Water Resources Management Plan 2019

August 2019

WONDERFUL ON TAP

SEVERN TRENT

Contents

Technical appendices

Handling Instruction, Please Note:
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1. About Severn Trent

Severn Trent is one of the largest of the 17 regulated water companies in England and Wales. We strive to provide high-quality services to more than 4.3 million households and businesses in the Midlands and Chester. Our customers pay the lowest average bills in England and Wales.

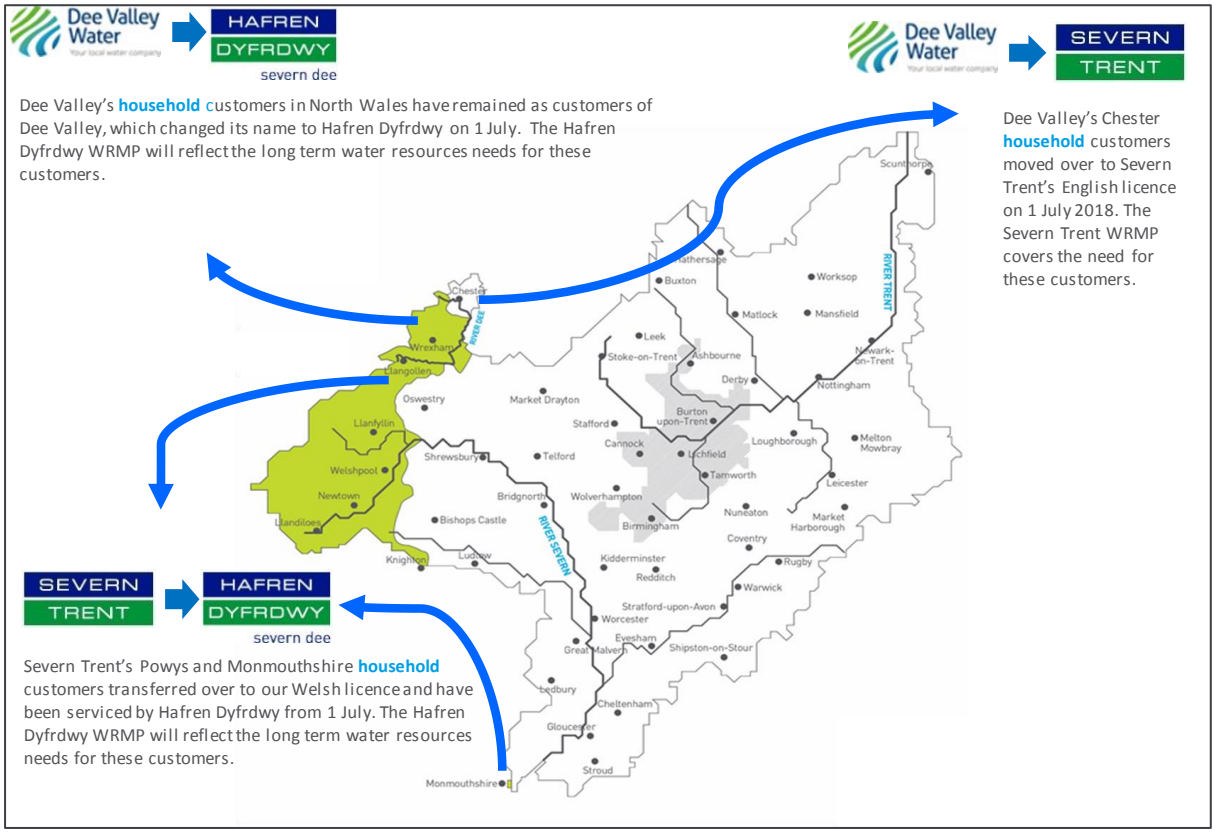
Our core purpose is to serve our customers and communities. This drives our vision to be the most trusted water company, delivering an outstanding customer experience, best value service and environmental leadership.

Severn Trent is part of Severn Trent Plc, and is listed on the London Stock Exchange in the FTSE100. In 2017 we welcomed Dee Valley Water as part of Severn Trent Plc with the shared purpose of serving our communities and building a lasting water legacy.

This Water Resources Management plan relates to the area served by Severn Trent. In February 2017, Dee Valley Water became part of the Severn Trent group. In early 2018, Ofwat approval was received to align the boundaries of Severn Trent and Dee Valley Water to the national boundaries of Wales and England. In line with this approval, we launched Hafren Dyfrdwy on 1 July 2018 to serve our customers in Wales. A separate Water Resources Management Plan has being developed for the Hafren Dyfrdwy area

Figure 1 below shows how customers have moved between the two companies and how this impacts the final WRMPs which have been produced based on the new licences:

Figure 1: Severn Trent and Hafren Dyfrdwy boundary changes



What we do

We're privileged to serve over 8 million people and businesses in an area stretching across the heart of the UK, from the Bristol Channel to the Humber, and from the West to the East Midlands.

We work in, and for, the environment. We take our name from the two main rivers, the Severn and the Trent, which run through our region - two of the three biggest rivers in the UK. To us, the health of rivers represents the health of the whole landscape and the communities that they exist alongside. From abstracting raw water to returning safely treated wastewater, everything we do is intrinsically linked to rivers and other water bodies in our region. So we work hard to play our part in protecting them, and that includes collaborating with stakeholders to help manage their catchments.

For further information about our business, please visit www.stwater.co.uk

2. About this Water Resources Management Plan

This is Severn Trent's fourth published Water Resources Management Plan (WRMP). It is a statutory requirement that every five years water companies produce and publish a WRMP. The WRMP demonstrates that we have long term plans in place to accommodate the impacts of population growth, drought, our environmental obligations and climate change uncertainty in order to balance the supply and demand for water in the communities we serve.

Our WRMP contributes to the government's and regulators' wider strategic objectives. We have taken into account the expectations set by Defra in its September 2017 *'Strategic policy statement (SPS)'* to Ofwat. The SPS sets out strategic objectives for Ofwat to take into account when setting price limits, including the need to reduce the long-term risk to water supply resilience from drought and other factors. Defra also set clear expectations that there should be ambitious plans to reduce leakage and help customers use water more efficiently. The SPS reinforced the expectations for drought resilience and ambitious demand management action that had already been set out by Defra in its *'Guiding principles for water resources planning'*.

We have also taken account of the recommendations made in Water UK's *'Long Term Water Resources Planning Framework*', which explored ways of increasing national drought resilience, including the use of new strategic water transfers. The options we have considered within our WRMP would facilitate new strategic transfers if needed in future.

Since we published our draft WRMP in February 2018, the National Infrastructure Commission (NIC) set out a number of long term challenges to the water industry, including the expectation that the industry should reduce leakage by 50% over the next 25 years. We have ensured that we have responded to this long term challenge in our final WRMP.

We began working on this WRMP in early 2016 to understand new and emerging future water supply / demand challenges, and to explore the options available to us. We have used our in-house expertise in hydrology, hydrogeology, ecology, engineering and economics to define and quantify risks and future supply / demand scenarios. We have also called on a number of specialist consultants and partners to help us develop the recommendations set out in our WRMP. Throughout the development of this plan, we have shared our emerging thinking with technical specialists at the Environment Agency, and we have engaged with expert stakeholders to understand their views.

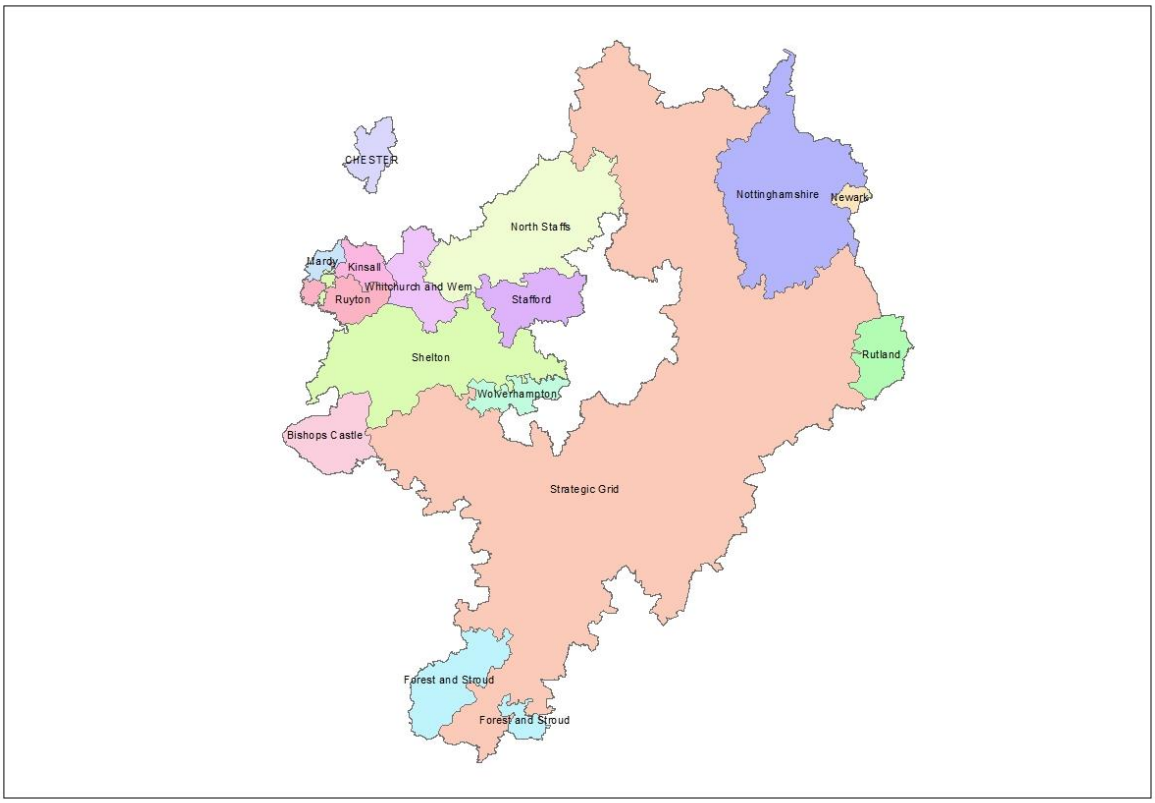
Following published our draft WRMP for consultation in February 2018, we were pleased to receive comments from 22 different stakeholders. We reviewed all of the comments and used the feedback to update and improve our plan. We published our Statement of Response to the consultation feedback in September 2018, and in that report we described the aspects of our draft WRMP we would change and why.

Our water resource zones

For the purposes of water resources planning, we divide the company supply area up into 15 water resource zones, including our new Chester zone (Figure 2). These zones vary widely in scale, from the Strategic Grid zone which supplies the majority of our customers, to the small zones of Mardy and Bishops Castle which supply much smaller populated areas.

Our zones have very different water resources concerns, with some requiring significant investment in the long term to ensure secure supplies, while others will need minimal investment other than to maintain the current assets and infrastructure. These future pressures are explained in this Water Resources Management Plan and the supporting technical appendices. Our plan also explains our long term plans to ensure sufficient supplies are available in each of these zones.

Figure 2: **Severn Trent's water resource zones**



New challenges

For this WRMP we face a new, strategic challenge in the form of demonstrating that our plan protects the environment in the long-term by not putting at risk the future ecological status of the water bodies in our region (as defined by the Water Framework Directive). This challenge requires a material shift in our thinking, and means that we need to make changes to how and where we currently source our water supplies.

In this WRMP we set out the actions that we recommend to meet the long term supply / demand challenge. Due to the scale of the challenge, and based on stakeholder engagement, we are prioritising demand management and a step-change in leakage, water efficiency and metering activity. To complement these ambitions, our plan also includes investment in new sources to maintain the security of supply and replace those sources where continued abstraction could lead to deterioration of the water environment.

Delivering multiple benefits

This WRMP has been developed in parallel with our business plan for 2020-25 - as part of Ofwat's (our economic regulator's) 2019 price review (PR19) process. By developing our WRMP in conjunction with our business plan, we have worked to ensure that the schemes and activities included in this WRMP not only contribute to addressing future supply / demand challenges, but also deliver broader benefits to our customers by creating more resilient supplies.

In August 2018, Defra, the Environment Agency, Drinking Water Inspectorate and Ofwat jointly set out the actions needed to ensure that water companies are on track to build resilience in water resources management in England. Their letter called for companies to own the challenge of meeting customers' water needs in a safe, resilient and efficient way while balancing the need to protect the environment, respecting good supply practice and meeting the needs of other water users. We welcomed this joint statement from our regulators as it reinforced the need for many of the water supply and demand actions already included in our WRMP and PR19 plans.

The joint letter set out regulators' expectations around the following challenges:

- Increasing ambition in the forthcoming business plans.
- Regional water resource planning.
- Greater use of markets and competition.
- A clear direction from government.
- A responsive regulatory approach.

We are fully supportive of meeting these challenges. We have already committed to reducing leakage by 15% over the next five years alongside a stretching commitment on reducing water consumption. We are planning to retain this momentum, which together with other measures such as legislative change on water efficiency standards for new homes and technological improvements on our network, will see a halving of leakage and consumption rates over the coming decades. Our WRMP contains an ambitious step-up in metering rates, an essential tool in reducing consumption. We know there are delivery risks, so we've sought to ensure the onus is on us to deliver rather than place the risk on customers. Our approach to demand management also includes a novel new way of ensuring future generations understand and value water.

The joint Defra, Environment Agency, Drinking Water Inspectorate and Ofwat letter emphasised the need to turn thinking into action. We have been actively looking at cross-sector solutions and want to build on the success of already having secured the largest ever abstraction rights trade between two utility sectors in 2016. So, as well as including a mechanism in our PR19 Business Plan to enable us to make real progress on an interconnector to transfer water from the North West to the South East, we'll continue to contribute to regional and multi-sector water resources planning. We are, and will remain, active participants in all regional groups; Water Resources East, Water Resources South East, Water Resources North and most recently West Country Water Resources.

We have initiated two multi-sector working groups on the primary river transfer routes that run through our region; the River Severn Working Group and the River Trent Working Group. The purpose of these groups is to understand the potential cumulative impacts of transfer and new abstractors on the rivers. Critically, we have included investment in our plan to carry out meaningful feasibility on our water resource options as we build towards the next price review and future iterations of our water resource management plan.

Another area of note is the need to make plans easier to understand to improve engagement with customers and other water users. We are committing to including analysis of potential climate change impacts in our Annual Performance Report. Until now, this has largely been a technical and academic debate but we believe more should be done to make customers part of the decision making process. Our approach is linked to the mechanism we have developed to manage climate change uncertainty. We will look into whether we can do more to share information on other key assumptions regional economic and population forecasts as these are critical in determining risks and the pace at which we should adapt and change to ensure we can meet customers' water needs in a safe, resilient and efficient way

3. Our WRMP in summary

This WRMP explains the technical assessments and modelling we have used to explore the future potential risks to the water supply / demand balance. The plan sets out how we will meet these future challenges, and what steps we believe are needed over the coming years to maintain security of water supplies for our current and future customers.

Responding to future challenges

In this WRMP we forecast a significant deficit will develop between supply and demand for water over the medium term unless we act. One key difference from our previous plans is the need to prevent the risk of future environmental deterioration, which is a fundamental requirement of the Water Framework Directive. This means that, in order to protect our environment for future customers, some of our current sources of water cannot be relied upon in the future and we need to find alternative ways of meeting demand.

Our plan aims to respond to this, and other strategic challenges, and ensure that we:

- Preserve our current level of resilience against droughts;
- Tackle unsustainable abstraction and prevent future environmental deterioration;
- Appropriately plan for climate change;
- Meet future population growth;
- Improve the resilience of customers' supplies;
- Meet our customers' and stakeholders' needs and expectations;
- Meet our wider regulatory obligations; and
- Understand and allow for future uncertainty.

Our longer term strategy

To achieve these outcomes, our long term water resources strategy is twofold.

We will use **demand management measures** to reduce the amount of water we need to put into supply by:

- Reducing leakage on our network;
- Helping customers to use less water through water efficiency activities and education; and
- Increasing the coverage of water meters across our network to further reduce consumption and to improve our understanding of water demand patterns.

While making the best use of our **sustainable sources of supply** by:

- Reducing abstraction from those water sources that have a detrimental impact on the environment;
- Making sure our future water abstractions do not pose a risk of environmental deterioration, as required by the Water Framework Directive;
- Increasing the flexibility and resilience of our supply system;
- Increasing or optimising deployable output from existing, sustainable sources where possible;
- Using catchment restoration techniques to improve habitats and ecological resilience to low flows;
- Using catchment management measures to protect our sources of drinking water supply from pollution risks; and
- Exploring trades in and out of our region to optimise national use of resources.

Understanding the views of our customers and wider stakeholders

We have worked with a wide range of stakeholders throughout the production of this WRMP. We have sought to understand whether we are addressing stakeholders' concerns about long term water supplies, and we have explored where we may have common risks or opportunities. Throughout our stakeholder engagement, we have heard clear feedback that we should be ambitious in our leakage and demand management thinking, and that we should continue to deliver on our environmental commitments. These views have shaped our thinking as we have explored the options set out in our WRMP.

We encouraged a wide range of stakeholders to provide us with feedback on our draft WRMP. While we did not receive any objections to our supply and demand proposals, there were some important topics where stakeholders challenged us to do more for our final WRMP. Table 1 overleaf summarises those topics into key themes, and sets out the action we have taken for our final WRMP.

Table 1: Key themes important to our stakeholders

Theme	Position in our draft WRMP	Action we have taken	Materiality of the changes we have made
Underlying assumptions – Customers & engagement	Our draft WRMP was informed by deliberative customer research into supply / demand needs and options.	We've continued with our customer engagement through our PR19 investment planning process, and we have used this further insight to inform our final WRMP thinking.	We've introduced measures to protect customers from the risks around the proportion of our investment programme that is driven by climate change uncertainty.
Demand management - Leakage	Reduce leakage by 15% in AMP7, with modest reductions in later AMPs depending on supply / demand need	We've increased our leakage ambition to achieve a 50% leakage reduction over 25 years. In AMP7 we will prioritise leakage reduction in the areas of greatest supply / demand need. In AMP8 and beyond we will expand our leakage reduction activities into all of our Water Resource Zones (WRZs) regardless of supply / demand need.	This is the largest change to our draft WRMP. We move from a 19% leakage reduction over 25 years to a 50% reduction.
Demand management - Metering & water efficiency	Adopting an enhanced metering programme to achieve 100% coverage by end AMP9.	We've benchmarked our planning assumptions against other companies' reported experience. We've initiated an enhanced metering trial to inform and strengthen our delivery plan. We've introduced measures to protect customers from the delivery risks associated with a large metering programme.	No change to our ambition of 100% meter coverage by the end of AMP9
Underlying assumptions – Water Industry National Environment Programme (WINEP) version 3	Based on the understanding of sustainability reductions indicated in WINEP2.	We've completed our AMP6 investigations into environmental impacts of abstraction, and we've updated our understanding of WFD deterioration risk. These conclusions were reflected in the Environment Agency's release of WINEP3 in April 2018. We've updated our supply / demand assessment to incorporate any changes between WINEP2 and WINEP3.	Minor changes to the supply / demand balance in our Forest & Stroud WRZ and our Nottinghamshire WRZ.

Theme	Position in our draft WRMP	Action we have taken	Materiality of the changes we have made
Supply – Water trading	We considered a number of potential new water trading options, but we did not include any new active trade in our draft WRMP. The preferred programme of options in our draft plan included an option that had consequences for the existing raw water export arrangements to Yorkshire Water.	We've revised the scope of our option to increase output from Derwent Valley Reservoirs so that it no longer impacts on Yorkshire Water's WRMP. We've continued to explore feasible new trading options with neighbouring companies. We have ensured that trading assumptions are aligned across different companies' final WRMPs.	The overall preferred programme of options in our final WRMP is not materially different from our draft WRMP.
Supply – Water supply options	Enhancements to a number of existing water treatment works plus new strategic transfer capacity to provide around 325Ml/d of new deployable output over 15 years.	We've revised the timing and scope of the programme of our supply-side options described in our draft WRMP to take account of our latest understanding of impacts on others, WINEP3 requirements and the costs and benefits of the supply-side options.	The overall preferred programme options is not materially different from our draft WRMP. We have introduced measures to protect customers against the risks of such a large infrastructure investment programme and the associated uncertainties.

Each of these themes are explored in more detail in our Statement of Response document.

As well as these key themes, stakeholders also asked us for more detail on a number of technical aspects of our planning and decision making. We provided more detail on these topics in our Statement of Response to the consultation comments that we received about our draft WRMP. Where necessary we have updated the relevant sections of this final WRMP publication.

4. Our current approach

Each WRMP describes our plans to meet expected changes in supply and demand for water over the coming years. We review our WRMP every five years and we revise our long term plans to reflect our latest understanding of the future supply and demand needs.

We have successfully delivered the supply and demand improvements described in our previous WRMPs, ensuring that we meet changing demand for water and preserve the security of our supplies. In turn, this has helped us to maintain our record of having no drought related water use restrictions since 1995-96.

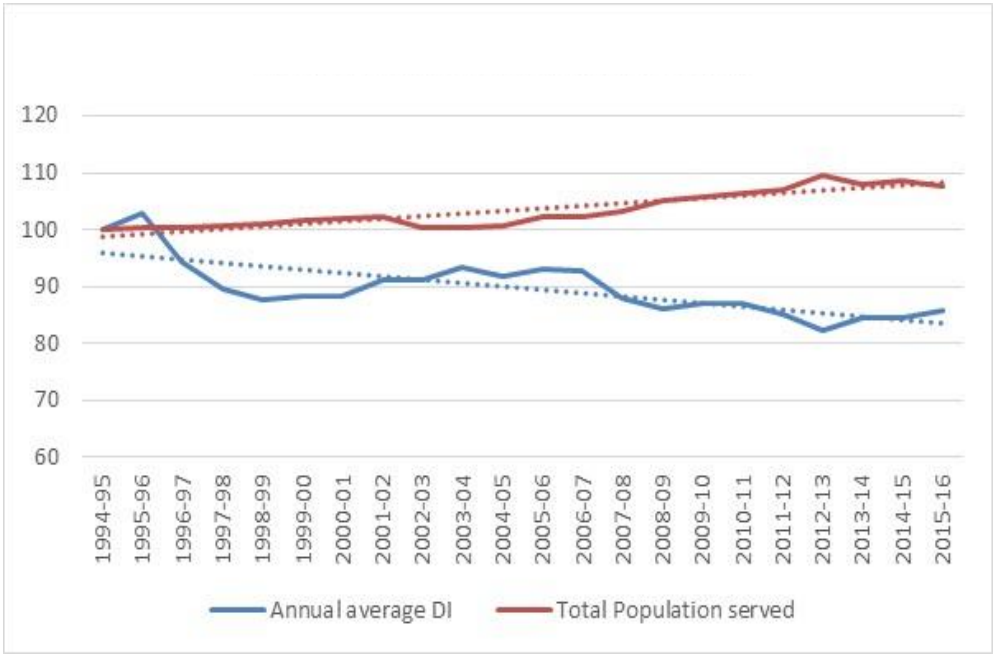
Meeting the changing demand for water

The success of our leakage and demand management initiatives means that over the past ten years we have been able to supply the growing number of customers in our region while also achieving a long term reduction in the volume of water we have to put into supply, known as 'Distribution Input' (DI).

Figure 3 illustrates that the long term downward trend of water into supply has been achieved against a backdrop of steadily growing regional population. Within this timeframe and long term downward trend, there have been short periods of rising and falling water into supply linked to the economic cycle affecting commercial demand, weather trends impacting leakage in the winter, and household consumption in the summer. For example, since 2012/13 we have seen an increase in commercial demand linked to the wider economic recovery. As we continue to deliver our leakage and water efficiency targets, we expect this long term downward trend to continue.

The activities set out in our previous WRMPs mean that we will achieve a leakage reduction of 72Ml/d (15%) between 2010 and 2020, and reduced water consumption by around 45Ml/d through our water efficiency programme.

Figure 3: Index of Distribution Input and population growth



Our successful leakage and demand management record gives us a strong platform on which to build the ambitious reductions set out in this latest WRMP.

Improving security of supply

Our previous WRMPs have explained how we will invest in new and improved sources of supply so that we can maintain the security of water supplies. Some of the most significant water supply improvements made over recent years include:

- Increasing the capacity of the Derwent Valley Aqueduct by duplicating sections of pipeline;
- Providing a new, alternative source of supply on the River Severn to support our 1.3 million customers in Birmingham and to facilitate the proactive maintenance of the Elan Valley Aqueduct;
- Drilling three new production boreholes in Edgbaston to support supplies to Birmingham;
- Refurbishing our Beechtree Lane boreholes for use as support to the Elan Valley Aqueduct flow; and
- Converting boreholes at Burbury Park, Newton Place and The Crescent (the Hockley boreholes) to public water supply sources for emergency use.

As well as these new water supply assets, we have used other innovative ways to improve the security of our water supply. These included:

- Abstraction rights trading
  Through water trading discussions in 2015 we agreed to purchase 31Ml/d abstraction rights from a third party on the River Severn and transfer these rights to our existing Site G water treatment works. Securing these rights increases our Strategic Grid deployable output, drought resilience and provides greater operational flexibility, and defers the need for some of the planned water resources schemes outlined in our last plan. An abstraction rights trade on this scale had not been completed before in England and Wales.

- Catchment management
  In recent years we have implemented an ambitious catchment management programme to protect our sources from pollution. Catchment management plays a critical role in supporting our supply/demand plan by helping ensure reliable and sustainable output from our existing sources.

This WRMP builds on our track record, but includes a further step change in our ambition in response to the future water supply challenges that we face.

5. Our response to future water supply challenges

As we have developed this WRMP, we have had regard to Government policies and priorities as set out in Defra's Guiding Principles document and the detailed technical requirements specified in the Environment Agency's Water Resources Planning Guidelines. We have used this policy and technical guidance to inform the methods used to develop the plan, and to help us in our decision making process. This includes the future water supply challenges that we have identified, and the outcomes for customers and the environment that we will deliver in response to them.

Preserving our resilience against droughts

The primary purpose of the WRMP is to demonstrate that we will be able to sustainably meet the demand for water over the next 25 years, even when under drought conditions. The 2017 Water Resources Planning Guideline recommends that as a reference level of service, companies' WRMPs should be tested against a reference 1 in 200 year drought event. Ofwat has also defined a 1 in 200 drought resilience metric for all water companies to report against in AMP7.

For our previous WRMPs, our historic level of service has been to make sure we experience no more than three hosepipe bans every 100 years, and that we should never resort to emergency drought measures such as standpipes or rota cuts. Since publishing our previous WRMP in 2014, we have worked with regulators and the wider industry to explore new ways to quantify drought risk so that we can better evaluate whether future investment is needed. We have done this by examining historic extreme droughts that occurred in the 19th century and comparing their severity with events that occurred in our 20th century data record. We have also used advanced statistical techniques to simulate theoretical drought events that go beyond our historic experiences.

Our drought assessment concludes that through the actions we have taken in the past, our raw water supplies are already resilient to a 1 in 200 year drought event.

Therefore we do not anticipate needing to invest in new sources of water for the purpose of improving drought resilience. Instead we will be looking to preserve our drought resilience as we consider how we respond to our other long term water supply and demand pressures. Also, through our wider water distribution investment planning we will identify where we need to increase our network distribution capacity to meet changing patterns of demand, particularly at peak times.

Securing sustainable abstraction and preventing future environmental deterioration

Previous WRMPs have dealt with the legacy of public water supply sources that impact on the environment and contribute to low flow and aquatic ecology problems. This latest WRMP continues that ongoing programme of restoring sustainable abstraction (RSA) and builds on the extensive environmental impact investigations that we are carrying out in AMP6, our largest ever impact investigation programme. For this WRMP, the RSA implications are that we need to reduce abstraction at a number of sources by up to 39Ml/d over the next ten years.

We have also considered the future, long term impacts of our wider abstractions. We need to put measures in place that will prevent a future deterioration of the environment. This is a fundamental objective of the Water Framework Directive (WFD). For us, this means we need to be satisfied that our abstractions and operations do not cause environmental deterioration at any point in the future.

This WFD 'no-deterioration' issue is a new challenge for the WRMP process and presents us with a material change to our previous WRMP assessments. The overall impact of this unsustainable abstraction and Water Framework Directive challenge is that around 170Ml/d of our current deployable output may have to be replaced. Since 2016, we have worked with the Environment Agency to assess the likelihood of our sources causing future deterioration, and we have developed an approach that allows us to prioritise where we need to provide alternative ways of supplying customers. We have also identified those sources where there is less likelihood of future deterioration, meaning we can maintain our existing sources of supply.

For our draft WRMP, we based our plan on the list of abstraction changes and water body priorities that we expected to see in the Environment Agency's Water Industry National Environment Programme (WINEP). Since we published our draft WRMP, the Environment Agency have updated their list of priorities and objectives in the third release of WINEP, known as WINEP3. Information associated with WINEP3 was made available by the Environment Agency in April 2018.

Overall, WINEP3 does not materially change the proposals described in our draft WRMP. The main changes that WINEP3 has made are:

- A reduced supply / demand deficit in our Forest & Stroud WRZ. Our draft WRMP had previously assumed we would need to make permanent reductions in abstraction from our Buckshaft source. However, WINEP3 reflected the conclusions of our AMP6 environmental investigations which were that we should focus on in-river and habitat improvement measures in the Cinderford Brook rather than make long term reductions in abstraction. The impact of this is to remove the need for the Whaddon to Forest & Stroud transfer option that was included in the preferred programme of options in our draft WRMP.
- A small increase in the supply / demand balance deficit that we were already planning to address in the Nottinghamshire WRZ by 2030. This change follows the conclusions of our AMP6 investigations into unsustainable abstraction across a number of our Nottinghamshire groundwater sources, and our latest assessment of sources with the potential to cause future groundwater body deterioration. The impact of this, along with the updates to the costs and benefits of our different supply options, has led to changes in the timing of the new supply-side option proposed for the Nottinghamshire WRZ and a revision to our long term leakage profile in this zone.

Our risk and prioritisation approach means we have developed a package of measures that we propose to implement over the next ten years to reduce unsustainable abstraction and prevent future deterioration. These measures range from strategic investment in new, alternative sources of supply to replace those abstractions that could cause future harm, through to local environmental protection measures that will mitigate for the effects of our ongoing operations. Our plan also includes a step improvement in leakage and demand management measures which will play a key role in preventing an increase in water abstraction which could otherwise contribute to a future deterioration of Water Framework Directive environmental status.

Planning for climate change and uncertainty

Our WRMP takes into account the potential long term impacts of climate change on our water resources. The WRMP also addresses the significant uncertainty around those long term impacts.

Our WRMP uses the best practice UKCP09 datasets and combines them with our own water resource modelling capability to produce a range of plausible, climate impacted future scenarios. We have tested the impact of the full range of those scenarios on our investment decision making, and have produced a plan that takes a proportionate approach to mitigating for this future uncertainty. The approach we have taken is an evolution of that used for our 2014 WRMP and which was used to underpin our 2015-20 (AMP6) water supply / demand investment measures.

While the UKCP09 climate change scenarios present us with a wide range of potential impacts, almost all of the scenarios point to a long term loss of deployable output due to changing weather conditions. As a result, we are proposing ambitious 'no-regret' leakage and demand management measures for 2020-25 (AMP7) that will complement our longer term plans to improve water supply reliability.

Our climate change modelling approach is described in detail in Appendix A.

Meeting future growth

We need a plan that can provide a reliable supply of water to our current and future customers. We expect population and housing numbers to continue to grow across our region and we need to be able to meet that growth in demand for water services. Our plan is to offset this growth through demand management measures, by improving the flexibility of our water supply network, and by providing new sources of water where necessary.

Since the year 2000 the population of our region has grown by 0.5 million people, but over this same period the total amount of water we put into supply has fallen by 3%. We have achieved this in part by reducing leakage on our own network, and helping customers to reduce their own water consumption.

Our WRMP highlights that the population of our region is likely to grow by a further 1.13 million people over the next 25 years and at the same time our water resources will become scarcer. Therefore we need to increase our leakage and demand management efforts to help offset this growth in water demand where possible.

Providing resilient supplies

The WRMP specifically considers our resilience to drought events, and sets out our long term proposals to manage this risk. Our WRMP has been developed in parallel to our wider PR19 investment plans so that there is full alignment in our approach for preventing loss of supplies to customers between both plans. We will achieve this improved operational resilience by carrying out activities and interventions that enable us to provide a continuous supply of water under a wide range of shocks and stresses. Our PR19 plans set out investment we need to make across the whole of our water supply and distribution system to so that our customers benefit from:

- Water that is always there when they need it; and
- Water that is good to drink.

Our plans to achieve these outcomes include a programme of proposed investments that will improve our ability to maintain supplies to customers during times of loss of water resource (for example, occurring due to borehole contamination), loss of treatment capacity (for example due to asset or power failure) or distribution issues (for example burst pipelines). Our overall strategy for managing system resilience is to:

- Operate at the right level of risk;
- Optimise the use of our existing assets/system capability
- Minimise failure points and implement a more pro-active maintenance approach which allows investment to be prioritised effectively; and
- Maximise efficiency and resilience - build a future network which is resilient and effective for customers and the environment and efficient to operate.

Finding the optimal response

We recognise the need to establish a balance between protecting our customers from the cost of activities to increase resilience and the risk of an event disruptive to supply occurring. To help find the optimal resilience response to risks to our critical infrastructure, processes, systems and networks, we apply the Cabinet Office's 2011 'Keeping the Country Running' '4Rs' four box model that comprises resistance, reliability, redundancy and response and recovery. These are described below and illustrated in Figure 4 overleaf.

- Resistance:
  Protecting or engineering assets and systems to withstand resilience events.
- Reliability:
  Ensuring assets and systems have a wide and stable operating range to operate under a resilience scenario.
- Redundancy:
  Duplicating capacity so service can be maintained under a resilience scenario.
- Response and recovery:
  The ability to effectively recover asset or system capability after a resilience event.

Figure 4: Components of the four box model

We consider each of the 4Rs against a given risk in turn to ensure we don't assess resilience options too narrowly. Before opting for an 'asset heavy' solution we would first consider other options or blend of options to produce the most cost effective and proportionate strategy. For example, for a short duration interruption and discolouration event, operational and process improvements may be more effective than building additional redundancy.

Our 'resilience in the round' framework

We've developed the Cabinet Office's approach that we've historically used into a 'resilience in the round framework' as we move to a 'systems thinking' approach. While our current approach addresses resilience, developing a more systematic approach has been essential to ensure our approach is more rounded and drives greater focus on finding the optimal solution for corporate and financial disruption – as well as operational.

We've worked with leading consultants experienced in resilience best practice and employed a holistic framework of a well-functioning and resilient system. The framework brings together the processes and activities already in place, with the approach set out by Ofwat, into a single framework – our 'resilience wheel' as illustrated in Figure 5 overleaf.

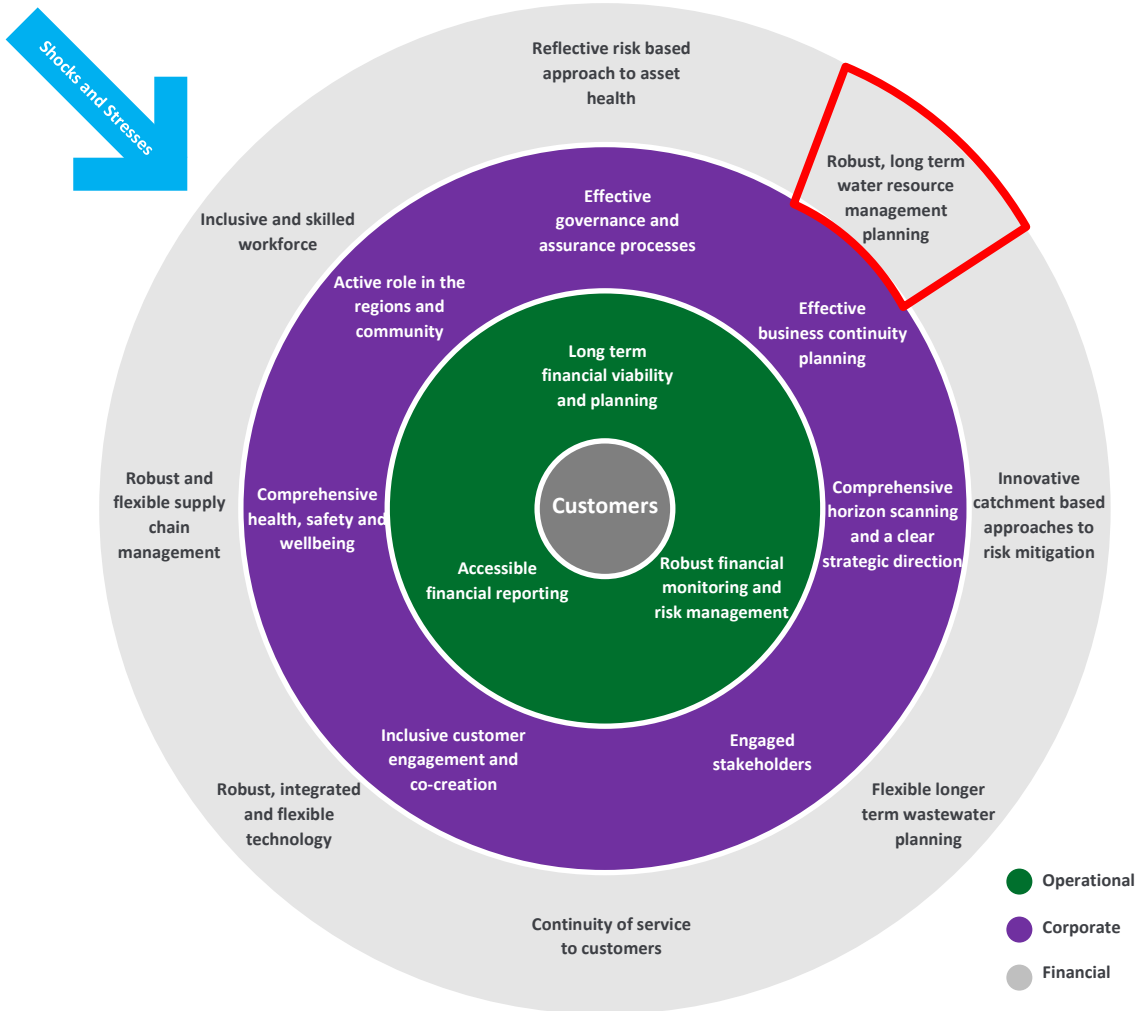
Approaching resilience through our resilience wheel ensures we think about the short-term risks and longer term trends that could impact our ability to deliver service – both business as usual and during times of external stress – and what we do to avoid, cope and recover from this disruption.

We decide on the best resilience solution 'in the round'. Avoiding or managing risks in one component, may effectively make us resilient in another, for example, our industry leading innovative catchment management initiatives tackle pollution problems at source, thus minimising costly treatment solutions later. Systems thinking also crosses between our operations, financial systems and wider organisation - with risks identified in one area informing our approach in another. For example, our long term financial viability testing, stress tests operational risks (e.g. failure of key assets, failure to deliver what customers want, cyber security) and risks to our organisation (e.g. failure to comply with legislation, health and safety) to inform our approach to long term financial planning. Adopting this framework ensures we don't look at resilience in isolation – the components work together as a system.

Our risk-based approach to building operational resilience puts customers at the centre of our decision making while balancing the needs of the environment and our communities.

We've taken a holistic systems approach to understanding the interrelations between the multiple decisions we make to plan and deliver operational resilience. Systems thinking enables us to make better, more informed and sustainable choices because we're able to better understand the wider consequences of decisions in one part of the system and their impact on others.

Figure 5: The 'resilience in the round' framework we have adopted – our resilience wheel



For our wider PR19 investment planning, we have applied these strategic principles of resilience to the following areas in particular:

- Resilience of our critical assets
- Borehole and ground water resilience
- Power resilience
- Local resilience
- Risk to our assets from flooding

Where we identified that new supply capacity is needed to maintain the supply / demand balance, we have prioritised selection of options that make the best use of our sustainable sources of supply. We have focussed on options that:

- Increase the flexibility and resilience of our supply system, such as the new strategic supply links.
- Increase or optimise deployable output from existing, sustainable sources where possible, such as increasing the capacity of our existing water treatment works.
- Make use of potential trades in and out of our region to optimise national use of resources.

The preferred programme of options and appraisal of different investment choices has been developed in parallel with our wider water distribution and supply resilience strategy. We have ensured that we understand the holistic total expenditure (Totex) implications of our investment choices, and we can derive a fully integrated, optimised supply/demand, infrastructure and leakage investment plan.

Our supply / demand decisions are underpinned by our broader capital maintenance and water quality investment programme. At the same time, the options and activities included in our WRMP not only contribute to addressing future supply/demand challenges, but also deliver broader benefits to our customers by creating more resilient supplies.

The full range of drivers that have been considered as we have sought to optimise water resources and supply / demand solutions over the long term are summarised in Table 1 below:

Table 2: Drivers considered when selecting an optimum programme of options

Driver	Summary of need and opportunity
Supply / demand pressures	Provide increased capacity to address future deficits driven by climate change, Water Framework Directive and population growth. Release 'locked up' deployable output by removing constraints.
Reduce operating costs	Reduce water treatment and pumping costs by achieving economies of scale and maximising the outputs of our treatment works with lower variable operating costs.
Enable Grid assets to be efficiently maintained	Improve maintenance efficiency through strategic rebuild rather than 'patching' individual processes with multiple intervention activities. Allow more efficient maintenance interventions by extending the period for which whole process streams can be taken offline. Reduce the risks to water quality and customer interruption when assets are taken out of service.

	Enable major water treatment works to be taken fully offline. Enable critical aqueducts and pipelines in our grid to be taken offline for inspection and extended maintenance.
Drought resilience	Increasing resilience to drought and reducing cost of failure.
Water quality risk	Effectively meet new raw water challenges and drinking water standards.
Water trading	Identify opportunities for trading water with neighbouring water companies, both into and out of our region.
Other resilience	Remove risks by developing a flexible network that can continue to maintain supplies during an unplanned outage of a water treatment works or strategic link. Provide more headroom to meet future peak demand.

Meeting our customers' and stakeholders' expectations

We have engaged with our customers and stakeholders throughout the production of this WRMP. We began formal engagement at the launch of our stakeholder workshops in 2016, and we have continued this proactive engagement through a series of ongoing events, forums and consultation exercises. Through this process we have communicated with a wide range of interested parties including regulators, environmental interest groups, planning authorities and customer representatives.

We have heard a consistent message throughout this engagement that our plan should focus on ambitious leakage and demand management measures and on ways we can better engage with customers on the environmental impacts of water resource management. The recommendations set out in this WRMP have been shaped by this customer and stakeholder feedback.

Since we published our draft WRMP, we have continued our customer research using face to face constructive, collaborative discussions with our customers about how we should approach delivering water supply and demand improvements. To ensure we gained appropriate understanding of our customer views we used a variety of different approaches, including deliberative research. One of the biggest advantages of using deliberative research is that is allows for in-depth discussion with customers not just about needs and outcomes, but also approach. Customers gained in understanding as our day-long workshops and sessions progressed. This enabled a more meaningful exploration of issues that could not be achieved using more traditional qualitative and quantitative approaches.

We have also used innovative techniques to gain insight from social media on customers' views and priorities. We also commissioned some additional customer research in response to the stakeholder responses to our draft WRMP.

Our insight into customers' views on water supply and demand is now even richer than at the time of writing our draft WRMP, and comes from a number of sources. Issues such as leakage tend to be top of customers' minds and our evidence sources include our analysis of customer contacts, social media scraping and numerous research projects. For other aspects such as metering and water efficiency we have used co-creation to work with customers to understand how they can be part of the solution.

Overall, there is a clear expectation from customers that we should have plans in place to ensure a continuous water supply, both now and in the future. As part of this, customers expect us to be prepared to address any

long term challenges which could affect water supply, such as climate change or population growth. Customers also expect us to meet our statutory obligations, including those related to restoring unsustainable abstraction and ensuring no environmental deterioration. Our customers tend to favour demand management approaches over supply-side approaches, but they recognise that any solution will need to include a blend of both approaches.

Our customers want us to pursue the best value supply/demand options, not necessarily just the lowest cost ones, and questions of value and bill impact were particularly important to customers when thinking about solutions that will take a number of years to implement. While most customers are happy to contribute to the cost of long-term water security, they are clear this should be spread out over time, so as not to cause undue financial burden for customers.

Chapter 7 lists the stakeholders we have worked with, and how their views have helped shape this WRMP.

Meeting our wider regulatory obligations

While the primary purpose of the WRMP is to ensure we have sustainable, long term plans to meet future demand for water, we also need to take our wider regulatory obligations into account. As part of the WRMP planning process, we have been given policy and technical guidance from Defra and our regulators including the Drinking Water Inspectorate, Environment Agency and Ofwat. This guidance covers a variety of statutory requirements covering topics such as supply resilience, drinking water protection and environmental protection. The guidance also sets out policy expectations and performance challenges covering leakage, demand management and innovation.

Throughout the development of our WRMP we have sought to address these different requirements and expectations. We believe that our plan provides a holistic approach to achieving these multiple drivers in an affordable and proportionate way.

Managing uncertainty and making complex decisions

Our WRMP looks ahead at the possible water supply and demand issues that we face over the next 25 years and longer. Many of these issues are very uncertain in terms of the magnitude of their impact, the likelihood of them occurring and the timing of when they could occur. Therefore, it is important that we test how sensitive our plan is to these uncertainties and that we understand which planning assumptions are most significant.

We have used a variety of methods to manage this uncertainty and to test the impacts on our long term plans. Through our approach, we have produced a plan that considers short, medium and long term risks and that recommends investment decisions that are 'low-regret' and are flexible enough to adapt to a changing future.

Chapter 8 describes the different stages of our decision making framework, and how we have arrived at the recommendations made in this WRMP.

The size of our supply / demand challenge

Based on our understanding of the future challenges described above, we have assessed the likely impacts on our ability to maintain a balance between the supply and demand for water over the next 25 years and longer term. Our assessment shows that without future investment, we face supply / demand shortfalls in our Strategic Grid, Nottinghamshire and North Staffordshire water resource zones. Figures 6 to 8 illustrate the potential scale of those shortfalls if we do not invest new supply / demand measures. Our proposals to manage these future challenges and prevent future supply / demand deficits from occurring are set out in Chapter 6.

Figure 6: Strategic Grid WRZ baseline supply / demand balance

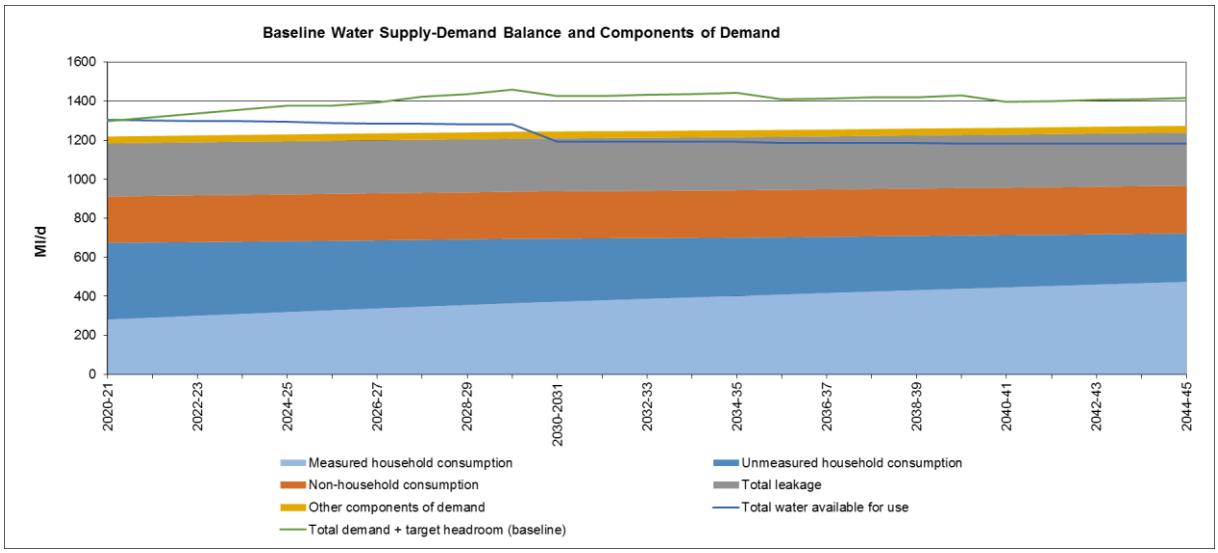


Figure 7: Nottinghamshire WRZ baseline supply / demand balance

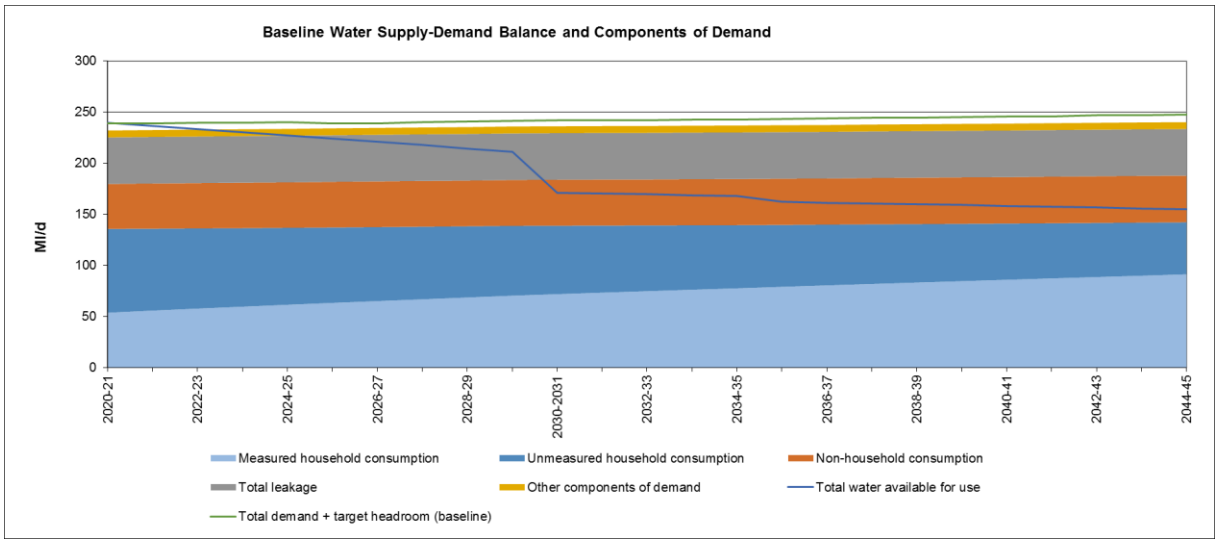
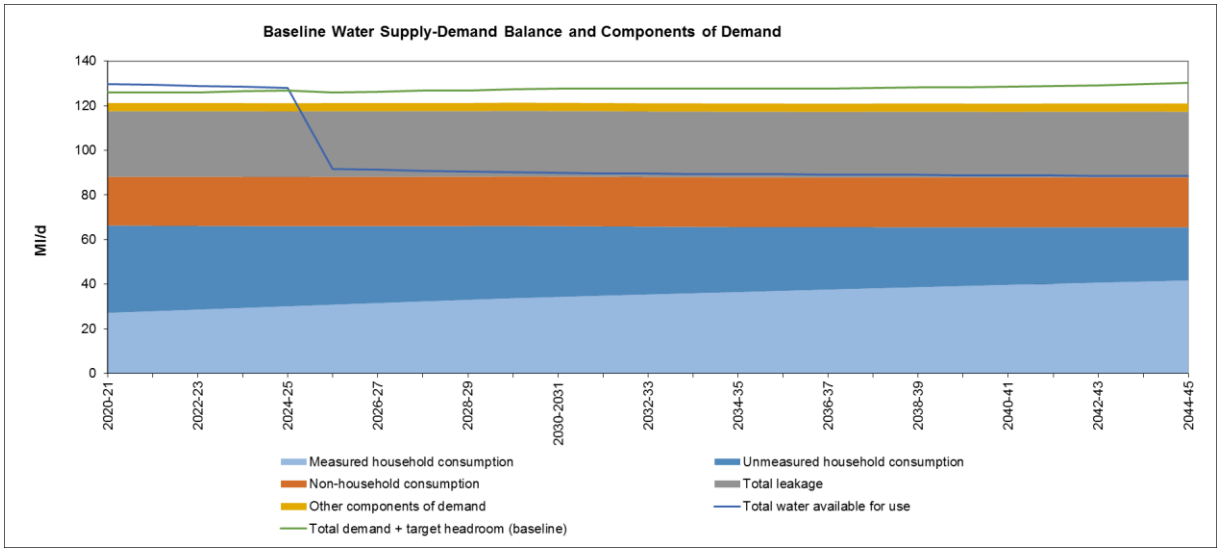


Figure 8: North Staffordshire WRZ baseline supply / demand balance



6. Our long term water resources strategy

While this is our fourth published WRMP, it responds to a supply / demand challenge that is far greater than in any of our previous plans. In particular, the issues around long term sustainable abstraction and how we achieve our Water Framework Directive obligations mean we need to make a step change in our leakage and demand management performance as well as developing new strategic sources of supply for the long term. Our long term strategy is therefore to maximise the use of demand management measures to reduce the amount of water we abstract from the environment, while making the best use of our sustainable sources of supply.

We explain the impacts of the different supply and demand challenges that we face over the coming years, and set out our proposals for meeting these challenges and making sure customers' supplies are not put at risk below. Supporting details on these issues and our proposals can be found in the accompanying technical appendices to this WRMP document.

Reducing leakage on our network

Leakage currently makes up around 23% of the total water we put into supply. As explained in Chapter 4, we have a strong track record of reducing leakage, and over the past 10 years this has helped us to meet the water needs of a growing population without having to increase the amount of water we abstract and put into supply. Our leakage reduction activities will have reduced leakage by around 72Ml/d (15%) over the ten years between 2010 and 2020.

As part of this WRMP, we propose to reduce leakage by a further 15% over the five years between 2020-25. This is driven in part by our need to generate more headroom to accommodate the impacts of climate change uncertainty, and to provide a significant contribution to offsetting the AMP8 supply / demand impacts of preventing environmental deterioration to achieve Water Framework Directive objectives. This level of leakage reduction is extremely ambitious, and is part of what we believe to be a 'no-regret' package of AMP7 leakage, metering and demand management measures. The 15% target contributes to our wider package of demand management and supply improvement investment proposals that has been derived using our least cost supply / demand investment modelling.

Every five years we update our long term economic level of leakage assessment as part of the WRMP process. Our traditional approach to setting leakage reduction targets in previous WRMPs has been led by an economic appraisal of the costs and benefits of reducing leakage in the context of the overall supply / demand needs. In zones where there is a forecast supply / demand deficit, then leakage reduction has been considered as part of the least-cost package of measures to resolve that deficit, along with water resources and other demand management measures.

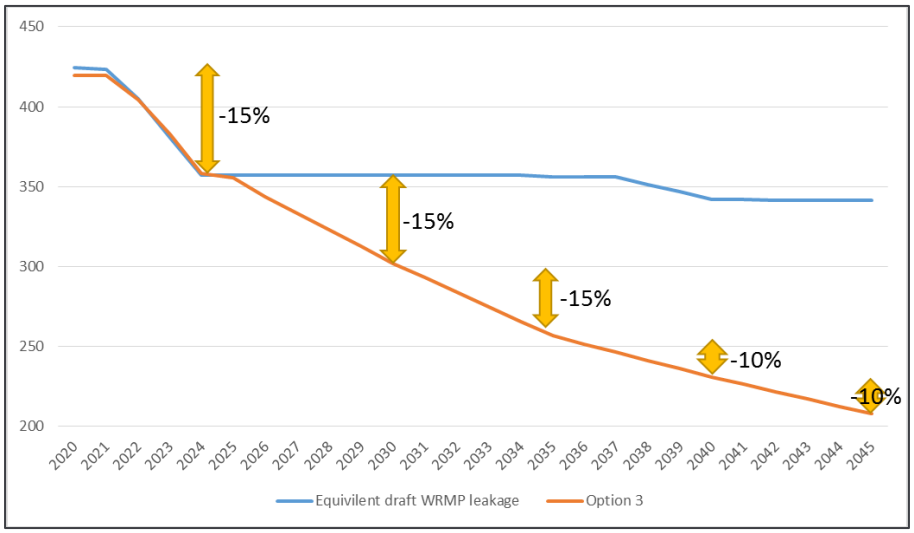
In our draft WRMP we proposed longer term leakage targets that were based on a continuation of the traditional approach to economic appraisal of supply and demand needs and intervention options. As a result, our draft WRMP included a long term leakage reduction profile that comprised a 15% reduction in AMP7 followed by modest reductions in subsequent AMPs.

Having listened to the feedback from stakeholders and our ongoing engagement with customers, we have changed our long term leakage ambition for the final WRMP. In AMP7 and AMP8 we will continue to prioritise leakage reduction activities to benefit customers in the zones with the greatest supply / demand balance challenges, but we will also extend our ambition into zones with a lower supply / demand balance risk. Our ambition is to reduce leakage by 50% over the next 25 years, and we will set targets that will drive our leakage technology and innovation thinking.

This approach means we continue to prioritise AMP7 leakage reductions targeted in the two zones with a supply / demand balance deficit. However, we would extend AMP8 / AMP9 leakage reduction into the remaining zones to maintain an overall AMP by AMP target reduction of 15%. In the very long term, the zonal reduction targets will not be set based on supply / demand balance need, but will be distributed across all zones based on short-run costs and ease of finding and fixing leaks.

Our new AMP by AMP leakage reduction profile is illustrated in Figure 9. Note that for WRMP purposes these numbers are pre-leakage convergence data changes, and are annual average targets. Our PR19 plan contains performance commitments based on new leakage and per capita consumption reporting guidelines and will state the leakage performance commitment as a three-year average.

Figure 9: Long term 50% leakage reduction target over 25 years



The leakage targets we are proposing through this WRMP are shown in Table 2 below. The biggest leakage reductions are targeted in the water resources zones with the greatest supply / demand needs.

Table 2: Leakage Targets

25 year leakage targets per water resource zone (Ml/d)	2019-20	2024-25	2029-30	2034-35	2039-40	2044-45
Bishops Castle	0.6	0.6	0.5	0.4	0.4	0.3
Kinsall	1.1	1.1	1.0	0.8	0.7	0.7
Mardy	0.9	0.9	0.8	0.7	0.6	0.6
Ruyton	1.6	1.6	1.4	1.2	1.1	1.0
Newark	1.8	1.8	1.6	1.3	1.2	1.1
Rutland	1.9	1.9	1.6	1.4	1.2	1.1
Chester	2.9	2.7	2.3	1.9	1.7	1.6
Whitchurch and Wem	3.0	3.0	2.5	2.1	1.9	1.7
Stafford	5.4	5.4	4.6	3.9	3.5	3.2
Forest and Stroud	15.0	14.6	12.7	10.8	9.7	8.8
Wolverhampton	14.4	14.4	12.2	10.4	9.4	8.4
Shelton	24.0	24.0	20.4	17.3	15.6	14.0
North Staffs	29.4	29.4	25.0	21.3	19.1	17.2
Nottinghamshire	45.6	39.6	33.6	28.6	25.7	23.2
Strategic Grid	272.1	214.1	181.9	154.7	39.2	125.3
Company total	**419.6**	**355.3**	**302.0**	**256.7**	**231.0**	**207.9**

Influencing customers' use of water through water efficiency activities

Similar to our approach to leakage, our thinking on water efficiency has been shaped by stakeholders' views. We have heard a clear expectation that our long term plans should include ambitious demand management activities.

We already have an ambitious water efficiency programme, and over AMP6 we expect to deliver around 25Ml/d of water savings. We will do this by providing our customers with water efficiency advice, free products on request and subsidised higher value products on request, plus our more proactive targeted home water efficiency checks.

In AMP6 we launched our water efficiency home check programme, which started in the Rugby area and then expanded to Coventry. Customers in and around the area can sign up for a free home check, where we will visit the customer's home and fit free water saving devices, offer advice on how they can save water and check for simple leaks. This free service will help customers save water, energy and money. So far we have completed over 23,000 home checks and we have used the learning from this activity to inform this WRMP.

Our WRMP proposes to continue with these water efficiency activities, and to scale up our water efficiency home check programme. This approach is more expensive than simply providing products on request to customers, but provides greater certainty that products are installed and that savings are achieved. Our experience of this approach in 2015-17 has also shown that it is also popular with our customers. To maximise cost effectiveness, we intend to roll this programme out area by area and we will focus on areas facing supply demand deficits. We will also extend the home check programme to engage directly with social housing providers to help their tenants save water. This approach will help more financially vulnerable customers by making their water, and potentially their energy bills, more affordable.

We will also continue with our customer and community programmes to inspire our customers to change their water use habits. Our AMP6 community engagement team are focused on delivering two key messages: the importance of water efficiency, and ensuring our sewers remain clean and blockage free. This work is really important in protecting our environment and our customers from pollution incidents as well as external and internal property flooding. By focussing on water efficiency in this way, we also give customers the potential to reduce their water usage and therefore water bills.

Our proposals focus on working with household customers and we expect them to reduce customer demand by around 19Ml/d through our programme over AMP7. The expected savings are derived from our improved understanding of the impact of activities which we have learned from our AMP6 water efficiency home check programme. The water savings data we have gathered from our AMP6 home check programme means we have updated our assessment of the effects of fitting different water efficiency devices. In the longer term, our education and behavioural change activities will become an increasingly important demand management measure as there will be fewer options to retrofit water efficient devices.

Our WRMP does not include specific activity with non-household customers. Reducing demand for water by working with non-household customers is a key opportunity, but there is more work to do with retailers to better understand their planned water efficiency activity in our region as the market develops. We will continue to engage with retailers to explore these opportunities and we will continue to monitor what is happening in this market.

Increasing the coverage of water meters to support water efficiency and improve our understanding of water demand patterns

Our previous WRMPs have set out an ongoing approach to household metering that has been led by customer demand for the free meter option. As a result, only around 41% of households in our region currently pay by meter. Our last WRMP published in 2014 projected that this would grow to around 70% by 2040 based on our current metering policy.

We have already described our ambition to achieve a step change in leakage reduction and demand management, and we believe that metering could play a crucial role in enabling that ambition. Experience reported by Southern Water, Thames Water and Affinity Water during AMP5 and AMP6 suggests significant demand reductions of between 8% and 16.5% can be achieved as a result of large scale metering roll out as well as a 10% reduction in peak demand. We are proposing a change to our metering policy, moving from a reactive approach to a more proactive and targeted approach to increase household meter coverage.

We have explored a range of metering growth strategies that could accelerate the rate of meter coverage through AMP7 with options to get to full metering by the end of AMP8 or AMP9. Based on the benefits reported by other companies, we believe that achieving full meter coverage could deliver up to an 80Ml/d demand benefit. Our current thinking is that to secure the full 80Ml/d reduction would require us to adopt an external metering policy and combine this with a policy of helping customers tackle supply pipe leakage on their properties. We have previously expressed support for supply pipe adoption, and we would be pleased to see this happen at some point in the future for the benefit of our customers, as it would simplify addressing the problem of supply pipe leakage. We also want to explore smarter metering technologies that could be deployed in future.

We do not currently have the power to implement a compulsory metering programme as we are not classified by the Environment Agency as a seriously water stressed area. However, the scale of the emerging supply / demand challenge means there are grounds for exploring with Environment Agency and Defra whether such an application would be appropriate, for either the whole region or specific water resource zones, and the timescale over which it would be applied. In the absence of these legal powers, we are recommending a 'persuaded optant' strategy in AMP7. This means installing meters proactively and offering customers the opportunity to switch based on information on what their measured bill would be.

We believe this metering approach complements our 'no-regret' package of AMP7 leakage and demand management measures. We would follow an area by area approach, targeting the water resource zones with the greatest supply/demand deficit (Nottinghamshire, North Staffordshire and Strategic Grid). This will complement our longer term plans for new water source development, as we want to fully explore options to manage water demand (and be able to demonstrate the options to planners and regulators) before we seek to develop new sources of water.

As a result of this metering policy change, we expect the rate of meter coverage to accelerate in AMP7 and we aim to have achieved full coverage by the end of AMP9. We have considered the cost / benefit implications of a range of metering delivery profiles, and we have tested different options for increasing the pace of delivery and for prioritising which zones to focus on.

We have included an ODI around the metering programme in our PR19 plan to protect customers from the uncertainty of achieving the increased meter installation rate described in our WRMP. The design of the ODI means that customers' AMP7 bills will reflect investment for around two-thirds of the 2020-25 meter volumes included in our WRMP. The remaining one-third will be reflected in bills at the end of the 2020-25 period (i.e. effectively customers will be paying for these meters in arrears rather than upfront).

The expected meter coverage that our recommended metering programme will deliver is set out in the Table 3 below.

Table 3: Household meter installations and coverage per AMP

		AMP7	AMP8	AMP9	AMP10
Current metering policy	Number of meter installations	148,309	134,424	121,935	110,684
	%age of households metered by end of AMP	55%	60%	65%	69%
Recommended new metering policy	Number of meter installations	496,899	768,177	443,743	0
	%age of households metered by end of AMP	65%	88%	100%	100%

We expect the increase in meter coverage to deliver an average demand saving of around 10Ml/d by the end of AMP7. This is based on an assumed consumption saving of around 10% and includes benefits from finding and fixing leaking supply pipes.

However, we believe that there are wider demand management benefits that will result from increasing metering coverage, especially if we target the delivery on a geographical basis. In particular, we view the need for increased meter coverage to be a crucial enabler to delivering our very ambitious leakage reduction strategy. Currently around 60% of our household customers are not metered, and that means we have to estimate their consumption when we monitor leakage performance on our network. That makes it very difficult to distinguish changing consumption patterns from any leakage breakout on our network.

By increasing the number of metered properties on our network, we will have greater visibility of changing water demand patterns and better control of our network performance. This will make leaks easier to detect, and will mean we are able to deploy leakage repair more effectively and efficiently. This improvement in leakage detection and repair performance will be crucial to us achieving our challenging 15% leakage reduction target in AMP7 and our long term ambition to reduce leakage by 50%

To give us even more confidence in our metering plan, we have initiated an extended metering trial for 2018-19. The trial will deliver full meter coverage in two District Metered Areas (DMAs) and in the process will help our understanding of:

- Customer communications (pre, during & post installation)
- Customer acceptability
- Installation and delivery options
- Meter technology options
- Data communications process (hardware & software)
- Demand management benefits (Water efficiency, supply side leakage, customer side leakage)
- Network management benefits
- Links to our lead-pipe replacement strategy
- Links to our shared supply strategy
- Links to our mains renewal strategy

The outputs from this trial will be available in time to inform our AMP7 enhanced metering delivery plans.

To complement our metering plans, we continue to actively engage with the wider industry and Defra to explore the potential for long term national targets for per capita consumption (PCC) in line with the proposals in the Government's 25 year Environment Plan. To help the deliver the changes in customer attitudes and behaviours needed to achieve these ambitious PCC targets we are working with Defra and the wider industry on recommendations to introduce water efficiency labelling to white goods.

We are also investigating what can be learned from the recent 2018 hot summer, during which we recorded exceptionally high demand for water.

Reducing abstraction from those water sources that may be having a detrimental impact on the environment

Our WRMP addresses the legacy of unsustainable sources of water abstraction that, in some cases, date back over 50 years. Our previous WRMPs have included measures to reduce the impact of our historic abstractions on the environment and to provide alternative sources of supply where necessary. Our 2014 WRMP included schemes that would deliver a package of short term catchment restoration solutions to complement longer term abstraction and supply infrastructure reconfiguration. The proposals set out in our new WRMP would mean scaling this approach up over the next ten years.

In AMP6 we are delivering an ambitious environmental programme that will improve rivers across our region. We have committed to improve river water quality and ecology in over 115 water bodies across our region, along with improving the condition of 75 hectares of designated SSSIs. Our improvement activities include removing or reducing the impacts of our water abstractions on river ecology, improving approximately 258km of river reach.

During AMP6 we have also undertaken our largest ever programme of Restoring Sustainable Abstraction (RSA) investigations. In AMP6 we investigated 37 of our public water supply abstractions (29 groundwater and 8 surface water), which provide up to 191 Ml/d of current daily abstraction. Our AMP6 work has focussed on quantifying the magnitude of any impacts and identifying the cost / beneficial options for removing those impacts. The learning from these investigations has informed the scope of this WRMP.

Our plan includes short and long term measures to remove or offset the environmental impacts of damaging abstractions, and to help the associated water bodies achieve Water Framework Directive (WFD) objectives. We have worked closely with the Environment Agency, using our AMP6 investigations to understand which of our sources of abstraction could be contributing to low flow problems, and which of our sources have the potential to cause future deterioration.

Our draft WRMP was based on the list of abstraction changes and water body priorities that we expected to see in version 2 of the Environment Agency's Water Industry National Environment Programme (WINEP). Since we published our draft WRMP, the Environment Agency have updated their list of priorities and objectives in version 3, known as WINEP3. Information associated with WINEP3 was made available by the Environment Agency in April 2018.

WINEP3 was informed by the conclusions of our AMP6 investigations into the potential environmental impacts of our abstractions. The conclusion of these investigations in February 2018 included agreement with the Environment Agency on our priority sites for reducing unsustainable abstraction along with a range of agreed solutions for helping the associated water bodies improve their WFD status.

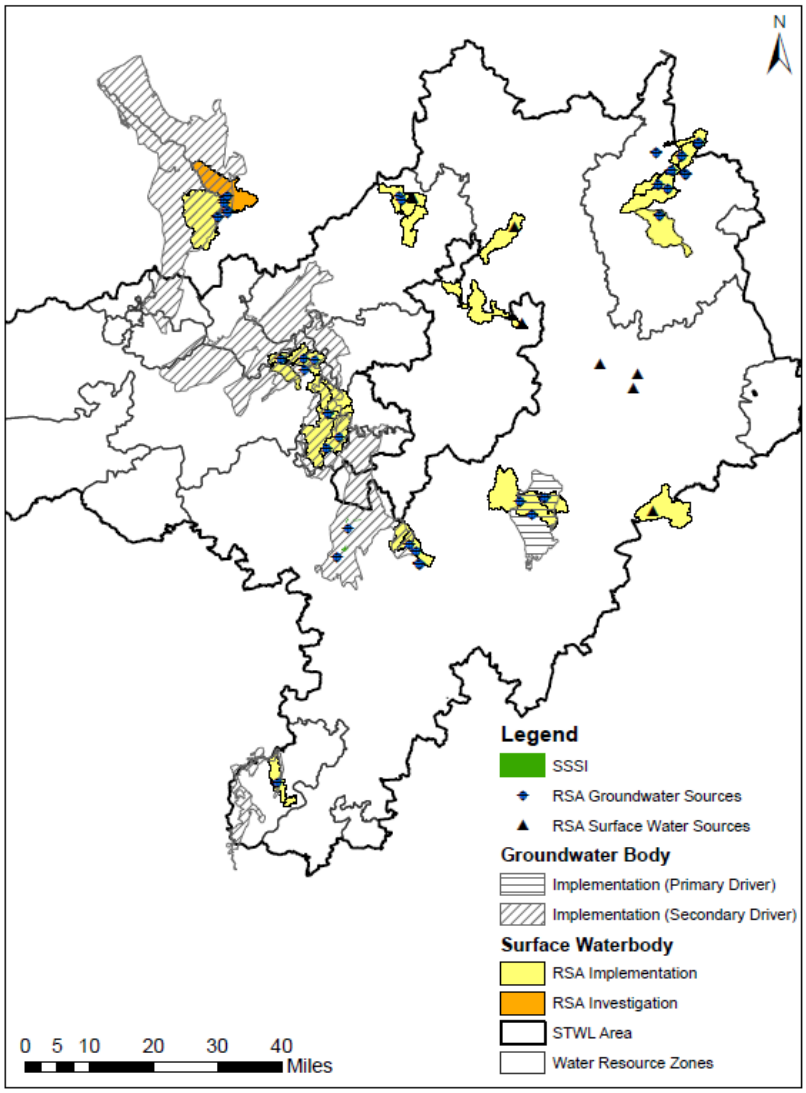
The conclusions of our investigations and our WFD risk assessments, along with any agreed actions, were incorporated by the Environment Agency into WINEP3. We have therefore included the WINEP3 changes in our final WRMP. Making the WINEP3 updates has resulted in some small changes to the size and timing of future abstraction reductions that we need to accommodate in our WRMP. Overall, WINEP3 does not materially change the proposals described in our draft WRMP.

The changes that WINEP3 made that are now accommodated in our final WRMP are:

- A reduced supply / demand deficit in our Forest & Stroud WRZ. Our draft WRMP had previously assumed we would need to make permanent reductions in abstraction from our Buckshaft source. However, WINEP3 reflected the conclusions of our AMP6 environmental investigations which recommended we should focus on in-river and habitat improvement measures in the Cinderford Brook rather than make long term reductions in abstraction. As a result, we no longer need the Whaddon to Forest & Stroud transfer option that was included in the preferred programme of options in our draft WRMP.
- A small increase in the supply / demand balance deficit that we were already planning to address in the Nottinghamshire WRZ by 2030. This change follows the conclusions of our AMP6 investigations into unsustainable abstraction across a number of our Nottinghamshire groundwater sources, and our latest assessment of sources with the potential to cause future groundwater body deterioration. The impact of this, along with the updates to the costs and benefits of our different supply options, has led to changes in the timing of the new supply-side option proposed for the Nottinghamshire WRZ along with a revision to our long term leakage profile in this zone.

Our investigations indicate that we need to reduce abstraction at a number of sources by up to 40Ml/d over the next ten years. Figure 10 below shows the sources being investigated, and illustrates the water resource zones most affected.

Figure 10: Unsustainable water bodies and water sources



In the short term we propose localised environmental protection measures that will allow us to continue to abstract from some sources until we can put longer term solutions in place to reduce or stop abstraction. We will also deliver an ambitious leakage reduction programme and a step change in demand management so that we prevent increasing our water abstractions at these sites.

However, the volume of abstraction at risk means that there is a need for new and alternative resources to be developed in order to maintain long term security of public water supplies. This challenge is further heightened by the need to protect the water and wetland environment from future deterioration, a key obligation under the Water Framework Directive. Historically, we could have accommodated abstraction reductions at unsustainable sources by increasing output from other, neighbouring sources of supply. The sites most affected by RSA impacts tend to be situated in the same water bodies as those sites with the greatest risk of causing further environmental deterioration in future. This means that we have had to rethink our approach to dealing with unsustainable abstraction, and we are having to consider the needs of the entire water body rather than just the localised impacts of our existing sources.

Making sure our future water abstractions do not pose a risk of environmental deterioration, as required by the Water Framework Directive

For this WRMP we face a new, strategic challenge in the form of demonstrating that our plan does not put at risk the future ecological status of the water bodies in our region.

Under the Water Framework Directive we have an obligation to prevent the deterioration of the quantitative and qualitative status of a waterbody. We have already described that our WRMP needs to explain how we will address unsustainable abstraction at sites that may have a history of causing environmental damage. For this latest WRMP, government and regulatory guidelines also require that our WRMP shows how we will prevent any future deterioration in Water Framework Directive status. For example, deterioration of the quantitative status of a waterbody could arise if our abstractions increase in the future due to needing to meet growth in demand.

This has a significant impact on our future supply capability and is a material change to our traditional approach to water resources planning. Many of our existing sources of water abstract at rates below the amount that they are fully licensed to take. This headroom in our abstraction licences is vital as it allows us to meet increases in demand during hot dry weather and plan for any growth in demand resulting from population change and housing development. Abstraction licenses issued currently require such headroom to be justified as both legitimate and environmentally sustainable. However, many of our historic licences were not subject to the kind of rigorous environmental assessment that is applied today.

The supply / demand forecasts we make in our WRMP are based upon an assessment of the maximum amount of demand we could meet using our fully licensed sources of supply. We know that we need to reduce unsustainable abstraction from sources that are causing environmental harm, and we know that we need to meet demand from a growing population. Our previous WRMPs have been based on an assumption that we can accommodate these changes by increasing abstraction from sources where there is abstraction licence headroom. For this WRMP, the WFD 'no deterioration' requirement means we can no longer assume we can take the full volumes that have been licensed.

We have been working with the Environment Agency on this issue since early 2016 to understand how our sources could put future Water Framework Directive water bodies at risk, and how we should deal with this challenge. As a result, our WRMP includes measures to manage this environmental risk in the short term, and longer term investment to reconfigure our water supply and abstraction system. For this WRMP we have worked on the basis that any formal changes to abstraction licences would not come into effect until the end of AMP8 in order to give us time to deliver the necessary new infrastructure.

The Environment Agency's release of WINEP3 was informed by our latest understanding of WFD deterioration risk, taking account of the Environment Agency's latest guidance on investigating the risk of WFD water body deterioration that was issued in January 2018. We have also improved our understanding of WFD deterioration risk at our river abstractions that are subject to Hands Off Flow (HOF) restrictions. As an example, through this additional modelling we have explored how the timing of any variations to our Egginton abstraction licence on the River Dove could impact on our final WRMP. As a result, we have updated our WRMP to reflect the changes made in WINEP3.

The types of solutions we plan to deliver have been categorised and are described in Table 4 overleaf.

Table 4: Types of solutions to prevent risk of environmental deterioration from our abstractions

Solution Type / Category	Description
Adapting our supply system and providing alternative ways of meeting future demand without increasing abstraction from sources that would deteriorate the Water Framework Directive status.	We propose to carry out this type of solution at those sources where we can be confident that deterioration is likely to occur if we increase our future abstractions. In many instances, there may be multiple other drivers impacting on the water body, such as already unsustainable abstractions or poor river water quality. In these cases the multiple lines of evidence tell us that we need to change our existing supply arrangements and use new, more sustainable sources of supply for the long term. For example, the combination of environmental pressures on groundwater bodies in our Nottinghamshire water resource zone tell us that we need to make strategic changes to the way we supply water to this zone. The planning and engineering aspects of developing new sources of water supply and reconfiguring our networks mean that such solutions are likely to require more than one AMP cycle to deliver. Therefore we are proposing a ten year package of environmental and catchment protection measures from 2020 to 2030 that will reduce the risk of deterioration in the short term, while we deliver new sources of supply for the long term.
Mitigating for the effects of abstraction and preventing future deterioration from occurring.	We will take this approach at sources where we believe we understand the potential for future deterioration and we believe we can manage the risk through a series of preventative actions. Measures such as local flow support, river restoration measures to improve environmental resilience, catchment and partnership solutions or localised demand management will help us mitigate against the risk of deterioration.
Other measures	Other measures such as enhanced source abstraction management controls through better Instrumentation Control and Automation (ICA) and telemetry and new distribution links to more sustainable sources of water will help us to prevent increasing overall abstraction from the water body and further reduce the risk of deterioration.
Investigating the environmental impacts of current abstraction and better understanding the likelihood of future deterioration occurring	We will do this at sources where we have no environmental data and therefore do not fully understand the risk of deterioration. We believe that we will need to collect data and undertake further assessments to improve our understanding of the risks. We would be promoting sources within this category for no deterioration investigations in AMP7.

The overall impacts of the Water Framework Directive no deterioration and RSA challenges on our water sources are shown in Figure 11 overleaf. Figure 11 illustrates the complexity of the challenge, and how it particularly affects our Nottinghamshire, North Staffordshire and Strategic Grid water resource zones.

Figure 11: Water Framework Directive and RSA abstraction pressures

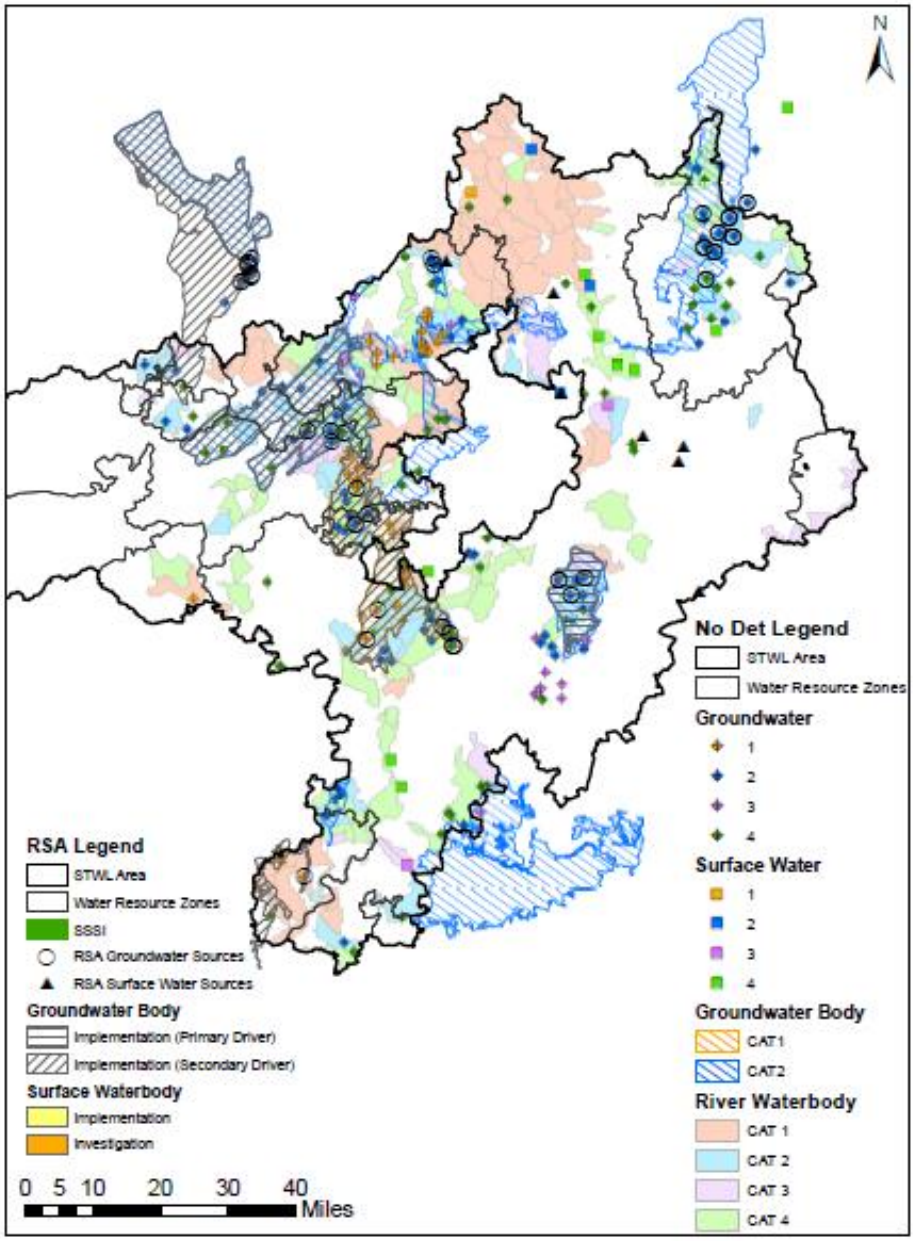


Figure 11 also illustrates the different categories of environmental risk that we need to address through our WRMP. These are:

- Category 1: Serious damage is being caused to the waterbody by current abstractions levels that are impacting either river flows or protected areas.
- Category 2: Waterbodies where future increases in abstraction up to 2027 (future scenario) are likely to cause deterioration to the waterbody or where the effects of current abstractions on river flows are not the main reason for the waterbody failing to achieve good status.
- Category 3: Future increases in abstraction after 2027 and before 2040 (future scenario) are likely to cause deterioration within the waterbody.
- Category 4: Waterbodies that are not at risk of deterioration up to 2040.

The combined effects of the Water Framework Directive challenge and the need to reduce unsustainable abstraction are factored into the supply forecasts used in this WRMP.

Improving our long term supply capability

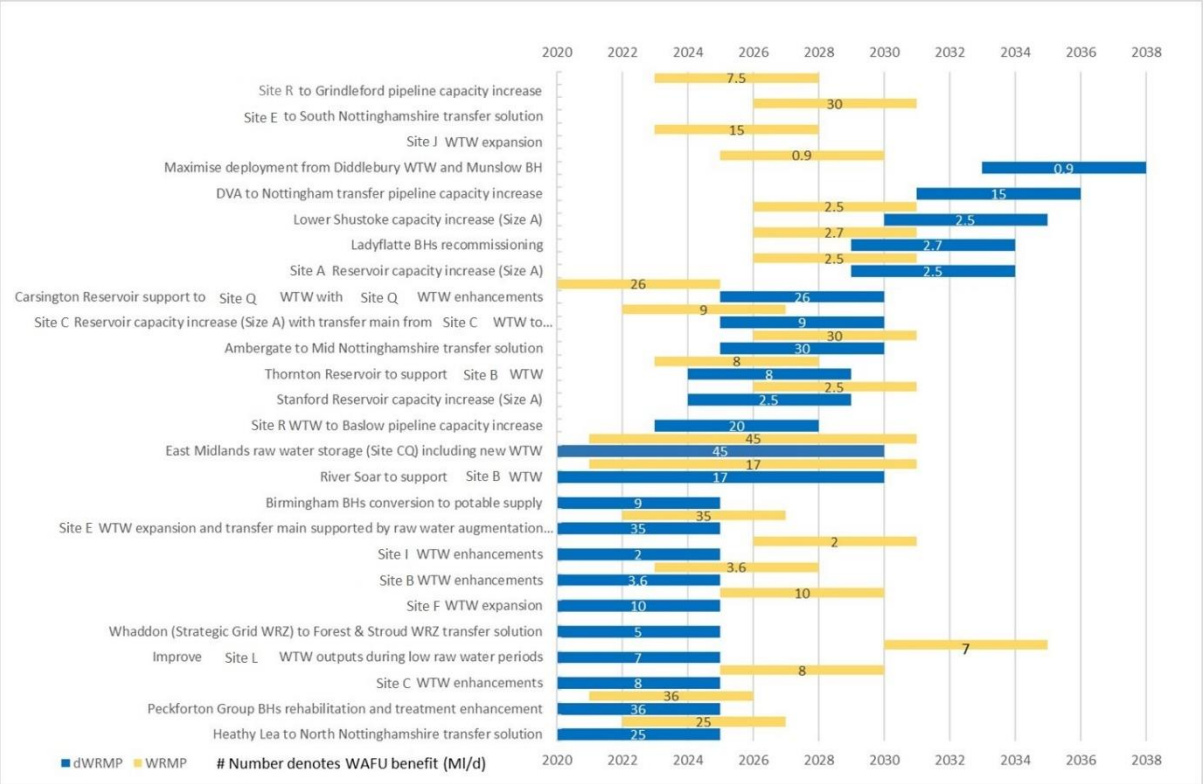
While we are committed to achieving a step change in leakage and demand management, these measures alone will not be sufficient to secure future supplies. Improvements are needed to replace the output from unsustainable sources of abstraction, and to give us the capability to meet future demand and maintain drought resilience without putting the Water Framework Directive objectives at risk.

Broadly, the challenges around unsustainable abstraction mean that there is a need to reduce pressure on some of the groundwater bodies from which our borehole sources abstract. In the future, to prevent deterioration there can be no sustained increase in the amount we abstract from a number of our region's groundwater bodies. As a result, our proposed improvements in supply capability focus on making more use of surface water sources of supply. The new schemes that we propose in this WRMP largely involve making more use of our existing river abstractions, our existing storage reservoirs and the water treatment works that we use to produce and deploy wholesome water to our customers. We also propose to enhance our strategic water distribution links so that we have more flexibility to move water around our system to the locations that need it most.

Our WRMP looks ahead over the next 25 years, and we recognise that there is increasing uncertainty over the scale and timing of some of our future needs. The actions we are proposing in this WRMP reflect the different degrees of confidence that we have about our short, medium and long term supply / demand needs. We continue to assess these different options and we have further improved our understanding of the costs, benefits and delivery risks since we published the draft WRMP in 2018. As a result we have made some refinements to the timing and sequencing of our recommended options, and we have made some changes to the scope of three of the recommended options. These changes are described in our Statement of Response to the consultation comments that we received about our draft WRMP. Where necessary we have also updated the relevant sections of this final WRMP publication.

Figure 12 illustrates the changes to the programme of options between our draft and final WRMP. The figure shows all of the proposed supply side options that featured in our draft WRMP published in 2018 and compares them with how those options now appear in our final WRMP. The figure shows the option name, Deployable Output (DO) benefit and the delivery timing of each option in the preferred programme. The blue bars represent the preferred programme of options in our draft WRMP whilst the orange bars represent the revised preferred programme of options in our final WRMP. Overall, while the majority of options remain unchanged, although we have made some revisions to the timing and sequencing of these options.

Figure 12: Comparison of our preferred programme of options between our draft and final WRMPs



In Table 5 overleaf, we have summarised the recommended supply options in the order of the future AMP period when we would be delivering them. The options proposed for the AMP7 and AMP8 periods cover our expected supply / demand needs for 2020 to 2030. The costs of delivering the AMP7 schemes, and the first stages of the AMP8 schemes, has directly informed our PR19 investment plan for the AMP7 period.

We are confident that the options we are proposing for the AMP7 period will be needed to meet the environmental challenges of reducing unsustainable abstraction and ensuring our existing sources do not cause future environmental deterioration. Table 5 summarises the new water supply options that we propose to deliver over the five year period 2020-25 as the first phase of our long term water resources strategy. These options all involve making better use of existing, sustainable sources of supply and enhancing our ability to deploy this water. We consider these to be 'low regret' investment decisions that complement our demand management and environmental improvement plans, and these are all options that will also contribute to our wider supply resilience ambitions. Table 5 also summarises options that we will investigate in more detail during AMP7, ready to deploy in AMP8 (2025-30).

The options proposed for the much longer term are far more uncertain, and we are not committed to investing in their delivery at this stage. The nature of the options that we are promoting means that we do not need to commit investment to large scale water resource developments that will take many years to deliver, and we are able to revisit these very long term decisions through the WRMP process every five years.

Table 5: Recommended new supply schemes for the period 2020-25

Scheme Name	Description	Water Resource Zone	Supply benefit (Ml/d)	AMP
Heathy Lea to North Nottinghamshire transfer solution	This solution aims to provide new strategic transfer capacity from the Strategic Grid water resource zone (WRZ) into the Nottinghamshire WRZ, via a new pipeline with a total distance of 34.6km. A new pumping station is also proposed as part of this solution.	Nottingham-shire	25	AMP7 to AMP8
Site E water treatment works expansion and transfer main supported by raw water augmentation of the River Trent	Using spare raw water from Carsington reservoir, we will use our existing abstraction at Witches Oak intake to support a 50 Mld expansion of Site E WTW. A new pipeline will transfer the additional potable water for use in the Strategic Grid.	Strategic Grid	35	AMP7 to AMP8
Site B water treatment works enhancements	By improving the treatment processes, we will increase the sustainable output of Site B WTW using the existing raw and potable water transfer capability.	Strategic Grid	3.6	AMP7 to AMP8
Peckforton Group boreholes treatment enhancement	The Peckforton borehole group will require enhanced water treatment in AMP7 due to deteriorating raw water quality in the groundwater unit. Installation of treatment offers an opportunity to increase the output from the group and relieve the supply/demand stress within the North Staffordshire water resource zone. The solution will include enhanced water treatment installation, new chlorination treatment, new pumping plant and the potential upgrade of Tixall booster pump to get water into the North Staffordshire zone. This solution brings wider benefits, as it allows us to preserve the integrity of the wider North Staffordshire water resource zone and prevent the large loss of zonal deployable outputs that would be caused by restoring sustainable abstraction licence changes.	North Staffordshire	6.5	AMP7 to AMP8

Scheme Name	Description	Water Resource Zone	Supply benefit (Ml/d)	AMP
Site J water treatment works expansion	Using spare raw water from Carsington reservoir and utilising the storage at Site J reservoir to maximise utilisation of the River Derwent, we will use our existing raw water abstraction with enhancements to raw water transfer capability to support a 40 Ml/d expansion at Site J WTW. The option will include a new pipeline to distribute the water into our Strategic Grid WRZ.	Strategic Grid	15	AMP7 to AMP8
Thornton Reservoir to support Site B water treatment works	This scheme will make use of the Thornton reservoir by constructing a raw water main and installing a booster pump to Site B water treatment works.	Strategic Grid	8	AMP7 to AMP8
River Trent to Site Q water treatment works transfer with Site Q treatment enhancements	This scheme will increase the dry weather output from Site Q water treatment works and support this with abstraction from the River Trent. We have recently completed the purchase of a third party's historic abstraction rights on the Trent, and so we are able to use this to support increased output from Site Q without increasing the licensed abstraction from the river. Utilising this abstraction licence will involve a new river intake, pumping station and pipeline to transfer raw water either to the Dove Reservoirs or directly to Site Q water treatment works. A new contact tank will be installed at Site Q water treatment works to operate in series with the existing contact tank to increase the overall treatment output to 235Ml/d.	Strategic Grid	26	AMP7
Site C Reservoir capacity increase (Size A) with transfer main from Site C water treatment works to Coventry	A small increase in storage capacity at Site C Reservoir will allow us to increase output at Site C WTW. A new pipeline will transfer potable water to our existing network for use in the Strategic Grid.	Strategic Grid	9	AMP7 to AMP8
Site R water treatment works to Grindleford pipeline capacity increase	By improving the hydraulic performance of the DVA we will be able to use spare treatment capacity at Site R WTW. Additional raw water will derive from the existing spare capacity in the Derwent Valley reservoirs	Strategic Grid	7.5	AMP7 to AMP8

Looking further ahead, there is less certainty about the scale and timing of when additional new supply capability is needed. In this WRMP we have described our assessment of the long term pressures on future supply and demand for water, and these are described in more detail in the technical appendices. We are proposing further investment in new supply capability for the period 2025-45 to address these long term challenges, and to cope with future uncertainty. The nature of these longer term solutions is to try to make use of existing water supply assets, and to focus on innovative and sustainable use of surface water supplies.

Table 6 sets out our proposed longer term supply improvement options. The nature of these options means that they can be delivered in relatively short time periods of between five to ten years. This means that they are relatively flexible, and they do not require us to commit to very long term decisions at this moment in time. If we proceed with the proposals outlined in this WRMP, our activities for the period 2020-25 would include further exploration of these longer term solutions to improve our understanding of any associated environmental, delivery or commercial risks and have them ready for implementation at the next round of WRMPs.

Table 6: Proposed new supply schemes for the period 2025-2045

Scheme Name	Description	Water Resource Zone	Supply benefit (Ml/d)	AMP
Site C water treatment works enhancements	The current maximum output of Site C treatment works is limited to 27 Ml/d, this scheme will enable the site to produce 36 Ml/d deployable output. This scheme will install additional treatment capacity which will increase output and improve resilience by providing some redundancy in our treatment process to allow maintenance and protect against failure.	Strategic Grid	8	AMP8
Site F water treatment works expansion	Using spare raw water from Carsington reservoir, we will use our existing abstraction at Site F to support a 30 Mld expansion of Site F WTW. Existing pipelines will be used to transfer the additional potable water for use in the Strategic Grid.	Strategic Grid	10	AMP8
River Soar to support Site B water treatment works	This scheme will make use of the River Soar to support Site B water treatment works during critical periods. Site B treatment works receives its water from Site B and Swithland reservoirs. One of the most viable options to increase raw water availability is to provide a new feed into the system from the River Soar. This scheme would preserve reservoir storage by using the river source when flows are above the hands off flow (HOF), and then using reservoir storage to supply the treatment works when river levels are below HOF. Based on the 2013 EA Soar CAMS review, the river has 17Ml/d water available for abstraction. This solution would also include: the creation of a primary settlement lagoon to aerate water and trap river sediment prior to transfer to Site B treatment	Strategic Grid	17	AMP7 to AMP9

Scheme Name	Description	Water Resource Zone	Supply benefit (Ml/d)	AMP
	works, new raw water pipelines & pumping stations, and upgrades to treatment processes to enable treatment of river water.			
East Midlands raw water storage (Site CQ) including new water treatment works	We have been engaging with a number of third parties who own existing, operational quarries that are nearing the end of their useful life and that could be used for future raw water storage. We have not included specific details of the preferred option here due to commercial sensitivity of our ongoing discussions, but we describe the option here as the conversion of large, disused third party quarries for the strategic storage of water abstracted from rivers during periods of high river flow. Several quarries have been investigated and the SEA has identified the need to carefully develop such solutions to avoid adverse effects on geological SSSIs that are present within some disused quarries, as reflected in the precautionary major adverse rating for the SEA geological objective. Further investigations will be required to develop this innovative solution in a sustainable manner so as to minimise adverse environmental effects whilst maximising the potential beneficial effects associated with using large disused quarries for substantial and sustainable water supply benefit, as well as allied recreational and biodiversity enhancement opportunities. This accords with County Council core policies for the sustainable reclamation of former mineral workings. The solution will include the conversion of the Asset to a raw water storage reservoir which will be filled with water pumped from the River Soar at times of high flow. A new water treatment works located at the Asset will treat raw water from either the River Soar or raw water storage reservoir. A new pipeline will transfer potable water to the nearby Avon Soar Link Main which forms part of the Strategic Grid.	Strategic Grid	45	AMP7 to AMP9
Site E to south Nottinghamshire transfer solution	This solution will increase the capacity of network connections to the Nottinghamshire WRZ from two potable water sources in our Strategic Grid WRZ – the Derwent Valley Aqueduct and site E WTW. This will enable additional transfer of potable water from the Strategic Grid WRZ into Nottinghamshire WRZ.	Notts	30	AMP8 to AMP9

Scheme Name	Description	Water Resource Zone	Supply benefit (Ml/d)	AMP
Stanford Reservoir capacity increase (Size A)	At Stanford Reservoir an expansion of 10% would provide an additional 134Ml of storage. The embankment has been designed to overtop for events between the 150 year and 1,000 year floods. In this option the spillway is to be raised by a small amount without making any alterations to the embankment.	Strategic Grid	2.5	AMP8 to AMP9
Ambergate to Mid Nottinghamshire transfer solution	This solution involves the construction of a new strategic link main from the Strategic Grid water resource zone into the Mansfield area of the Nottinghamshire zone. The concept is for a new 21km pipeline and pumping station to be installed, which will transfer water from our River Derwent sources via the Strategic Grid into the Nottinghamshire zone to replace unsustainable groundwater abstraction.	Nottinghamshire	30	AMP8 to AMP9
Site A Reservoir capacity increase (Size A)	This scheme will increase Site A reservoir capacity by 5% to provide an additional 74 Ml of storage, involving raising the top water level by 0.17m	Strategic Grid	2.5	AMP8 to AMP9
Ladyflatte boreholes recommissioning	Ladyflatte borehole stopped abstracting in 2013. It is licenced to produce just over 3Ml/d and the treatment was designed to treat that quantity. Upgrading the process units to achieve the licence would be considered as part of the scheme.	Strategic Grid	2.7	AMP8 to AMP9
Lower Shustoke capacity increase (Size A)	At Lower Shustoke reservoir an expansion of 10% would provide an additional 192Ml of storage and would involve raising the top water level by 0.52m. Lower Shustoke reservoir operates in conjunction with Upper Shustoke which, together, form an off-line storage facility. At this stage it has been assumed that a non-return arrangement could be fitted to the pipework connecting the two reservoirs. This arrangement would enable the lower reservoir to be held at a higher water level than in the upper reservoir.	Strategic Grid	2.5	AMP8 to AMP9
Maximise deployment from Diddlebury water treatment works and Munslow borehole	The concept behind this scheme is to upgrade existing assets at Diddlebury water treatment works to provide an additional flow into the local distribution service reservoir in order to meet peak demands within our Ludlow control group.	Strategic Grid	0.9	AMP8
Site I water treatment works enhancements	A minor improvement to the treatment process at Site I WTW will allow us to increase treatment	Strategic Grid	2	AMP8 to AMP9

Scheme Name	Description	Water Resource Zone	Supply benefit (Ml/d)	AMP
	capacity. The additional output will be used in the Strategic Grid.			
Improve Site L water treatment works outputs during low raw water periods	The maximum design capacity of Site L treatment works is 48 Ml/d but its normal output is closer to 44 Ml/d. Site L operates in conjunction with the wider groundwater sources in the North Staffordshire water resource zone, and the zonal deployable output is maximised by optimising the balance between the reservoir and the groundwater sources. During winter and spring, we maximise use of the reservoir while storage is at or above target levels, and during summer months we reduce output from the reservoir and increase use of the groundwater sources. The minimum output from Site L treatment works is around 16Ml/d due to the configuration of the water treatment process. This minimum output is a key constraint on the zonal deployable output. When reservoir storage is very low we cannot reduce Site L treatment output below 16Ml/d, and so to preserve storage we have to shut down the treatment works and transfer all demand onto the groundwater sources. This solution will reconfigure Site L treatment works to allow output to go below the current 16Ml/d minimum. This will giving greater operational flexibility during dry weather and will improve the conjunctive use with the North Staffordshire groundwater system.	North Staffs	7	AMP9

Using river restoration techniques to improve habitats and ecological resilience to low flows

Our WRMP includes short and long term measures to remove or offset the environmental impacts of abstractions, and to help the associated water bodies achieve Water Framework Directive objectives. In the short term we propose localised environmental protection measures that will allow us to continue to abstract from some sources until we can put longer term solutions in place to reduce or stop abstraction.

In water bodies where local environmental protection measures could work as mitigation for abstraction impacts, our aim is to engage with local stakeholders and landowners and build on the networks that already exist, such as Catchment Based Approach (CaBA) partnerships. We will also work with these networks throughout the planning and delivery these measures. The localised environmental measures that we propose include:

- **Local flow support measures**
  These types of options involve providing additional water to localised river reaches in times of low flow. This can be achieved in river reaches below reservoirs by releasing water into the river to ensure flow does not get too low and by providing some variation in the amount released through the year. In rivers that are not downstream of a reservoir water can be added from another source, such as groundwater if available.
- **Catchment and river restoration improvements**
  Many streams suffer from a range of problems that exacerbate the impacts of low flow, such as modification of the channel, lack of instream habitat, pollution, sedimentation and barriers to the movement of fish. Reducing abstraction without also addressing other issues in the waterbody will only provide limited benefit, whereas improvements in stream habitat it will improve the stream in the short term and also enhance the environmental benefit of the longer term reduction in abstraction.

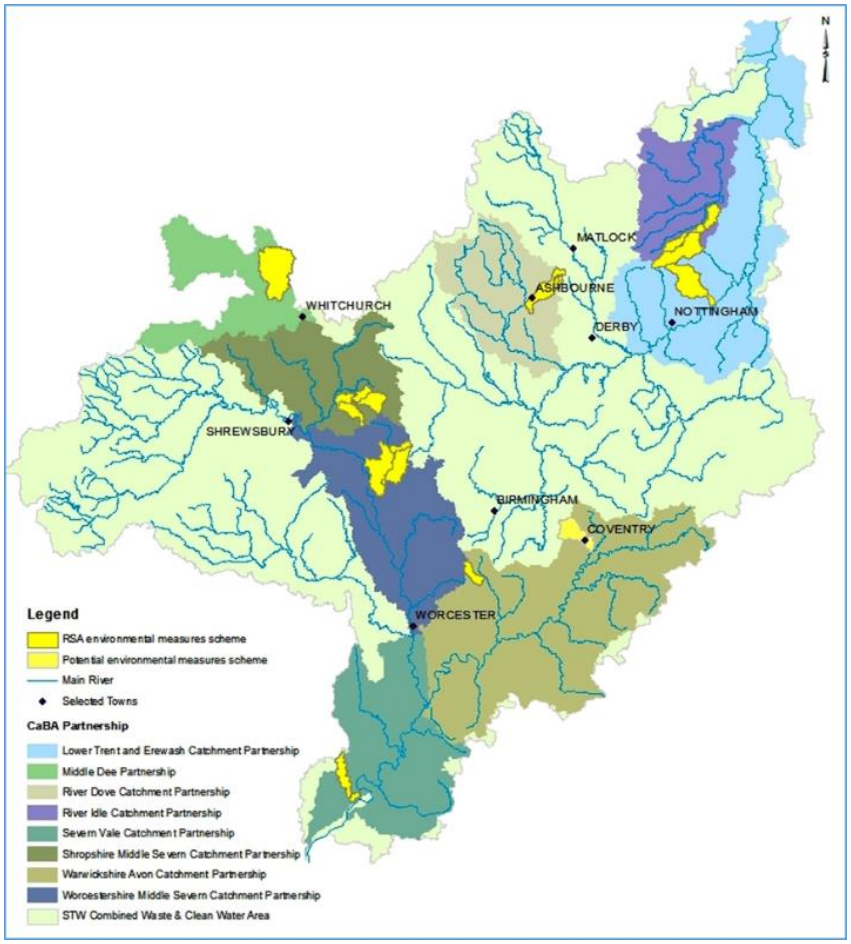
Our aim is to plan and develop a package of improvement measures in each of the affected waterbodies in collaboration with the relevant CaBA group, landowners and other organisations working in the area. Our aim is to ensure we build on programmes that are already being planned or are underway to avoid duplication and enhance environmental outcomes. We will also look for opportunities to achieve multiple benefits such as biodiversity and public amenity where possible.

The main types of environmental improvements that could be made to waterbodies include realignment and changes to make the shape of the water course more natural, instream measures to improve the diversity of habitat types, riparian management such as fencing and buffer strips to reduce nutrients and sediments entering rivers, and fish passes and removal of instream barriers. Where supported by our catchment partners and evidence we will also consider other types of wider catchment environmental improvements if they will improve instream flow or water quality such as creation or restoration of wetland habitats or woodland/other plantings.

During AMP6 we investigated a number of waterbodies as part of our Restoring Sustainable Abstraction investigations. The learning from these investigations has informed the development of a notional solution for these waterbodies where required, many of which include local measures. Figure 13 shows the waterbodies where river restoration improvements will form part of our AMP7 solution. Improvements to existing localised flow support measures are also planned for some of our surface water sources.

We also plan to undertake local environmental measures in additional waterbodies in AMP7 to prevent future deterioration as part of a package of measures to mitigate for the effects of our ongoing operation, however we would plan these schemes as required in AMP7. We aim to operate in a way that prevents the need for mitigation in the first instance. In cases where is this is not possible until we put longer term solutions in place to reduce or stop abstraction we will implement mitigation measures.

Figure 13: Waterbodies where catchment or river restoration measures will be implemented in AMP7 as part of an RSA solution. CaBA partnerships are also shown on this map.



We are already using this kind of approach in AMP6, but on a smaller scale. For example, we are implementing a ten year plan to resolve the legacy of unsustainable abstraction in the Bromsgrove groundwater unit and the associated impacts on the Battlefield Brook. Our plan is to scale up this kind of approach in AMP7 to make physical catchment changes that will mitigate for the effects of abstraction and reduce the risk of future abstraction.

Case Study – Battlefield Brook

The Environment Agency identified Battlefield Brook through the National Environment Programme as a stream where improvement may be required to meet 'good' river quality status. Battlefield Brook rises on the Lickey Hills and flows south westwards to become the Sugar Brook in Bromsgrove. In its lower reaches it flows through Sanders Park which is a priority Biodiversity Action Plan site and an important public amenity. The section of the brook through Sanders Park was canalised and lined with concrete in the 1960s.

We investigated the effect of our abstractions on the local ecology between 2010 and 2013 prior to publishing our 2014 WRMP. The brook flows over an 'over-abstracted' groundwater unit, so to make our abstraction in the region more sustainable we are implementing a solution to reconfigure the existing public water supply system to reduce long term abstraction and provide additional flow support to the brook. We aim to complete this work by the end of AMP7 (2025).

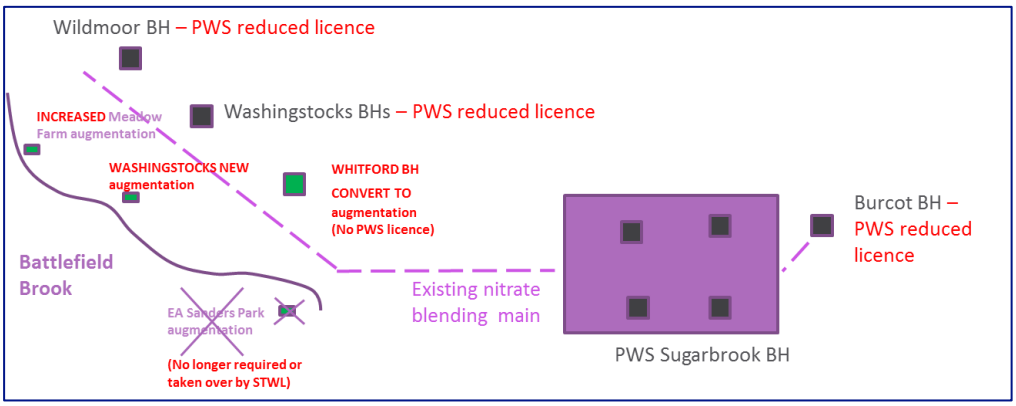
The Battlefield Brook also required habitat improvements to enable the watercourse to achieve "good" river quality status. We are currently working on a local solution which will be completed in a shorter timeframe.

This scheme will remove approximately 300m of the existing concrete channel running through the park and replacing it with a naturalised channel which will connect the already naturalised sections of the upstream and downstream reaches of the brook. The work aims to improve local habitat and provide an environment in which wildlife, such as the water voles, can populate and traverse between the natural upstream and downstream sections of the brook. The design has taken into account best practice to specifically create habitats for water voles. We have been working collaboratively with Bromsgrove District Council on the design, taking into account their local knowledge to provide improvements and maintain specific vegetation. Our 2014 WRMP put forward a two phase improvement plan covering AMP6 and AMP7:

- Local solution: Naturalise stretches of the water course to improve habitat and ecological resilience, as demonstrated in Figure 14.
- Strategic solution: Reconfigure the existing public water supply system to reduce long term abstraction and provide additional flow support to the brook as shown in Figure 15.

Figure 14: Battlefield Brook local solution project photographs

Figure 15: Battlefield Brook strategic solution schematic



The proposals set out in this WRMP build on this type of approach but on a much larger scale, focussing on those water bodies with the greatest pressures.

Using the Abstraction Incentive Mechanism to prevent future deterioration

We have explored whether we can use Ofwat's Abstraction Incentive Mechanism (AIM) as an innovative way of helping prevent future deterioration. In AMP6, Ofwat introduced the Abstraction Incentive Mechanism (AIM) as a way of incentivising water companies to minimise abstraction from sources with the potential to

cause environmental harm. The AIM works by rewarding or penalising abstractors based on the amount they take from a source over the year, with reference to an environmentally sustainable threshold.

Following our WINEP3 prioritisation work, we identified a total of 33 sites that were potential AIM sites. These were then reduced to 17 sites once we removed sites where abstraction could not be reduced due to their supply criticality. Further sites were removed by assessing each site using Ofwat's screening criteria. Any sites where the abstraction licence was a compensation licence were removed as this abstraction already takes place for environmental benefit. Any source where AMP6 interventions were already taking place to change the abstraction licence to a compensation source were also removed.

Finally, our operational teams were consulted to understand any supply issues in relation to water quality that may affect site selection. This resulted in removing any sites with interdependency to other site, for example where blending water from more than one source is required to enable us to meet water quality requirements. Ultimately, we screened our initial 33 sites to a total of four sites that showed potential suitability for AIM. However only two of these sites have suitable observation boreholes close to their sites that could be used to set trigger thresholds based on groundwater levels. These two sites are:

- Highgate borehole
- Dunhampton borehole

Managing abstraction at these two sites has been included in our PR19 business plan as AMP7 performance commitments.

The AIM threshold will be based on groundwater level trigger points instead of surface water flow trigger levels. We will monitor the water level within an identified observation borehole that is close to the AIM site and within the same groundwater management unit from which the source abstracts. Once the groundwater level in the observation borehole falls to below the trigger threshold, we will reduce our abstraction in line with the baseline average daily abstraction value for the site. The AIM calculation will work exactly the same as if the trigger level was a surface water flow.

We have adopted the full Ofwat definition of the Abstraction Incentive Mechanism (AIM) as per the guidelines released by Ofwat in February 2016. Our monitoring metric will be the difference in abstracted volume (measured in Megalitres, Ml) between the set baseline daily average abstraction value and the actual abstraction at our identified AIM sites during periods when the AIM threshold has been crossed. A negative number will signify our average abstraction is less than the baseline and hence an improved performance.

Using catchment management measures to improve biodiversity and protect drinking water supplies

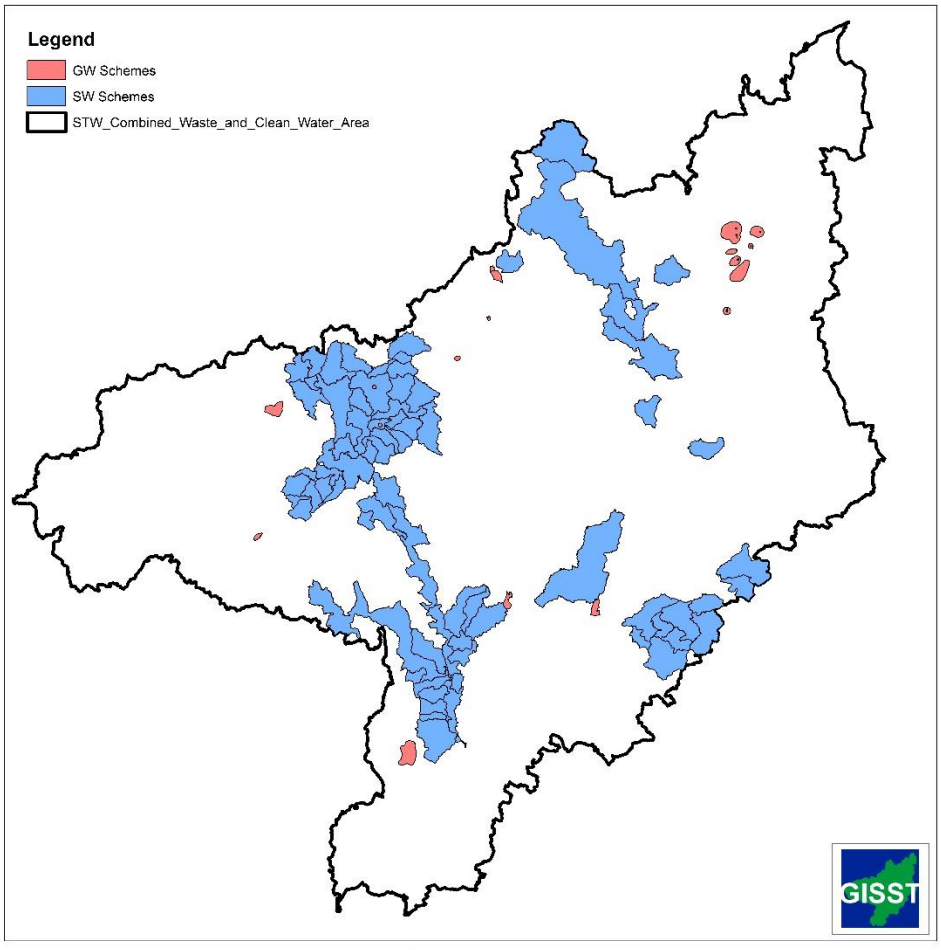
Our drinking water protection strategy is to, where possible, use catchment management techniques to reduce the number of drinking water failures and minimise or delay future water treatment expenditure on raw water quality deterioration. This will be achieved through collaboration with Environment Agency, Drinking Water Inspectorate and Ofwat along with other key stakeholders and catchment partnerships. It will also deliver our obligations under the WFD, further enhance catchment risk assessments that support our drinking water safety plans (DWSPs) and reduce carbon usage.

Over the last two AMPs our catchment management programme has been both ambitious (covering the whole of the STW region) and pioneering (one of the first such programmes in the country). We undertake catchment investigations and deliver improvement schemes in both surface water and groundwater catchments. This programme of work has allowed us to manage water quality risks in a sustainable and cost

beneficial manner in accordance with the regulatory requirements of Article 7 of the Water Framework Directive and Water Supply (Water Quality) Regulations.

Our AMP6 catchment activities involve us working with landowners and partner organisations to reduce potentially harmful agricultural run-off into our region's rivers as shown in Figure 16. We have recruited our own in-house agricultural advisers to deliver our catchment programme by engaging with farmers across 27 different catchments. Partnerships such as those with Wye & Usk Foundation, Trent Rivers Trust, Severn Rivers Trust, Catchment Sensitive Farming and Nottinghamshire Wildlife Trust are also key to helping us deliver our AMP6 catchment ambitions. More recently we have established partnerships with the West Midlands Wildlife Trusts. We fully recognise and appreciate the cost effective, reliable and extensive expertise these partnerships bring to our current catchment programme. Through this approach we are reducing agricultural run-off, such as pesticides getting into the water and polluting it, therefore improving river water quality, reducing treatment costs and improving the river environment as a whole.

Figure 16. Map of catchment schemes in AMP6



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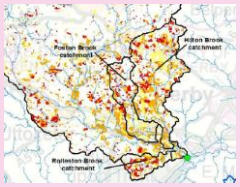
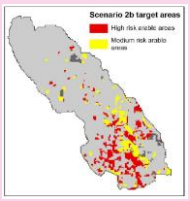
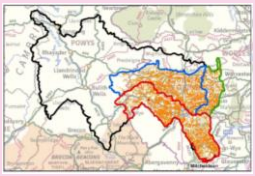
Our plan for AMP7 and beyond includes the continuation of our 27 current catchment schemes plus eight new schemes recommended through our AMP6 investigations (Figure 17). The proposed catchment schemes will help protect our current sources from water quality risks, protect against future deterioration, help improve the resilience of our assets, and generate wider environmental benefits.

Figure 17. New catchment schemes for AMP7

NEW CATCHMENT SCHEMES FOR AMP7

Surface water

Dove	Ogston	Mitcheldean
Metaldehyde scheme on arable land in the Hilton Brook, Foston Brook and Rolleston Brook sub-catchments of the River Dove catchment supporting continued work in Staunton Harold catchment. 	Metaldehyde scheme on high and medium risk areas of arable land within the Ogston Reservoir natural catchment. Also addressing nutrients and grassland herbicides. 	Metaldehdye scheme on arable land within the three Mitcheldean sub catchments – shown in orange below. 

Groundwater water

Astley	Bellington	Copley	Hilton
• Strong CBA justification for advisory scheme • Light touch advisory scheme would address uncertainty in trend – sensitive analysis envelope around trend takes baseline just above target concentration for site	• Light touch advisory scheme recommended to address changes in the catchment observed during walkovers e.g. increase in veg growing • Scheme would address short term start up spikes	• Light touch advisory scheme to address uncertainty in trend and start up spikes – potential to combined under Hilton scheme – located close by	• CBA justification for light touch advisory scheme to address uncertainty in model and mitigate any significant change in the catchment

The scope of our future drinking water catchment management activities includes the following:

STEPS (Severn Trent Environmental Protection Scheme)

Under our STEPS scheme we offer capital grants to farmers to undertake works which will help reduce diffuse pollution e.g. installation of biobeds/biofilters. The capital grants window is open annually from January to March.

Since 2015 we have undertaken three rounds of grant applications and have received over 600 applications for funding. Applications have ranged from improved pesticide handling facilities to water course fencing to rainwater harvesting equipment. More innovative ideas have been welcomed through a unique 'farmer innovation' option where farmers present their own ideas for improving water quality.

STEPS is a competitive scheme run across all priority catchments in the Severn Trent Region. We recognise that there has been high uptake of the STEPS scheme and that this has been popular with farmers. Similarly, the support that we have received during the consultation regarding our innovative 'Farm to Tap' scheme is acknowledged. We recognise that we need to communicate the benefits and outcomes of these schemes more widely to promote the benefits of these schemes and drive wider confidence in these programmes and similar new products and practices elsewhere. This is something we are currently looking to address and we would welcome support and input from the NFU in ways to establish ways of strengthening communication links with farming networks.

Within our current STEPs grants we offer a number of options which help support improved soil biodiversity for example low input grasslands and arable reversion. There are also grant options for water retention such as farm wetlands, grass swales and sedimentation ponds. More information can be found about these items at https://www.stwater.co.uk/about-us/environment/catchment-management/steps1/

Payment for Ecosystem Services – Farm to Tap, previously known as Farmers as Producers of Clean Water (FaPCW)

Previously known as 'Farmers as Producers of Clean Water' (FaPCW), our 'Farm to Tap' initiative commenced in September 2016 and runs annually between September and December each year (which is the period of highest risk of Metaldehyde runoff). This scheme pays farmers for producing clean run-off from their land and therefore contributing to improvements in drinking water quality within their local sub-catchments. The scheme encompasses the principles of PES (paid ecosystem services) with the overall aim of changing farmer behaviour and promoting ownership of the river within their catchments. It is envisaged that this approach will help drive long lasting behavioural change and sustainable improvements in water quality.

The scheme provides landowners with information on what activities can help reduce Metaldehdye losses. However, it does not stipulate that they must undertake these activities, but instead it allows the farmer to choose management options that suit their farm business. Farmers can receive payments per hectare for improvements or no deterioration downstream in water quality.

Advice, training and other support

In addition to our STEPS and Farm to Tap schemes we also offer the following support to farmers:

- Pesticide sprayer testing
- Pesticide Application training
- Metaldehyde spreader calibration

We are the first water company to partner with Natural England's Farm Advice Framework (FAF) contract and are funding farm advice visits through this established framework of approved technical expert contractors. This framework is being used to deliver Defra's current countryside stewardship programme.

We also fund a pesticide amnesty to reduce the amount of unwanted pesticides within catchments. To date in AMP6 a total of 13 tonnes of pesticides that were being stored by farmers in our catchments have been removed.

Water trading

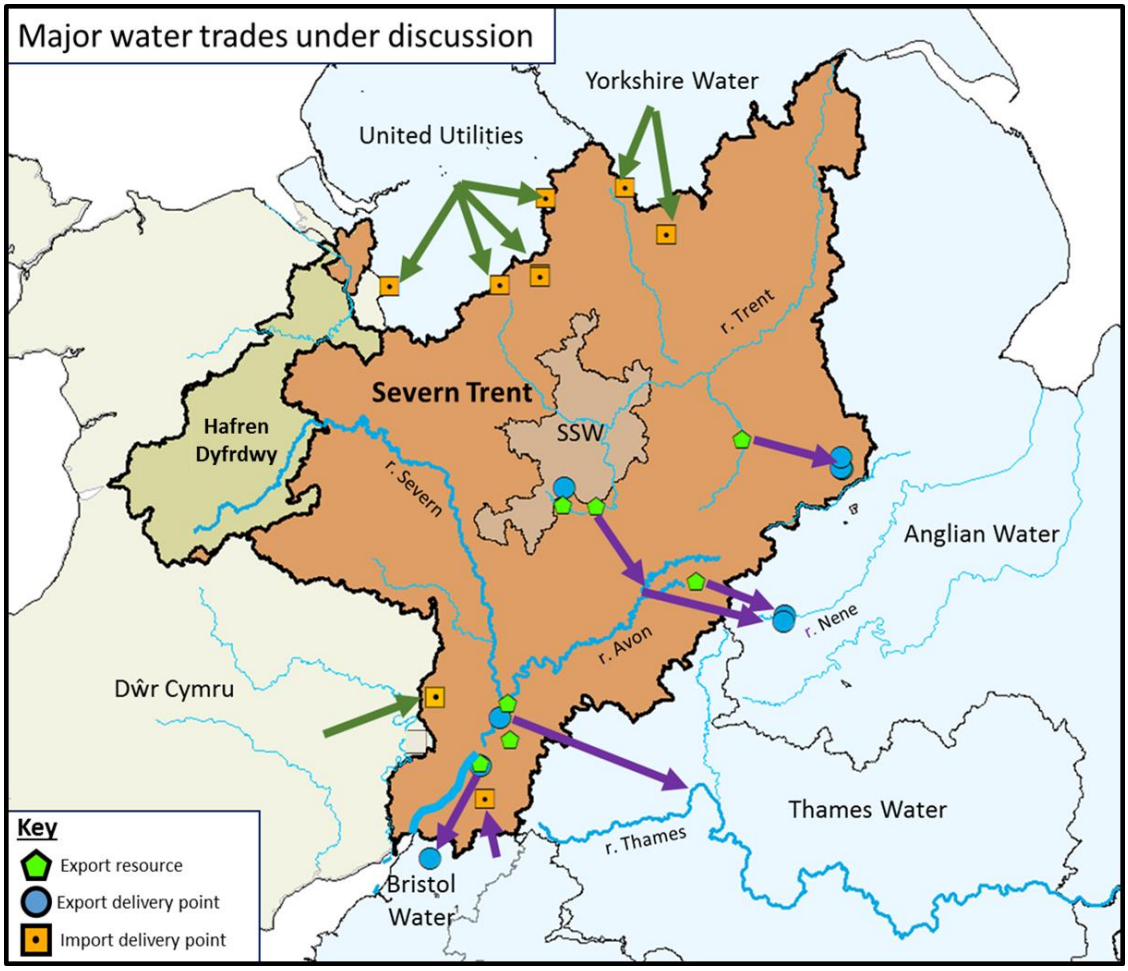
Through the WRMP pre-consultation process we investigated opportunities to trade or share water resources with third parties. We met with all neighbouring water companies and potential suppliers from other sectors on a bi-lateral basis and worked within regional water resource initiatives to scope out and agree viable options. This effort identified 30 potential imports and exports that we consider viable (see Table 7 and Figure 18).

Table 7: Summary of water transfers in active discussion during our WRMP development

	Imports (Ml/d)			Exports* (Ml/d)		
	Raw	Potable	Total	Raw	Potable	Total
Water companies	105	122	227	419	56	475
Other sectors	127	-	127	-	-	-
Total	232	122	354	419	56	475

* All sources of 'export' water are new with the exception of 15Ml/day of existing licence at Mythe

Figure 18: Proposed major water trading schematic



Following publication of our draft WRMP we have continued to meet all neighbouring companies to discuss options named in our draft plan, as well as their own, and explore any new opportunities. The outcome of these discussion have ensure that we have fully aligned our final WRMPs. A summary of the updates that we have agreed with other companies is given in Table 8 overleaf.

Table 8: Updated water trading options

Company	Draft WRMP position	Update	Date agreed
Anglian Water	We developed five viable water transfer options for consideration in Anglian Water's draft WRMP. The potable water bulk supply to an Anglian Water treatment works near Oakham was included in their preferred plan.	Changes to the timing of Anglian Water's need for additional supply mean that the transfer option is no longer able to resolve their deficit due to the long construction period. Instead we have offered a further transfer option involving the transfer of Wanlip Final Effluent to Rutland Water for their consideration. Anglian Water have confirmed that none of the transfers that we offered are included in their revised preferred plan. We have committed to work together with Anglian Water to develop an optimised transfer taking in the wider context of the Water Resources East needs. This joint work will involve water resources modelling of the River Trent system.	28th June 2018
South Staffs Water	A new transfer between our supply network and South Staffs Water's supply network was included in South Staffs Water's draft WRMP.	South Staffs have clarified that the proposed transfer is for resilience and planned maintenance use only. This transfer option will therefore no longer be reflected in their final WRMP tables.	8th June 2018
Thames Water	We worked closely with Thames Water and United Utilities to develop the River Severn to River Thames transfer scheme, the purpose of which is to augment the flows in the River Severn for transfer to the River Thames near Oxford. The scheme would be used only during periods of dry weather in the Thames catchment. Our principle contribution to the scheme involves improving tertiary treatment of Minworth Wastewater Treatment Works final effluent, transferring the effluent to the River Avon (a tributary of the River Severn) by pipeline and then abstraction by Thames Water near Tewksbury on the River Severn. The scheme was not included in Thames Water's draft WRMP.	Since the draft WRMPs were published the requirement for Thames Water to provide a transfer of their own to the water companies in the Water Resources in the South East group (WRSE) has reduced from 130Ml/day to 100Ml/d, which means that the River Severn to River Thames transfer is unlikely to be selected in Thames Water's revised WRMP19. Given the national strategic importance of the River Severn to River Thames transfer scheme, we will continue to work on appropriate technical and environmental aspects in AMP7, for example ecological work, losses and reliability, water quality, regulation, river temperature, in partnership with United Utilities and Thames Water..	19th June 2018

Company	Draft WRMP position	Update	Date agreed
United Utilities	We have discussed with United Utilities the possibility of utilising water from Lake Vyrnwy into the River Severn for use at our existing treatment works downstream. Our draft WRMP explored investment scenarios that utilised this new trade. However, the uncertainty around the longer term River Severn to River Thames transfer scheme meant that we did not include it in our preferred plan.	Further joint analysis by United Utilities and ourselves has revealed that this option would not represent best value and it will therefore not be in our final WRMP preferred programme of options. The primary reason for exclusion is an erosion of our Birmingham resilience capability. The complex interaction with a possible River Severn to River Thames transfer scheme will also need more detailed analysis to ensure that we properly consider the wider national interest. We have agreed to work with United Utilities on further modelling in AMP7 to fully understand whether the scheme could work conjunctively with the River Severn to River Thames transfer scheme.	9th May 2018
Yorkshire Water	We proposed increasing our share of the raw water in the Derwent Valley Reservoirs by 20Ml/d to help support our future supply / demand balance needs and facilitate an eastwards transfer to Anglian Water.	Discussions with Yorkshire Water and Anglian water since our draft WRMP was published mean that we now intend to progress a different option to increase utilisation of the Derwent Valley reservoirs. The primary reason for this is that Yorkshire Water are unable to accommodate a variation of the Derwent Valley agreement within the timeframes that we had assumed without threatening their customers' level of service. Furthermore the size and timing of Anglian Water's needs since we published our draft WRMP have changed meaning that the transfer option included in their draft WRMP no longer forms part of their preferred plan. We have amended the scope of the option to provide a smaller increase in output of 7.5Ml/d from the Derwent Valley reservoirs into our Strategic Grid. Our water resources modelling shows that we can sustain this increased output without impacting on the current export arrangements to Yorkshire Water.	5th June 2018

The most significant change to the recommendations made in our draft WRMP relates to the scope and timing of our supply-side option to increase the use of the Derwent Valley reservoirs. In our draft WRMP we proposed an option that by 2028 would allow us to increase the output from the water treatment works that is supply with raw water from the Derwent Valley reservoirs. As noted in Table 7, it became clear after publishing our draft WRMP that this option could not be accommodated by Yorkshire Water's draft WRMP. Therefore, for our final WRMP we have reduced the scope of this option from 20Ml/d to 7.5Ml/d. The smaller scale option can be accommodated within the existing Derwent Valley agreement and will not impact on raw water exports to Yorkshire Water.

Since we published our draft WRMP, we have continued to contribute to regional and multi-sector water resources planning. We continue to be active participants in all regional groups; Water Resources East, Water Resources South East, Water Resources North and most recently West Country Water Resources. We have initiated two multi-sector working groups on the primary river transfer routes that pass through our region; the River Severn Working Group and the River Trent Working Group. The purpose of these groups is to understand the potential in-combination impacts of transfer and new abstractors on the rivers. Environmental regulators (Natural Resources Wales, the Environment Agency and Natural England) are members of these working groups as well as abstractors.

While we are disappointed that our active discussions have not generated a new trade within our final WRMP, we have a strong platform for developing future solutions. We remain committed to the concept of water trading and will continue to work hard to develop viable solutions for transferring water between Severn Trent and other organisations.

In addition to participating in these collaborative groups, we set up and lead a multi-sector catchment based approach in the River Idle and River Torne catchment in Nottinghamshire (one of our most water stressed areas). This group has successfully identified new local water trades, resource development opportunities and enhancements to our Severn Trent Environmental Protection Scheme (STEPS) catchment management programme to incentivise water efficiency. We are pursuing co-development of water resource schemes with the local agricultural community. We believe that this local approach to water resource planning is highly beneficial and we intend to adopt this approach in AMP7 on a targeted basis.

The Idle and Torne rivers catchment has now been selected as an Initial Priority Catchments (IPCs) within Defra's Abstraction Plan. We are in discussions with the Environment Agency on how to build on our work to further develop innovative solutions to abstraction issues. We will continue to provide leadership in this area and the area of water trading in AMP7.

Alternative options and managing uncertainty

We have set out our short, medium and long term investment proposals to maintain security of customers' water supplies in a sustainable and affordable way. In arriving at these proposed solutions, we have considered a wide range of feasible options and we have explored different possible future supply / demand scenarios. We believe that the options that we are proposing provide a balanced package of 'no-regret' leakage and demand management measures and flexible supply improvement schemes. The nature of the schemes being promoted is such that we can review and revise our decisions at future WRMP updates and we do not need to commit to large, very long term investment decisions at this stage.

7 Using input from customers and stakeholders to shape our plan

We have worked with customers, stakeholders and regulators to shape our long term water resources strategy and the proposals set out in our final WRMP.

Our preferred programme of options included in this WRMP has been shaped, and is supported, by our customers. Since our draft WRMP was published in 2018, we have continued our customer research using face to face constructive, collaborative discussions with our customers about how we should approach delivering water supply and demand improvements. We ensured that we gained appropriate understanding of our customer views by using a variety of different approaches, including deliberative research. One of the biggest advantages of using deliberative research is that is allows for in-depth discussion with customers not just about needs and outcomes, but also approach. Customers gained in understanding as our day-long workshops and sessions progressed. This enabled a more meaningful exploration of issues that could not be achieved using more traditional qualitative and quantitative approaches.

We have also used innovative techniques to gain insight from social media on customers' views and priorities. We also commissioned some additional customer research in response to the stakeholder responses to our draft WRMP.

Our insight into customers' views on water supply and demand is now even richer than at the time of writing our draft WRMP, and comes from a number of sources. Issues such as leakage tend to be top of our customers' minds and our evidence sources include our analysis of customer contacts, social media scraping and numerous research projects. For other aspects such as metering and water efficiency we have used co-creation to work with customers to understand how they can be part of the solution.

Since customers are not always aware of the future pressures on water availability we have used our deliberative research to explore perceptions of water stress and the best way we can meet these challenges. It is only when prompted that customers recognise the pressures of ensuring there is sufficient availability of water for future generations and understand that everyone has to play their part to make this happen.

Our deliberative research tells us that customers have a strong moral viewpoint when thinking about water usage, resulting in an emphasis on personal and corporate responsibility to use less water. Because of this, our customers tend to favour demand management approaches over supply-side approaches, but they recognise that any solution will need to include a blend of both approaches.

Overall, there is a clear expectation from customers that we should have plans in place to ensure a continuous water supply, both now and in the future. As part of this, customers expect us to be prepared to address any long term challenges which could affect water supply, such as climate change or population growth. Customers also expect us to meet our statutory obligations, including those related to restoring unsustainable abstraction and ensuring no environmental deterioration.

Customers want us to pursue the best value supply / demand options, not necessarily just the lowest cost ones, and questions of value and bill impact were particularly important to customers when thinking about solutions that will take a number of years to implement. While most customers are happy to contribute to the cost of long-term water security, they are clear this should be spread out over time, so as not to cause undue financial burden for customers.

More detail on our customer engagement approach and what we have learned is provided in Appendix A1

We have also worked closely with our wider stakeholders throughout the creation of this WRMP. The following provides a summary of how we have engaged with stakeholders at the different stages of producing our final WRMP:

- We held our first stakeholder forum in September 2016.
- We issued the WRMP pre-consultation letter in December 2016.
- We have completed consultation with planning authorities across the region to get an update on housing growth outlook.
- We published the PR19 Shaping Our Future consultation describing the water resource challenge.
- We consulted on the scope of our Strategic Environmental Assessment.
- We have worked with the regulators and stakeholders to understand priorities.
- We met twice with Ofwat in 2017 to share the emerging WRMP needs and likely impacts.
- We have updated our website to sign-post the WRMP work and to make it easier to access information.
- We held our second stakeholder forum in April 2017.
- We held two Welsh facing stakeholder forum events in July 2017.
- We held English and Welsh stakeholder forums in October 2017 to signpost and engage on what solutions are likely to feature in the WRMP.
- We held a number of customer engagement workshops during October 2017 to understand their priorities, attitudes to metering and willingness to pay.
- We published our draft WRMP for consultation in February 2018.
- We considered the outcomes of the consultation process and adjusted our WRMP where appropriate and provide our Statement of Response to the consultation in September 2018.

Through the water resources stakeholder forum events we gathered hundreds of items of feedback through the interactive breakout sessions and follow up correspondence. The material presented at the forum events along with the stakeholder feedback is visible on our website here https://www.severntrent.com/about-us/future-plans/water-resource-management/water-resource-management-plan/

Throughout our stakeholder engagement and discussions with regulators, we heard some clear messages.

- We need to be more ambitious with our leakage reduction targets than in our previous WRMPs.
- Improving customer understanding is the biggest issue when tackling water efficiency and we need to better explain our company's drivers and needs.
- We should explore opportunities for more partnership working.
- We should explore innovative ways of broadening our catchment management thinking beyond just drinking water quality protection to deliver wider benefits such as biodiversity and flow attenuation/slow flow etc.
- New water supply schemes should deliver multi-benefits and we should explore options for water / waste water catchment thinking.

We have used this insight to shape our plan, and to guide our thinking as we worked through our different supply / demand scenarios and options. We have also used it to guide our more focussed customer engagement workshops, where we have conducted more deliberative research into customer attitudes to drought restrictions, water metering and environmental impacts of abstraction.

In the following sections we have set out some examples of how our ongoing stakeholder engagement has helped us to make some key decisions in our final WRMP.

Balancing the risk between the environment and customers' security of supply

In Section 6 we described how our long term water resources plan is largely driven by the need to address the legacy of unsustainable abstraction and meeting future Water Framework Directive objectives. The scale of impact of these environmental needs became apparent to us early in 2016 when the Environment Agency launched its Sustainable Catchments initiative and made clear the expectations for water resources planning. Since then we have been actively exploring this challenge with the Environment Agency, and evaluating what the impacts could mean for our customers' security of supply and where me would need investment in alternative supplies. In early 2016, over 130 of our sources of supply were identified by Environment Agency as posing a risk to future WFD status and could cause environmental deterioration in the future.

We shared this new and emerging issue with stakeholders at our September 2016 water resources forum, and we began trailing our idea of phasing any changes over more than one AMP period in order to maintain security of supply.

We continued to share our thinking as it developed through 2016-17, and at our September 2017 event we shared our proposal to take a multi-AMP approach to meeting the sustainable abstraction challenge. We discussed with stakeholders our recommendation for a package of measures that focussed on catchment improvements in the short term and strategic supply reconfiguration over a longer time period. Stakeholders broadly supported the approach and we were encouraged to explore ways of partnering with other organisations to help deliver wider catchment benefits.

We have shared and developed our evolving work on this topic with the Environment Agency throughout the production of our WRMP and have used their technical feedback to inform our processes. As a result, our risk and prioritisation approach has directly informed the Environment Agency's latest version of the Water Industry National Environment Programme (WINEP) which in turn is used to inform the scope of our PR19 investment programme.

We believe that we have taken a balanced approach to meeting environmental objectives without putting security of supply at risk. We have tested our approach at a conceptual and technical level with stakeholders throughout.

Setting our leakage ambition

We know that leakage is a priority issue for customers and stakeholders, and we know our leakage performance has reputational impacts that go beyond a simple economic appraisal.

Stakeholders confirmed this view from an early stage in our development of our latest WRMP. Throughout our stakeholder engagement, we have heard a clear expectation that we need to do more to reduce leakage on our network. Stakeholders told us that they expect us to prioritise leakage reduction as part of our supply / demand approach before we seek to develop new sources of supply. Discussion at our water resource forums also made clear that without an ambitious leakage plan, we will find it difficult to engage with customers on broader demand management needs.

Complementing stakeholder views, our regulators have set an ambition that the industry needs to continue to drive leakage down. Ofwat has set an expectation that companies will reduce leakage by at least 15% by 2025, and more recently the National Infrastructure Commission has challenged the industry to reduce leakage by 50% over the next 25 years.

Reducing leakage consistently emerges as customers' top priority for improvement, as it is seen as a pre-requisite to asking customers to reduce their consumption. Customers consider leakage reduction as non-negotiable and a moral responsibility for us, as the amount of water currently lost though leakage is perceived to be unacceptably high. Fixing leaks is considered to be a visible demonstration of our commitment to use water resources responsibly. Analysis of social media also highlighted that leakage was a key metric dominating customer conversations. Primarily this was because most conversations relate to informing others about service issues experienced.

In our Choices research with customers, we found that our leakage reduction target of 15% in AMP7 is seen as stretching, although some customers feel it should be more ambitious (without fully understanding the scale of the improvement proposed or required to provide further reductions). Customers across the region will also benefit from improvements in the speed of response to leakage. In response to feedback on our draft WRMP we have now set much more ambitious long term leakage reduction targets.

We have used these expectations to test a range of leakage ambitions, and we have used our investment modelling techniques to test what these mean for our future leakage ambition. Our AMP7 leakage reduction target of 15%, is driven by our supply / demand investment planning needs, and contributes to a package of 'no-regret' demand management measures. We recognise that in the long term we need to develop new sources of supply to replace environmentally unsustainable ones, and to secure stakeholder support for these we will need to demonstrate that we have taken an ambitious approach to leakage reduction. Therefore, we have accepted the National Infrastructure Commission's challenge to reduce leakage by around 50% over the next 25 years.

Making a change to our metering strategy

Up until now, our household metering policy has been to offer free meters to customers upon request, so the rate of uptake has been led by customers' demand for meters. We have already explained that customers and stakeholders have given us a clear message that our future leakage and demand management plans need to be more ambitious, and we believe that metering could play a crucial role in achieving that ambition. We have seen other water companies reporting that their proactive metering programmes have delivered significant demand savings, and we know that increased meter coverage will help us be more effective in finding and fixing leaks. As a result, this WRMP includes a change in our metering strategy to become more proactive in increasing the use of household metering.

We have worked with customers and stakeholders to help us shape our proposed new metering strategy. At our first water resources stakeholder forum, we explored the different types of supply and demand options we might consider in our planning, and we discussed our decision making process. At the second stakeholder forum we focussed on the potential demand management benefits that metering could bring, and we discussed the potential barriers to increasing meter uptake. Our breakout discussions covered the different aspects of water metering, including customer perceptions and ways to improve engagement. At our third stakeholder event we sought feedback on our intentions to increase customer metering as a crucial part of our wider demand management and leakage ambition.

In addition to seeking wider stakeholder views on metering, we have held more focussed customer research on attitudes to water metering. During October 2017 we held customer deliberative research workshops in Birmingham, Mansfield and Stoke-on-Trent to explore attitudes and concerns around water metering. At these events, customers told us that we should ultimately be aiming to move all customers to a metered arrangement, and they favoured an approach where we seek to persuade customers to voluntarily make the change.

We are therefore proposing an enhanced meter installation programme to accelerate meter penetration. This would follow the area by area approach, installing meters at the customer boundary, first targeting the water resource zones with the greatest supply / demand deficit (Nottinghamshire, North Staffordshire and Strategic Grid). Customers would not be automatically transferred to metered charges, instead we propose a persuaded optant programme through sharing a billing comparison to encourage customers to switch to metered charges. We then propose to roll this enhanced programme out across all zones, with a target of achieving full coverage by the end of AMP9.

Screening new water resource options

As we developed this latest WRMP, we have tried to be unconstrained in our thinking and we have explored a wide range of potential new supply options. Early on in the process we began an unconstrained list of potential options that we subsequently put through a screening process to help focus our efforts onto the most feasible options. We worked with stakeholders to test our option screening approach and criteria, and we invited them to offer any ideas that we may have missed in our unconstrained thinking.

We wrote to our key stakeholders in December 2016 officially launching the pre-consultation phase of our latest WRMP and we set out the high level issues we expected the plan to cover. We invited stakeholders to offer early views on the issues and potential options that they expected us to consider within our WRMP. At the same time we published and sought views on our Strategic Environmental Assessment (SEA) scoping report, which described the environmental objectives and criteria we would be using when assessing options in our plan.

At our September 2016 water resources stakeholder forum we shared our options screening approach, the screening criteria we proposed to use and the scope of our Strategic Environmental Assessment. We held breakout discussions on the proposed screening criteria and we sought views on our decision making framework.

At our April 2017 stakeholder forum we held more focussed discussions on demand management options and on options to increase river abstraction. We shared our thinking about the sorts of environmental and planning issues that would need to be included in any decisions about river abstraction, and we held breakout discussions to understand if we had missed any potential issues or opportunities.

At our October 2017 stakeholder forum we signposted that the draft WRMP was likely to include supply options that could involve increasing abstraction from rivers in our region. We also highlighted that the plan would likely include options to make better use of some of our existing strategic sources of supply. Our breakout discussions sought early views on the options being presented and we wanted to understand any potential concerns or opportunities that we should factor into our thinking.

Working with customers, our deliberative research discussed a range of options to meet the supply / demand balance deficit. The research took participants on a ‘journey’ from obtaining their spontaneous reaction to a high level description of the options, through to more informed views when presented with a range of considerations, including relative cost, customer participation, certainty of outcome, environmental impact and lead time.

As well as discussing each option independently, to understand customer views and perceived merits and disadvantages of each approach, we also probed customer views on their preferred package of options, including the balance of supply-side and demand-side interventions. Figure 19 provides a visual representation of the relative customer support for different interventions and initiatives that we presented during the engagement process.

Figure 19: Customer engagement support for different intervention options

Of the supply-side and demand-side options presented to customers in the deliberative research, increasing the roll out of water meters was the option receiving the most support, followed by water efficiency and reducing leakage. Metering also received considerable support from our employees when discussing supply and demand challenges in our company wide roadshows. Supply-side options received less support, due to concerns about the level of promotion of responsible water usage and the potential for environmental damage.

In addition to these general discussions about the supply / demand balance, we used co-creation to 'deep dive' into some specific solutions, such as metering. The 'deep dive' process seeks to provide concerted and targeted considerations into the specific topic. Our discussions with customers have helped uncover some of the misperceptions and myths that customers associate with metering, and how we could dispel these in the future. We have also used co-creation to talk to customers about water efficiency, and through our online community 'Tap Chat' we have tested water efficiency campaign materials with customers, uncovering valuable insight about their preferred creative images and messaging.

Throughout our water resource options development, we have worked with the Environment Agency and Natural Resources Wales to share our thinking and to get their input to our options design and scoping. We held initial workshops with the Environment Agency in December 2016 to share our early thinking on the emerging supply / demand needs, and to share our unconstrained list of options. At that early stage the Environment Agency helped us to refine the scope of a number of options based on Water Framework Directive impacts, 'Hands-off Flow' requirements and abstraction licensing constraints.

In January 2017 we issued the Environment Agency with our first iteration of a constrained list of options and the supporting assumptions. We continued to work with the Environment Agency through 2017 to ensure that we understood the environmental or abstraction licensing aspects that they expected us to consider for our more feasible options. Environment Agency teams returned comments to us in spring 2017, and their comments and data was used to inform our ongoing options screening and scoping process. As a result of Environment Agency input, six of these options were rejected / screened out, and a we refined the scope and design of a further 28 options to reflect concerns such as abstraction licence considerations, Invasive Non-Native Species (INNS) risks, Water Framework Directive requirements and fish migration.

Using this screening and engagement process, we generated a constrained list of 111 possible new water supply options which we have then used in our investment modelling to inform this WRMP.

Responding to customers view on managing uncertainty

One of the key themes that came through our research and wider customer engagement is that customers expect that our services represent value for money, are efficient and that we are mindful of the bill impacts of our investment choices.

However, we recognise that this doesn't mean customers simply want us to pursue the cheapest option, as reflected in our deliberative research on supply / demand options. Customers explicitly want us to pursue best value options and, similarly, customers do not want us to ignore risks to future supplies. Our customer engagement revealed a much more nuanced view that seeks to balance issues such as affordability, long term sustainability and resilience.

Our engagement on using a 'Real Options' approach to managing uncertainty occurred through both a deliberative workshop and engagement using our online community. Our Water Forum challenged us strongly on the need for the deliberative research to supplement the online community engagement. This is because the potential complexity of the issue and forward looking nature means it's important to explore whether the results are different when customers have a more informed understanding.

In the deliberative workshop we sought to understand customers' views on a range of issues, including:

- Water Framework Directive (WFD) – explore customers' views about how to manage uncertain options (those which are not certain to be progressed), with a preference for higher bills now with potential for a reduction in the future, or lower bills now with a risk of higher bills in the future.
- Explore customers' views about different supply-side and demand-side solutions
- Explore customers' attitudes about how we respond to uncertainty associated with climate change – including the balance between investing now versus investing later
- Understand how customers feel about variation in their bill, and their perceptions of acceptable levels of variation

Overall customers expressed strong support for finding a middle position to manage uncertainty. On climate change there was a clear desire to protect the environment through the use of demand-side measures. Customers were not supportive of large scale supply-side solutions, despite the research occurring during the notable hot weather conditions of summer 2018. Instead there was strong support for taking action to prepare for climate change uncertainty but not undertaking significant investment now (i.e. prepare to move quickly). We used our online panel to test different options for how we might respond to the uncertainty associated with climate change.

This research was undertaken using detailed polling on our online panel with approximately 800 customers taking part. We followed the polls with a discussion thread on the panel to explore customers' views about the approaches to uncertainty, their preferences and why.

In relation to climate change, 69% of customers expressed support to our approach to prepare now but to avoid significant investment until further information is available. We also note that 13% of customers supported no activity (including feasibility and design work), whilst 18% supported investment irrespective of the uncertainty.

Key feedback from our customers included:

- *"With the rapid changes in how water should be stored, managed and used, I think that it would be unwise to decide now what approach should be taken"*.
- *"As a customer and shareholder I am definitely not in favour of large scale investment in one 'lump' but feel looking into the requirements for future investment is suitable at this stage"*.
- *"I'm voting for research and project planning rather than leaping straight into solutions that may be outdated"*.
- *"I believe it is reasonable to assume the demand for water will increase, not least due to the increase in house building. It therefore makes sense to make a start on building a 'base' provision for anticipated future requirements, rather than being caught on the back foot playing catchup. Let's get on and make progress"*.

The feedback from our customers shows that there is strong support in principle for managing uncertainty through a mechanism such as Real Options. Customers want us to balance a range of factors when making investment decisions, including:

- Protecting the environment;
- Promoting affordability by investing only in assets that required; and
- Promoting resilience by being able to respond to changes or new information quickly.

The results of the bill volatility engagement sessions also help to allay concern that even in the extreme event that all options are needed, customers would not find the change in bills volatile.

Informing our customer engagement approach

One key theme that emerged from our early stakeholder engagement was the question of how we engage with our customers on the issues dealt with by the WRMP. At our stakeholder forum events, we discussed the potential barriers to our demand management and metering options and the importance of engaging customers on these issues. We also explored the difficulties of communicating complex issues such as drought risk and environmental impacts of water abstraction.

We used the outputs from these stakeholder discussions to inform our customer research approach. We held customer deliberative research workshops and 'in-home' interviews during October 2017 where we discussed water resources and demand issues and then asked participants about their attitudes to these topics and their preferences for different supply and demand options. We used deliberative techniques to engage customers because this approach allowed us to provide information on complex topics, building participants' knowledge over the course of the day so that they are able to make informed decisions about different options and priorities to address the supply and demand challenge.

Three deliberative workshops, with a total of 48 participants, were held in different locations across the Midlands, including two in areas facing challenging supply / demand situations. The main day-long workshop focused on the general supply / demand problem, while two half day workshops focussed on metering and balancing water supply sources in areas facing a supply / demand challenge. We also held ten in depth, 'in-home' interviews in order to capture the views of customers facing more vulnerable circumstances (from both a financial and a service perspective). These interviews covered a summarised set of the workshop material. The participants recruited for the workshops covered a mix of demographics (age, socio-economic group, life stage, ethnicity and tenure type) and bill payment methods.

The topics covered at these workshops included:

- Understanding customer views on the impact of drought.
- Exploring levels of tolerance regarding risk and impact of drought.
- Exploring informed reactions to proposed solutions regarding supply options (e.g. water transfer, effluent reuse, alternative use of sources) and demand management solutions (e.g. metering, behavioural change), and attitudes towards leakage and leakage reduction.
- Exploring attitudes towards short term versus long term investment options.
- Exploring attitudes to metering.
- Exploring attitudes to balancing water supply sources in areas with a supply / demand challenge.
- Gauging willingness to pay for investment to improve supply / demand balance.

The key findings from the supply / demand workshop and in depth interviews were as follows:

- Customers have a strong moral framework when thinking about water usage, resulting in an emphasis on personal and corporate responsibility to use less water.
- Awareness of the supply / demand challenge is very low amongst customers. For most, drought is not an issue that they anticipate will affect the UK.
- Because of the emphasis they place on personal responsibility, customers tend to favour demand management approaches over supply side approaches. However, they recognise that any solution will need to include a blend of both.

Customers used four questions when evaluating the solutions that they were shown:

- Does it encourage responsible use of water?
- Is this a long term / sustainable solution?
- Is it value for money?
- Does it avoid harming the environment?

Of the options presented to customers, metering is the one that best satisfied their key questions, and which therefore received the most support. The key findings from the half day workshops on metering and managing our water resources were as follows:

- Customers feel that metering offers real benefits to both customers and us.
- Most notably, the possibility of saving money through a water meter is highly motivating.
- In addition, customers welcome the enhanced level of personal responsibility meters bring about.

As a result, customers told us that we should ultimately be aiming to move all customers to a meter, and they favoured an approach where we seek to persuade customers to voluntarily make the shift.

8 How we have developed a cost effective and sustainable plan

Our WRMP recommends a programme of short, medium and long term investment in leakage reduction, demand management, water metering and supply improvements. This recommended programme reflects our current understanding of the future water supply and demand challenges facing our region.

We believe that the proposed solutions include 'low regret' solutions that we can commence with confidence in the next five years. The plan also includes proposals for the next ten years and beyond which are flexible and do not require investment decisions to be made before our strategy is updated in our next WRMP in 2024. Overall, the proposals set out in our WRMP represent a sustainable and affordable balance of demand management and supply improvement measures that mean we can meet demand for water from our current and future customers over the next 25 years and beyond.

Our draft WRMP focussed primarily on a planning horizon of 25 years. This horizon is the minimum required by the WRMP guidelines and we have selected this period due to the scale of the supply / demand challenge we face over the next ten years to achieve Water Framework Directive objectives and address the uncertainty around climate change impacts. Since our draft WRMP was published we have continued to explore the sensitivity of our investment planning decisions and we have extended our investment scenario modelling to cover an 80 year horizon.

The options we have considered and the decisions we have taken have all been shaped by a framework which considers the following aspects:

- Understanding regulators' expectations
- Understanding stakeholders' and customers' expectations
- Costs and benefits of options
- Supply / demand investment modelling
- Environmental impacts of our options
- Sensitivity testing of future scenarios
- Extending the investment planning time horizon
- Governance and assurance

The supply / demand recommendations in our WRMP have tried to balance all of these factors to produce a flexible, sustainable and affordable plan. We explain below how we have taken these into consideration as we have formed our recommended plan.

Understanding regulators' expectations

The Water Resources Management Plan follows a well-established statutory process which is supported by clear policy and technical guidelines set by Government and regulators. We need to demonstrate that we have taken account of Defra's high level policy objectives, and that we have satisfied technical guidance given by Environment Agency (EA), Natural Resources Wales (NRW), Drinking Water Inspectorate (DWI) and Ofwat.

Defra published its '*Guiding principles for water resources planning*' in May 2016, in which it explains the key policy priorities the Government expects WRMPs to address. There are clear environmental expectations that the WRMP should demonstrate that it supports River Basin Management Plan objectives, including preventing the deterioration of water body status. There are also clear government expectations that the plan should include challenging leakage and demand management proposals with an ambition that customer consumption should reduce over time. The WRMP should also demonstrate that we have considered the widest possible range of supply and demand options, and consider the costs, benefits and environmental impacts of these.

Alongside these Defra guiding principles, the Environment Agency and Natural Resources Wales have published water resources planning guidelines that are designed to help companies write a plan that complies with all the relevant statutory requirements and government policy. These guidelines promote the same principles as the Defra guidance including expectations that the WRMP should include statutory environmental objectives, set ambitious leakage reduction and demand management targets and should consider a wide range of possible supply options. Overall, we acknowledge that our WRMP needs to demonstrate how we contribute to the delivery of Water Framework Directive objectives by:

- Setting out a secure and sustainable set of options to supply our customers with water over the long-term, negating the need to make unplanned abstractions therefore helping to build sustainable and resilient catchments;
- Showing how we will implement alternative supply or demand management options where current abstraction is identified as causing or at risk of causing environmental damage, including schemes to prevent deterioration in status, achieve protected area objectives or improve water body status (potential);
- Showing how our plans reduce leakage and operational use of water;
- Demonstrating how we will fulfil our obligation to promote water efficiency and our plans for increased customer metering, thereby reducing abstraction and its impact on flows and groundwater levels;
- Setting out how you we manage resources during a drought, including stating where and under what conditions you will seek drought permits / orders to take more water.

In September 2017 the DWI also published supplementary guidance on how the WRMP should take drinking water obligations into account. The DWI guidance requires that our WRMP takes into account all statutory drinking water quality obligations and drinking water quality legislation.

Throughout the development of this WRMP, we have had regard to these clear government policy objectives and regulatory expectations. These have shaped our thinking, and in particular our approach to achieving Water Framework Directive objectives, and the role that leakage and demand management can play in our long term planning.

Understanding stakeholders' and customers' expectations

We have worked with stakeholders and customers to shape our long term water resources strategy and the proposals set out in this WRMP. Chapter 7 of this WRMP explains how we have engaged with stakeholders and describes what we have learned. Throughout our stakeholder engagement and discussions with regulators, we heard some clear messages that:

- We need to be more ambitious with our leakage reduction targets;
- Improving customer understanding is the biggest issue when tackling water efficiency, they need to be educated on the company's drivers, and the engagement needs to be tailored to different communities;
- We should explore opportunities for more partnership working;
- We should explore innovative ways of broadening our catchment management thinking beyond just drinking water quality protection to deliver wider benefits such as biodiversity and flow attenuation/slow flow etc; New water supply schemes should deliver multi-benefits and we should explore options for water / waste water catchment thinking.

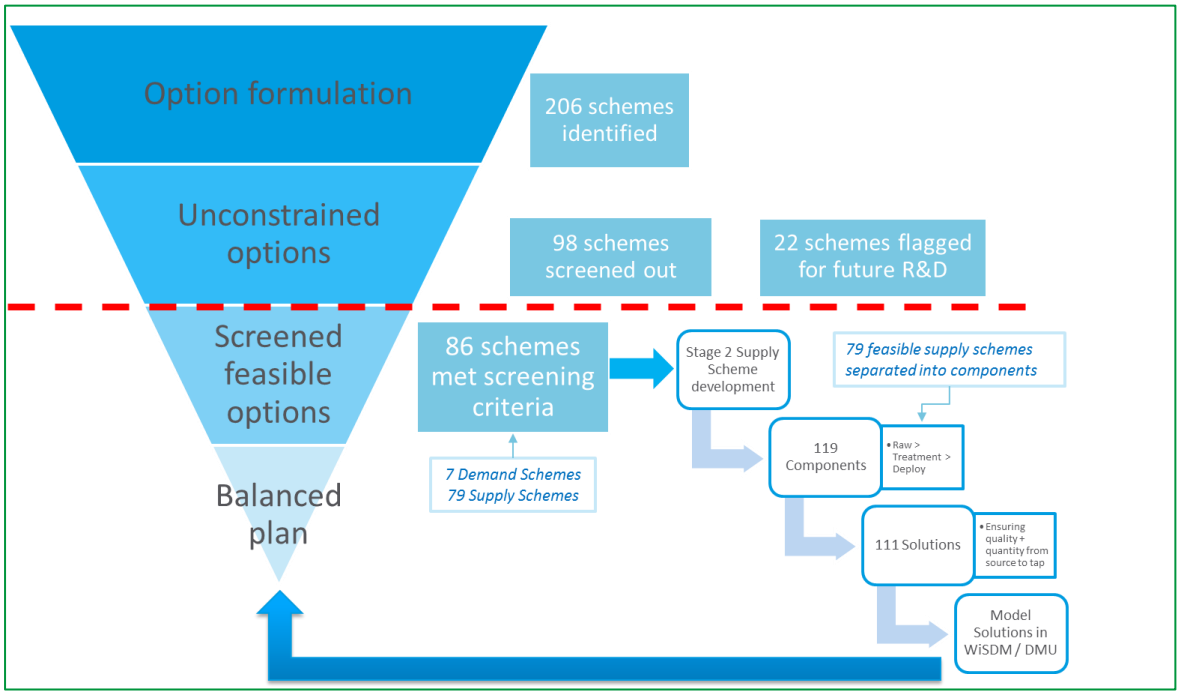
We have used these clear stakeholder messages to help shape our plan, and to guide our thinking as we worked through our different supply / demand scenarios and options. In particular, stakeholders' views have helped us to set the challenging leakage and demand management targets proposed in this WRMP. We recognise that our stakeholders expect us to focus on reducing leakage and demand before developing new sources of water.

Costs and benefits of options

We have considered a wide range of leakage, demand management and new supply investment options before arriving at our recommended plan. We have also explored potential new water trading opportunities with neighbouring water companies, and we have worked with other third parties to develop innovative commercial opportunities.

We have followed an option screening process to help us capture a wide range of these potential options early on, and that has helped us to screen out those options that we don't consider feasible for consideration in this plan. The screening process and screening criteria were shared with Environment Agency, Natural Resource Wales and our wider stakeholders. The input from these parties helped us to refine our unconstrained list into a shorter list of feasible options to which we could provide more focussed attention. Figure 20 illustrates the stages of our option formulation and screening process, and shows how we moved from over 200 possible options on our early unconstrained list, to around 111 options that were taken forward for cost and benefit appraisal.

Figure 20: The stages in our options appraisal process



The stages of our options appraisal process are described in Appendix D.

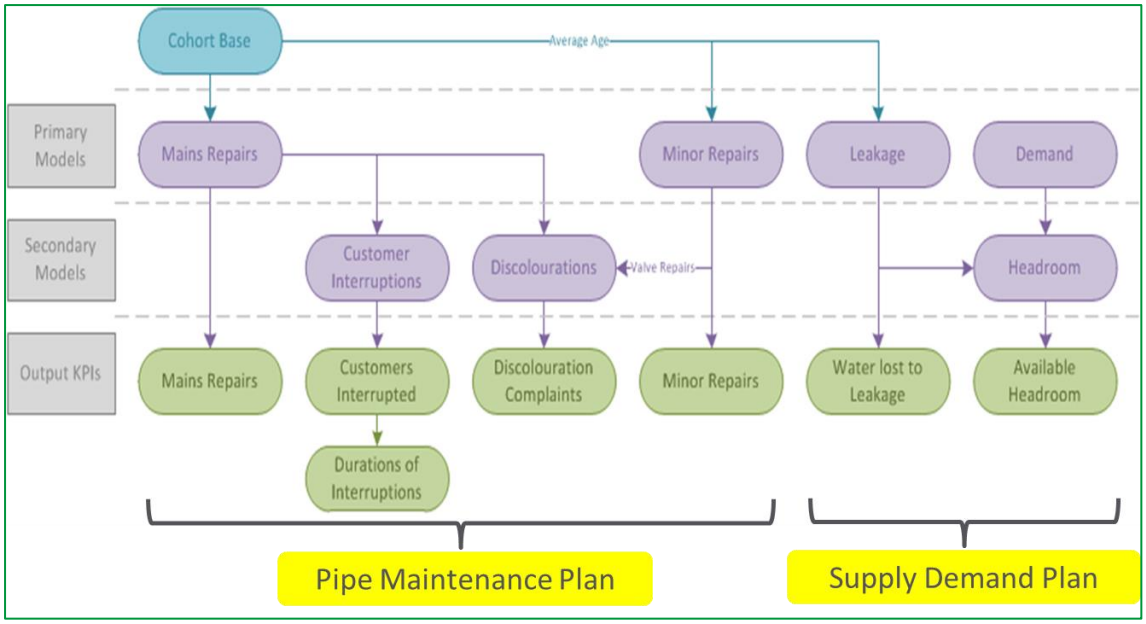
The most feasible options were then taken forward for outline design, cost estimation and environmental appraisal. For these feasible options we assessed the likely construction and operating costs, the potential volume of supply or demand benefit they might deliver, the likely time it would take to plan, build and commission the scheme, and the environmental impacts. These cost and benefit values were then then used in our investment modelling so that we could understand what the optimised balance of leakage reduction, demand management and new supply investment might look like.

Investment optimisation and least cost planning

We have used advanced investment modelling techniques to derive the optimised investment programme that could be used to meet our supply / demand challenges. Our Water Infrastructure and Supply / Demand investment model (WISDM) allows us to test the very long term, holistic investment decisions needed to both maintain the performance of our water distribution network and improve the balance between future supply and demand.

The WISDM model tests the costs and benefits of different levels of mains renewal, leakage reduction, demand management and metering alongside options to increase supply capability. The model allows us to predict the future performance of our water distribution assets, the investment needed to achieve different levels of performance, and the scale of investment needed to make sure we have sufficient water supply to meet future demand. As a result, we can be confident that we are able to generate a truly optimised package of demand and supply investment measures, and we can fully explore the economics of different leakage decisions. Our approach means that the supply-side and demand-side options included in our WRMP are fully integrated into our broader PR19 investment plans. Figure 21 illustrates the how the different elements of WISDM model combine to derive the holistic least cost plan to achieve the supply / demand balance and infrastructure maintenance needs.

Figure 21: The components of the WISDM investment model



Our investment optimisation approach follows elements of the “intermediate” and “advanced” of the UKWIR / EA Economics of Balancing Supply and Demand (EBSD) approach. Using WISDM, we have generated many ‘least cost plans’ that could be used to solve different potential supply / demand scenarios. We have also used complex scenario and uncertainty modelling to test how sensitive certain investment decisions are to our supply and demand assumptions.

The outputs of our approach have allowed us to generate a number of potential long term investment programmes which represent different ways of securing our long term supply and demand objectives. We have also used the model to test the costs and benefits of adopting different top-down policy decisions on issues such as leakage, metering and the pace at which we adapt to Water Framework Directive requirements. We have also been able to examine how water trading options could impact on our long term investment

needs, and the investment that would be needed to achieve the strategic objectives of Water UK's Water Resources Long Term Planning Framework.

As a result, we have been able to generate a range of different feasible investment programmes and use these test the cost implications of maintaining the supply / demand balance while achieving stakeholders' expectations. Through this approach, to inform our draft WRMP we arrived at three feasible supply / demand investment programmes that could be used to achieve our long term supply / demand balance needs at very similar overall programme costs, but using different options. The overall Net Present Value (NPV) difference between these three feasible programmes was approximately 3.5%, and was not considered material.

The headline difference between the supply and demand options recommended in the draft WRMP and the two alternative programmes of similar NPV, related to the potential impacts on a strategic water trade with Thames Water. The two alternative least cost programmes we derived included differing levels of leakage and metering ambition, but both included an option to develop a new water import to our region from United Utilities' Vyrnwy Reservoir via the River Severn. This transfer option also had the potential to feature in Thames Water's draft WRMP as part of a larger scale, national water trade. We therefore did not include this water trade in our recommended preferred plan. Instead we have committed to continue to explore this option with Thames Water and United Utilities through AMP7 with the aim of including it in our 2024 WRMP .

Instead, our recommended least cost programme includes an option to purchase a third party Asset and develop it into raw water storage to help meet our long term supply / demand balance needs. This is an innovative solution to develop strategic raw water storage in a way that minimises environmental impact. The option features in our proposed investment plan for the period 2025-2030, which means that we have flexibility to continue exploring it alongside the water trading alternatives during AMP7.

Since we published our draft WRMP, we have carried out a number of additional WiSDM investment scenario assessments to inform our final WRMP. These additional assessments have included:

- Updates to supply and demand data.
- Updated option costs and benefit data.
- WINEP3 revisions – we modelled the potential WINEP3 licence changes and tested the implications on the plan of implementing the licence changes at 2025 and 2030.
- Water trading – we tested the implications of incorporating trades outlined by other water companies in their draft WRMPs.

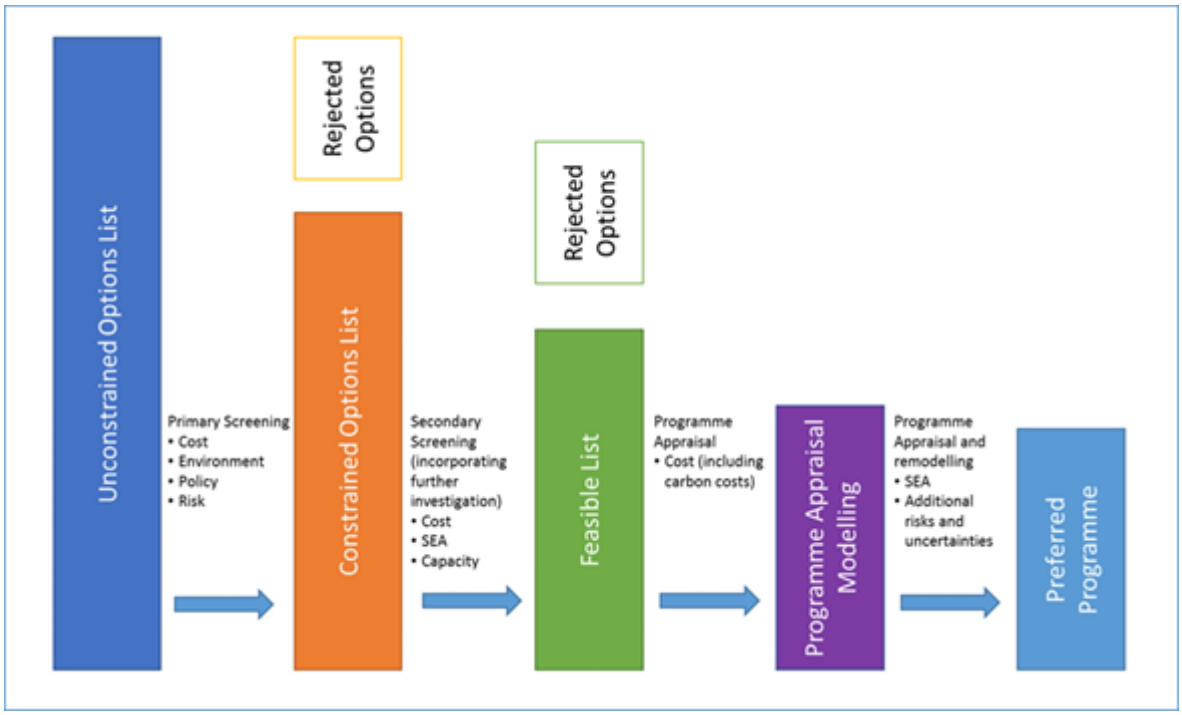
We have also used complex scenario and uncertainty modelling to test how sensitive certain investment decisions are to our underlying supply and demand assumptions. For PR19, we enhanced our WiSDM investment optimisation model to go beyond the traditional approach to sensitivity analysis. These enhancements allow the investment optimisation to more explicitly account for uncertainty parameters around the supply and demand options, as well as considering a range of alternative future scenarios. This Decision Making Upgrade (DMU) to our WiSDM investment model has given us the ability to compute large amounts of supply / demand and options data and present it in a repeatable format. This has informed our decision making, and our ability to test the cost implications of meeting different supply / demand challenges and what our whole life cost investment plan might look like under a range of alternative futures. These developments to the DMU enable us to derive adaptive plans by enabling the impact of any future changes to the underlying data or assumptions to be relatively quickly analysed.

Appendix E explains our investment modelling and decision making approach.

Environmental impacts of our options

We have followed national water industry guidance on applying Strategic Environmental Assessment (SEA) to the development of our WRMP. Figure 22 below summarises the overall approach to the application of SEA to the evolution of our WRMP19, from the initial screening of a large number of 'unconstrained' list of options through to the application of SEA in considering a wide range of alternative programmes produced through the investment modelling approach.

Figure 22: Application of SEA to WRMP19



Initially, SEA screening was carried out of the very large set of options in the unconstrained list. The screening included consideration of key environmental and social criteria, including:

- Habitats Risk Assessment (HRA) and Water Framework Directive (WFD) compliance risks;
- Key risks to the water environment;
- Key risks to important landscape, recreation and heritage features.

This screening identified options with unacceptable adverse environmental effects which were rejected from the options list and were not taken further in the option appraisal process.

More detailed environmental and social assessment was then applied to the screening of the 'constrained' list of options. HRA and WFD risks were assessed on a scale from negligible to high; Other potential effects were assessed against the SEA effects scale ranging from major beneficial to major adverse – beneficial and adverse effects were assessed separately in line with best practice. The screening assessment of the constrained options list was also discussed with the Environment Agency and Natural England, and feedback from these regulatory bodies was used to refine assessments. Options assessed as having unacceptable adverse environmental or social effects were removed from the options list; remaining options were then included in the 'Feasible List' of options. The 'Feasible List' of options were included in the WiSDM investment model for consideration for inclusion in the preferred programmes; for each option, the carbon costs and some monetised environmental and social costs were input to model, alongside the construction and operational costs.

SEA was carried out of all of the options on the 'Feasible List', along with HRA and WFD assessments, to provide us with information on the environmental performance of each option to help inform the appraisal of the various alternative programmes produce from the investment model. In this way, we were able to assess and consider the environmental and social effects of different alternative programmes to inform our decision-making process for determining the recommended plan for our WRMP.

Our decision-making process ultimately led us to three feasible, alternative supply-demand investment programmes that could be used to secure the long-term supply-demand requirements at very similar overall programme costs, but involving different options. These programmes were assessed for their environmental performance as well through SEA, HRA and WFD assessment, and we used the findings to help us reach the final decision on which programme to adopt for the WRMP19.

Alongside the SEA, HRA and WFD assessments, we have considered our approach to biodiversity and potential impacts on natural capital. We acknowledge our ability to influence, protect and enhance the biodiversity of our region as a result of the scale and scope of our operations. Promoting biodiversity, particularly in the aquatic ecosystem, is one of the cornerstones of our business objectives. Similarly, as a company we look for solutions which are the most environmentally beneficial. Incorporating natural and social capital into our decision making processes allow us to quantify and compare the environmental and social benefits of each option.

When developing our water resource supply-side options we have regard for all Government strategies, including the 25 year Environmental Plan, published by the UK Government in 'A Green Future: Our 25 year plan to Improve the Environment', as well as other government guidance. Our options appraisal process ensures that we undertake water resource solutions which are deemed the most environmentally beneficial - including enhancements to biodiversity – whilst also achieving the needs of our customers. Our biodiversity strategy for AMP7 will be aligned to all of our company's activities, including our water resources supply-side options.

We were actively involved in the UKWIR Implementing Ecosystem Service and Natural and Social Capital Accounting Approaches project and working group. Led by the consultant Eftec, this working group created a tool intended for water companies to incorporate Natural and Social Capital into PR19 business decisions and beyond. We have since commissioned further work on a number of case studies to investigate the practicality of this tool when applied to both PR19 and wider business decisions.

We have already sought to incorporate the knowledge of environmental stakeholders to support our AMP7 biodiversity commitments. Our consultation with Natural England and RSPB has supported the development of our approach of measuring natural capital through a biodiversity stock take at our larger sites and those which are known to have habitats that require protection, for example Sites of Special Scientific Interest (SSSI) and Special Areas of Conservation (SAC) etc. We have chosen to focus our efforts on our larger sites to maximise the habitat we can cover whilst being the most cost effective for our customers.

Sensitivity testing of future scenarios

As described previously in this section we have how our WISDM model allows us derive the optimised supply and demand investment programme that could be used to meet our supply / demand challenges. For this WRMP we made enhancements to our WISDM model to allow the investment optimisation to more explicitly account for uncertainty parameters around the supply and demand options, as well as considering a range of alternative future scenarios. This Decision Making Upgrade (DMU) to our WISDM investment model has given us the ability to compute large amounts of supply / demand and options data and present it in a repeatable format. This has informed our internal decision making, and our ability to test the cost implications of meeting

different stakeholders' expectations and what our whole life cost investment plan might look like under a range of alternative futures.

We have used the DMU to model a large number of different supply / demand scenarios to examine how sensitive our investment decisions are to different planning assumptions. These scenarios represent different possible 'alternative futures' which have allowed us to test the sensitivity of our plan to different combinations of events. These alternative futures were generated by varying the supply / demand factors that have the greatest uncertainty, including sustainability reductions, impacts of Water Framework Directive, climate change and future demand for water. Each scenario used a bespoke "water available for use" profile reflecting the deployable output impacts of the component being investigated and a "high", "mid" or "low" demand profile.

In August 2017 we ran 6000 DMU supply / demand investment optimisations, covering 60 different possible future scenarios. Scenarios covered the range of high / medium / low demand, WFD and climate change scenarios, along with multiple combinations of these different possible futures. We used frequency analysis to examine how different options are chosen in the 6000 different optimisations, how certain we can be that different options will deliver the expected benefits, and to investigate how sensitive our investment programme is to the different supply / demand planning assumptions.

The outputs of this analysis informed the pace and magnitude of our chosen leakage and demand management targets, and tested how robust our supply / demand choices are in a range of possible futures. For example, the DMU scenario testing demonstrated that it would be preferable to stagger the abstraction changes needed to meet WFD and sustainable abstraction objectives in our Strategic Grid and Nottinghamshire water resource zones over a ten year period. Our DMU modelling showed that making these abstraction licence reductions in a shorter time period would put security of supply at severe risk, and would drive very high cost, short term investment decisions. The DMU showed us that if these changes were to be made over a ten year period, this would produce a lower whole life cost investment programme and would mean much lower risk to security of supply. It was through this kind of analysis that the DMU outputs shaped the underlying supply / demand planning assumptions used in this recommended WRMP and the investment decisions that we are proposing.

Extending the investment planning time horizon

Our draft WRMP focussed primarily on a planning horizon of 25 years. Since the draft WRMP was published and as part of our PR19 strategic modelling programme, we have made significant updates to our cost optimisation Water Infrastructure Supply and Demand Model (WiSDM), improving model configuration, data inputs, model processing and building the Decision Making Upgrade (DMU), which has improved our decision making capabilities. Building on the long time horizon analysis we carried out for PR14, we have made a number of further adaptations to WiSDM to enable us to consider an 80 year analysis period to 2100.

We ran a number of scenarios using the adapted '80 year' WiSDM model, with baseline supply and demand planning assumptions extrapolated to 2100. Two scenarios varied the climate change assumptions:

- Central estimate reduction in deployable output based on our rank 50 2030s climate change projections.
- 2080s climate change projections used to inform the reduction in deployable output.

Both of these scenarios used the same leakage assumptions as our final WRMP until 2030. The model was then allowed to find the economic level of leakage from 2030 onwards, with the key prerequisite that leakage can never rise.

Our extended horizon modelling indicates that beyond the 25 year plan, increasing demand may mean we need to develop options to increase supply to some of our smaller water resource zones, including Whitchurch and Wem, Mardy, Ruyton and Kinsall. This could be done using interzone transfers, making these zones more resilient by connecting them to larger zones, or by enhancing treatment capacity at some of the existing sources within these zones.

In our larger water resource zones, including the Strategic Grid and Nottinghamshire, the combined impact of increasing demand and the impacts of climate change beyond 2045 may mean we need to consider developing a number of new water supply options, including:

- Final effluent reuse schemes.
- Exploit existing underground void dewatering activities for potable water supply with enhanced water treatment methodologies.
- Additional surface water storage.
- New river intakes with new water treatment works.
- Aquifer storage and recovery.

In the longer term, we may also need to consider increasing capacity at some of the larger reservoirs in our region.

We will continue to refine our long term strategy, using our long horizon modelling in conjunction with our other modelling tools to inform the decision making process and help build a robust long term plan greater than 25 years for inclusion in our 2024 Water Resources Management Plan.

Governance and assurance

Throughout the development of this WRMP, we have engaged with the Severn Trent Executive Team (STEC), the Severn Trent plc Board and with our PR19 Water Forum. We have used this ongoing engagement to agree the strategic decisions set out in this WRMP. A summary of the key stages of engagement is given below.

Severn Trent plc Board

- November 2016 – emerging PR19 Strategic Challenges, highlighting WFD and supply / demand needs
- July 2017 – emerging SDB challenge, highlighting choices, agreed timeline and governance route.
- Sept 2017 – climate change and drought deep dive with individual Board members.
- Nov 2017 – Seek Board approval to submit draft WRMP
- January 2019 – Seek Board approval to submit final WRMP, incorporating the feedback on the draft WRMP.

Severn Trent Executive Committee:

- August 2016 – emerging PR19 Strategic Challenges, highlighting WFD and supply / demand needs
- June 2017 – emerging SDB challenge, WFD impacts, stakeholder views, highlighting choices.
- Sept 2017 – findings from WISDM and DMU investment scenarios, testing leakage and metering choices, decisions on strategic directions.
- Oct 2017 – deep dive costs and benefits of leakage and metering choices.
- Nov 2017 – agreed SDB programme to include in draft WRMP consultation, explored choices and decisions.
- August 2018 – Severn Trent's Disclosure Committee agreed to the changes described in the Statement of Response.

- May 2019 – Severn Trent's Disclosure Committee confirmed that the final WRMP document had been updated to reflect the feedback on the draft WRMP and had been through SVT's full assurance process.

Water Forum

- May 2017 - Water Forum Investment sub-group supply / demand and investment modelling deep dive
- June 2017 – a technical review of our drought and climate change modelling approach
- August 2017 – Water Forum Investment sub-group deep dive into the leakage investment modelling approach.
- October 2017 – Water Forum overview of water resources and resilience investment approach.

Our decision making and recommendations are supported by a robust assurance framework. As explained in our annual assurance plans, and assurance summary which accompanies our Annual Performance Report, we use an established three lines of defence model for our regulatory submissions. We employ third line assurance in areas of greatest risk and where that assurance requires specialist engineering, financial or regulatory knowledge, we use external parties to undertake that assurance. This WRMP submission has been reviewed through our established governance and controls framework.

Given the importance of this submission we have employed third line assurance, delivered by expert external parties for those areas of greatest risk. Jacobs Consulting (Jacobs), our established independent technical assuror, has undertaken a two stage approach to assurance that included both desk-top reviews and face-to face interviews.

Phase one focussed on the proposed WRMP including:

- Review of process documentation and methodology.
- Test and challenge the robustness of our approach to forecasting.
- Review the sufficiency of our stakeholder involvement in the development of our plan.
- Review the methodology, process and controls to demand, supply, trading and third party solutions. Specifically the range of solutions considered and how the final solutions where selected.
- Integration with Drought Plan and Ofwat methodology.
- Test and challenge the plan is a cost effective and sustainable proposal.

Phase two provided a review of the accompanying data tables to confirm accuracy and completeness of the data.

We were pleased that in its feedback on our draft WRMP, OFWAT recognised our independent assurance of the draft WRMP and the engagement between the Severn Trent Water executive team and the Severn Trent plc Board during the plan development and its approval. We have continued this approach to assurance in the production of our final WRMP.

Having reviewed the WRMP, the supporting assurance and having taken Jacobs' conclusions into account, the Severn Trent Water Board makes the following statement:

- The Board is satisfied the plan represents the most cost effective and sustainable long term solution.
- The Board believes it has sufficiently collaborated with customers, partners and regulators to develop a strong understanding of future needs, explore every option, and build consensus on delivery plans.
- The Board confirms the integrity of the risk assessment process put in place by the company for all of its water supplies.

- The Board is satisfied that the WRMP takes account of all statutory drinking water quality obligations, and plans to meet all drinking water quality legislation in full.
- The Board confirms that Severn Trent complies with its duties on drinking water quality matters in its broader resilience and resource planning arrangements.