would be impractical. Following recent EA guidance, we are assessing the impact of removing these options from our plans. To improve levels of service in this way will require significant investment.

8.18 To mitigate the risk in our Ruthamford supply zone we are proposing a transfer from the River Trent during extended periods of dry weather. This would move raw water into the catchments of the River Great Ouse and the Welland allowing storage levels in our Rutland and Grafham reservoirs to be supported during a future three dry winter event.

8.19 We are undertaking detailed design work to fully understand the costs and risks in AMP6. Any related assets would be delivered from AMP7 onwards.

Catchment management

8.20 In AMP5 we carried out a catchment management study to improve our understanding of the raw water quality issues we face. We liaised with landowners and other stakeholders to identify hazards and pathways, assess risk, collect data, raise awareness and influence behaviours. We then carried out monitoring and modelling to assess if catchment measures provide an alternative to traditional water treatment. This informed our AMP6 approach.

8.21 Our catchment management work will be significantly expanded in AMP6. Five catchment advisors are now in post, with the work aimed at preventing the deterioration of raw water quality as required under the WFD. Many of the catchment management interventions will also enhance the resilience of the natural environment upon which we depend for the sustainable delivery of our services. An example is the installation of buffer strips which can slow the flow of water into a river and reduce the runoff of pollutants. This can mitigate the risk of flooding and raw water deterioration caused by severe storms which are projected to become more frequent in the future. Catchment management will help to protect natural capital resources such as soil and biodiversity, protecting the region's environment and enhancing the sustainability of the agriculture sector.

Leakage reduction

8.22 Our planned AMP5 leakage policy was initially aligned with Ofwat's Sustainable Economic Level of Leakage methodology. This is the leakage level below which it is cheaper to secure new water supplies than to further reduce leakage. Our plan was primarily focused on the repair of leaks identified by the public and proactively detecting and repairing hidden leaks not visible at the surface.

8.23 In response to the drought of 2011-12, following on from the preceding harsh winters, we undertook a full review of our current and longer-term leakage plans. We decided to enhance our plan as this would bring it more in line with our customers' views that leakage reduction was a top priority. This would put us in a better position to cope with climate change and growth, and would send the right message to our customers who have a role to play in delivering water efficiency.

8.24 To achieve this we directed a large proportion of our drought investment into leakage control. We recruited 62 leakage detection technicians and increased our partners' detection and repair resources, reducing the leak fixing response time to hours rather than days. We also embarked on a large programme of works to proactively manage the pressure in our network. This reduced our leakage to 192 Ml/d, 19 Ml/d below our Ofwat target.

8.25 The success of this initiative informed our plans for AMP6. We have set ourselves the most ambitious leakage reduction plan in the industry. By the end of AMP6 we will reduce our leakage by 20 Ml/d to 172 Ml/d, which is 15% of our distribution input. Subject to feasibility and customer support our long-term strategy is to further reduce this to less than 10% (93 Ml/d) by 2040.

8.26 We will achieve this through a combination of:

- Finding and repairing visible leaks
- The detection and repair of hidden leaks
- Pressure management of the network
- Targeted renewal of the network.

Pressure management

8.27 Calming the water network to minimise pressure changes allows the network to be run more efficiently with fewer interruptions to customers' supplies, lower leakage and a more consistent supply for customers than traditional pumped or gravity water distribution systems. We refer to these controlled networks as being 'pressure managed'.

8.28 During AMP5 the Optimised Water Networks initiative changed the way pressure management was planned and implemented. The operation and maintenance of 495 existing assets were reviewed and a further 62 pressure management assets were installed resulting in a cumulative distribution input reduction of 23.9 Ml/d due to reduced leakage and open tap consumption. In addition to the resilience benefits, the reductions in distribution input and bursts reduced operating costs by £2.3m in AMP5.

8.29 In AMP6 there will be further investment in network calming equipment to increase the area of pressure managed network from 24% to 50%. This will reduce distribution input by 40 Ml/d, leakage by 13 Ml/d and the number of burst mains by 1800.

Metering

8.30 We are committed to metering as the fairest way to charge for water usage and it is a core component of our demand management strategy. We install meters in all new properties and by customer request. We also undertake Enhanced Metering. We know our customers support this policy, but that they are not in favour of compulsory metering.

8.31 Enhanced Metering is targeted at water supply zones with supply/demand deficits in the short to medium term. It involves installing a meter at all domestic properties and providing water efficiency advice to show customers how to reduce their water and energy bills. They can then decide whether to switch to a metered bill. If the customer does not switch billing becomes automatically metered on change of ownership.

8.32 During AMP5 we installed just over 300,000 domestic meters. The percentage of properties metered in our region rose to 85% and customers using a meter grew from 66% to 77%. This included a smart meter trial at Colchester which indicated the potential significant water efficiency savings and leakage reductions. However, the cost-benefit case for investment was marginal.

8.33 Therefore in AMP6 we will extend our smart meter trial to Newmarket. This will allow us to gain a more robust understanding of the benefits of smart metering as well a more detailed assessment of the cost-effectiveness.

8.34 We intend to reach 95% of properties metered and 88% of customers with metered bills by 2020. Our long-term aim is to reach full domestic meter penetration by 2035.

8.35 Our AMP5 demand management actions helped to reduce our customers' PCC[(1)] by 12 l/h/d from 145 l/h/d to 133 l/h/d.

8.36 In 2012-13 we started to measure water use as PPC and at the end of AMP5 this was 310 l/d. PPC performance is one of our AMP6 ODIs and our commitment is to reduce it by seven l/d.

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1 The PCC and PPC figures quoted in this report are weighted averages. These are calculated by weighting the PCC or PPC figures for the number of individual metered and un-metered customers/properties attributed to them and then combining them.

8.37 These reductions also benefit the environment as well as our customers' bills. Reduced demand lowers the volume of current and future water abstraction, reduces the volume of used water to be recycled and minimises the amount of future water and water recycling investment necessary to maintain service levels in the face of climate change.

Water efficiency

8.38 Our WRMP15 shows that achieving water efficiency savings is a vital part of our water demand management strategy. Our water efficiency programme is delivered alongside our metering and leakage reduction work helping us to engage with customers. Showing them that we are serious about reducing leakage encourages them to play their part too.

8.39 Working with our customers to help them become more water efficient is a key part of our Love Every Drop ethos. In the 2010-12 drought we launched our Drop 20 campaign encouraging them to reduce their water use by 20 l/p/d. This contributed to cumulative saving of 60 Ml/d during the drought.

8.40 Throughout AMP5 we also:

- Exceeded our target of 87,500 free water audits and water saving product installations at domestic properties achieving average savings of 46 l/d
- Worked closely with partners, including the Royal Horticultural Society and the Energy Saving Trust, to raise awareness.

8.41 We collaborated with Green Energy Options to design, produce and supply 11,300 in-house displays to customers with smart meters. These show people how much water they are using and let them set a 'water budget'. Our aim was to help them reduce their consumption and save money on their water and electricity bills. A survey of 450 participants found an average four percent drop in use of nine l/p/d. In-house displays are available for tracking electricity and gas use, but this was an innovative development in the water industry. It won us the ENDS Green Economy Award for Water Efficiency, which is supported by DECC.

8.42 Over AMP5 our water efficiency measures contributed to the reduction of daily PCC from 145 l/d to 133 l/d. We have out-performed the cumulative AMP5 Base Level of Water Efficiency (BSWE) Target of 9.6 Ml/d by 0.95 Ml/d, and our cumulative AMP5 Sustainable level of Water Efficiency (SELWE) target of 2.6 Ml/d by 1.96 Ml/d.

8.43 Our Bits and Bobs water saving programme also won The Water Industry Achievement Award for the Customer Satisfaction Initiative of the Year in 2015.

8.44 In AMP6 our water efficiency activities will contribute to the ODI target of reducing PPC by seven l/d. It is intended that our Bits and Bobs programme will deliver water savings of eight to nine Ml/d towards this by the end of the period.

8.45 Our planned water efficiency activities include:

- Undertaking 120,000 Bits and Bobs audits and retrofit efficiency products
- Providing 48,000 Drop 20 Water Check-up visits when customers request a water meter
- Continuing our online Potting Shed Garden Club offering garden kits and advice to save water in the garden
- Supplying customers with comparison water consumption data within their communities

- Working with partner organisations and communities to help change behaviour through innovative solutions such as gamification
- Working with developers and planners to ensure that future homes are water efficient
- Continuing to work with schools, students and teachers to educate our future home owners about the value of water.

Sewerage supply/demand

8.46 Sewerage supply/demand planning addresses the risks of flooding and pollution from new development, climate change and urban creep (a rise in paved areas adding surface water to sewers). Our AMP5 investment ensured that we maintained our service levels to our customers and helped us to prepare for future challenges. It mainly focused on mitigating flood risk from new development and improving our discharges into watercourses. Our plans for new developments are based on modelled predicted flooding, however investment to mitigate the impacts of urban creep and other causes of flooding is more reactive.

8.47 A recent Ofwat study concluded that climate change, new development and urban creep could combine to increase flooding from sewers by 50% by 2050. To address this risk we will develop new tools to accurately predict flooding and develop a long-term plan to prevent it. This will enable us to identify future risks and the optimum mitigation solutions.

8.48 We have commissioned studies to better understand our risk of future flooding across the region and set targets for future performance. An example is determining how climate change and sea level rise will change the risk of tide locking at outfalls. We are also taking an in depth look at four catchments to identify the optimum mix of sewer enhancements and SuDS with a long term view on implementation.

Sewerage Management Plans

8.49 During AMP6 we will create SMPs for all of our sewerage catchments. These will work with our IDS to align our asset planning process with the Drainage Strategy Framework (DSF) and Defra's expectations for long-term sewerage planning. As part of this we will be increase the coverage of our hydraulic models to 100% of our sewerage network.

8.50 SMPs will be core to the continued evolution of our partnership working approach with stakeholders such as LLFAs, the EA and LAs. They will give us an overview of the current and future risks and issues within catchments, including growth and climate change.

8.51 They will be used to inform operational and investment decisions for our assets such as property flooding solutions, network maintenance and customer engagement campaigns like Keep It Clear.

Integrated Drainage Strategy

8.52 Defra expects water and sewerage companies to understand how their networks currently perform and how they interact with other drainage systems, so that they can effectively manage future pressures.

8.53 To ensure this Ofwat and the EA developed the DSF, which outlines some of the key principles and expectations for the development of long term plans. A key aim of this is to ensure better working together (both internally and externally) to manage drainage networks.

8.54 To deliver the DSF we have developed our IDS which pulls together our SMPs and WRC asset plans. It will also enable us to meet our FWMA duty to co-operate and share information with others.

Case study 5

Integrated Drainage Strategy

The IDS helps deliver our business outcomes by taking a holistic view of the risks and opportunities. It informs customers of our intended investment strategy within a sewerage catchment and its receiving WRC.

The IDS is based upon the six guiding principles of the DSF; Partnership, Managing Uncertainty, Managing Risk, Whole Life Costs and Benefits, Live Processes, Innovation and Sustainability. These are also embedded in our Risk, Opportunities and Value based investment management process enabling us to deliver minimum regret solutions that are resilient to change. In turn this drives our Water Recycling Long-Term Plan (WRLTP) for growth in our region and aids future business planning.

Through close relationships to the Asset Plans, the IDS identifies the short (zero to five years), medium (six to 10 years) and long-term (11 to 25 years) risks and opportunities. All proposed investments are reviewed as part of our investment planning process and consider climate change and urban creep scenarios.

The IDS will:

- Include a catchment description and map illustrating principal drainage
- Describe related company aims and outcomes
- Summarise wider catchment drainage issues, their relation to our assets and the organisations consulted
- Describe and quantify any pressures in the catchment that will affect the achievement of our outcomes
- Describe how the pressures identified would influence predicted future performance measures, including the rate of change over time and uncertainties
- Describe feasible alternative investment strategies, considering the perspectives of customers and other organisations
- Explain the selection of a preferred strategy with plans, time lines and images
- Explain how the delivery progress of the IDS and the achievement of outcomes will be monitored and reported.

During AMP5 we developed and tested our first IDS in Norwich where lots of new development is planned. This received positive feedback from LAs and the EA and its creation aided long-term thinking on how we serve these developments. It has enabled us to take an even more strategic approach and helped us identify work required in early AMP6 to allow us to profile catchment risk and test scenarios. The results of this work will feed into the IDS and our WRLTP.

The IDS will be rolled out across our region during AMP6, initially focusing on catchments and WRCs vulnerable to, for example growth, flooding or environmental issues.

Flood protection

Protecting properties from sewer flooding

8.55 In ARP1 we stated that our network modelling used the results of a Met Office project on the impacts of climate change on storm intensities and return frequencies. Throughout AMP5 we worked to improve our knowledge and the use of climate change data in this area (see Chapter 5 and Table 11.1). In line with Defra guidance we now routinely include the use of climate change rainfall scenarios in our network and solution modelling for addressing property flooding from sewers.

8.56 During AMP5 exceptional weather events and data collection and handling improvements added new properties to our flood risk registers. In the same period we:

- Alleviated flooding for 201 properties at high risk of internal flooding (risk of flooding twice in 10 years)
- Alleviated flooding for 53 properties at low risk of internal flooding (risk of flooding once in 10 years)
- Alleviated flooding at 309 properties at risk of external flooding (at risk of flooding at least once in 20 years)
- Mitigated flooding for 216 properties at high and low risk of internal flooding
- Mitigated flooding for 140 properties at risk of external flooding.

8.57 As Table 11.4 shows the above investment work has reduced the number of properties at high risk of internal flooding, but the extreme weather has more than counteracted our investment in the other categories. Investment in our network will continue in AMP6.

8.58 Throughout AMP5 we were very active in the development of SuDS standards and guidance. In 2011 we published our SuDS Adoption Manual which provided design guidance to developers. This informed them of the minimum standards that we would require their SuDS to meet before we would adopt them. We also carried out SuDS pilots at two locations.

8.59 We created a full SuDS solution in Drayton (Cambridgeshire) to reduce and slow the flow of water to the existing drainage system. Five infiltration basins in public open spaces capture rainwater allowing it to infiltrate into the ground. If these fill a new permeable footpath channels excess flows down to a wetland area and pond. This exceedence route ensures that the system is resilient to extreme rainfall and future changes in rainfall patterns.

8.60 In Ipswich (Suffolk) a SuDS park was integrated into a more traditional flood alleviation scheme. This will intercept and attenuate the surface water flows from the local road network, removing them from the sewerage network.

8.61 In December 2014 the government confirmed that LPAs would implement SuDS through the planning process. Defra and DCLG also confirmed that the previously developed guidance would be converted into non-statutory planning guidance.

8.62 During AMP5 we developed our understanding of how the response of our networks to weather events relates to the responses of other organisations' assets and the wider catchments in which they sit. This lead to the development of our new IDS which brings together our asset planning and maintenance activities and our customer behaviour influencing and stakeholder engagement. This will be fully implemented in AMP6 and further details can be found in Case study 5.

8.63 In AMP6 we will continue to reduce the risk of property flooding from sewers, through alleviation and mitigation investment. Our strategy is to:

- Provide one in 30 year protection for a number of properties at risk of internal and external flooding
- Consider lower levels of, or less certain protection for properties where one in 30 year protection is not cost beneficial (for AMP7 delivery)
- Implement a policy to fully integrate the consideration of SuDS alongside traditional solutions in our investment decisions
- Continue working with developers to manage the risk of surface water flooding in new developments through SuDS.

8.64 Any SuDS proposals must meet our design manual criteria and where developers wish us to adopt them we expect to see climate change and flood exceedance routes included in their designs and calculations.

We will also continue to work on improving both the climate change scenarios that we use in our hydraulic modelling and our understanding of how best to apply them and their outputs. For further detail on the AMP5 and AMP6 investments see Table 11.4 and Table 11.5.

Keep It Clear

8.65 The disposal of Fats, Oils and Greases (FOG) into our network in combination with unflushables (sanitary products, wipes etc.) creates sewer blockages and flow restrictions in our sewers. These can lead to customer flooding, discharges into watercourses and increased pumping costs. Each year we clear around 30,000 blockages, more than half of which are attributable to the accumulation of FOG and unflushables. This costs us over £7m and it is estimated that there are 20,000 tonnes of FOG in our network at any one time.

8.66 Climate change will increase the variability of rainfall, affecting the seasonality, intensity and duration of wet and dry weather. This will exacerbate the current challenges that we already face from FOG and unflushables.

8.67 Keep It Clear is our campaign to influence our customers' attitudes and behaviours towards discarding FOG and unflushables. We are preventing the causes of blockages by working with local community and volunteer groups to deliver innovative customer engagement projects and tailored mail drops. This is aimed at raising customer awareness of the issues that blockages can cause in their local area and encouraging them to make long-term changes such as recycling cooking oil and binning their wipes and sanitary waste.

8.68 The pilot campaign launched in Peterborough in 2011 has achieved a sustained 80% reduction in FOG and unflushables-related blockages. A further 22 target areas run in AMP5 covered 210,000 homes and have shown average blockage reductions of 44%.

8.69 We are also undertaking work with BSI, ISO, retailers, manufactures, Business In The Community and the Water UK Sewerage Network Abuse Partnership to further raise unflushables awareness. Currently an ISO technical flushability specification is being developed with manufacturers, retailers and the water industry globally. A representative from Anglian Water chairs the BSI mirror committee feeding into the ISO specification.

8.70 In AMP6 we intend to expand our Keep It Clear campaign. We will add a further three campaign areas to our existing 23 and increase our efforts to further drive down the level of avoidable sewer blockages.

8.71 In addition to focusing on network maintenance and influencing customer behaviour we will add a new strand of activity. This will focus on the operation of vulnerable pumping stations and their upstream network aiming to reduce their failure rates attributable to FOG and unflushables. New targets for reductions in avoidable blockages in sewers and pumping station incidents are currently being developed.

8.72 In addition to our Keep It Clear campaign we are also undertaking work that will help to address the other causes of blockages, flow restrictions and sewer flooding:

- In AMP5 we developed climate change scenarios for use in our hydraulic sewer models. These will also be used in AMP6
- We are involved in two EPSRC/UKWIR PhD projects modelling flow reductions caused by water conservation devices in domestic plumbing systems and the effects on solids transport and sedimentation.

Protecting our sites

8.73 In preparation for AMP5 we used Ofwat's analytical framework to assess which of our WTWs and WRCs were at risk of current and future fluvial and coastal flooding. Mitigation work at 20 WTWs was approved by Ofwat and these schemes to mitigate the risk of one in 100 year fluvial flooding and one in 200 year coastal flooding have now been completed.

8.74 In line with the Cabinet Office's model of infrastructure resilience the most cost effective solution was a combination of resistance and recovery. By protecting critical assets from flooding and ensuring their rapid recovery after a flooding event we have increased the security of supply to nearly 1.5m customers.

8.75 For our AMP6 Business Plan we built on and improved our AMP5 methodology for assessing the flood risk to all of our above ground water and water recycling assets. We used more detailed mapping and analysis methods and we included the risk of pluvial flooding and the consideration of flood depths.

8.76 In AMP6 we will be mitigating flood risk at 12 water and 23 water recycling sites protecting service to 800,000 properties.

8.77 Beyond AMP6 the creation of Asset Plans and solution designs will consider current and future flood risk. The risk to assets will be regularly reviewed to account for periodic updates to the EA flood maps because of changes in flood defences and the flood risk itself. This is being developed as a ‘business as usual’ activity to inform operational and asset management decisions, and it will support our business planning processes.

Flood and erosion defence partnership funding

8.78 In partnership with our three Regional Flood and Coastal Committees we jointly funded a secondee from the EA to help develop our partnership funding proposals and establish ‘business as usual’ practices to strengthen our links with LLFAs and the Flood Defence Grant in Aid funding process. Through this we received 91 applications for partnership funding ranging from surface water flood risk reduction to coastal erosion defence schemes. After a rigorous screening process 53 were put in the AMP6 Business Plan, including coastal defences at Clacton-on-Sea (see Case study 7). They cover:

- Local flood/erosion defence schemes protecting our customers from external or internal flooding

- Local flood/erosion defence schemes that protect AW assets thereby securing service to customers
- Flooding investigations and surveys.

Power resilience

8.79 As a reliable power supply is one of our most significant interdependencies we have been very active in understand our vulnerabilities and to addressing them. Over a number of AMP periods we have identified assets where a power failure would have unacceptable impacts on our processes, customers and/or the environment.

8.80 Traditionally standby generators have been installed at such critical assets to prevent the impacts from manifesting and we currently have 565 installed. This has continued to be an important strand of our resilience work and through AMP5 we have spent over £6m on a programme of generator installation, refurbishment and maintenance.

8.81 In addition to having fixed standby generators on our sites we also have the ability to obtain mobile generators through a framework agreed with our supply chain.

8.82 At a number of sites our resilience to power failures in the electricity distribution network is increased by having more than one power supply to the site. Since our ARP1 we have also carried out collaborative work with the National Grid and the DNOs to better understand our vulnerability. This provided additional information to help formulate AMP6 power resilience investment strategy. Additional detail on this can be seen in Case study 4.

Business continuity

8.83 Our Business Resilience Team ensures we have processes in place to prepare for, respond to and recover from the impacts of key risks. We use an all hazards approach with the National Risk Register as the main source of potential risks we need to plan for. Changing weather patterns and severe weather are part of this planning with coastal and inland flooding, storms, gales and drought as key risks.

8.84 Alongside the resistance, reliability and redundancy measures mentioned elsewhere, we have emergency site response and recovery plans in place. Our coastal flooding severe weather plan was implemented during the coastal surge of 2013 (see Case study 6).

8.85 We have two Workplace Recovery Centres for 360 employees to use should our offices be unavailable. These facilities have full, independent Information Technology (IT) and telephony capabilities. Our site at Canwick in Lincolnshire accommodates critical roles from our Operations Management Centre and can be up and running in one hour. Our second centre, near Peterborough, is larger and provides office space for longer disruption events if required. Resilience exercises for staff are carried out regularly.

8.86 We have also built-in redundancy for our networks, telephony and data centres:

- Each corporate office site has two diverse network paths providing a high degree of resilience
- All Campus locations have been designed in such a way that resilience is implemented for Carriers, Local Fibre, Exchanges and Data Centre termination points
- Our telephony services are supported by two geographically-separate data centres

- Two telephony platforms are used (one for standard telephony and a second for contact centres). Business units that are provisioned on the contact centre platform have business continuity provided by the standard platform
- Our data centres are Tier 3, ISO27001-2005 and IS14001 certified and security-level compliant with a List X audit, the same standard used by MoD and Police
- Key services and systems are 'clustered' (multiples) within the primary data centre and benefit from secure off-site data backup storage.

8.87 We use training and exercises to verify our plans and also take opportunities to exercise with multiple agencies. We are part of the Multi Agency Support Group (MASG) operating mainly in the East of England and work with partners and agencies across all categories of responders. We work closely with LRFs and are part of several sub-groups working together to manage and mitigate risks for our customers and communities. Our resilience work also extends to our key partners in our supply chain.

8.88 As part of our verification process we are audited by LRQA and during AMP5 we transitioned from BS25999 to ISO22301 which is the international standard for business continuity management.

9 Monitoring and evaluation

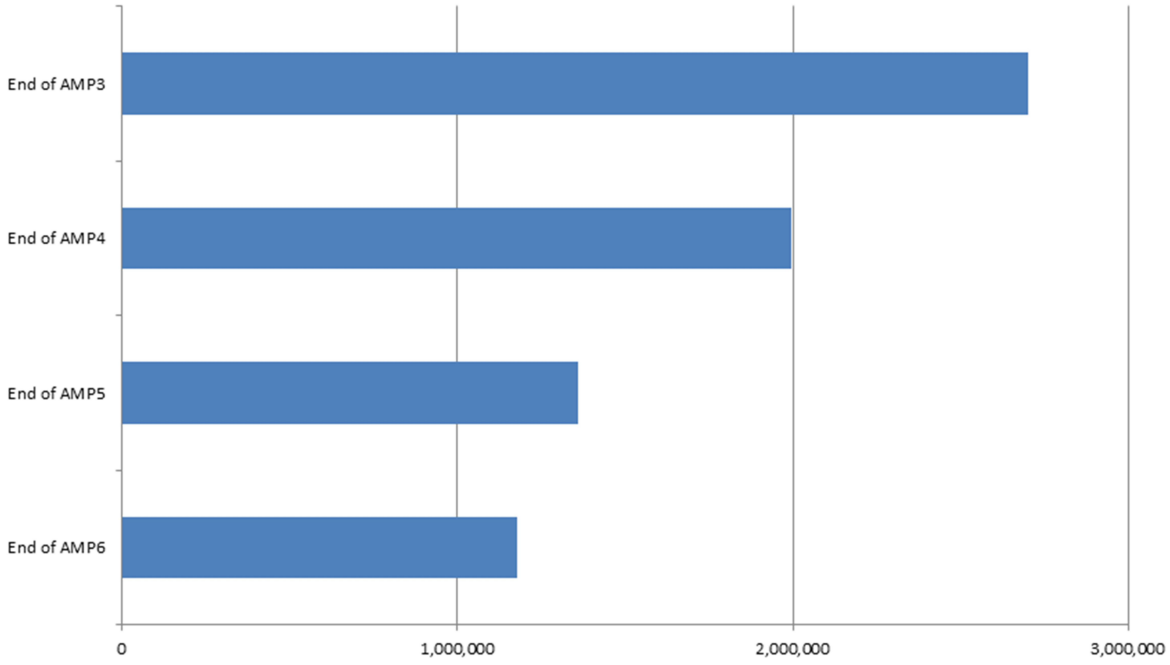
Embedding climate change

9.1 Where climate change impacts are well understood we can embed adaptation consideration in our systems and processes. Table 9.1 summarises our progress.

Monitoring adaptation action

9.2 As a regulated company we are required to generate good data and evidence to support investment proposals, closely monitor progress and report to a wide range of stakeholders. This data allows us to track activities that have adaptation as their primary or secondary driver. For example we can confidently report on security of supply, reducing unsustainable abstraction, leakage reduction, metering penetration, PPC, customers reliant on a single potable water supply, customer time without water, flood defence investment, SuDS adoption and properties at risk from sewer flooding. This enables us to track progress over a year, across a five-year AMP cycle and across multiple AMP cycles. For example, Table 9.1 shows how the number of customers reliant on a single supply of potable water has decreased since the end of AMP3 (2005) and will decrease further by the end of AMP6.

Picture 9.1 Customers supplied by a single source of supply



9.3 Whilst some measures, such as security of supply, are common across water companies, others are not or may be measured in different ways. Furthermore, as there are different ways to adapt to the same impact one company could favour resistance to flooding of water sites whilst another could favour rapid recovery and putting customers on dual supply. Without considerable effort this makes it difficult to assess one company's preparedness against another or to assess the water sector as a whole.

9.4 Assessing our performance in recent weather events can help inform us of how resilient we are. Case study 6 describes how we coped with the December 2013 east coast surge.

Financial benefit

9.5 Pressure management is an increasingly important part of our leakage reduction strategy. Pressure calming the network results in fewer bursts, increasing our resilience by improving our Security of Supply Index. The reduced consumption, leakage and bursts have contributed to Capex and Opex savings, in AMP5, of over £916k and £2.39m respectively.

9.6 Whilst not a direct financial benefit from adaptation itself, the ability to provide partnership funding for third party flood and erosion defences can be the most cost beneficial way to reduce the flood risk to our assets. In AMP5 we developed our partnership funding strategy and and used it to generate an AMP6 business case for partnership funding schemes. An example is our £3m contribution to the replacement of coastal erosion defences at Clacton-on-Sea which is estimated to have saved us and our customers over £23m (see Case study 7). Further details of our partnership funding activity can be seen in Chapter 8.

Table 9.1 Progress with embedding climate change consideration

Climate impact	Starting	Intermediate	Advanced	Leader	Comments
Reduced water availability for abstraction				X	We have produced a robust WRMP15 using industry-leading scenario-planning methodologies. We are leading on leakage reduction, metering penetration and water efficiency campaigning
Sea-level rise damages our assets			X		Monitoring the implementation of Shoreline Management Plans and engaging where appropriate
Increased flooding from rivers damages our assets			X		We follow national standards for flood risk assessment. We have published SuDS design guidance to developers to enable us to adopt SuDS systems
Increased surface water flooding damages our assets		X			Surface water flood modelling included in AMP6 site protection investment
Reduced raw water quality needing more treatment			X		Our potable water quality is world-standard and will continue to be so. Our catchment-management team is newly established for AMP6, focused on preventing deterioration of water quality in priority catchments.
Reduced flow in sewers leading to odour problems		X			We have used innovative models to map the risk of septicity in the sewers of a test catchments
Peak flows exceed sewer capacity			X		Sewer modelling, IDS
High temperatures/prolonged warm spells affecting asset performance		X			The sector is collaborating in research to address the paucity of data which is preventing us identifying thresholds beyond which asset performance suffers. We are also undertaking our own company specific work

Case study 6

East coast surge December 2013

On the fifth and sixth of December 2013 the East Coast experienced its most serious coastal flooding event for 60 years. The effects of a high spring tide were magnified by strong winds resulting in a sea level 1.60 metres higher than normal.

Agencies with flooding duties have plans in place for extreme weather events. We implemented our Inland and Coastal Flooding Severe Weather plan and LAs and the EA activated their flood response plans. The MASG established communication before the event to get a shared understanding of the risk from the EA and the Met office.

Our incident room was opened to manage the engagement with external agencies and the media and to provide the capacity to cope with significant increased workload over the days following the surge. Our aim was to keep assets running for as long as possible and to keep employees safe. We also sent staff to multi-agency command groups.

41 Severe Flood Warnings were issued and 200 flood defence assets damaged. This caused flooding to 1,218 properties across Lincolnshire, Norfolk and Suffolk. 38 Water recycling assets were affected directly by the surge. No clean water assets were affected

Following the surge a significant recovery exercise followed to bring the affected assets back into service, with nearly £600,000 worth of investment.

A full debrief and lessons-learned exercise was undertaken and some of the key conclusions were:

- Planning and practising for such events helped
- The formation of the MASG brought real benefit in maintaining situational awareness across our whole region
- We could quickly prioritise impacted assets, enabling us to plan how we brought them back into service
- Asset-recovery went well, benefiting from the close collaboration between different parts of the company
- Multiple sources of flood risk information has the potential to cause confusion. Everyone should have access to the same information
- Communicating with everyone, including those out in the field, is challenging. We need to continually improve how we do this.

10 Opportunities and benefits

Opportunities

10.1 There have been no significant changes in our view of the opportunities arising from climate change since ARP1. In the main, climate change poses risks and challenges rather than opportunity. However, where they exist we should consider exploiting them when it is in the interests of our customers and stakeholders.

10.2 Our customers want us to plan for the long-term and enhance our resilience. The imperative of dealing with climate change is therefore an opportunity to engage with them. For example, reducing PPC will be crucial to managing future supply/demand risk. Our award-winning Love Every Drop campaign is our means of engaging with customers and others (see Chapter 4). As described earlier in this report customers have been receptive to this, for example they saved 60 Ml/d during the 2010-12 drought. They will also have saved money, especially on the energy costs associated with heating water.

10.3 In our ARP1 we highlighted the need for greater cooperation, for example between us and regulators or LAs and we anticipated regulatory changes that could facilitate this. As Case study 7 shows, being able to fund third party assets is an opportunity we have already been able to exploit to cost-effectively address climate change. Collaboration has also worked well elsewhere, such as between RMAs and LRFs.

10.4 We know that temperature effects could have positive implications for us. For example fewer frost days could result in fewer pipe bursts and warmer summer temperatures can enhance water recycling processes. Attribution science is starting to more confidently relate climate change to today's weather so we may already be benefiting from these impacts.

Case study 7

Clacton-on-Sea coastal defences - building resilience through working collaboratively

When we asked our customers about how to best respond to the challenges of disruptive events and increasingly severe weather, we heard that they wanted us to take preventative action, engage in long-term planning to build resilience and work in partnership with others.

Supported by the increased flexibility of Totex funding, that is the approach we are taking for flood alleviation projects across our region. It is a move supported by our independent CEF, where it delivers value for money for customers.

A good example is Clacton-on-Sea where coastal erosion threatens the sewer network. This includes a 2.8m diameter strategic sewer that runs along the coast relying on the coastal defences to protect it. If this was to fail it would cause sewer flooding to any properties still standing, as well as pollution to the environment and bathing waters popular with tourists.

Tendring District Council is responsible for the defences and had received 70% of the £37m needed to enhance them from Defra. However contributions from other partners were still needed to secure the full funding, so they approached us for support.

Our assessment showed it would cost £27.4m to redesign and relocate sections of the strategic sewer. Such work would also cause significant disruption for the local community.

Contributing £3m to the council's partnership scheme as an alternative way of achieving the same outcomes was therefore a clear benefit for customers, saving over £23m.

It also supports an important resilience scheme with wider benefits for the community businesses and future of tourism in Clacton-on-Sea.

11 Tables

Table 11.1 Research

Row	Project	Source	Description	Due	Status	Outcome
1	Water recycling - Increase in temperature	ARP1 Table 7.5	In house - Innovation team	n/a	Ongoing	Delivered by multiple projects rather than one Innovation project. See lines 5, 7, 9, 14 and 22
2	Extreme rainfall - sewer capacity exceedence	ARP1 Table 7.5	In house - Innovation team	n/a	Ongoing	Delivered by multiple projects rather than one Innovation project. See lines 8 and 13
3	Water treatment - Increase in temperature	ARP1 Table 7.5	In house - Innovation team	n/a	Ongoing	Delivered by multiple projects rather than one Innovation project. See lines 6, 9, 14 and 22
4	Validate operational thresholds used within climate change risk tool	ARP1 Table 6.3	In house - Innovation team	n/a	Ongoing	Delivered by multiple projects rather than one Innovation project. See all lines
5	The effect of temperature change on aerated systems within WRC treatment processes	ARP1 Table 6.3	In house - Innovation team	Under review	Under review	Aeration lane energy use did increase with temperature, but it was not statistically significant. Other factors may have affected the data, so the methodology and other monitoring sites are under review
6	Climate change implications for water treatment	ARP1 Table 9.1	UKWIR project	2011	Complete	This assessed the climate change impact on catchment water quality and drinking water treatment. It developed a ‘no or low-regrets’ sustainable asset adaptation framework under growing carbon constraints

Row	Project	Source	Description	Due	Status	Outcome
7	Climate change implications for wastewater treatment	ARP1 Table 9.1	UKWIR project	2011	Complete	This identified climate change impacts on wastewater quality and quantity and assessed the implications for network and WRC performance. It sought to understand sensitivity and performance thresholds and identify available adaptation options
8	Climate change modelling for sewerage networks	New	UKWIR project	2011	Complete	Software tool developed to process UKCP09 Weather Generator data along with methods and guidance on how to use it, and the outputs, to assess the impact on sewer networks. This is for both design events and time series applications
9	Practical methodologies for monitoring and responding to the impacts of climate change on industry treatment processes	New	UKWIR project	2012	Complete	Provided a method to establish critical climate sensitive treatment process thresholds, monitor them and assess performance to inform investment. Drawing on the projects in lines 6 and 7 it identified parameters to be measured, reviewed existing asset monitoring data, identified monitoring options and locations, described trends and provided information to allow the development of critical asset performance thresholds. It recommended primary and secondary monitoring parameters for water treatment and water recycling activities
10	ARCC water: water system resilience	ARP1 Table 6.3	EPSRC PhD - HR Wallingford, UCL and Oxford, Loughborough, Exeter, and Lancaster Universities	March 2013	Complete	This built a model of the south east of England's water supply system, allowing its climate change vulnerability to be assessed. Learning from this was used to develop a model of our supply system which is being used to support the WREA project

Row	Project	Source	Description	Due	Status	Outcome
11	Impact of climate change on water demand	ARP1 Table 6.3	PhD - Loughborough university	January 2014	Complete	Used UKCP09 data for the 2050s and 80s. Showed that future water use will increase modestly. Shower and outside use will be more sensitive to climate change
12	Septicity project	New	In house - Innovation team	December 2014	Ongoing	A model to predict sewerage network septicity and odour occurrences has been developed and piloted. Future use of the model is now being explored. For further detail see Case study 2
13	Rainfall intensity for sewer design	New	UKWIR project	March 2015	Complete	This used CONVEX project outputs to simulate flooding volumes for current and climate change uplifted 5, 10, 30, 50 and 100 year return period design rainfall events. These were verified using three urban drainage models and combined with learning from design and storm water management approaches used in international analogues for the future UK climate. It has created guidance on how to provide for adaptation and ways to manage future serviceability under the modelled futures
14	Planning for, and responding to, the mean and extremes of weather	New	UKWIR project	May 2015	Ongoing	The project will establish hypotheses and quantifiable links for causal relationships between current, antecedent and extreme weather events and their impact on the performance of selected assets. Where appropriate standardised algorithms will be developed between weather and company performance measures to improve investment planning.

Row	Project	Source	Description	Due	Status	Outcome
15	Biodiversity climate change project	New	UKWIR project	September 2015	To start	A project to develop a framework of research into ecosystems services, including assessing and addressing the impacts of climate change
16	Planning and designing an Aquifer Storage and Recovery (ASR) scheme in the UK	New	STREAM EngD - Cranfield University	October 2015	Ongoing	Developing a methodology integrating pre-treatment, recharge, storage, recovery and post treatment elements of an ASR scheme as well as the strategic element when assessing scheme viability. Experiments will help determine the best treatment to meet operational and regulatory requirements, and investigate the potential for clogging in the aquifer and potential pre-treatments to minimise negative impacts
17	Flow modeling of urban water distribution systems using water conservation fittings	New	EPSRC PhD - Heriot Watt University	December 2016	Ongoing	A project to develop a sewerage flow model for water distribution systems using water conservation fittings. The outcome of this will be the ability to predict areas which may be under threat from problems related to low flow rates, and to suggest mitigation strategies so that water conservation goals can be achieved safely
18	UK droughts and water scarcity programme	New	NERC projects - CEH, Met Office and Oxford, Cranfield and Bristol Universities.	March 2017	Ongoing	Four projects with our focus on 'Managing the risks, impacts and uncertainties of drought and water scarcity'. A risk-based approach for managing drought and water scarcity effects including closer integration of water resources and drought planning and the development of robust and adaptive management strategies.

Row	Project	Source	Description	Due	Status	Outcome
19	Modelling solid transport and deposition in urban sewerage systems	New	EPSRC PhD - Heriot Watt University	June 2018	Ongoing	Using data from the project in line 16 this is assessing water conservation impacts on sediment transport and build up in sewer systems and the link to climate change flow impacts. A physical model has been built and verified to simulate sediment build up for a range of particle types and sizes. The project will develop guidance for design code changes and updating the current DRAINET model
20	UKCP09 Review of 2008 UKCIP02 saline intrusion assessment	ARP1 Table 6.3	TBC	2020	To start	The results of the 2008 saline intrusion assessment will be reassessed using UKCP09 projections
21	Mathematics for the planet earth - Anglian Water risk tool assessment	New	PhD placement project - Imperial College/Reading University	TBC	To start	An eight week placement within year two or three of the maths PhD. It will analyse our risk tool and make recommendations for improvement
22	Mathematics for the planet earth - sensitivity analysis of our surface water climate change yield assessments	New	PhD placement project - Imperial College/Reading University	TBC	To start	An eight week placement within year two or three of the maths PhD. It will verify our assessment methodologies and their conclusions giving greater confidence/certainty and potentially improvements in the conclusions drawn from them
23	Asset monitoring project TBC	New	STREAM EngD - Imperial College	TBC	To Start	Aims to establish quantifiable links between asset performance and current and future weather patterns. This will be for assets that are a priority for us and not covered by the project in line 15

Row	Project	Source	Description	Due	Status	Outcome
24	Climate change and groundwater quality	ARP1 Table 9.1	PhD - Loughborough University	n/a	Stopped	This was not completed by the student and has no outputs. Further work was not commissioned as our action priorities had changed
25	Climate change impacts on above ground water infrastructure	ARP1 Table 6.3	STREAM EngD - Sheffield University	n/a	Stopped	This changed to 'Investigating the impacts of climate change on pesticide transport in freshwater systems'. The project was not completed by the student and the decision was taken not to continue the work. There are no significant outputs

Table 11.2 Barriers, uncertainties and assumptions

Row	Type	Source	Description	Owner	Our past action[1]	Status	Our planned action[2]	Deadline
1	Uncertainty	ARP1	Climate change is a cutting edge discipline and there are uncertainties in the projections. However the current UKCIP projections are the best available science	Defra, Met. Office, UKCIP, research community	Used most current data acknowledging the limitations	Ongoing	No change	Ongoing
					Watching brief	Ongoing	No change	Ongoing
2	Uncertainty	ARP1	Housing growth, population growth, demographic changes and intra-region migration owing to climate impacts such as rising sea levels. These could all influence many operational activities	UK government, DCLG, Defra, Ofwat, LAs, water industry	Regulator engagement on growth	Ongoing	Regulator engagement on growth	Ongoing
					No land loss/population movement so no action			

Row	Type	Source	Description	Owner	Our past action[1]	Status	Our planned action[2]	Deadline
3	Uncertainty	ARP1	Our engagement with our interdependencies on climate change has been limited. We have limited knowledge of their adaptation and make assumptions in our adaptation strategy	UK/global - Defra, DECC Local - ourselves, interdependencies	Regulator engagement	Ongoing	Regulator engagement	Ongoing
					Provided data for first UK CCRA	Complete	AMP6 power resilience work	2020
					Provided data for Adaptation Sub-Commitee (ASC) Utilities Sector Report 2014	Complete	AMP6 partnership funding work	2020
					Supply chain resilience review	Ongoing	Supply chain resilience review	Ongoing
					Stakeholder flooding engagement	Ongoing	Stakeholder flooding engagement	Ongoing
					AMP5 WREA project	Complete	AMP6 WREA project	2020
					Power resilience project	Complete		
					Engagement in second UK CCRA	Ongoing		
					Co-authoring of NAP	Complete		

Row	Type	Source	Description	Owner	Our past action[1]	Status	Our planned action[2]	Deadline
4	Uncertainty	ARP1	Uncertainty over which emissions scenario to use as there is no 'correct' scenario. All have the same validity	Defra, Met. Office, UKCIP, research community	Used all scenarios in risk assessments and research unless national guidance or expert judgement to indicated otherwise	Ongoing	No change	Ongoing
5	Uncertainty	ARP1	Future changes in regulatory regimes	EU, Defra, Ofwat, EA, DWI, NE	Regulator engagement	Ongoing	Regulator engagement	Ongoing
					Defra - SuDS	Ongoing	Defra - SuDS	Ongoing
					Ad hoc liaison groups	Ongoing	Defra - abstraction reform	Ongoing
					EA - working together initiative	Ongoing	Ad hoc liaison groups	Ongoing
					EA - WFD	Ongoing	EA - working together initiative	Ongoing
					Ofwat - competition	Ongoing	EA - WFD/River Basin Management Plans (RBMPs)	Ongoing
					Ofwat - partnership funding	Complete	Ofwat - competition	Ongoing

Row	Type	Source	Description	Owner	Our past action[1]	Status	Our planned action[2]	Deadline
6	Uncertainty	ARP1	Availability of flood defence partnership funding	UK government, Ofwat, flood defence stakeholders, ourselves	Defra - industry consultation response	Complete	AMP6 partnership funding	2020
					Ofwat - AMP6 partnership funding agreement	Complete		
					Created our partnership funding policy and assessment process	Complete		
					AMP6 partnership funding submission	Complete		
7	Uncertainty	ARP1	Will our customers' priorities be the same as ours and will they be willing or able to afford the necessary bill increases?	UK Government, Ofwat, CCW, EA, ourselves	Regulator engagement	Ongoing	Regulator engagement	Ongoing
					CEF	Ongoing	CEF	Ongoing
					Discover Discuss Decide	Complete		
					AMP6 submission delivering customer priorities affordably	Complete		
8	Barrier	ARP1	Lack of national research coordination	Defra, DECC, research community	Various research projects and multi-party engagement forums	Ongoing and complete	No change	Ongoing and complete

Row	Type	Source	Description	Owner	Our past action[1]	Status	Our planned action[2]	Deadline
9	Barrier	ARP1	Public acceptance of climate change is varied, with a residual scepticism. Many people also cannot relate it to their individual actions	All	CEF	Ongoing	CEF	Ongoing
					Education programme	Ongoing	Education programme	Ongoing
					Love Every Drop	Ongoing	Love Every Drop	Ongoing
					Water efficiency	Ongoing	Water efficiency	Ongoing
					Discover, Discuss, Decide	Complete		
10	Barrier	ARP1	Lack of flexibility within and conflict between current and new regulations. Many do not incorporate adaptation, do not allow sustainable adaptation or are at odds with climate change targets	EU, Defra, EA, DWI, Ofwat, NE, stakeholders	Regulator engagement	Ongoing	Regulator engagement	Ongoing
					Defra - SuDS	Ongoing	Defra - SuDS	Ongoing
					EA - WFD	Ongoing	Defra - abstraction reform	Ongoing
					EA - working together initiative	Ongoing	EA - WFD/RBMPs	Ongoing
					Ad hoc liaison groups	Ongoing	EA - working together initiative	Ongoing
					Ofwat - competition	Ongoing	Ad hoc liaison groups	Ongoing
					Ofwat - partnership funding	Complete	Ofwat - competition	Ongoing

Row	Type	Source	Description	Owner	Our past action[1]	Status	Our planned action[2]	Deadline
11	Barrier	ARP1	Misalignment between us and our regulators on the valuations used for elements of cost/benefit assessment	All stakeholders in the periodic review process	Regulator engagement	Ongoing	Regulator engagement	Ongoing
					CEF	Ongoing	CEF	Ongoing
					Discover Discuss Decide	Complete		
12	Barrier	ARP1	Conflict between our adaptation requirements and the stance of our regulators such as fluvial and coastal flooding of water recycling assets and changes to sewer design standards	All stakeholders in the periodic review process	Regulator engagement	Ongoing	Regulator engagement	Ongoing
					CEF	Ongoing	CEF	Ongoing
					PR14 fluvial, pluvial and coastal flooding resilience submission	Complete	AMP6 fluvial, pluvial and coastal flooding resilience work	2020
					Inclusion of climate change scenarios in sewer modelling	Ongoing	AMP6 sewer schemes	2020
					Discover Discuss Decide	Complete		

Row	Type	Source	Description	Owner	Our past action[1]	Status	Our planned action[2]	Deadline
13	Assumption	ARP1	Many assumptions are used in our risk tool for example: climate change probabilities, likelihood estimates, frequency estimates for impacts and thresholds for asset performance	Defra (national projects e.g. UKCP09), research bodies, industry sponsors	Various research projects and multi-party engagement forums	Ongoing and complete	No change	Ongoing and complete
14	Assumption	ARP1	There will be no change in the government position on climate change	UK government, policy implementation stakeholders	Government engagement (Defra, DECC, DCLG, BIS Climate Change Committee, ASC)	Ongoing	We will continue engage with these and other bodies, as appropriate, to influence future policy and legislation where it is in the interests of our customers	Ongoing
					Stakeholder groups (Aldersgate Group, Corporate Leaders Group)	Ongoing		

Row	Type	Source	Description	Owner	Our past action[1]	Status	Our planned action[2]	Deadline
15	Assumption	ARP1	There will be no change to the water industry structure	EU, Defra, Ofwat, EA, DWI	Regulator engagement	Ongoing	Regulator engagement	Ongoing
					Defra - SuDS	Ongoing	Defra - SuDS	Ongoing
					EA - WFD	Ongoing	Defra - abstraction reform	Ongoing
					EA - working together initiative	Ongoing	EA - WFD/RBMPs	Ongoing
					Ad hoc liaison groups	Ongoing	EA - working together initiative	Ongoing
					Ofwat - competition	Ongoing	Ad hoc liaison groups	Ongoing
					Ofwat - partnership funding	Complete	Ofwat - competition	Ongoing
16	Uncertainty	New	Lack of land loss extent data for managed retreat and no active intervention options in some shoreline management plans	EA, LAs			Explore internal mapping project	TBC
							Stakeholder engagement	TBC

Row	Type	Source	Description	Owner	Our past action[1]	Status	Our planned action[2]	Deadline
17	Uncertainty	New	Ofwat now has a resilience duty which could affect the pace and direction of adaptation action	Ofwat			Sit on the Resilience Duty Task Force	Ongoing
							Respond to Ofwat's consultation	Autumn 2015

1. Details of our AMP5 actions can be seen in Chapter 8 and Table 11.4. Research project details can be see in Chapter 5 and Table 11.1
2. Details of our AMP6 plans can be seen in Chapter 8 and Table 11.5. Research project details can be seen in Chapter 5 and Table 11.1

Table 11.3 Addressing interdependencies

Row	Type	Our dependency	Their dependency	Action taken	Status	Action planned	Deadline
1	Regulator	Appropriate regulatory regime (Defra, DWI, Ofwat, EA, NE) NAP (Defra) Investment approval (Ofwat) Sampling, monitoring, flood defences, modelling (EA) Permits (EA, NE) **New - retail and upstream competition (Ofwat)**	All - Data **New - flood/erosion defence funding (EA)**	Regulator engagement	Ongoing	Regulator engagement	Ongoing
				Defra - SuDS	Ongoing	Defra - abstraction reform	Ongoing
				Ofwat - competition	Ongoing	Ofwat - competition	Ongoing
				Ofwat - partnership funding	Ongoing	EA - flood defence funding	Ongoing
				EA - Working Together Initiative	Ongoing	EA - working together initiative	Ongoing
				EA - partnership funding	Ongoing	EA - WFD/RBMPs	Ongoing
				EA - WFD	Ongoing	Ad hoc liaison groups	Ongoing
				LLFA and Resilience Forum memberships	Ongoing	LLFA and Resilience Forum memberships	Ongoing
				Ad hoc liaison groups	Ongoing	AMP6 WREA project	2020
				Created partnership funding policy and process	Complete	AMP6 catchment management	2020
				WRMP15	Complete	AMP6 partnership funding	2020
				AMP5 WREA project	Complete		

Row	Type	Our dependency	Their dependency	Action taken	Status	Action planned	Deadline
2	Power supplies	Electricity generation, supply and distribution Gas supply and distribution Liquid fuel production Standby power sources **New - abstraction competition** **New - power exports**	Boiler feed Process water **New - abstraction competition** **New - power exports**	Power resilience project	Complete	Defra - abstraction reform	Ongoing
				Ofwat - competition	Ongoing	Ofwat - competition	Ongoing
				WRMP15	Complete	AMP6 power resilience	2020
				AMP5 WREA project	Complete	AMP6 WREA project	2020
				Supply chain resilience review	Ongoing	Supply chain resilience review	Ongoing
3	Supplier	Chemicals, GAC regeneration, bottled water, construction materials, plant hire, office supplies and more	Process water	Supply chain resilience review	Ongoing	Supply chain resilience review	Ongoing

Row	Type	Our dependency	Their dependency	Action taken	Status	Action planned	Deadline
4	Agriculture	Farmers - land bank for biosolids, abstraction competition, raw water quality	Abstraction competition	Regulator engagement	Ongoing	Regulator engagement	Ongoing
				Ofwat - competition	Ongoing	Ofwat - competition	Ongoing
				EA - working together initiative	Ongoing	Defra - abstraction reform	Ongoing
				EA - WFD	Ongoing	EA - working together initiative	Ongoing
				WRMP15	Complete	EA - WFD/RBMPs	Ongoing
				AMP5 WREA project	Complete	AMP6 WREA project	2020
				AMP5 catchment management	Complete	AMP6 catchment management	2020
5	**New - gas production (fracking)**	**New - abstraction competition** **New - water supply/demand** **New - raw water quality** **New - water recycling capacity**	**New - abstraction competition** **New - trade effluent**	Regulator engagement	Ongoing	Regulator engagement	Ongoing
				Defra - statutory consultee appointment	Complete	Defra - abstraction reform	Ongoing
				Ofwat - competition	Complete	Ofwat - competition	Ongoing
				WRMP15	Complete	AMP6 WREA project	2020
				UKWIR industry position statement	Complete	AMP6 water recycling supply/demand	2020
				AMP5 WREA project	Complete	Consultation responses	Ongoing

Row	Type	Our dependency	Their dependency	Action taken	Status	Action planned	Deadline
6	Communications	Mobile, telemetry - service **New - IT - service**		Supply chain resilience review	Ongoing	Supply chain resilience review	Ongoing
				Telecommunications hazard plan	Ongoing	Telecommunications hazard plan	Ongoing
7	Water companies	Mutual aid agreements, water transfers **New - abstraction competition**	Mutual aid agreements Water transfers **New - abstraction competition**	Ofwat - competition	Ongoing	Ofwat - competition	Ongoing
				EA - water transfer map engagement	Complete	Defra - abstraction reform	Ongoing
				WRMP15	Complete	Joint exercises	Ongoing
				AMP5 WREA project	Complete	AMP6 WREA project	2020
				Joint exercises	Ongoing		
8	Other customers	Manufacturing and food processing industries - demand patterns **New - abstraction competition**	**New - process water** **New - abstraction competition**	Supply chain resilience review	Ongoing	Supply chain resilience review	Ongoing
				Ofwat - competition	Ongoing	Ofwat - competition	Ongoing
				WRMP15	Complete	Defra - abstraction reform	Ongoing
				AMP5 WREA project	Complete	AMP6 WREA project	2020
		Domestic - demand patterns		See Chapter 5 and Chapter 8	As appropriate	See Chapter 5 and Chapter 8	As appropriate

Row	Type	Our dependency	Their dependency	Action taken	Status	Action planned	Deadline
9	Public sector	Hospitals - health and wellbeing		Sustainability East - Health and Well Being Network	Ongoing	Sustainability East - Health and Well Being Network	Ongoing
				Hospital Information Plans	Ongoing	Hospital Information Plans	Ongoing
				Incident response plans	Ongoing	Incident response plans	Ongoing
		Schools - education		Education programme	Ongoing	Education programme	Ongoing
		Highways Agency - drainage, road maintenance		LLFA and Resilience Forum memberships	Ongoing	LLFA and Resilience Forum memberships	Ongoing
				Developing SMPs and our IDS	Ongoing	Implement SMPs and our IDS	Ongoing
		IDB/British Water Ways - drainage, flood defences **New - permits**	**New - flood defence funding**	Created partnership funding policy and process	Complete	LLFA and Resilience Forum memberships	Ongoing
				LLFA and Resilience Forum memberships	Ongoing	AMP6 partnership funding	2020
		LAs - favourable regulatory environment, drainage and erosion defences	Data **New - flood defence funding**	Created partnership funding policy and process	Complete	AMP6 partnership funding	2020
				LLFA and Resilience Forum memberships	Ongoing	LLFA and Resilience Forum memberships	Ongoing

Row	Type	Our dependency	Their dependency	Action taken	Status	Action planned	Deadline
				Developing SMPs and our IDS	Ongoing	Implement SMPs and our IDS	Ongoing
		New - emergency services - response	**New - data**	LLFA and Resilience Forum memberships	Ongoing	LLFA and Resilience Forum memberships	Ongoing
				Gold and Silver Command participation	Ongoing	Gold and Silver Command participation	Ongoing

Table 11.4 Adaptation delivery in AMP5

Row	Original risk	Action	Benefit	Residual risk
1	20 water sites at risk of fluvial and coastal flooding	Flood proofing at 20 water sites against 1:100 year fluvial and 1:200 year coastal flood events adjusted by 20% for high emissions scenario climate change to 2055[(1)]	Risk of supply loss reduced for 1,424,230 customers	Supply loss risk still exists for flood events greater than the protection thresholds
2	300 properties on high risk register 324 properties on low risk register 1448 on external register	Alleviate flooding for 102 properties at high risk of internal flooding, 52 at low risk of internal and 246 at risk of external flooding Mitigate flooding for 210 properties at risk of internal flooding and 100 at risk of external flooding	Alleviated 201, 53 and 309 respectively Mitigated 216 and 140 respectively	197 properties on high risk register 377 on low risk register[(2)] 2597 on external register
		Two SuDS pilots completed		
3	Loss of supply due to catastrophic WTW failure	Water resilience investment at WTW serving >50,000 customers	1:1000 risk reduced for 162,000 customers	No risk of supply loss due to catastrophic WTW failure
4	Supply/demand deficit and service level reduction (including more frequent supply restrictions)	Increase in supply capacity	46 Ml/d new capacity in a dry year annual average scenario. 43 Ml/d in the equivalent critical period (peak demand) scenario	Levels of service maintained
		Demand management (metering, leakage reduction, water efficiency)	20 Ml/d reduction in demand in a dry year annual average scenario. 20.5 Ml/d in the equivalent critical period (peak demand) scenario	

Row	Original risk	Action	Benefit	Residual risk
5	PCC 145 l/d	87,500 water audits and efficiency measures installations planned to achieve: BSWE 9.6 Ml/d savings SELWE 2.6 Ml/d savings	88,111 water audits achieved: BSWE 10.6 Ml/d savings SELWE 4.6 Ml/d savings	PCC 133 l/d
6	Un-metered domestic customer bills 35%	Target - 20% domestic customers with un-metered bills 183,530 enhanced meters installed 112,964 optant meters installed 4,901 selective meters installed	12% reduction in un-metered domestic customer bills	Un-metered domestic customer bills 23%
7	Leakage of 211 Ml/d	Increased resource available for leakage detection and repair Shift of focus from reactive repair to proactive detection	19 Ml/d saving	Leakage of 192 Ml/d
		Pressure management in the network to reduce leakage by 2.13 Ml/d	3.04 Ml/d reduction achieved	
8	WCSs do not align with our investment plans	Gap analysis for LA WCSs	Improved alignment and awareness between our plans and 50 WCSs	20 new WCSs need analysis

Row	Original risk	Action	Benefit	Residual risk
9	LA SWMPs may not align with our investment plans	Aid completion of 8 SWMPs including detailed modelling where appropriate Contributions were made to 39 SWMPs, with 27 being completed	27 SWMPs aligned to deliver solutions optimised for all stakeholders	12 SWMPs outstanding
10	15,411 sewer blockages across our region	Delivery of Keep It Clear campaign targeted in 23 areas	Average decrease in blockages of 44% in target areas running for over one year	9,354 sewer blockages across our region
11	Loss of service from a supplier	Supply chain resilience review	Generation of actions to improve resilience and reduce the risk of service loss	Reduced loss of service risk pending delivery of actions
12	Current sewer models do not fully include future climate impacts	Integrate climate change consideration into sewerage network modelling	Climate change modelling scenarios and climate change design storms generated	No risk Further work on implementation
13	Site resilience to flooding compromised	Review of site flood resilience plans	Improved site flood resilience	Vulnerability beyond plan scope and at sites not covered by plans

1. Relevant EA, Ofwat and Defra guidance at the time was used to inform the standards, uplifts and scenarios used.
2. The reasons for the increase in the numbers of properties on the low risk internal and external flooding registers are provided in the text of Chapter 8.

Table 11.5 Adaptation action in AMP6

Row	Planned actions	Risk addressed	Deadline
1	Increase resilience of water and water recycling assets to fluvial, pluvial and coastal flooding	Water and water recycling site resilience around 800,000 customers protected from supply loss	2020
2	Reduce three year average number of customer properties flooding	Sewerage network resilience 27 internal and 22 external customers protected	2020
3	Reduce customers reliant on a single source of supply from 27.5% to 24.7%	Supply resilience Extended supply loss due to catastrophic WTW failure	2020
4	Water supply/demand investment to maintain levels of service	Long-term water supply/demand balance Unacceptable increase in level of service restriction on supply due to growth and climate change	2020
5	Reduce PPC by seven l/d through various programmes including metering and water efficiency campaigns	Long-term water supply/demand balance Demand	2020
6	Reduce un-metered customer bills to 12%	Long-term water supply/demand balance Demand	2020

Row	Planned actions	Risk addressed	Deadline
7	Reduce leakage to a rolling three year average of 172 Ml/d	Long-term water supply/demand balance Supply losses	2020
8	Aid completion of 20 LA WCSs	Long-term sewerage supply/demand balance WCSs may not align with our investment plans	2020
9	Aid completion of 36 SWMPs including detailed modelling where appropriate	Long-term sewerage supply/demand balance 36 LA SWMPs may not align with our investment plans	2020
10	Continuing the 23 AMP5 Keep It Clear programme areas and expanding to three more Developing a strategy for addressing pumping station blockage patterns	Long-term sewerage supply/demand balance Customer behaviour contribution to sewer blockages	2020
11	Increase our understanding of the performance of our sewerage network this will include increasing the detail and coverage of our hydraulic models	Sewerage network resilience Long-term sewerage supply demand/balance	2020
12	WTW power resilience investment	Power supply failure to our most critical assets	2020
13	Continue supply chain resilience review and action implementation	Reduction in risk of supplier service loss	2020

12 Glossary

Abbreviations and Acronyms	
AMP	Asset Management Plan
AMP3	Asset Management Plan 3 (2000-05)
AMP4	Asset Management Plan 4 (2005-10)
AMP5	Asset Management Plan 5 (2010-15)
AMP6	Asset Management Plan 6 (2015-20)
AMP7	Asset Management Plan 7 (2020-25)
AMP8	Asset Management Plan 8 (2025-30)
ARCC Network	Adaptation and Resilience in the Context of Change Network
ARP1	First Adaptation Reporting Power report
ASC	Adaptation Sub-Committee
ASR	Aquifer Storage and Recovery
BIS	Department for Business
BSI	British Standards Company
BSWE	Base Level of Water Efficiency
CCAM	Climate Change Adaptation Manual
Capex	Capital Expenditure
CCSG	Climate Change Steering Group
CCW	Consumer Council for Water
CEF	Customer Engagement Forum
CEH	Centre for Ecology and Hydrology
Coastal flooding	Flooding from the sea
CONVEX	A NERC project to improve predictions of extreme rainfall change
CPSL	Cambridge Programme for Sustainability Leadership
DCLG	Department for Communities and Local Government
DECC	Department of Energy and Climate Change

Abbreviations and Acronyms	
Defra	Department for Environment, Farming and Rural Affairs
DNO	Distribution Network Operator (Electricity)
DRAINET	Model for flow and solids transport in sewer systems
DSF	Drainage Strategy Framework
DWI	Drinking Water Inspectorate
EA	Environment Agency
EPSRC	Engineering and Physical Sciences Research Council
EU	European Union
Fluvial flooding	Flooding from watercourses
FOG	Fats, Oils and Greases
FWMA	Flood and Water Management Act 2010
GAC	Granular Activated Carbon
Ha	Hectare
IDB	Internal Drainage Board
IDS	Integrated Drainage Strategy
ISO	International Organisation for Standardisation
IT	Information Technology
l/d	Litres per day
l/h/d	Litres per head per day
l/p/d	Litres per person per day
LA	Local Authority
List X	Security certification level for data centres
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Local Resilience Forum

Climate Change Adaptation Report 2015
Glossary

Abbreviations and Acronyms	
LRQA	Lloyds Register Quality Assurance
MASG	Multi-Agency Support Group
Met. Office	Meteorological Office
Ml/d	Megalitres per day
MoD	Ministry of Defence
NAP	National Adaptation Programme
NE	Natural England
NERC	Natural Environment Research Council
ODI	Outcome Delivery Incentive
Ofwat	Water industry regulator
Opex	Operational Expenditure
PCC	Per Capita Consumption
Pluvial flooding	Localised flooding caused by surface water from rainfall
PPC	Per Property Consumption
PR14	Periodic Review 2014, one of the five yearly price reviews
PWS	Public Water Supply
RDM	Robust Decision Making
RBMP	River Basin Management Plan
RMA	Risk Management Authority
Ruthamford	Integrated water distribution system in the west of our region
SELWE	Sustainable Economic Level of Water Efficiency
SMP	Sewerage Management Plan
SSSI	Site of Special Scientific Interest
STREAM	Industrial doctoral centre for the water sector
SuDS	Sustainable Drainage System
SWMP	Surface Water Management Plan
Tier 3	Data centre resilience rating giving 99.98% 'up time'

Anglian Water Services
Lancaster House
Lancaster Way
Ermine Business Park
Huntingdon
PE29 6XU

www.anglianwater.co.uk

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Abbreviations and Acronyms	
Totex	Total capital and operational expenditure over an asset's lifetime
UCL	University College London
UK CCRA	UK Climate Change Risk Assessment
UKCIP	UK Climate Impacts Programme
UKCIP02	UK Climate Impacts Programme projections 2002
UKCP09	UK Climate Impacts Programme projections 2009
UKWIR	UK Water Industry Research
Unflushables	Items that should not be disposed of down the toilet
Water UK	Body representing the water Industry in the UK
WCS	Water Cycle Studies
WFD	Water Framework Directive
WRC	Water Recycling Centre
WREA	Water Resources East Anglia project
WRLTP	Water Recycling Long-Term Plan
WRMP	Water Resources Management Plan
WRMP10	Water Resources Management Plan 2010
WRMP15	Water Resources Management Plan 2015
WTP	Willingness To Pay