WRMP 2019 Technical Document:

Options Appraisal

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Contents

1. Introduction

This document summarises our approach to option appraisal for the WRMP.

It should be read in conjunction with the following supporting technical reports:

- Managing uncertainty and risk (including Problem Characterisation)
- Resource zone integrity assessment
- Demand Management Strategy
- Supply-side option development, and
- Sustainable abstraction

The principal focus of this report is on the following:

- Engagement (in relation to option appraisal)
- Considerations when choosing options for both supply and demand management
- Resilience options
- Assessing the solutions for our plan
- Deciding on solutions, and
- Testing our plan

1.1 Engagement and consultation

1.1.1 Methods discussions

We have had a series of discussions with the Environment Agency about our approach to the WRMP 2019 (WRMP), and have documented the results of each of these in records of meetings and minutes. These meetings started in May 2016 and in respect of option appraisal, the key "Method Discussions" were:

1 July 5 2016: alignment between the Water Resources East (WRE) project and the draft WRMP

2 November 8 2016: technical approach and schedule of future meetings

3 February 2 2017: problem characterisation, decision making framework and customer engagement

4 June 6 2017: Strategic Environmental Assessment and assessment of environmental and social impacts, and

5 September 7 2017: Drought permits and EBSD modelling approach.

In the course of our discussions we committed to the use of EBSD (least-cost optimisation) methods as the basis for appraising the options available for our WRMP. To meet the requirements of the Defra water resource planning "Guiding Principles" (WRP Guiding Principles), that our plan should be long-term and strategic, we have supported our EBSD work with more advanced decision-making under uncertainty (DMUU) approaches. These have been delivered in collaboration with stakeholders using the Water Resources East (WRE) project and the Water UK Water Resource Long-Term Planning Framework (Water UK WRLTPF).

We have also completed a series of WRMP pre-consultation meetings with Ofwat, at which the Environment Agency was represented. These meetings were based on an extensive list of WRMP-related questions provided by Ofwat and included both a (prior) water resource management planning "Masterclass" and a subsequent meeting on the WRE project. In the course of the meetings, we confirmed:

- That our WRMP would be developed using EBSD modelling techniques, and
- We would use advanced DMUU techniques from the WRE project to support our EBSD analysis, as well as the process for selecting our preferred options.

1.1.2 Pre-consultation

Our formal pre-consultation letter was sent to over 150 stakeholders in October 2017 and described the following:

- What has changed since our last plan (WRMP 2015)
- What we have been doing in preparation for the WRMP
- What kind of plan we will be consulting on
- What the Government is expecting
- What consultees need to do if they want to respond, either to the pre-consultation letter or to the consultation on the draft, and
- Key dates in the consultation process.

Our planning objectives were set out in the pre-consultation letter and are reproduced in the text box:

WRMP 2019 planning objectives (From our pre-consultation letter):

Our WRMP will propose investment to increase drought resilience, reduce our vulnerability to climate change and to meet our growth and environment related needs. We have four specific planning objectives.

- Provide enough water to meet local authority growth targets.
- Ensure our system is resilient to the combined effects of severe drought and climate change so that none of our customers are exposed to an unacceptable risk of standpipes and rota-cuts.
- Meet all of our statutory environmental obligations. These include, where necessary, restoring abstraction to sustainable levels and preventing deterioration in water body status.
- Making efficient use of the available water resources. This includes delivering an industry-leading water efficiency and leakage reduction programme and trading to share any available surpluses.

Overall, we are aiming for a system of supply that is reliable, affordable and sustainable.

We have received responses from a number of organisations. The responses were of two basic types:

- Requesting notification of the consultation dates and seeking confirmation that housing projections in the WRMP are aligned with local housing projections, and
- Seeking a commitment in the WRMP to the collaborative (water resource) planning approach we have established through our work on the WRE project. This included support for the planning objectives described above.

1.1.3 Consultation

Our WRMP was published for public consultation in spring 2018. We received a number of responses which are summarised in our Statement of Response, along with how we have addressed the comments.

There were no fundamental issues raised regarding our options appraisal, although Ofwat has questioned the outcome of our Problem Characterisation process, in which we concluded that we were facing lower levels of concern compared with our draft assessment.

The latter was completed in June 2016 and discussed with the Environment Agency. The results showed moderate to high levels of concern across our region. This was primarily driven by uncertainty associated with complexity factors, including vulnerability to severe drought and Deployable Output (DO) calculations.

Since completing the draft assessment, we have significantly improved our understanding of the planning problem. For example, we carried out further modelling to allow us to refine our understanding of current DO. We also completed a detailed analysis of our vulnerability to severe drought and an extensive programme of customer engagement to explore trade-offs related to our WRMP.

In our final Problem Characterisation we have updated our assessment to reflect this improved understanding. The final assessment confirms that our supply demand balance is under significant pressure; however, the associated complexity is greatly reduced. Consequently we are facing lower concerns across our region compared with the draft assessment, and the EBSD approach to decision making is appropriate for use in our WRMP.

Other responses included the need for:

- **Clear comparison of supply and demand options.** We have not directly compared supply and demand options due to our strategy (see below) of first promoting demand measures, as customers have clearly requested.
- **Clarity regarding the environmental appraisal of options and environmental costs and benefits.** We have undertaken a thorough assessment of environmental and social impacts, following the 'building blocks' approach proposed in the WRP Guidance. The SEA provided qualitative and semi-quantitative assessments of the environmental and social effects at a detailed level. We have also undertaken a qualitative Ecosystems Service Assessment (ESA) to complement the SEA. We considered the use of environmental valuation (using a monetised Ecosystems Services Approach). However, the absence of an agreed methodology and a lack of data means that currently, only certain environmental and social effects can be costed, thereby leading to a partial assessment. The only exception is carbon, which we have monetised and included in the AISC calculations.

- **Engagement with third parties.** We have included third party options where available, and have followed Ofwat guidance to establish our Market Information platform and associated bidding arrangements.
- **Further justification for the interconnections (pipes connecting our network) including with regard to future changes.** We have provided additional information on the needs for each set of interconnections and stress testing in our WRMP, with additional detail in this document.
- Additional information on metering costs, scheme feasibility and deliverability (provided).

1.2 Best value decision-making and our Plan

Recognising our challenges, we have adopted a planning approach that uses least-cost optimisation as well as broader criteria to develop a Best Value Plan which takes account of 'best value' decision making criteria:

- Cost - how much does the plan cost to build and operate? In areas where we are departing from 'least cost', does the additional investment deliver additional benefit to customers and the environment?
- Adaptability and flexibility - is the plan flexible enough to cope with uncertain future needs? Does it include potentially 'high regret' options, or limit future choices?
- Alignment to WRE - how well does the plan align to the regional strategy?
- Risk and resilience - how resilient is the plan to severe and extreme drought and other hazards, and what are the residual risks?
- Deliverability - can the plan be delivered on the timescales needed to manage risks?
- Customer preferences - how well does the plan align to customer preferences?
- Environmental and social impacts - what are the environmental and social impacts? Does the plan result in a net environmental benefit?

1.2.1 'Demand management is our priority'

Demand management has been, and continues to be, our priority. We put less water into supply today than at privatisation in 1989, despite an increase of more than 30% in the number of properties we serve. In addition, our leakage performance is industry leading and, by the end of AMP6 (2015-20), we aim to have 93% of households metered and 86% paying measured charges.

In developing our WRMP, we have looked first to see what risk could be offset from demand management, before seeking to develop supply-side options. Demand management continues to be our priority because it:

- Meets customer and government expectations to continue to reduce leakage and manage demand,
- Saves water that would otherwise be abstracted from the environment, allowing us to mitigate water body status deterioration risk,
- Reduces the need to develop additional supply-side capacity, and,
- Is required to ensure the reliability, sustainability and affordability of water resources over the long-term.

Our objective was to develop an integrated, multi-AMP demand management strategy that:

- Recognises the value of demand management to our customers and the environment,
- Develops demand management programmes holistically,
- Recognises the role demand management can play in managing future uncertainty, and,
- Challenges us and our customers to push the boundaries of what is achievable.

In developing the strategy, we considered three alternative strategic demand management options, each of which consisted of a combination of smart metering, leakage reduction and water efficiency activities. We then undertook a cost benefit analysis of the three strategic options, using a building blocks approach. Each strategic option was also evaluated against the wider best-value criteria above.

1.2.2 Development of the demand-side strategy

Our Preferred Plan is underpinned by a four stage appraisal process, as outlined below:

Figure 1.1: Demand-side appraisal processes

Stage 1:
Assessment of potential strategies to meet regulatory, customer and environmental expectations

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Stage 2:
Option package design for leakage, metering and water efficiency demand management initiatives

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Stage 3:
Assessment of costs and benefits for CBA analysis including customer, societal and deferred investment valuation

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Stage 4:
CBA Analysis and scenario testing of Options selected for review in order to select preferred demand management option

Stage 1 - Assessment of potential demand management strategies

Reflecting the importance of demand management to the WRMP, internal governance under the aegis of the 'Demand Management Strategy Steering Group' was implemented, to oversee the entire process of developing the demand management options. This Group, chaired at Director level, was instrumental in bringing together key Anglian Water stakeholders, overseeing the appraisal and consultation processes, and gaining final approval for the preferred demand management option.

During the first stage, consideration was given to the scale of the challenge and the range of demand management interventions (unconstrained) which might mitigate the expected growth in demand over the WRMP period.

Stage 2 - Option package design including all elements (leakage, metering, water-efficiency)

As a part of the 'Demand Management Strategy Steering Group' remit, synergies between leakage, metering and water efficiency measures were assessed in order to produce holistic demand management option packages. This led to the design of the 'Extended', 'Extended Plus' and 'Aspirational' demand management options.

Reflecting guidance and noting that our demand management measures needed to be considered holistically, we produced a number of variations of the strategic options, including complementary elements of leakage, smart metering and water efficiency interventions.

Stage 3 - Assessments of costs and benefits for all options

Detailed assessments were made of the costs and benefits that might be associated with each demand management element, including assessments for customer, societal and deferred supply-side investment valuations. Detailed assessments were also conducted with respect to the deliverability of the option packages.

Stage 4 - Cost benefit analysis and final selection of preferred option

Cost benefit analysis was then undertaken in order to select our preferred option ('Extended Plus'). Additionally, further scenario and stress testing was undertaken, in combination with supply side optioneering.

1.2.3 'Supply-side investment is also required'

Despite our ambitious demand management strategy, the scale of the challenge is such that we still need carefully targeted investment in supply-side capacity.

The supply-side options considered for inclusion in our WRMP have been developed following industry and regulator guidance. We have limited options for new local water resources in many parts of our region. This is largely due to constraints on the amount of new water we can abstract from the environment, as well as planning factors.

In addition, we included a number of trading and third party options in our feasible option set. We have engaged in detailed discussions with our neighbouring water companies (Affinity Water, Severn Trent Water, Cambridge Water, Essex and Suffolk Water), as well as water management organisations in our region such as the Environment

Agency and the Canal and River Trust. We have also held discussions with third party suppliers and other large industrial users in our region to explore trading opportunities.

1.2.4 Supply-side programme appraisal

Traditionally, companies have used the EBSD approach to guide decision making. EBSD allows planners to meet a supply-demand deficit with the lowest overall cost, or 'least cost' solution. Our WRMP 2010 and WRMP 2015 were both based on least cost option appraisal.

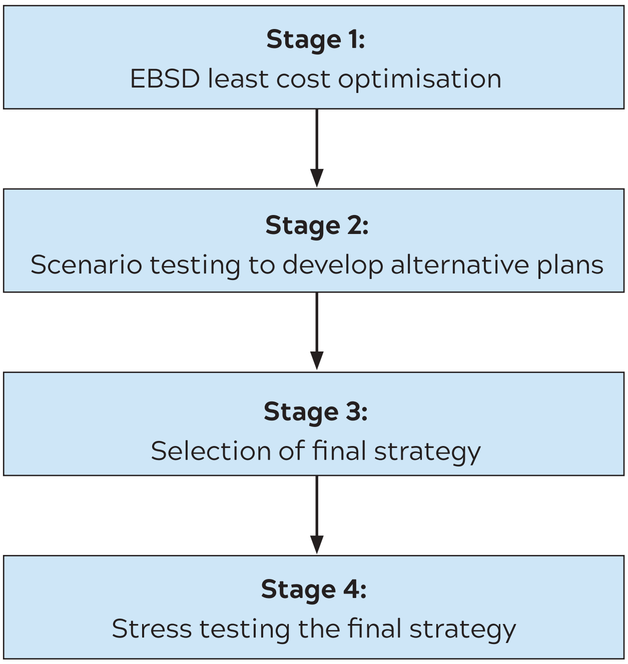
The limitations of least cost planning approach are now widely recognised, and there is support from regulators, stakeholders and our customers, to develop Best Value Plans. Such plans must consider more than cost and include issues such as the environmental impact, resilience and customer preferences. Defra's own Guiding Principles state: 'We expect to see evidence that you have taken a strategic approach to water resources planning that represents best value to customers over the long term.'

We have assessed a number of factors in developing our Preferred Plan, based on the 'Best Value Criteria' described above.

1.2.5 Development of the supply-side strategy

Our Preferred Plan is underpinned by a four stage appraisal process, as outlined below:

Figure 1.2: Supply-side appraisal processes



Stage 1 - EBSD and Least Cost Optimisation

During the first stage, we used the industry-standard EBSD methodology that is based on least-cost optimisation, to determine the Baseline Least Cost Plan (bLCP). The optimisation used the baseline WRMP scenario described in chapter 2 'The scale of the challenge' in main WRMP report.

Our Baseline Least Cost Plan was the starting point for the development of our Preferred Plan, and any decision to move away from this has been clearly explained and documented.

Stage 2 - Scenario testing to develop alternative strategies

For this stage we ran a number of scenarios through the EBSD process using the Baseline Least Cost Plan as a basis to create a set of alternative plans. The scenarios included testing which options would be selected if we maximised use of existing resources between WRZs and to understand how plans would change if a strategic resource (e.g. a winter storage reservoir) was developed in preference to other smaller new resources. At this stage we also tested sets of options under different future scenarios, such as extreme droughts and additional future exports to neighbouring water companies. Once we had a set of alternative plans, we started to see common transfer strategies. The main difference between the plans was the capacity of the transfers.

Stage 3 - Selection of final strategy

We used performance criteria to assess the alternative plans. We found that increasing the capacity in some transfers had the benefit of providing flexibility and adaptability to meet potential future challenges. It also enabled a wider range of new water resource options that may be required in the future.

The stress testing helped us to find the balance between adequate capacity to be future proof with actual utilisation in a business as usual scenario. We selected the optimal combination of transfer capacities which formed our preferred plan or Best Value Plan. Determining the capacity of the transfer options is critical as they are all required to be installed in AMP7. Delaying new resource options gives us choices in the future for more strategic, sustainable resources, if required.

The outputs from this process were used to inform the recommendation to our Strategic Priorities Board as part of the PR19 governance process. Once our Board signed off the strategy, we refined the capacities of the options through the stress testing process.

Stage 4 - Stress testing the final strategy

We stress-tested the final set of schemes to ensure that the final strategy was robust to future uncertainties and that we understood how the plan would operate in a 'business as usual' scenario. The strategy was tested under four future scenarios:

- The need to provide resilience to extreme drought (with an approximate 1 in 500 year return period)
- Drier climate change scenarios
- The possibility that our demand management strategy achieves lower water savings than estimated, and
- Possible future trades with neighbouring water companies.

To demonstrate the benefits of the Best Value Plan we completed a performance criteria assessment for each plan. This includes a comparison with the Alternative Least Cost Plan which is the least cost version of our Best Value strategy. In this plan the transfer capacity is limited to only meet the needs of the WRMP baseline scenario.

We used 'multi-criteria analysis', rather than standard Cost Benefit Analysis, as some of the performance criteria we have assessed are difficult to monetise. The plans were compared with each other and scored on the basis of best performance.

2. Developing the Demand-side Strategy for the Preferred Plan

The development of our demand management options

In the development of the WRMP, we have sought to develop an ambitious integrated, multi-AMP demand management strategy that:

- Recognises the value of demand management with regard
  - To DEFRA's Guiding Principles,
  - To our customers and
  - To the environment
- Develops demand management programmes holistically
- Recognises the role demand management can play in managing future uncertainty, and,
- Challenges us and our customers to push the boundaries of what is achievable.

The importance of managing demand is emphasised in Defra's Guiding Principles.

In developing our WRMP, we have noted the stress placed upon demand management by Defra, as a preferred strategy to address anticipated growth and mitigate environmental impact. As stated;

> 'We expect you to choose demand-side options as part of the preferred programme wherever it is reasonably likely that the benefits will outweigh the costs.'

and;

> 'WRMPs are expected to continue to ensure the reduction of the overall demand for water through demand management activities; including the reduction of leakage and increasing water efficiency through metering programmes.'

Additionally, we have noted that it is expected that leakage should remain a priority and that, between 2020 and 2025, companies should aim to achieve at least a 15% reduction in leakage.

This guidance has, consequently, been key to informing and developing our demand management strategy.

Both the government and our customers expect us to continue to reduce demand for water resources. Our customers have told us that they prefer options that make best use of available resources and that leakage reduction should be prioritised.

In addition, demand management forms an essential strategy in mitigating short-term environmental risks. Increasing our current abstractions to meet growth related requirements would represent a serious deterioration risk and it is noted that there is envisaged to be no more licensable water available to meet future demand.

We have, therefore, placed demand management strategies at the core of our plan to offset any growth in demand.

Demand management also has wider environmental benefits. It directly benefits our local environment as we are saving water that would otherwise have to be abstracted, increasing the well-being and resilience of natural aquatic habitats.

Avoiding the need for additional abstraction is particularly important in our region, which is home to many internationally important wetland ecosystems and is classified as an area of 'serious water stress' by the Environment Agency.

In addition, water saved does not need to be treated and distributed which reduces our operational energy consumption, making us more efficient and saving carbon.

We believe there is great potential for increasing future demand savings, driven by innovation and investment.

We have used the results of our 'Problem Characterisation' analysis, together with the outcomes of customer and stakeholder engagement to develop our specific planning objectives.

Thus it was determined that any plan for demand management should fulfil the following criteria:

- Fulfil our regulatory obligations
- Meet our customer expectations

- Be of reasonable cost
- Mitigate growth in demand
- Be achievable/deliverable
- Meet SEA requirements
- Align with WRE expectations

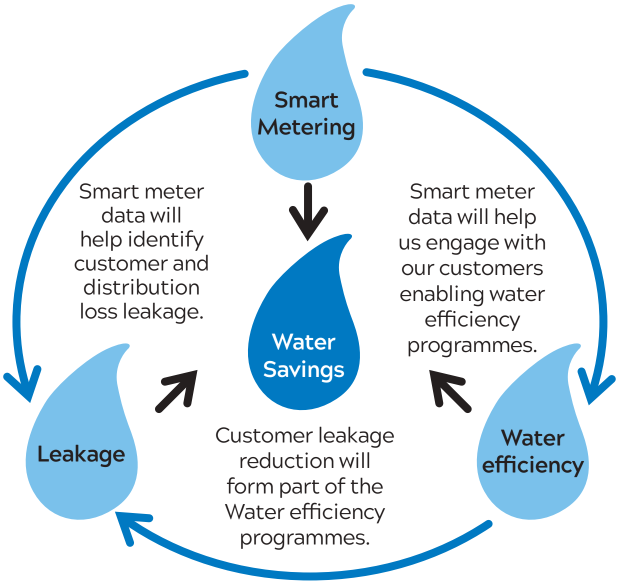
Our current achievements in demand management limit the potential to achieve further savings through 'tried and tested' demand management activities.

In particular it should be noted that our standard 'dumb' meter penetration currently stands at a very high level, with 81% of our customers receiving a measured bill, (and 89% having a meter 2017/18) with associated behavioural savings (as customers switch from being unmeasured to measured status) already being seen. Additionally, our leakage levels are already significantly below the assessed Economic Leakage level of 211Ml/d, at 182.66 Ml/d (2017/18).

However, our ambition is to build upon our current position. The next step-change in demand management will be achieved through technological innovation and the implementation of 'frontier' initiatives that are relatively un-tested in a UK context.

Due to the synergies and interdependencies between metering, leakage and our water efficiency measures, the programme was determined to comprise three strongly interlinked strategies.

Figure 2.1: Our holistic demand management plan



2.1 Demand Management Option Development

The selection of our demand management options

In order to develop this ambitious plan, we initially began by reviewing an extensive set of options, drawing on a wide range of sources. These options included:

- Multiple interventions to reduce leakage
- Alternative methods and timescales for implementing a smart metering strategy
- A wide variety of water efficiency programmes

We reviewed these options to develop a shortlist of feasible options.

There are significant synergies between leakage reduction, smart metering and water efficiency activities. Given these synergies, it was essential to consider demand management programmes holistically through the development of 'strategic options'.

Consequently the feasible elements selected for demand management were packaged into 'high', 'medium' and 'low' 'strategic' options for further analysis. Thus, our three strategic demand management options each consist of a combination of smart metering, leakage reduction and water efficiency activity.

Each option has been built from the bottom-up by combining water resource zone sub-options. Decisions regarding the geographical focus of each strategic option were informed by a risk assessment including the 'Draft Problem Characterisation' scores, current levels of leakage and metering, and the practicalities of implementation.

2.1.1 Developing the options list

We have a strong track record delivering demand management. Our success, however, means that there is limited potential to achieve further savings through tried and tested demand management activity as these have effectively been 'locked-in'. The next step-change in demand management will be achieved through technological innovation (such as smart metering) and initiatives that are relatively untested in a UK context.

In order to consider the widest possible range of options, we developed and reviewed an unconstrained list of options that drew on:

- Our current business practises and how we could improve them
- Current practises and plans of other UK water companies
- Practises in other sectors (e.g. gas and electricity) to encourage demand management and behaviour change
- Practises in other countries or localities that experience water stress
- Opportunities provided by technology and innovation, and,
- Latest academic research.

This process identified options such as:

- The use of rewards and competitions to incentivise behaviour change, and
- 'Development' scale grey water reuse systems to reduce potable consumption to 80 l/head/d.

It also included an option to install smart meters, specifically Advanced Meter Infrastructure (AMI) technologies.

Smart meters offer the opportunity to collect significantly more consumer consumption data than dumb meters (which are currently read annually or bi-annually). They transmit readings every hour over a fixed, long-range radio network. This data will then be provided to customers over a dedicated website or 'customer portal'.

2.1.2 Screening the unconstrained list

We then assessed the unconstrained list to identify feasible option-types using the screening criteria set out in WR27 Water resources tools (UKWIR, 2012). As a result of this process, a number of option-types were screened out. Options were assessed and selected, based upon customer and societal valuation, cost, risk, feasibility and suitability to meet the WRMP strategic goals. The options we have screened out and our reasoning are described in detail in the 'Demand Management Strategy Report'.

2.1.3 Developing strategic options

Using the remaining options on the 'short-list', we undertook a 'process of definition' in order to develop the detail of each option (for example, for smart metering options this included roll-out trajectories, meter technology selection, customer interaction and supporting technologies), to understand dependencies and exclusivities, and to create options that are specific to WRZs.

There are significant synergies between leakage reduction, smart metering and water efficiency activities. For example, before we can ask our customers to conserve water resources we must show that we are 'doing our bit', particularly by reducing leakage and fixing visible leaks as quickly as possible.

The frequent meter readings and abundance of data provided by smart meters will allow us to identify customer supply pipe leakage (CSPL) and internal plumbing losses (especially leaky loos) and then to proactively contact customers so that they can repair those leaks. Smart metering data will also allow us to identify leaks on our network more efficiently.

Many potential water efficiency initiatives will be dependent upon the installation of smart meters, including the introduction of targeted behavioural change initiatives, tariffs, and the installation of smart appliances.

Given these synergies, it was essential to consider demand management programmes holistically through the development of 'strategic options'. Each strategic option includes smart metering, leakage reduction and water efficiency sub-options, and has been built from the bottom-up at the WRZ geographic level.

Decisions regarding the geographical focus of each strategic option were informed by Draft Problem Characterisation scores, growth risks, current levels of leakage and metering, and the practicalities of implementation. Option targeting and prioritisation have been directed at WRZs/PZs based upon identified:

- Forecast WRZ risks and issues
- Opportunities based upon current WRZ status

- Potential barriers (technological) to option development (geographic implications - household distribution/density)

This approach is consistent with the approach to demand management in the Water UK study, Water Resources Long Term Planning Framework (WRLTPF), which developed four demand management scenarios consisting of a combination of leakage, metering and water efficiency initiatives.

The WRLTPF considered four scenarios for demand management by water companies as part of its forecast for demand. These are shown below.

- 'Business as Usual' (BAU) - Base: this represents the situation that would occur if water companies continue with their current policies and methods for reducing demand, but the societal and policy support for demand management is low.
- 'Business as Usual' (BAU) - Upper: as above, but with a greater degree of societal and policy support.
- Extended: this represents an ambitious extension to demand management, incorporating initiatives such as the use of differential tariffs to help reduce demand.
- Enhanced: this represents a significant advance in demand management, incorporating initiatives such as grey water re-use and much tighter controls on water efficient design for new households.

Reflecting this guidance, we produced a number of variations of the strategic options, including complementary elements of leakage, smart metering and water efficiency interventions for evaluation.

2.1.4 The strategic options

The strategic options developed for our WRMP are summarised in the table below.

Table 2.1: The strategic demand management options

	Baseline	Extended	Extended plus	Aspirational
Metering	No additional smart metering - dumb meter only Continued 'dumb meter' roll-out to maximum feasible penetration (95%)	3 AMP AMI roll-out 15 Year roll-out to practical limit of meter penetration 50Ml/d savings in 2045 including; 22Ml/d savings from behavioural change 22Ml/d CSPL savings, 6Ml/d distribution loss savings	2 AMP AMI roll-out 10 Year roll-out to practical limit of meter penetration 51Ml/d savings in 2045 including; 23Ml/d savings from behavioural change 22Ml/d CSPL savings, 6Ml/d distribution loss savings	2 AMP AMI roll-out 10 Year roll-out to practical limit of meter penetration 51Ml/d savings in 2045 including; 23Ml/d savings from behavioural change 22Ml/d CSPL savings, 6Ml/d distribution loss savings
Leakage reduction	Leakage held at 172 Ml/d (the AMP 6 company commitment) (177Ml/d 3 year rolling average	10 Ml/d reduction by 2045 (excludes 28 Ml/d CSPL and distribution loss reductions from smart metering programme - see above) Reduction of leakage by 38Ml/d to 134Ml/d by 2045, by a combination of leakage and smart metering strategies. This does not meet our 15% reduction target.	42 Ml/d reduction by 2045 (excludes 28 Ml/d CSPL and distribution loss reductions from smart metering programme - see above) Reduction of leakage by 70Ml/d to 106Ml/d by 2045, by a combination of leakage and smart metering strategies Leakage reducing by 21% to 142Ml/d by 2025 and by 42% to 106Ml/d from the current value (182.66Ml/d) Note leakage currently represents 16% of Distribution input and will represent 9.5% of DI in 2045.	77 Ml/d reduction by 2045 (excludes 28 Ml/d CSPL and distribution loss reductions from smart metering programme - see above) Reduction of leakage by 105Ml/d to 72Ml/d by 2045, by a combination of leakage and smart metering strategies

	Baseline	Extended	Extended plus	Aspirational
Water efficiency - household	Continuation of current activity, including: The Potting Shed initiative Communications campaigns on discretionary use including events, education, and use of Broadcast Beacons	Leaky Loos campaign A rewards scheme for customers who sign-up on the portal A base Bits and Bobs campaign (up to 15,000 audits) Free installation of water butts (when purchased by a customer) 8Ml/d savings by 2045	In addition to the Extended option: Multi-utility consumption portal Provide and install water butts to certain customers Rebate to replace old toilets Retrofit 'smart devices' (such as taps) that can send data to the customer portal 32Ml/d savings by 2045	In addition to the Extended Plus option: Provide and install water butts to all customers Use satellite technology to advise customer when to water their gardens 38Ml/d savings by 2045
Total Option Savings		Total Option savings · End of AMP7: 26Ml/d · End of AMP11: 71Ml/d	Total Option savings · End of AMP7: 43Ml/d · End of AMP11: 123Ml/d	Total Option savings; · End of AMP7: 60Ml/d · End of AMP11: 164Ml/d

2.2 Metering - Options considered

It is important to note that all of the strategic options include the installation of smart meters across our region, reaching the limit of feasible meter penetration (95%) by the end of AMP9 (in the 'Extended' option) or AMP8 (in the 'Extended Plus' and 'Aspirational' options). By 'smart meters' we specifically mean Advanced Meter Infrastructure (AMI) meters and their associated transmission networks, with the data provided to customers over a dedicated website or 'customer portal'.

As discussed, we believe that smart meters offer the potential to deliver significant future demand savings, through the innovative methods of customer engagement that will be enabled by the frequent data provided (over and above what they would save with a dumb meter). Secondly, they make possible a range of future water efficiency initiatives, such as non-price behavioural change incentives, financial incentives, or increasing block tariffs, which can generate further water saving. In addition, the frequent consumption data that smart meters generate will allow us to unlock a range of additional benefits. For example, a better understanding of demand will allow us to improve the efficiency of our operations through targeted network optimisation. Finally, smart metering is also an integral part of our strategy to achieve the leakage targets associated with each of the strategic options. Smart metering data will help us to identify leaks on our network which can then be fixed more quickly, saving water.

It will also allow us to identify customer supply pipe leakage and plumbing loss leaks inside the customer's property. Although these leaks are not our legal responsibility to fix, they represent a significant proportion of total water lost through leakage. For example, in 2017/18, CPSL accounted for nearly 25% of our total leakage. Once we have identified these leaks, we will then contact customers proactively and encourage them to fix it.

For the purposes of our cost benefit analysis we have assumed that the same or similar technology as is currently being trialled would be used for the company wide roll-out.

2.2.1 Smart meter option summary

Five options were developed to support demand reduction under the category of metering. These options are:

1. Business as usual (BAU) metering i.e. continuation of the company's AMP6 programme with the exception of enhanced metering policy.

2. Advanced metering infrastructure (AMI) metering over 3 AMP periods.

3. AMI metering over 3 AMP periods with a reduced proactive meter replacement programme.

4. AMI metering over 2 AMP periods.

5. AMI metering over 2 AMP periods with a reduced proactive meter replacement programme.

Figure 2.2: 'Smart' metering - roll-out projection over 3 AMPs

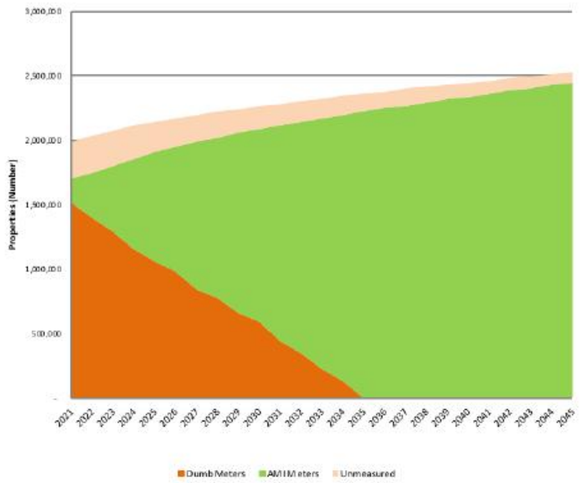
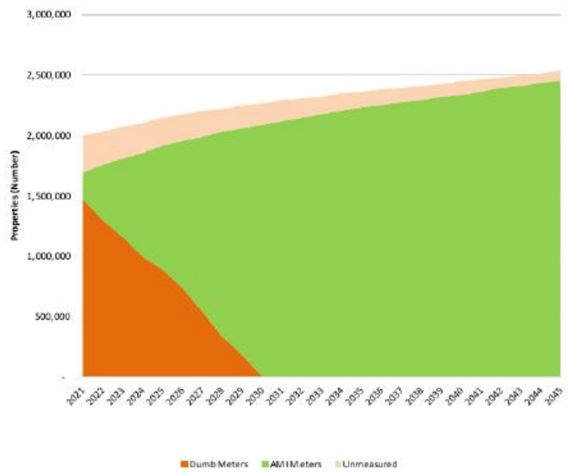


Figure 2.3: Smart' metering - roll-out projection over 2 AMPs



2.2.2 Comparative costs of metering programmes

Detailed analysis has been carried out with regard to each element of the meter roll-out programme, as both smart meters are introduced and 'dumb' meters continue to be replaced. This will reflect the sequential roll-out of the smart meter programme, WRZ by WRZ over the 10 year 2 AMP preferred plan period.

Thus for each metering programme the following average costs per meter can be determined for AMP7.

These costs reflect the different metering programmes:

- PMX - Proactive meter replacement of meters as they reach the end of their life, will be a mixture of dumb and smart based on geography.
- AMI Smart meter - Proactive replacement of 'dumb' meters which haven't reached end of life in areas designated for smart meter roll-out; all smart.
- RMX - Reactive replacement of meters. Meters have malfunctioned, will be a mixture of dumb and smart based on geography.
- Enhanced - Company driven meter installation programme in particular areas. The meter is fitted and then customers are encouraged to switch to measured charges; all smart meters.
- Meter Options - Customer driven meter installation programme at the request of customer, will be a mixture of dumb and smart based on geography.
- Selective - Company driven meter installation programme at properties where current method of charging is not appropriate (RV no longer valid, unregistered properties); this will be a mixture of dumb and smart based on geography.

In addition we have programmed the following types of interventions, associated with smart metering.

- AMI Leakage - Company driven programme of leakage investigation visits where help customer fix leaks identified through smart meter data. We help identify the source of the leak in the customer's home or supply pipe, the customer then repairs it.
- AMI Maintenance - Reactive replacement of smart points used to provide smart meter data.

Table 2.2: Average costs per meter installation for the different meter programmes

Meter Programme	Average cost per meter AMP7
AMI - Smart meter	£108
PMX	£88
RMX	£137
Enhanced	£234
Meter Option	£277
Selective	£333
AMI Leak	£50
AMI Maintenance	£68

Additionally, the meter volumes anticipated for each metering programme for AMP7 can be shown.

Table 2.3: Number of meter installations for each meter programme

Programme Volume	2020/21	2021/22	2022/23	2023/24	2024/25
AMI	108,735	61,782	157,654	145,708	128,501
PMX	125,289	165,756	72,834	88,540	97,284
RMX	17,079	17,079	17,079	17,079	17,079
Enhanced	5,974	1,314	15,436	9,137	1,615
Meter Option	8,203	7,289	6,907	6,087	5,691
Selective	293	261	247	218	204
AMI Maintenance	1,155	1,020	1,339	1,299	1,210

The smart meter programme has been designed to be geographically introduced area by area, as the data transmission network is completed. 'Dumb' meters will, therefore, continue to be installed in areas, where the data network has not been installed.

2.2.3 Metering costs and benefits

Current actual costs have been used to develop all the options, including costs for below ground meter installation and customer contacts.

Current estimates for the cost of the communications network have been provided by our chosen partners for the Newmarket trial. These costs have been developed to reflect our annual roll-out plan. Additionally we have used current costs for the smart meters deployed in our ongoing trials.

Labour costs have been considered, from both the perspective of using in-source or outsourced resources.

Key assumptions have informed the metering strategy;

Table 2.4: Key metering assumptions

CBA:	Includes all metering costs (including PMX exchange) discounted over 80 years
Customer use:	15% reduction of PHC when installing new Dumb meter to an unmetered property
	Further 3 % reduction (17.55% in total) when installing new AMI meter to an unmetered property (initial 15% with an additional 3% subsequently applied)
	Alternatively, 3% reduction when replacing existing Dumb meter with AMI meter
CSPL:	Savings based on initial findings from Newmarket. Current estimate 8.2 l/prop/day by AMP11
	Savings based upon 90% of large leaks (paid by customer) and 10% of small leaks repaired (supported by AWS data)
Distribution losses:	5% distribution loss saving after the end of 'AMI upgrade' programme in each WRZ

Quantitative benefits

Costs and benefits have been considered in detail for the smart metering programme and are described in detail in the WRMP 'Demand Management Strategy' Report. This includes detailed analysis of the following:

Reduced customer use - Both dumb metering and smart metering can help reduce household water consumption.

Reduced distribution losses and more efficient network management - Smart metering will support a reduction in leakage in our distribution network through an improved understanding of water balance data and via easier leak detection (enabling speedier repairs).

Reduced supply pipe losses - Smart metering will support the identification of continuous flows in properties

Reduced customer service costs - Smart metering will reduce the cost of dealing with customer contacts. This is mainly the result of more accurate billing leading to fewer 'bill shocks' for customers (which result in customer contact).

Recovered revenue from zero flow meters - Smart metering will provide data that can minimise the number of properties classified as voids (i.e. empty properties).

More efficient meter reading - A key expected benefit of smart metering will be a reduction in meter reading costs compared with dumb metering.

Replacement of loggers with smart data - We currently install data loggers when a non-household customer exceeds a certain level of daily use or for customers with high levels of night use.

Reduced carbon emissions - Reduced demand for water has a resultant impact on customer's carbon emissions.

Qualitative benefits

Customer focus - We believe there is great potential for smart metering to encourage customer engagement, making them part of the 'water saving' journey, and allowing us to produce an individually tailored service.

Environmental benefits - By helping to enable demand reductions, smart meters will provide significant environmental benefits. In particular they will mitigate growth, reducing the amount of water abstracted from the environment, potentially offsetting the need for additional supply side investments (which often have larger environmental impacts).

Enabling other activities and our holistic approach - A number of our water efficiency options rely on the smart metering option being taken forward.

2.2.4 Metering Scenarios and costs

The smart meter option has been modelled to reflect a 2 AMP, 10 year, roll-out and an option of a 3 AMP, 15 year roll-out.

Figure 2.4: Smart meter savings (2AMP)

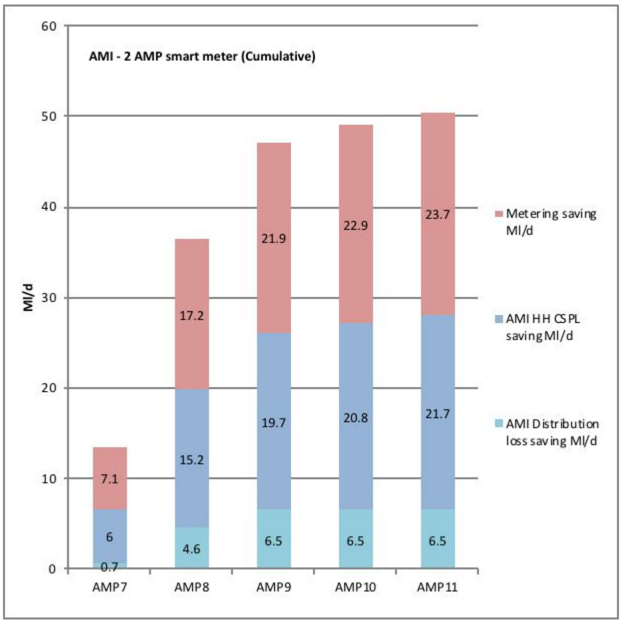


Table 2.5: 2 AMP smart metering costs

2 AMP roll-out	Total Cost (AMP7)	Avg Saving (AMP7)	Total Cost (AMP11)	Avg Saving (AMP11)
Fixed Capex/ Opex inc - Finance	£174m		£734m	
Fixed Capex/ Opex pre - Finance	£162m	13.8 Ml/d	£595m	51.9 Ml/d
Opex saving	£12m		£263m	

Figure 2.5: Smart meter savings (3AMP)

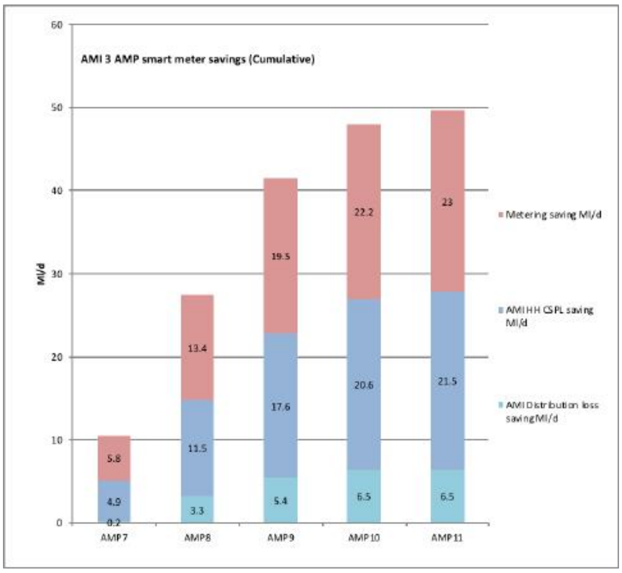


Table 2.6: 3 AMP smart metering costs

<table>
<tr><th>3 AMP roll-out</th><th>Total (AMP7)</th><th>Avg Saving (AMP7)</th><th>Total (AMP11)</th><th>Avg Saving (AMP11)</th></tr>
<tr><td>Fixed Capex/ Opex inc - Finance</td><td>£149m</td><td rowspan="3">10.9 Ml/d</td><td>£707m</td><td rowspan="3">51.0 Ml/d</td></tr>
<tr><td>Fixed Capex/Opex excluding - Finance</td><td>£139m</td><td>£572m</td></tr>
<tr><td>Opex saving</td><td>£9m</td><td>£241m</td></tr>
</table>

2.3 Leakage reduction - Options considered

We are determined to continue to improve on our excellent recent performance reducing leakage. To this end we considered a large number of sub-options for leakage reductions activities which covered approximately 1,700 specific interventions.

We ordered this long list of detailed sub-options by Average Incremental Cost (AIC) and adjusted for overlaps and dependencies. We used this AIC ranking to generate three sub-option bundles for each of our WRZs. The three bundles align to our broad option packages which cut across leakage, metering and water efficiency. These options are above and beyond the activities we are currently undertaking.

The three leakage options bundles we considered are:

1. Extended - with expected water savings of 10Ml/d or up to 15Ml/d if associated with smart metering (AMP7) - 38Ml/d by the end of the WRMP period (including smart meter savings).
2. Extended plus - an ambitious bundle aiming to achieve water savings of 23Ml/d or up to 30Ml/d in association with smart metering (AMP7) - nominal 70Ml/d by the end of the WRMP period (including smart meter savings).
3. Aspirational - a challenging package with high water savings and high costs, aiming to achieve water savings of 38Ml/d or up to 45Ml/d in association with smart metering (AMP7) - nominal 105Ml/d by the end of the WRMP period (including smart meter savings).

Within these three bundles we have considered six direct leakage reduction options and six options for activities that enable further leakage reduction.

2.3.1 Leakage reduction sub-options

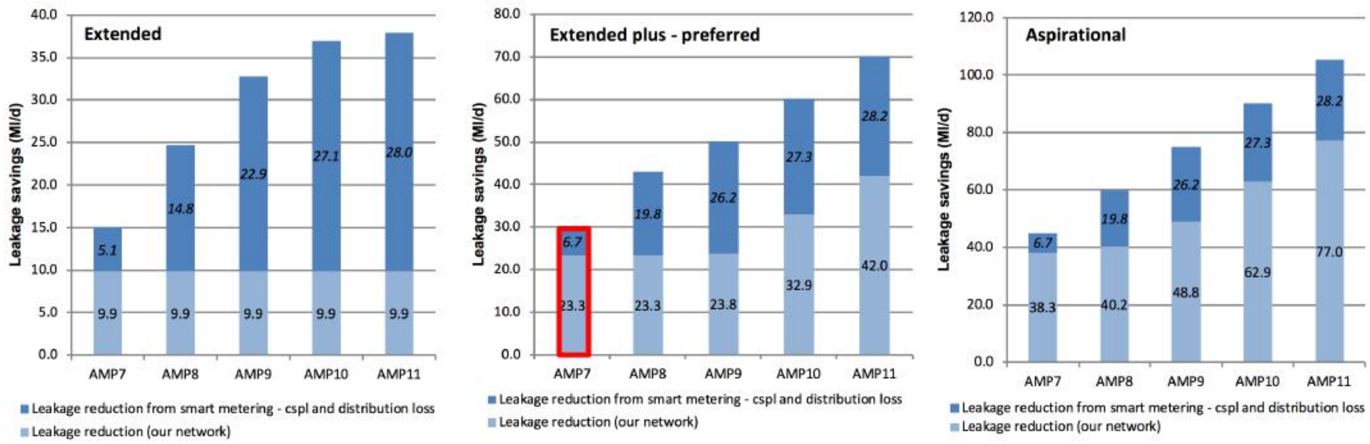
The leakage sub-options represent a range from tried and tested to innovative and less certain and are described in detail in the WRMP 'Demand Management Strategy' Report

For all of these sub-options, except the targeted investigations, the potential sites where this sub-option could be deployed have been allocated to the strategic options on the basis of the AIC ranking:

- The least costly sites being included in the 'Extended' package,
- The next tranche of sites in the 'Extended Plus' package and,
- The most expensive sites in the 'Aspirational' package.

A detailed list of the assumptions for the leakage and leakage enabling options is provided in our consultant's report.

Figure 2.6: Leakage savings for each option, over the WRMP plan period (this also shows the leakage savings associated with the smart meter roll-out) for each modelled option.



As noted the Ofwat Draft Methodology requires a 15% reduction in leakage in AMP7, as achieved in the preferred 'Extended Plus' option (15% of 177Ml/d = 26Ml/d).

2.3.2 Leakage Costs and benefits

For the leakage options the costs can be summarised (Note these include the cost of intervention only):

Table 2.7: Extended - Note these savings do not include those leakage savings from smart metering for CSPL and plumbing losses.

	Cost (AMP7)	Saving (AMP7)	Cost (AMP11)	Saving (AMP11)
Total financial (pre financing)	£37m	9.9 Ml/d	£116m	9.9 Ml/d
Total financial (with financing)	£39m		£134m	

Table 2.8: Aspirational - Note these savings do not include those leakage savings from smart metering for CSPL and plumbing losses.

	Cost (AMP7)	Saving (AMP7)	Cost (AMP11)	Saving (AMP11)
Total financial (pre financing)	£114m	38.3 Ml/d	£687m	77.0 Ml/d
Total financial (with financing)	£122m		£799m	

Table 2.9: Extended Plus - Note these savings do not include those leakage savings from smart metering for CSPL and plumbing losses.

	Cost (AMP7)	Saving (AMP7)	Cost (AMP11)	Saving (AMP11)
Total financial (pre financing)	£72m	23.3 Ml/d	£282m	42.0 Ml/d
Total financial (with financing)	£77m		£344m	

Reduced distribution losses - The key benefit of the leakage programme is reduced losses of water from our distribution system.

Reduced repair costs - Through proactive activity, we can reduce our reactive operations, avoid bursts and reduce our repair costs.

Reduced supply pipe losses - Through more intensive leakage investigations, we will identify leaks on our networks and also those on supply pipes. Identifying these leaks will allow them to be repaired, as typically they go unnoticed.

2.4 Water efficiency measures - Options considered

We identified a number of sub-options for water efficiency. The sub-options have been grouped into three packages, aligned to our Extended, Extended Plus and Aspirational strategic options. Each of these sets comprises three exclusive options i.e. low, middle and high savings.

The costs and benefits associated with these sub-options have been assessed exclusive of (or in addition to) the costs and benefits associated with our current baseline strategy. Our baseline strategy is incorporated within the baseline demand forecast and as such does not form a specific option. Our baseline strategy includes:

- The Potting Shed initiative
- Communications campaigns on discretionary use including events, education, and use of Broadcast Beacons, and,
- Annual awards ceremony.

The three options were modelled in accordance with our base assumptions including; the size and demographic of the target customer audience, assumed savings per unit affected, PCC values etc. Due to the interdependencies of the water efficiency options with smart metering, options have been developed for both the 2AMP (10 year) and 3AMP (15 year) roll-out.

2.4.1 Water efficiency building blocks, assumptions and benefits

Detailed information regarding the costs and benefits of our water efficiency measures can be found in our WRMP 'Demand Management Strategy' Report, and can be summarised:

Plumbing loss reduction - Leaks within the customer's premises are known as plumbing losses and are considered consumption rather than leakage. By promoting awareness of leaky loos and encouraging their replacement, we can reduce these losses of water.

Reduced customer use - Through our water efficiency options and smart metering we have an opportunity to support customers using significantly less water.

Hot water carbon saving - Reduced demand for water has a knock on impact for customer's bills and carbon emissions.

Costs - The costs of our water efficiency sub-options are largely operating costs. The main costs are:

- System operating costs, for example, the online water calculator for developers
- Operating costs, such as the time taken for home audits
- Customer engagement costs, associated with customer facing campaigns and information provisions, and
- Portal running costs, to maintain the operation of the customer facing portal.

The costs and benefits of our Bits and Bobs audits are relatively well understood given the on-going programme during AMP6.

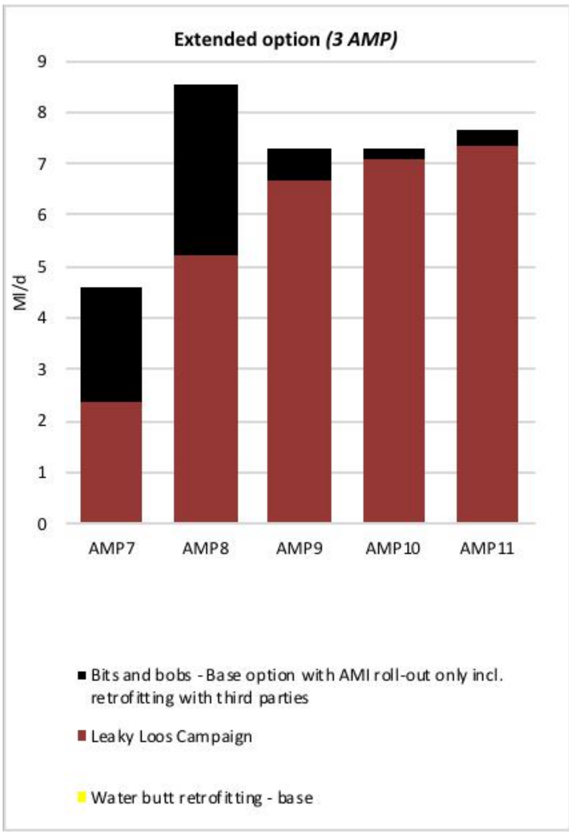
2.4.2 Water efficiency costs and water savings

Household water efficiency costs and savings Extended Option (3 AMP smart metering roll-out)

Table 2.10: Extended water efficiency savings

Extended option - (3 AMP)		Average water saving per year Ml/d	Average water saving per year Ml/d
		AMP7	AMP11
1e	Standard blueprint for new home sustainable gardens	-	-
1f	Engagement with new home owners (with any meter type) - AMI roll-out options	-	-
2b	Water butt retrofitting - base	0.023	0.002
3b	Multi-utility portal for smart metered properties	-	-
5b	Leaky Loos Campaign	2.348	7.347
5c	Rewards scheme for sign-up to the portal	-	-
7	Bits and bobs - Base option with AMI roll-out only including retrofitting with third parties	2.250	0.336
		4.6Ml/d	7.7Ml/d

Figure 2.7: Extended water efficiency savings



Costs have been calculated for this option, accounting for the interdependencies of the programmes with the smart meter roll-out programme.

Table 2.11: Differential costs/savings dependent upon 2AMP / 3AMP smart meter roll-out - Extended

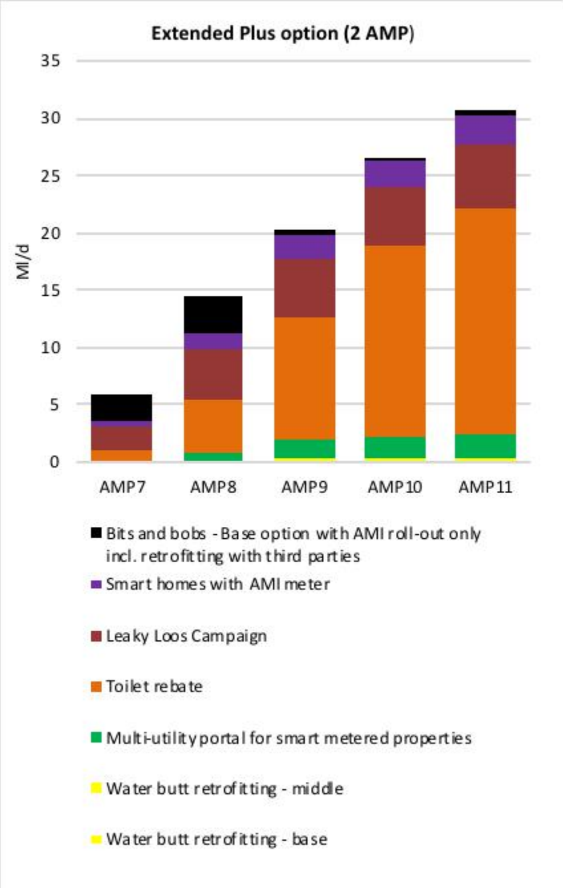
Dependency		Cost (AMP7) Exc Opex saving	Avg Saving (AMP7)	Cost (AMP 11) Exc Opex saving	Avg Saving (AMP 11)
Combined with Smart metering 2 AMP	OPEX	£9.2m	4.5Ml/d	£32m	5.8Ml/d
Combined with Smart metering 3 AMPs	OPEX	£9.1m	4.6Ml/d	£45m	7.7Ml/d

Household water efficiency costs and savings 'Extended Plus' Option with (2 AMP smart metering) (Preferred)

Table 2.12: Extended Plus water efficiency savings

Extended Plus option - 2AMP		Average water saving per year Ml/d	Average water saving per year Ml/d
		AMP7	AMP11
1e	Standard blueprint for new home sustainable gardens	-	-
1f	Engagement with new home owners (with any meter type) - AMI roll-out options	-	-
2b	Water butt retrofitting - base	0.022	0.001
2c	Water butt retrofitting - middle	0.038	0.344
3b	Multi-utility portal for smart metered properties	0.018	2.005
4	Toilet rebate	0.908	19.892
5b	Leaky Loos Campaign	2.206	5.501
5c	Rewards scheme for sign-up to the portal	-	-
6	Smart homes with AMI meter	0.414	2.546
7	Bits and bobs - Base option with AMI roll-out only including retrofitting with third parties	2.250	0.336
		5.86 Ml/d	30.6Ml/d

Figure 2.8: Extended Plus water efficiency savings



Costs have been calculated for this option, accounting for the interdependencies of the programmes with the smart meter roll-out programme.

Table 2.13: Differential costs/savings dependent upon 2AMP / 3AMP smart meter roll-out - Extended Plus

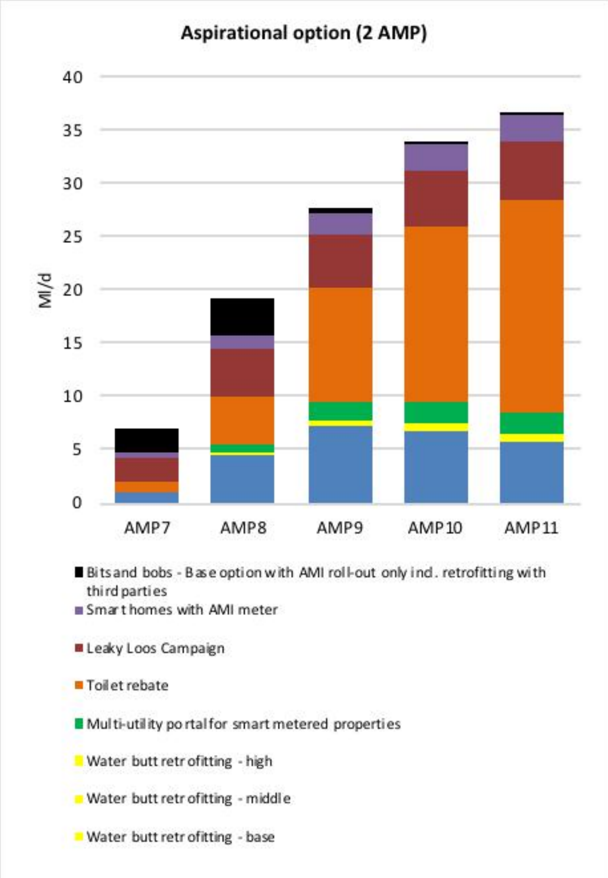
Dependency		Cost (AMP7) Exc Opex saving	Avg Saving (AMP7)	Cost (AMP 11) Exc Opex saving	Avg Saving (AMP 11)
Combined with Smart metering 2 AMP	OPEX	£16m	5.9 Ml/d	£93m	30.6 Ml/d
Combined with Smart metering 3 AMPs	OPEX	£15m	5.7 Ml/d	£88m	31.1 Ml/d

Household water efficiency costs and savings 'Aspirational' Option (2 AMP smart metering)

Table 2.14 Aspirational water efficiency savings

Aspirational option - 2AMP		Average water saving per year Ml/d	Average water saving per year Ml/d
		AMP7	AMP11
1e	Standard blueprint for new home sustainable gardens	-	-
1f	Engagement with new home owners (with any meter type) - AMI roll-out options	-	-
2a	Smart irrigation	0.986	5.761
2b	Water butt retrofitting - base	0.022	0.001
2c	Water butt retrofitting - middle	0.038	0.344
2c	Water butt retrofitting - high	0.038	0.344
3b	Multi-utility portal for smart metered properties	0.018	2.05
4	Toilet rebate	0.908	19.892
5b	Leaky Loos Campaign	2.206	5.501
5c	Rewards scheme for sign-up to the portal	0	-
6	Smart homes with AMI meter	0.414	2.546
7	Bits and bobs - Base option with AMI roll-out only including retrofitting with third parties	2.250	0.336
		7.49Ml/d	36.7Ml/d

Figure 2.9: Aspirational water efficiency savings



Costs have been calculated for this option, accounting for the interdependencies of the programmes with the smart meter roll-out programme.

Table 2.15: Differential costs/savings dependent upon 2AMP / 3AMP smart meter roll-out - Aspirational

Dependency		Cost (AMP7) Exc Opex saving	Avg Saving (AMP7)	Cost (AMP 11) Exc Opex saving	Avg Saving (AMP 11)
Combined with Smart metering 2 AMP	OPEX	£30.6m	6.9Ml/d	£172m	36.7 Ml/d
Combined with Smart metering 3 AMPs	OPEX	£29.2m	6.6Ml/d	£166m	37.7 Ml/d

2.5 Demand Options Costs and benefits

2.5.1 Our approach

Our approach for the assessment of demand management options was structured according to seven steps:

I. Options definition.

II. Identification of cost and benefit elements, referred to as building blocks, to be included in the cost-benefit analysis. This step includes itemising the information needed for that calculation; and, where appropriate, includes a set of values and assumptions that could be used in the calculation in the absence of company-specific data.

III. Assessment of full impact (i.e. costs and benefits) of each option. This step was carried out using bespoke Excel-based models.

IV. Options comparison and incremental impact calculation.

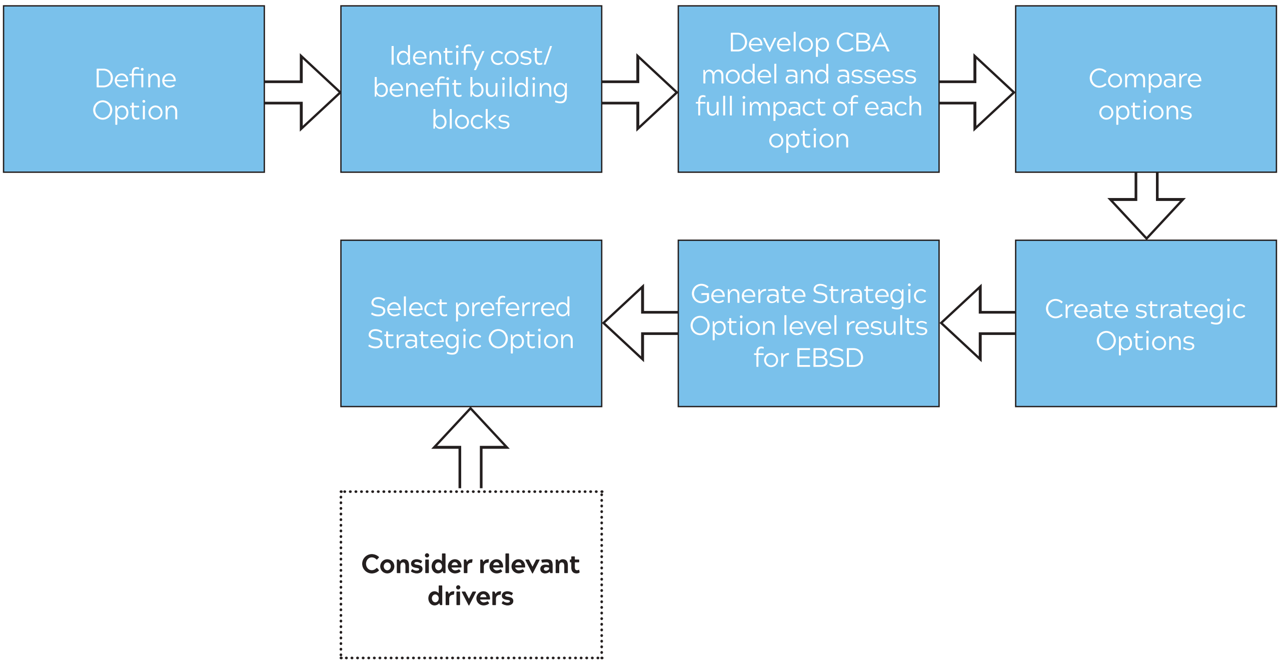
V. Creation of strategic option portfolios.

VI. Generation of sub-option level results for the EBSD model.

VII. Selection of the preferred strategic option representing the preferred demand management strategy.

The approach is illustrated in the following diagram:

Figure 2.10: Option development and appraisal



2.5.2 Sources of evidence and assumptions

The sources of evidence and assumptions that have underpinned the analysis include:

- Anglian Water's own data or data provided by the Company's consultants and contractors;
- Unpublished evidence obtained by Anglian Water through professional contacts and networking with other UK water companies;
- Published sources such as relevant research reports;

Assumptions made in discussions with relevant Anglian Water experts and based on their experience and engineering judgement.

2.5.3 Cost and benefit building blocks

In order to determine the preferred strategic option, we have undertaken a cost benefit analysis of the three strategic options. This included identification of all of the costs and benefits, the majority of which we have monetised.

Of course there are important non-economic benefits associated with demand management, and it was important to consider the qualitative benefits (that cannot be easily monetised) associated with each strategic option. In addition, all of the strategic demand management options were assessed in the Strategic Environmental Assessment.

2.5.4 CBA Modelling

To develop our CBA models, we identified a comprehensive list of quantitative costs and benefits, known as building blocks. The development of these building blocks was based on our own data, expertise and experience as well as published and unpublished information available to us through industry research groups and academic research.

We identified a total of 25 individual building blocks. These building blocks may apply to all, some or only a few of the demand management sub-options. The single, coherent list of building blocks developed across all the demand management options allowed us to develop consistent models to undertake the CBA on a consistent basis. The building blocks we identified are described in detail in the accompanying reports.

In order to monetise the cost and benefit building blocks associated with each sub-option, we have developed assumptions about the costs, take-up and water savings. We have used the best information available to us at this point in time. The assumptions are based on our own experiences of costs and benefits from our extensive demand management activity to date, industry standards and learning from our innovative trials. As our innovative trials progress further data will become available on the most effective demand management interventions.

The results of the assessment were extracted from three models developed separately for metering, household water efficiency and leakage. These models allow us to input values for each individual building block associated with each sub-option (e.g. smart metering or retrofitting of devices) over an 80-year period. They enable a cost-benefit comparison of different strategies through the calculation of incremental difference between the impacts of the compared options.

2.5.5 Benefits

There are a number of quantifiable benefits from demand management. If we can reduce the amount of water consumed by customers and lost through leaks, we will:

- Reduce costs for customers through lower consumption of water
- Reduce treatment and pumping costs for ourselves
- Defer capital investment in supply-side solutions, and
- Reduce CO_2 emissions from us and customers, as we will be pumping less water around our systems.

The full list of benefits that formed our cost- benefit building blocks considered in our analysis is detailed in the WRMP 'Demand Management Strategy' Report.

2.5.6 Value of deferred supply-side capital investment

Reducing demand for water supplies not only reduces operating costs, but has the potential to defer or even avoid capital investment in supply-side schemes. Where there is a forecast deficit in the baseline supply-demand balance, a reduction in demand can reduce, defer or even eliminate that deficit. This can have a significant impact on the selection of supply-side options.

The consideration of deferred supply-side capital investment in setting demand management policy is established industry practice, as demonstrated by the examples set out below.

- The WRC report 'Leakage Policy and Practice' states that the benefit of leakage reduction to the water undertaker should be thought of in terms of:

  i) A reduction in annual operating costs; and,

  ii) Deferment of capital schemes.

- The Environment Agency, Ofwat and Defra review of the sustainable economic level of leakage (SELL) states that, in determining leakage targets, companies should consider the impact of leakage upon the capital programme and the potential for the deferment of expenditure.

- The UKWIR report 'Smart metering in the water sector - making the case' states that companies should consider the impact of smart meters on demand (particularly seasonal peak demand) and the requirement for the development of new water resources.

- In 2011 Ofwat assessed the costs and benefits of faster, more systematic water metering in England and Wales, compared with the then current approach. The assessment includes the impact of reduced demand on both operating costs and capital investment.

In this assessment, we have quantified the impact of each of the strategic demand management options on the supply-side capital investment required to mitigate supply-demand deficits. We have done this by running different scenarios in our EBSD model, and then comparing the scheme selection and associated totex requirements. All of the scenarios were run using a feasible options list made up of supply-side options only.

Scenario 1: Business as usual demand management

Scenario 2: 'Extended' strategy

Scenario 3: 'Extended Plus' strategy

Scenario 4: 'Aspirational' strategy

For each strategy option, we then calculated the value of the deferred capital investment compared with the 'business as usual' scenario.

Consequently, despite the fact that over the WRMP planning period, demand is expected to increase by (DYAA) 109Ml/d, our demand management strategy has been designed to achieve the full mitigation of this.

This should, therefore, reduce the need for new supply side capacity, although supply side options may still be needed to address sustainability and resilience issues.

We have then apportioned the value of the avoided investment and apportioned it to the relevant sub-options on the basis of water savings attributable to each sub-option.

2.5.7 Notes on the derivation of deferred supply-side capital investment values

The values for deferred supply-side investment over the 25 year WRMP plan period are considerable; being equivalent to £864m for our preferred option ('Extended Plus'); for the 'Extended' option it is £509m and for the 'Aspirational' option it is £1084m.

These values are noted to play a central role in making the case for these options cost beneficial, and consequently have been scrutinised to ensure that they align with Guidance and are truly reflective of the supply-side costs that would be incurred, if no demand management took place.

These figures have been calculated to reflect totex values in order to ensure that 'like for like' figures are being compared in the CBA. It has been noted that the current methodology is straightforward and easily understood, however, we will look to improve our understanding of how this figure might be derived to more accurately reflect 'timings' and how investment would be staged through the 25 year period.

External audit has suggested that this figure might be derived to potentially reflect some or all of the following:

- 'Whole life' cost - this could potentially take into account asset lives, but may be much more complex to derive.
- The values could be assessed from the perspective of the 'bill impact' implications of the development of supply-side option. This would be a more 'customer focused' methodology, but might give a more short term focus to the results.
- The benefits could be considered in a more holistic fashion (quantifying natural / environmental / societal capital). This might be much harder to ascertain and quantify, but would tie in with our 'societal valuation' processes.

We will look to investigate these methodologies, as part of our ongoing WRMP review and improvement strategy.

2.5.8 Qualitative benefits

As well as quantitative benefits, we considered a wide range of qualitative benefits. These are benefits that are important to us and our stakeholders, but cannot be easily monetised.

These include items such as:

- Water left in the environment as a result of demand management activity
- Helping connect customers to their environment
- Improved resilience of our systems
- Offsetting demand growth, which helps us to manage deterioration risk
- Offsetting or mitigating the impacts of climate change, and,
- Enabling future innovation, such as smart meters potentially unlocking smarter tariffs.

We identify which qualitative benefits have informed our decision making when we discuss our decisions.

2.5.9 Societal valuation

In order to inform our cost benefit analysis, we have undertaken extensive work to understand the value that customers place on certain standards of service and different outcomes. The overall methodology and approach for delivery of societal valuations required for the WRMP and PR19 business planning has been underpinned by the development of a valuation strategy. We developed this strategy by prioritising the values required for business planning (including WRMP) by assessing them against the four criteria listed below:

- Customer priority
- Stakeholder importance
- Size of investment programme, and
- Sensitivity to cost benefit analysis.

Water resource options, including leakage and demand management, were assessed as being a high priority.

As a result, the PR19 societal valuation programme looked to ensure there were a range of valuation studies and valuation methods that could inform this process for water resource options including:

- A main survey: a stated preference study covering a broad range of service attributes across the business including leakage reduction and water restrictions.
- A second stage water resources study: focusing on customer preferences and valuations for water resource options and water restrictions.

The second stage resilience study utilised a stated preference approach, which is a survey-based method for eliciting customer priorities and preferences for changes in service levels. A total of 1,008 household customers and 408 non-household customers were interviewed with the survey administered through online interviews. The two samples are representative of their respective customer bases. The study was undertaken in line with latest best practice guidance.

For smart metering, we have evaluated the value that customers place on having a smart meter. Smart meters can also help us and our customers identify leaks. To account for this, we have apportioned some of the monetised benefit from the customer valuation for fixing leaks to the AMI business case. This has been done on a pro-rata basis for both reduced CSPL, which will be enabled by the smart metering system, and the reduction in distribution network losses attributable to smart metering. We have been careful to avoid double counting of these benefits within the leakage business cases.

2.5.10 Customer values for water resource options

This second stage resilience study elicited customer preferences for a range of water resource options:

Demand management options: leakage reduction, incentives and education to save water, providing water saving devices, compulsory metering, encouraging metering.

The survey also asked customers to value the benefits of the introduction of smart meters. These benefits result from the abundance of frequently read consumption data that they provide, enabling customers to manage their consumption more effectively, thus saving water and money. In addition, smart meters should also help in identifying potential leaks.

Given the complexity associated with these areas, we placed a large focus on ensuring our surveys were accessible and meaningful. This included a comprehensive design and testing phase, a focus on ensuring the survey was engaging to customers to promote understanding and considered responses, and undertaking detailed analysis and validity testing of the results. To add further assurance and deepen our understanding of the results, we followed up the surveys with customer focus groups that discussed the results and checked our interpretation of them.

2.5.11 Using the societal valuations

The results from the PR19 second stage water resources study and the main stage study have been taken into account in providing recommended values for use in the WRMP and demand management strategy cost-benefit appraisal. This reflects a process of triangulation which is the use of multiple, independent data sources and research methods to produce a common perspective or understanding. The key steps in the process include synthesising and assessing the evidence based on relevance and robustness. It also involves reviewing the recommended values in comparison to PR14 values and other company studies as well as in the context of the wider customer engagement evidence.

The triangulation resulted in a range of estimates for each category of intervention. The ranges are made up of low, middle and high estimates. We have undertaken our CBA using both the low and middle points of the societal valuations, in order to take a conservative approach to these benefits.

For ‘leakage reduction’, ‘providing water savings devices’ and ‘incentives and education to save water’, we have applied the values to the water saved in each of these categories under each of the options.

For smart metering, we have accounted for the value that customers place on having a smart meter. Additionally, smart meters can also help customers and ourselves to identify internal plumbing leaks, CSPL and distribution losses.

To account for this, we have apportioned some of the monetised benefits from customer valuation for fixing leaks to the smart meter business case. This has been done on a pro-rata basis for both the reduction in customer supply pipe leakage (CSPL), which is enabled fully by smart metering, and the reduction in distribution network losses attributable to smart metering. We have been careful to avoid double counting of these benefits within the leakage business cases.

As our main survey has continued to gather evidence from a range of sources, the values we have used has been modified to reflect this in our final plan.

2.6 Demand Management Option Appraisal Outcome

Cost benefit summary and Scenario testing

Integral to the WRMP process has been the cost-benefit analysis of all the strategic options developed. This section presents the cost-benefit and water saving results by strategic option.

Results can be summarised:

- The Extended option is cost-beneficial overall, but does not offset predicted demand growth.

This option does not meet our commitment to reduce leakage by 15% during AMP7.

Additionally, we do not believe that the Extended option is sufficiently ambitious to deliver the water savings that we, our customers and our stakeholders expect.

- The Extended Plus option is cost beneficial overall and has the strongest economic business case of the three strategic options.

This option more than offsets current predicted demand growth.

This option is the only one to remain cost beneficial in the combined stress-testing scenarios.

- The Aspirational option is cost beneficial overall and would deliver the highest level of water savings.

The water savings associated with the Aspirational option rely on more extreme and less well understood activities, and consequently these savings are less certain. This option is less desirable due to the higher costs associated with achieving the water savings.

Overall we conclude that 'Extended Plus' delivers the ambitious water savings we require, but crucially with sufficient levels of confidence in achieving those reductions, whilst being cost beneficial.

The results of the assessment were derived using models developed separately for metering, water efficiency/behaviour and leakage, which allowed us to input values for each individual impact associated with the introduction of a specific measure (e.g. smart metering or retrofitting of devices over an 80-year period) and enabled a cost-benefit comparison of different strategies through the calculation of incremental differences between the impacts of the compared options.

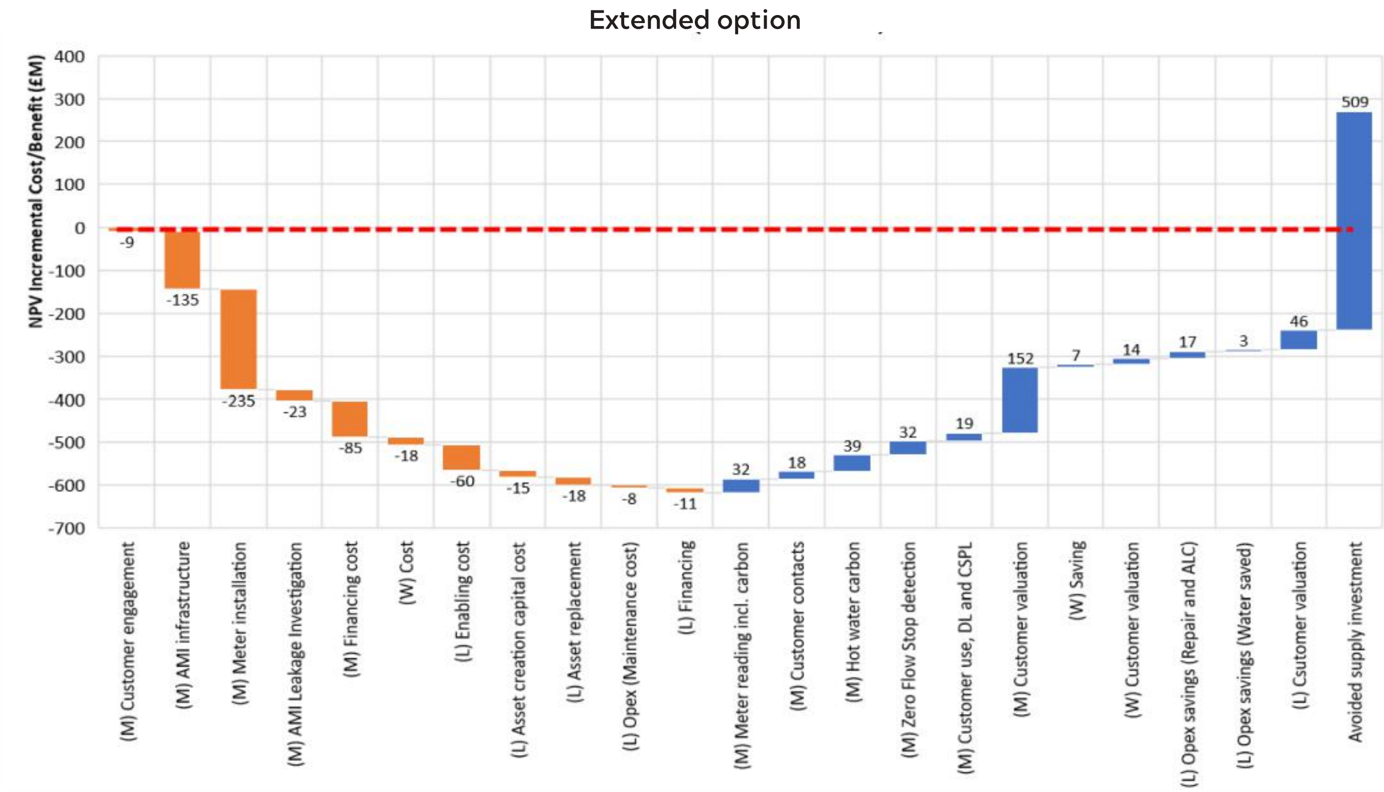
Each of the options, Extended, Extended Plus and Aspirational were CBA evaluated, along with additional scenarios reflecting reduced values for the expected savings (in Ml/d).

Thus it has been determined that 'Extended Plus' will form part of our ambitious and deliverable twin track approach, of using demand and supply solutions, to secure future water supplies.

2.6.1 Option 1 - Extended - Cost-benefit analysis

The Extended strategic option represents an ambitious extension of our demand management techniques. The figure below presents the aggregate results of our CBA for this strategic option.

Figure 2.11: Costs and benefits of the Extended strategic option (25 year incremental NPV) with mean societal valuation



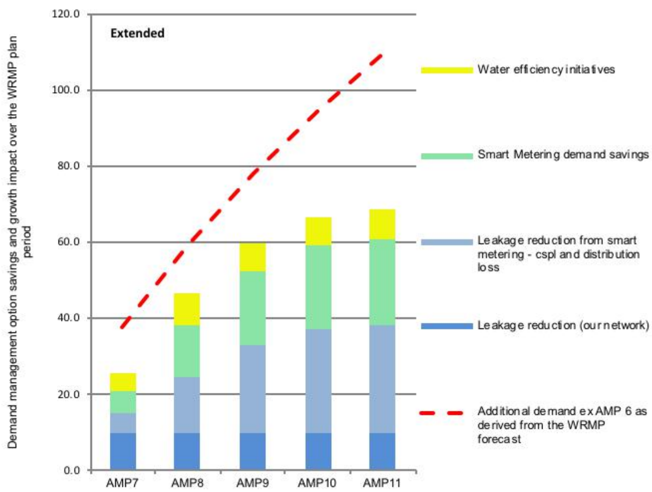
The CBA demonstrates that the overall economic benefits would be the least beneficial for this package.

Demand reduction (water savings)

The figure shows our expected water savings from this strategic option.

While it is an extension of our current demand management activities, it would not, alone, be sufficient to mitigate expected demand growth. This means we would need additional supply side investment in comparison to the other strategic options.

Figure 2.12: Water savings for the 'Extended' option (Low option)

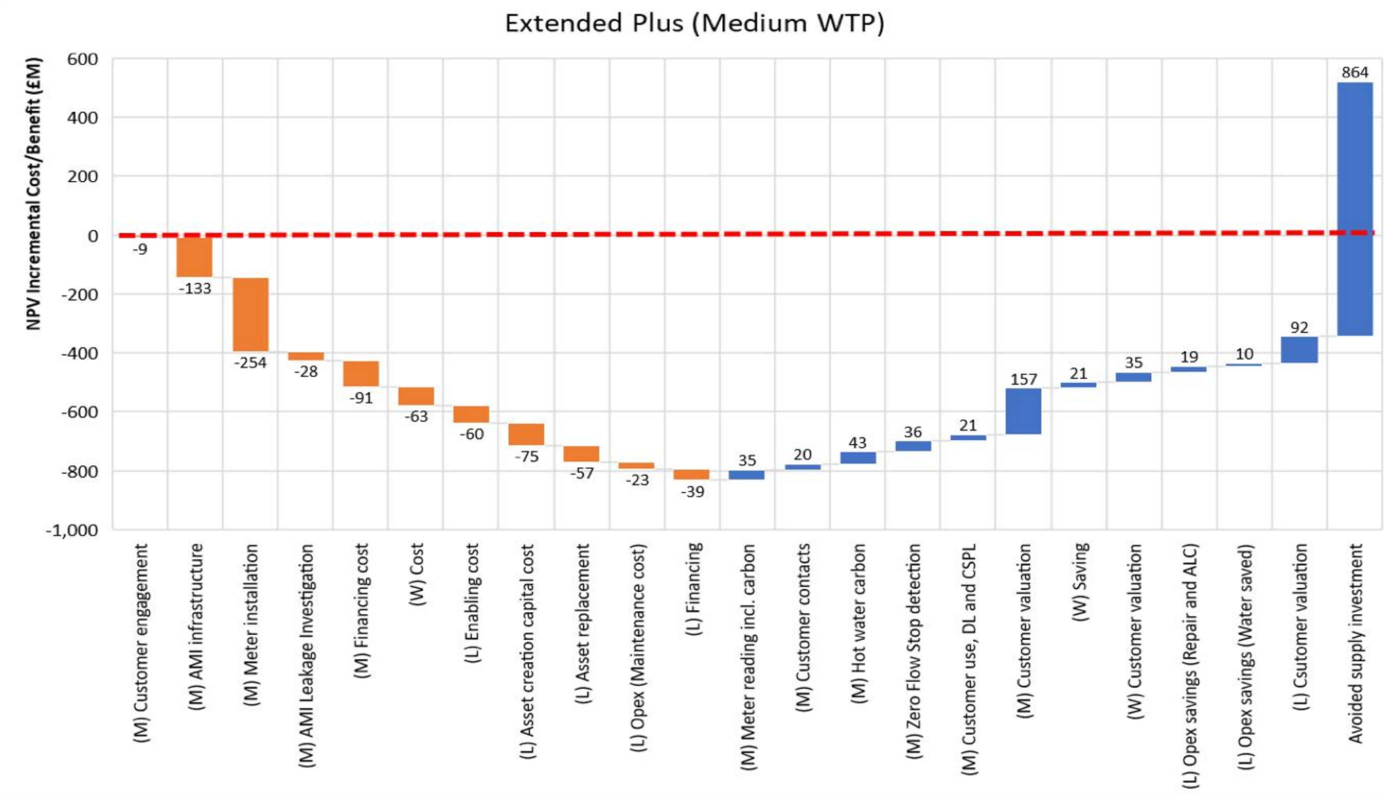


2.6.2 Option 2 - Extended Plus (preferred) - Cost-benefit analysis

The 'Extended Plus' strategic option represents an ambitious extension of our demand management techniques.

It builds on the Extended option with a faster smart meter roll-out and large scale piloting of innovative water efficiency programmes. The figure below presents the aggregate results of our CBA for this strategic option.

Figure 2.13: Costs and benefits of the Extended Plus option (25 year incremental NPV) with mean societal valuation



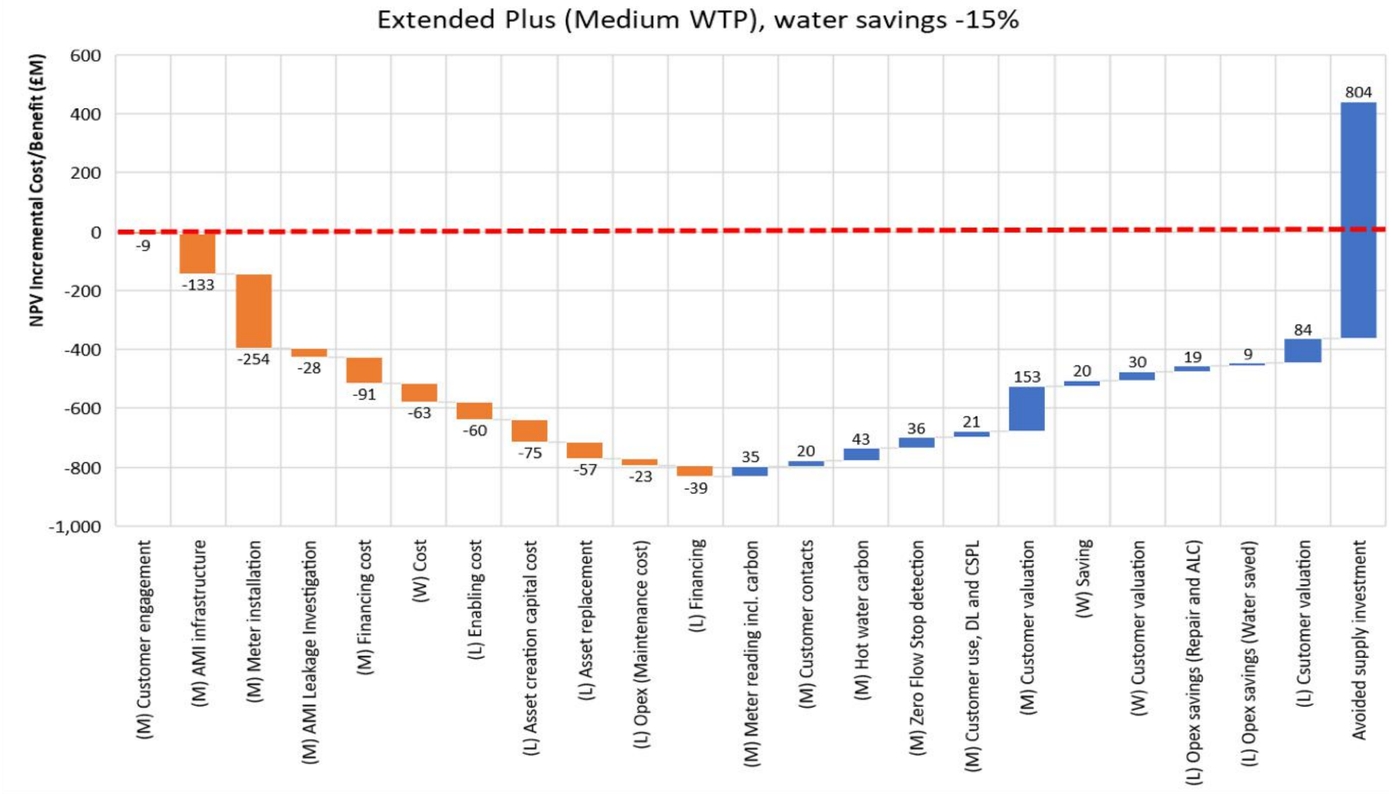
Our CBA shows that there is a strong business case for this option. This is the most cost beneficial of the three strategic options.

With regard to this option we have undertaken a programme of sensitivity analysis, testing the following scenarios:

- Increased costs of capital expenditure by 10% (capex) and increase costs of Operating expenditure of 5% (Opex)
- Using the lower estimate of the societal valuation results (our main CBA used the central estimate)
- Using lower than expected consumption reductions (water savings) of either 15% or 30%, and
- A combination of the higher cost and lower consumption reduction scenarios (15%) while using the low estimate of societal valuation.

The 'Extended Plus' option remains cost beneficial in all of these scenarios, even in the combined scenario. It is worth noting that the Extended and Aspirational options were not cost beneficial in the combined stress-testing scenario.

Figure 2.14: Sensitivity analysis for costs and benefits of the total Extended Plus option package (25- year incremental NPV) with lower value customer valuation, increased costs and reduced water savings by 15%

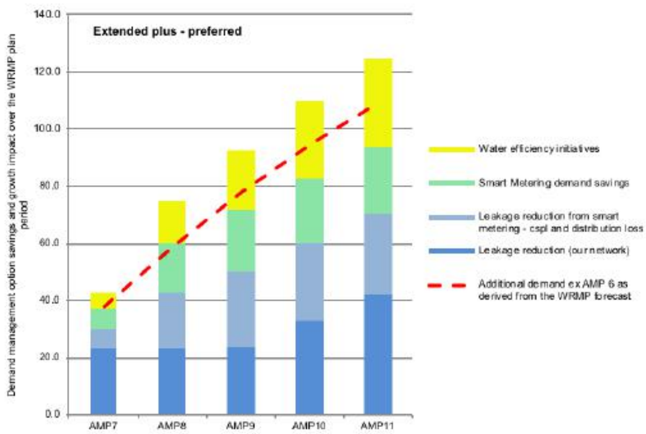


Demand reductions (water savings)

The figure below shows our expected water savings from this strategic option. The 'Extended Plus' strategic option builds on the 'Extended' option with a faster smart meter roll-out and large scale piloting of innovative water efficiency programmes.

This option would be sufficient to account for expected demand growth, avoiding some of the supply side investment needed under the 'Extended' option and delivering environmental benefits.

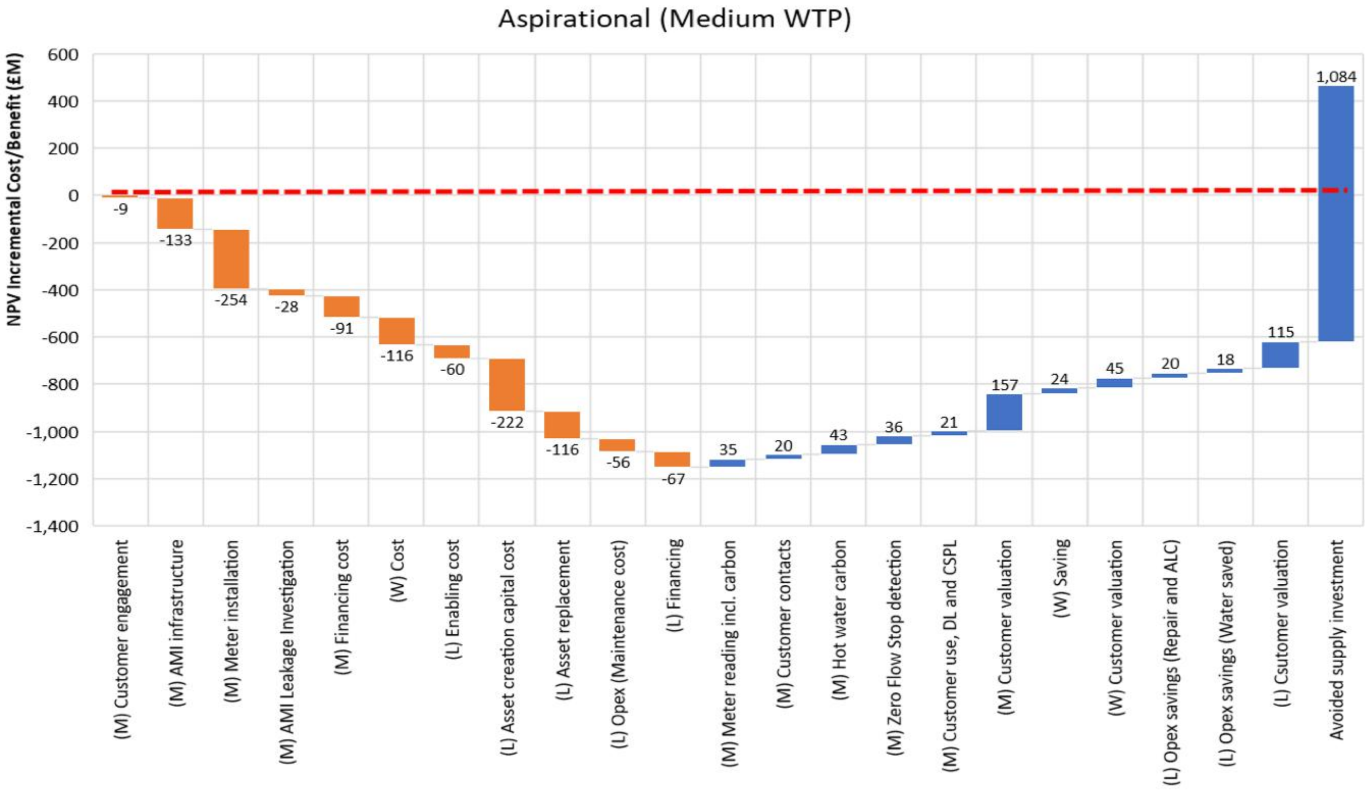
Figure 2.15: Water savings for the 'Extended Plus' preferred option



2.6.3 Option 3 - Aspirational - Cost-benefit analysis

The Aspirational strategic option builds on the previous options with a faster smart meter roll-out than the Extended option and a large scale roll-out of additional innovative water efficiency programmes. The figure below presents the aggregate results of our CBA for this strategic option.

Figure 2.16: Sensitivity analysis for costs and benefits of the Aspirational option (25-year incremental NPV) mean societal valuation



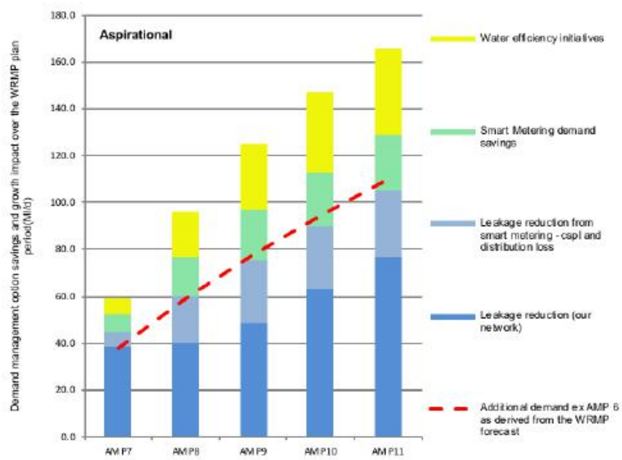
Our CBA shows that there is a positive business case for this option, although it is not as strongly cost beneficial as the 'Extended Plus' option. Due to the more innovative nature of the sub-options there is much more uncertainty around the delivery of net benefits than under the more conservative Extended Plus option. Within the option, the leakage, metering and water efficiency business cases are cost beneficial on a stand alone basis.

Demand reductions (water savings)

The figure shows our expected water savings from this strategic option. This option delivers the highest levels of demand reduction, albeit with the greatest level of uncertainty. If the expected savings were delivered they would be more than sufficient to account for expected demand growth.

If achievable, this strategic option would offset many of the supply side options.

Figure 2.17: Water savings for the 'Aspirational' option



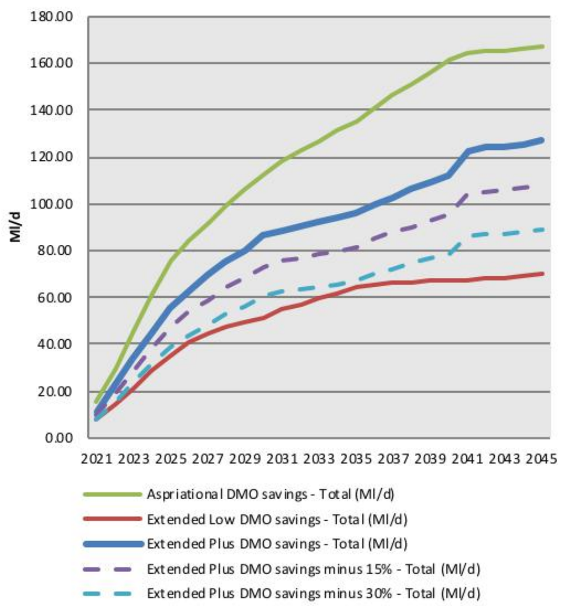
2.6.4 Scenario testing

We additionally tested scenarios, in which the demand management strategy was modelled to under-achieve in terms of savings, in order to determine the implications for the supply-demand balance and potential supply-side options (or additional demand management option modifications) that might be required in this event.

Specific scenarios, were modelled to include demand management options that would save 15% and 30% less water than expected in our Extended Plus (preferred option)

The savings for our strategic options (low - 'Extended'), (medium - 'Extended plus' (preferred)), (high - 'aspirational') and the minus 15%, minus 30% 'Extended Plus' savings scenarios, can be shown.

Figure 2.18: Comparison of savings for Extended, Extended Plus and Aspiration Options (including sensitivity testing of Extended Plus with reduced savings (-15% and -30%)



The differences in water saved can also be shown when compared to our preferred 'extended plus' option, indicating that if the extended plus programme, achieved a 15% less savings, this would be equivalent to a reduction in savings of - 8Ml/d compared to the anticipated amount and 30% less savings would incur a reduction of -16Ml/d compared to the anticipated value. It is noted that overall, the impact of somewhat reduced demand management savings (-15%) on the Supply-Demand balance will be relatively modest in AMP7, allowing for correction going forward. Additionally, it is noted that the minus 15% and minus 30% scenarios lie within a range between our 'Extended' and 'Extended Plus' Options.

Table 2.16: Difference between scenarios and the preferred option (Extended Plus)

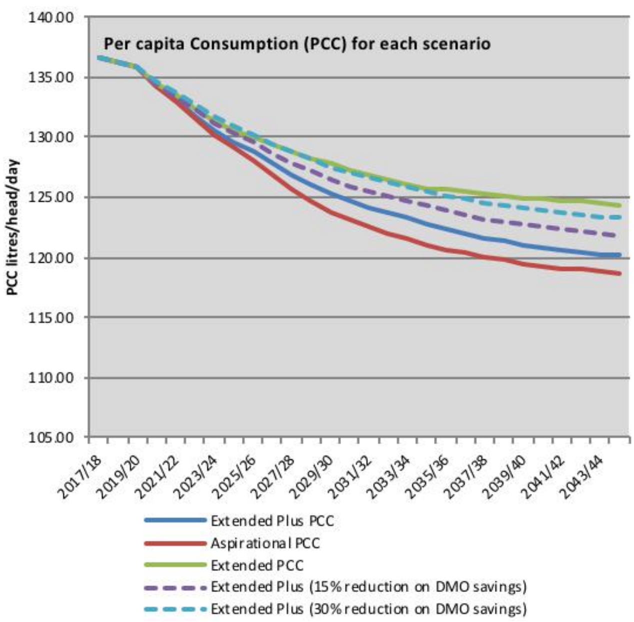
	End AMP7	End AMP11
Extended Low DMO savings - 'difference to Ext Plus' (Ml/d)	-20.37	-56.92
Extended Plus DMO savings - 'difference to Ext Plus' (Ml/d)	0.00	0.00
Extended Plus DMO savings minus 15% - 'difference to Ext Plus' (Ml/d)	-8.35	-19.01
Extended Plus DMO savings minus 30% - 'difference to Ext Plus' (Ml/d)	-16.71	-38.02
Aspirational DMO savings - 'difference to Ext Plus' (Ml/d)	19.89	40.59

Table 2.17: Total saving for each option and reduced saving scenarios

	End AMP7	End AMP11
Extended Low DMO savings - Total (Ml/d)	35.32	69.81
Extended Plus DMO savings - Total (Ml/d)	55.69	126.72
Extended Plus DMO savings minus 15% - Total (Ml/d)	47.34	107.72
Extended Plus DMO savings minus 30% - Total (Ml/d)	38.98	88.71
Aspirational DMO savings - Total (Ml/d)	75.58	167.31

Consequently, per capita consumption (for each strategic option and for the Extended Plus sensitivity tests) shows that for the Extended Plus option, even with reduced demand savings, the PCC values remain within the 120-125 litres/head/day range.

Figure 2.19: Comparison of PCC values for the alternate scenarios



Note that in addition to the sensitivity testing carried out for the Extended Plus Option, similar scenarios with demand management reduction (minus 15% and minus 30%) have been created and tested for the Extended and Aspirational strategic options.

2.6.5 Our Preferred Demand Management Option 'Extended Plus'

The 'Extended Plus' option allows us to innovate and deliver a step change in our demand management activity, while delivering a strong economic case.

The other strategic options do not strike the same balance, compared with our preferred 'Extended Plus' option.

We do not believe that the less ambitious, 'Extended' option goes far enough in delivering the demand management that our customers and stakeholders expect.

The 'Aspirational' option, however, is more expensive and the hoped for water savings are less certain.

Thus, our preferred option (Extended Plus) has been assessed to 'best meet' our multi-criteria approach to selection, meeting customer need, mitigating growth and meeting all our obligations.

Table 2.18: Comparison of assessed options against our selection criteria

Criteria	Extended Option	Extended Plus Option (Preferred)	Aspirational Option
(1) Meets Customer expectations			
(2) Reasonable Cost			
(3) Mitigates Growth			
(4) Fulfills Regulatory Obligations			
(5) Aligns with WRE			
(6) Is deliverable / achievable			
(7) Meets SEA requirements			

(1) Meets Customer expectations

For this criteria, the Extended Option was found to not achieve the required leakage and behavioural change savings to meet Customer expectation, whereas the Aspirational option exceeded expectation, but at too high a cost.

The Extended strategy does not go far enough to meet expectations for continued demand savings. The Aspirational option is too expensive and there is too much uncertainty associated with it.

A plan that best meets customer expectations

There is clear support from customers for further demand management activities, with leakage reduction remaining a priority for our customers. However customers will not support demand management at any cost, especially where there are cheaper supply-side alternatives. Customers also value options that are reliable. Our preferred plan best meets customer expectations of continued improvements in reliable demand management at an affordable cost.

Best Option: Extended Plus

(2) Reasonable Cost

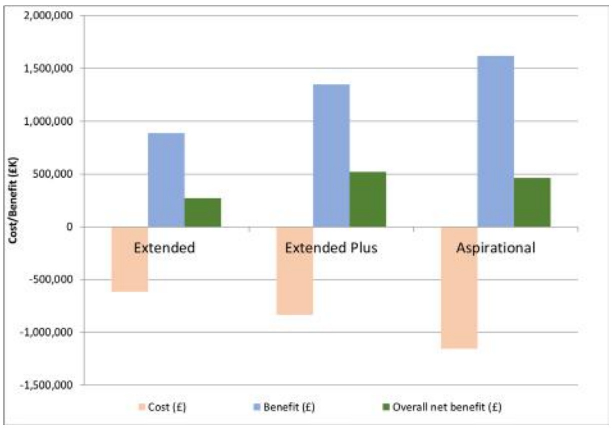
Both the Extended and Extended Plus Option were determined to be of reasonable cost, once the CBA had been conducted, with the Aspirational option being deemed to be excessive. It was also noted that the Extended Plus option was seen to be the most cost beneficial, under all scenarios, even when tested under stress.

The Extended Plus option has the strongest economic business case and the Extended option has the weakest.

A Strong business case

Our preferred option is the most cost beneficial of the three strategic options that we have evaluated. The costs and benefits of this option are shown in the figure below. The figure is clear that the option is significantly cost beneficial - this is partly driven by the level of water savings we will achieve, which allow us to offset supply side investment. The option remains cost beneficial under a number of sensitivity tests.

Figure 2.20: Total costs and benefits (25 year incremental NPV)



The cost of our demand management strategy is £255 million (totex) in AMP7. This does not result in an impact on the average customer bill as the costs are offset by the additional revenue from new connections (assuming that forecast growth materialises). We have undertaken an assessment of costs and benefits which shows that our strategy is cost beneficial.

Costs can be shown for the 25 year period (AMP11) as below;

Table 2.19: Demand management option costs over the 25 year plan period

	Capex (AMP11) £k	Opex £k /yr	Opex saving inc value of water saved £k / yr	Finance Costs (AMP11) £k	Total Cost inc finance and Opex savings (AMP11) £k
Leakage programme	£72,632	£1,420	-£1,810	£62,001	£344,272
Smart Metering programme	£343,113	£10,084	-£10,539	£138,665	£470,412
Water Efficiency programme		£3,717	-£1,395		£58,064
TOTALS	£415,746	£15,222	-£13,743	£200,666	£872,748

Best Options: Extended and Extended Plus

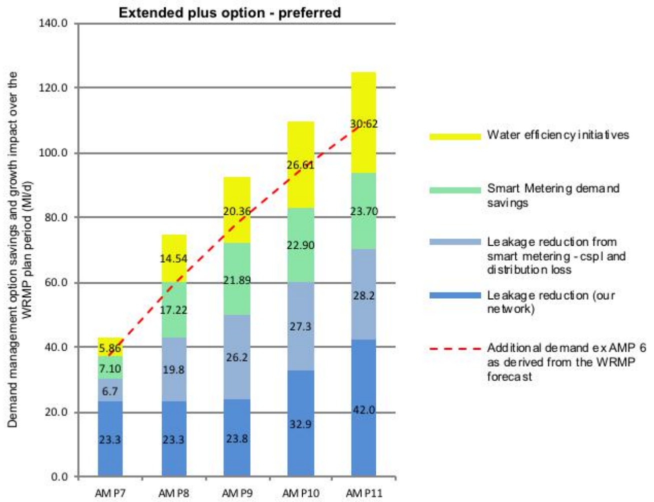
(3) Mitigates growth

Both the Extended Plus and Aspirational Options mitigate the growth in demand, however with the Extended Option not achieving the requisite savings. However the Aspirational option, considerably exceeds the required savings at a much higher additional cost. Growth is mitigated by the Extended Plus and Aspirational strategies, but not by the Extended strategy.

A Plan that mitigates demand growth

As can be seen, in our preferred option package, the demand management programmes should effectively mitigate the growth impact from demand.

Figure 2.21: Demand reductions from our preferred strategy compared to forecast growth.



In terms of actual demand, without demand management consumption (DYAA) is forecast to rise by 109Ml/d. With our preferred 'Extended Plus' management option this is completely mitigated with consumption in 2045 set to decrease by 18Ml/d from the initial 2020 value (1130Ml/d)

Best Option: Extended Plus

(4) Meets regulatory requirements

Both the Extended Plus and Aspirational Options meet our obligations to reduce leakage, (by 15% by the end of AMP7 (2025) and by 40% by the end of the WRMP) and customer per capita consumption. The Extended Option does not meet these obligations.

The Extended option does not deliver sufficient savings to ensure the sustainability of water resources over the long term.

Best Options: Extended Plus, Aspirational option

(5) Aligns with WRE

Only the Extended Plus option fully aligns with WRE analysis, as it was found that demand management was key to maintaining system resilience, and 'uncontrolled' demand growth needed to be mitigated to avoid system failure.

Best Option: Extended Plus, Aspirational

(6) Deliverable / achievable

Both the Extended and Extended Plus options would be achievable and deliverable, however, the Extended Option is considered too modest in its outcomes. The Aspirational option has been deemed too difficult to put into practice with significant risk of failure.

There is increased delivery risk associated with the Aspirational option as it relies on more untested activities where there is less certainty over the water savings.

An ambitious, but achievable plan

The results of our analysis, the Water UK WRLTP and WRE show that we should be aiming to enhance our demand management activity to secure future water supplies.

Our 'Extended Plus' plan represents an ambitious extension to our existing demand management activities; incorporating innovative initiatives to deliver further water savings. It will facilitate further leakage reduction, driving the performance frontier in the UK, and utilise new smart meters which unlock a host of other activities to deliver water savings that can offset projected demand growth.

Figure 2.22: Consumption with and without the 'Enhanced Plus' demand management strategy

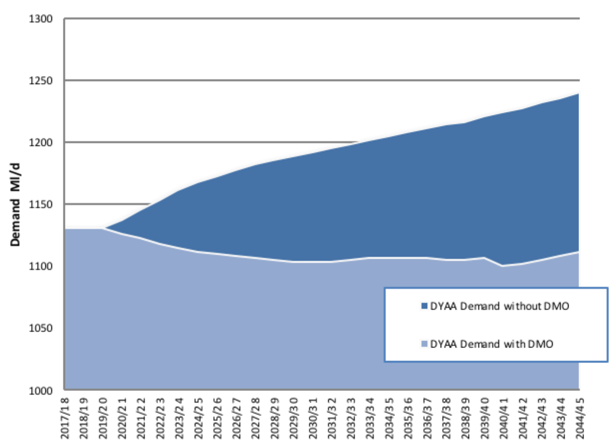
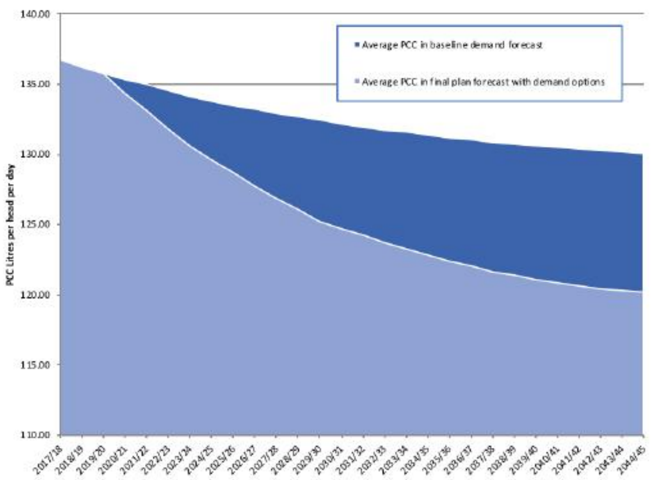


Figure 2.23: Impact of our demand management strategy on average per capita consumption (PCC)



The impact of our demand management strategy on per capita consumption (PCC) is shown in the figure. By the end of the period (2045), we expect that our average PCC will be 120 l/h/d, a reduction of 14% (16 l/h/d) compared with 2017/18. This aligns with national expectations and is in accordance with WRMP19 from our neighbouring water companies.

Additionally, building on our current position, leakage will reduce from the current position, representing 16% of water put into distribution (Distribution input (DI)) to less than 10% by 2045.

Our ambitious demand management strategy is made up of many activities within our control. However, in addition to this, we believe that with the support of the Government and other stakeholders, it will be possible for the UK water sector to deliver further significant demand management savings. Through our engagement with the government and the National Infrastructure Commission we hope to support the development of the following measures:

- For new homes, discounts for water efficient buildings could be supported by clear messages from government as well as local authorities requiring increased water efficiency.
- The introduction of a single water efficiency label covering bathroom, kitchen and garden products has been slow. This should be on a par with labelling of product energy efficiency ratings.
- New regulations have a part to play; in particular Water Fittings Regulations could further prevent waste, and higher bills for individuals that arise, from leaking toilets

Best Option: Extended Plus

(7) Meets SEA requirements

Both the Extended and Aspirational options meet the SEA requirements, however again the Extended Plus option has been determined to be the most cost effective. All strategic options benefit the environment. The Extended strategy provides less benefit than the other strategies, and does not mitigate growth and therefore some deterioration risk remains. The Aspirational option delivers the most environmental benefit, assuming the savings can be achieved in full.

Striking the right balance between affordability and the environment

We have an important role to play in protecting the natural environment. It is important to us to act as stewards of the natural environment and to be leaders in environmental protection. Demand management is essential to mitigating short-term environmental risks. Increasing our current abstractions to meet growth related requirements would represent a serious environmental deterioration risk. By choosing ‘Extended Plus’, we are using demand management to offset any growth in demand mitigating deterioration risks.

The ‘Aspirational’ option also offsets demand growth but this option has a weaker business case than ‘Extended Plus’ and is more expensive. We believe that ‘Extended Plus’ strikes the right balance between protecting the environment and ensuring affordability.

Best Options: Extended Plus, Aspirational option

3. Developing the Supply-side Strategy for Preferred Plan

3.0.1 Supply-side programme appraisal

Traditionally, we have used the EBSD approach to guide decision making. EBSD allows planners to meet a supply-demand deficit with the lowest overall cost, or 'least cost' solution. Our WRMP 2010 and WRMP 2015 were both based on least cost option appraisal.

The limitations of least cost planning approach are now widely recognised, and there is support from regulators, stakeholders and our customers, to develop Best Value Plans. Such plans must consider more than cost and include issues such as the environmental impact, resilience and customer preferences. Defra's own Guiding Principles state: 'We expect to see evidence that you have taken a strategic approach to water resources planning that represents best value to customers over the long term.' This section of the report describes the methodology used to develop the supply-side strategy for the Preferred Plan.

3.0.2 Methodology used to develop the supply-side strategy

We have followed a four stage appraisal process, as outlined below and shown below.

Stage 1 - EBSD and Least Cost Optimisation

During the first stage, we used the industry-standard EBSD methodology that is based on least-cost optimisation, to determine the Baseline Least Cost Plan (bLCP). The optimisation used the baseline WRMP scenario described in chapter 2 'The scale of the challenge' in main WRMP report.

Our Baseline Least Cost Plan was the starting point for the development of our Preferred Plan, and any decision to move away from this has been clearly explained and documented.

Stage 2 - Scenario testing to develop alternative strategies

For this stage we ran a number of scenarios through the EBSD process using the Baseline Least Cost Plan as a basis to create a set of alternative plans. The scenarios included testing which options would be selected if we maximised use of existing resources between WRZs and to understand how plans would change if a strategic resource (e.g. a winter storage reservoir) was developed in preference to other smaller new resources. At this stage we also tested sets of options under different future scenarios, such as extreme droughts and additional future exports to neighbouring water companies. Once we had a set of alternative plans, we started to see common transfer strategies. The main difference between the plans was the capacity of the transfers.

Stage 3 - Selection of final strategy

We used performance criteria to assess the alternative plans. We found that increasing the capacity in some transfers had the benefit of providing flexibility and adaptability to meet potential future challenges. It also enabled a wider range of new water resource options that may be required in the future.

The stress testing helped us to find the balance between adequate capacity to be future proof with actual utilisation in a business as usual scenario. We selected the optimal combination of transfer capacities which formed our preferred plan or Best Value Plan. Determining the capacity of the transfer options is critical as they are all required to be installed in AMP7. Delaying new resource options gives us choices in the future for more strategic, sustainable resources, if required.

The outputs from this process were used to inform the recommendation to our Strategic Priorities Board as part of the PR19 governance process. Once our Board signed off the strategy, we refined the capacities of the options through the stress testing process.

Stage 4 - Stress testing the final strategy

We stress-tested the final set of schemes to ensure that the final strategy was robust to future uncertainties and that we understood how the plan would operate in a 'business as usual' scenario. The strategy was tested under four future scenarios:

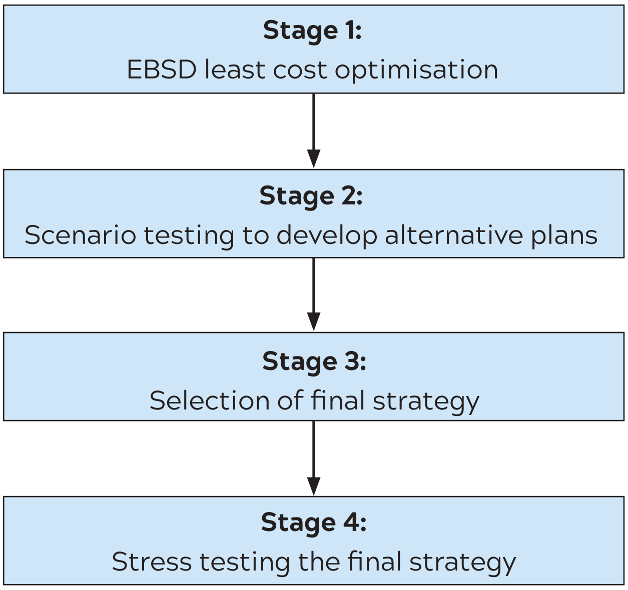
- The need to provide resilience to extreme drought (with an approximate 1 in 500 year return period)
- Drier climate change scenarios
- The possibility that our demand management strategy achieves lower water savings than estimated, and

- Possible future trades with neighbouring water companies.

To demonstrate the benefits of the Best Value Plan we completed a performance criteria assessment for each plan. This includes a comparison with the Alternative Least Cost Plan which is the least cost version of our Best Value strategy. In this plan the transfer capacity is limited to only meet the needs of the WRMP baseline scenario.

We used 'multi-criteria analysis', rather than standard Cost Benefit Analysis, as some of the performance criteria we have assessed are difficult to monetise. The plans were compared with each other and scored on the basis of best performance.

Figure 3.1: Four stage process to develop supply-side strategy



3.1 Stage 1 - EBSD Baseline Least Cost Optimisation

For the development of the Baseline LCP we used EBSD with the following assumptions,

- Benefits of the Extended Plus demand management programme included in baseline demand forecast
- Benefits of NEP options included in the baseline supply forecast
- All new resource options available at the same time (2024) apart from the reservoirs (2035) and the trading options (as specified by other water companies). Discount rate varied over the 80 year appraisal period as specified in the WRPG[1]
- Option costs as detailed in Supply-Side Option Development Report

The Baseline LCP selected by EBSD contains treatment options in Lincolnshire and transfers to Ruthamford. It selects a new resource (desalination) in 2024 to supply the east along with transfers into the central areas (Bury, Newmarket WRZs). In subsequent AMPs it connects Newmarket WRZ to Ely WRZ and up to North Fenland WRZ with small capacity transfers (4-10Ml/d).

The Figure right shows the transfer options selected.

Figure 3.2: Transfer options selected in the Baseline Least Cost Plan

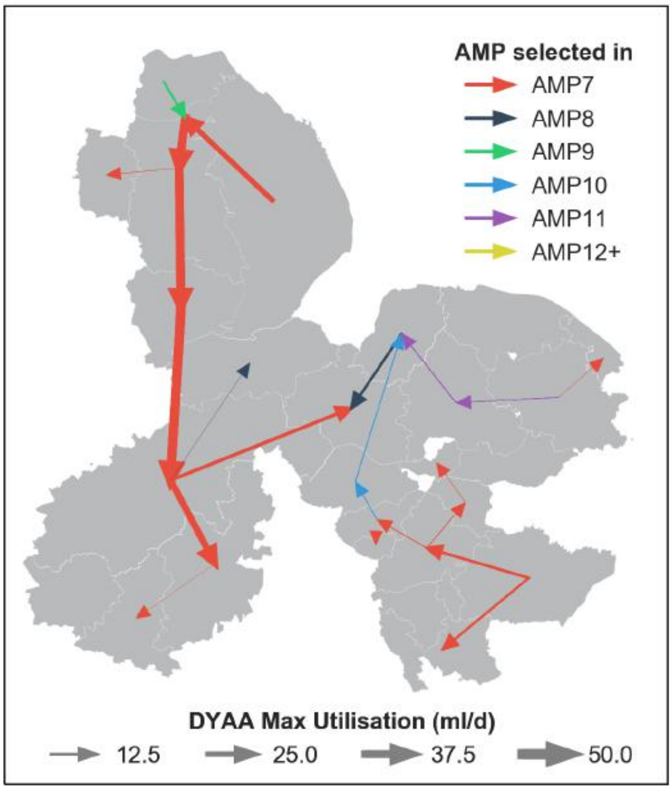


Table 3.1: Treatment and new resource options in the Baseline LCP

Option Ref	Option Name	Year Selected	Maximum Capacity	Utilisation end of AMP7	Utilisation end of AMP8	Utilisation by 2045
CLN14	Central Lincolnshire WRZ locked in DO	2025	6	0.00	5.45	6.00
CLN11a	South Humber Bank WRZ to Central Lincolnshire WRZ (treatment only)	2032	10	0.00	0.00	10.00
ESU1	Felixstowe Desalination	2024	25	15.36	19.44	23.69
SEX2	Ardleigh Reservoir Extension	2044	3.4	0.00	0.00	3.40

Analysing the Baseline SDB we realised that the Baseline LCP was not fully utilising existing resources. There is adequate existing resource in the north to meet demand in Ruthamford and the East until the end of AMP7 and by the end of AMP8 only 3.9Ml/d of new resource would be required. The Baseline LCP selected a network of diminishing capacity transfers from south to north preventing the existing surplus resource being fully utilised in the future.

It also limits the benefit of a potential strategic resource option like a winter storage reservoir being developed as this could not be transferred to large areas of our region. This led to the development of alternative strategies to compare against the Baseline LCP.

The Baseline LCP was the starting point for the development of our Preferred Plan, and has been used for comparison against other alternative plans.

[1] *Environmental Agency and Natural Resources Wales, April 2017, 'Water Resources Planning Guideline: Interim update'. Environmental Agency and Natural Resources Wales, May 2017WRMP guideline supplementary document: WRMP 2019 - Water company checklist*

3.2 Stage 2 - Scenario testing to develop alternative strategies

For the development of alternative plans we varied the following in the EBSD runs to develop alternative least cost plans.

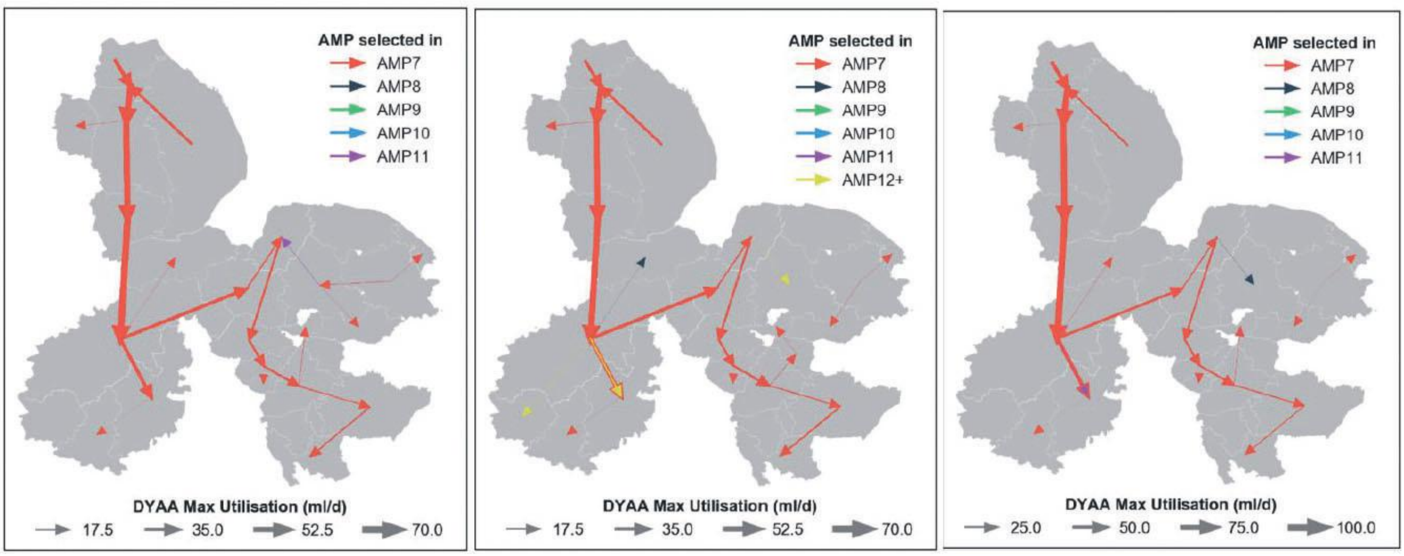
- Ensured maximum use of existing resources in preference to developing new resource options by delaying the availability of resource options to end of AMP8.
- Varied the inclusion of a strategic water resource option such as a winter storage reservoir.

For the scenarios above we constrained part of the model set to meet the requirements of the scenario, but still allowed the ESBD model to select the least cost plan within those constraints. For example, for the maximum use of existing resources scenario we constrained the new resource options (water reuse and desalination) so they were only available from 2029. The EBSD model was then free to select the least cost combination of existing resources, new resources (after 2029) and transfer options to satisfy demand over the planning period.

For the strategic reservoir option scenario the model set was constrained by making the reservoir options available at minimum cost from 2032, but again the model was free to select the least cost combination of existing resources, other new resources and transfer options. The purpose of this run was to see impact on the Baseline LCP if strategic resources (winter storage reservoirs) were developed in preference to other new resources.

The Figure below shows examples of the alternative least cost plans.

Figure 3.3: Examples of transfer options selected in alternative least cost plans



As we completed the scenario testing to develop alternative strategies we started to see common transfer routes. In many scenarios the LCPs selected transfers from north to south, utilising existing resources and moving these south to where the deficits were. For each scenario though the capacity of the transfer selected varied.

Using the common transfer routes from the North to Ruthamford and onto the South East of our region we then ran the model to understand the optimal capacity of these options to meet different scenarios. We did this by making the selected transfers 'must do' in EBSD and allowed the model to select the capacity of the transfer to meet each scenario. The scenarios tested were:

- Varied the level of water savings from the demand management programme
- High climate change scenario
- Extreme droughts (1:500 droughts)
- Different trading options with other water company scenarios.
- Business as usual utilisation runs excluding either: climate change impacts, target headroom or drought impacts (1:200).

For Stage 2 we completed 60 runs using EBSD. These allowed us to develop alternative plans with different capacity transfers that could meet varying future uncertainty needs.

We found that by delaying new resource option development until AMP8 meant that determining the capacity of the transfer options was critical as they would all need to be installed in AMP7.

We used the EBSD output to further develop one of the alternative least cost plans. We found that there were 4 transfers where if the capacity was increased above that required for the baseline WRMP scenario these allowed additional flexibility in terms of the development of new resource options i.e. increasing transfer capacity meant the model was less constrained enabling a greater number of new resource options to be considered in each scenario. An example is the transfer between Bury Haverhill WRZ and East Suffolk WRZ, if this is constrained to 10Ml/d capacity, this can restrict the new resource options available to only those downstream in East Suffolk or South Essex WRZs. Whereas, if the capacity is increased then options upstream maybe selected such as the strategic reservoir options.

The four transfers where the capacity could be increased to provide greater flexibility and adaptability to future scenarios are,

- Ruthamford North WRZ to South Fenland WRZ
- South Fenland WRZ to North Fenland WRZ
- Bury Haverhill WRZ to East Suffolk WRZ
- East Suffolk WRZ to South Essex WRZ

3.3 Stage 3 - Selection of final strategy

The scenario testing competed in Stage 2 was used to select an optimal version of the plan that utilised existing resources. This provides a balance between adequate capacity to be future proof with actual utilisation in a business as usual scenario. This version became our preferred strategy and is referred to as the Best Value Plan going forward in the performance criteria assessment. To clearly demonstrate the additional benefits of increasing capacity for certain transfer options we have also assessed a least cost version of our Best Value Plan, this is referred to as the Alternative Least Cost Plan going forward. Table 3.2 provides a definition of the three plans used in the performance criteria assessment.

Table 3.2: Description of plans

Baseline Least Cost Plan	This is the default least cost strategy, selected through the first stage of the EBSD modelling. This plan does not provide the flexibility or connectivity required to meet the future challenges in our region and is infeasible for implementation in AMP7.
Alternative Least Cost Plan	This plan represents the least cost version of our best value strategy. The overall strategy is consistent with our best value plan but the scheme capacities are sized only to address the supply demand deficits identified for WRMP19, and do not address any future uncertainty.
Best Value Plan	This plan represents our best value strategy. This is the plan we submitted in our September 2018 Business Plan submission, which provides additional benefits to address future uncertainty

Table 3.3: Comparison of Solutions in AMP7

WRZ	Least Cost Plan				Alternative Least Cost Plan				Best Value Plan			
	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex
Bury Haverhil	BHV2	East Suffolk WRZ to Bury Haverhill WRZ Transfer (25Ml/d)	25	69,664	BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	20	19,778	BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	20	19,778
Central Lincolnshire					CLN13a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Treatment only	31	46,152	CLN13a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Treatment only	31	46,152
	CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ existing transfer	25	28,460	CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ existing transfer	25	28,460	CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ existing transfer	25	28,460
	CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	62	73,162	CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	62	73,162	CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	62	73,162
Cheveley	CVY1	Newmarket WRZ to Cheveley WRZ Transfer	1	2,505	CVY1	Newmarket WRZ to Cheveley WRZ Transfer	1	2,505	CVY1	Newmarket WRZ to Cheveley WRZ Transfer	1	2,505
East Suffolk	ESU1	Felixstowe Desalination	25	61,325	ESU9	Bury Haverhill WRZ to East Suffolk WRZ transfer (10Ml/d)	10	18,072	ESU8	Bury Haverhill WRZ to East Suffolk WRZ transfer (20Ml/d)	20	25,598
Ely					ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	20	61,557	ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	20	61,557
Happisburgh	HPB1	Norwich and the Boards WRZ to Happisburgh WRZ Transfer	1.5	12,375	HPB1	Norwich and the Boards WRZ to Happisburgh WRZ Transfer	1.5	12,375	HPB1	Norwich and the Boards WRZ to Happisburgh WRZ Transfer	1.5	12,375

WRZ	Least Cost Plan				Alternative Least Cost Plan				Best Value Plan			
	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex
Newmarket	NWM2	Bury Haverhill WRZ to Newmarket WRZ Transfer (10 Ml/d)	10	13,794	NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	20	14,782	NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	20	14,782
North Norfolk Rural					NNR8	Norwich and the Boards WRZ to Norfolk Rural North WRZ Transfer (5Ml/d)	5	3,966	NNR8	Norwich and the Boards WRZ to Norfolk Rural North WRZ Transfer (5Ml/d)	5	3,966
North Fenland					LCP9	South Fenland WRZ to North Fenland WRZ Transfer (12.1 Ml/d)	12.1	10,058	NFN4	South Fenland WRZ to North Fenland WRZ Transfer (20 Ml/d)	20	13,664
Nottingham-shire	NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	3.5	23,717	NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	3.5	23,717	NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	3.5	23,717
Ruthamford Central	RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	12	10,242	RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	12	10,242	RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	12	10,242
Ruthamford North	RTN27	South Lincolnshire WRZ to Ruthamford North WRZ transfer (67 Ml/d)	67	55,240	RTN27	South Lincolnshire WRZ to Ruthamford North WRZ transfer (67 Ml/d)	67	55,240	RTN27	South Lincolnshire WRZ to Ruthamford North WRZ transfer (67 Ml/d)	67	55,240
South Essex	SEX4	East Suffolk WRZ to South Essex WRZ transfer (15Ml/d)	15	24,467	LCP12	East Suffolk WRZ to South Essex WRZ transfer (12Ml/d)	12	21,390	SEX4	East Suffolk WRZ to South Essex WRZ transfer (15Ml/d)	15	24,467

WRZ	Least Cost Plan				Alternative Least Cost Plan				Best Value Plan			
	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex
South Fenland	SFN3	Ruthamford North WRZ to South Fenland WRZ Transfer (22 Ml/d)	22	35,307	LCP13	Ruthamford North WRZ to South Fenland WRZ Transfer (32 Ml/d)	32	42,260	SFN4	Ruthamford North WRZ to South Fenland WRZ Transfer (40 Ml/d)	40	50,290
South Lincolnshire	SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	63	28,754	SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	63	28,754	SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	63	28,754
Thetford	THT1	Bury Haverhill WRZ to Thetford WRZ Transfer via existing infrastructure	3	652	THT1	Bury Haverhill WRZ to Thetford WRZ Transfer via existing infrastructure	3	652	THT1	Bury Haverhill WRZ to Thetford WRZ Transfer via existing infrastructure	3	652
South Humber Bank					SHB2	Pyewipe Water Reuse for non-potable use	20.4	56,194		Pyewipe Water Reuse for non-potable use	20.4	56,194
Total				**439,664**				**529,316**				**551,555**

Table 3.4: Comparison of Solutions in AMP8

WRZ	Pre RPE and Productivity Costs (£k)											
	Least Cost Plan				Alternative Least Cost Plan				Best Value Plan			
	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex
Central Lincolnshire	CLN14	Central Lincolnshire locked in DO (6 Ml/d)	6	15,182								
South Fenland	SFN2	North Fenland WRZ to South Fenland WRZ Transfer (22Ml/d)	22	14,751								
Total				**29,933**								

Table 3.5: Comparison of Solutions in AMP9

WRZ	Pre RPE and Productivity Costs (£k)											
	Least Cost Plan				Alternative Least Cost Plan				Best Value Plan			
	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex
Central Lincolnshire	CLN11a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Treatment Only	10	26,441								
East Suffolk					ESU1	Felixstowe Desalination	25	61,325	ESU1	Felixstowe Desalination	25	61,325
Total				**26,441**				**61,325**				**61,325**

Table 3.6: Comparison of Solutions in AMP10

WRZ	Pre RPE and Productivity Costs (£k)											
	Least Cost Plan				Alternative Least Cost Plan				Best Value Plan			
	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex
Ely	ELY2	Newmarket WRZ to Ely WRZ Transfer (4Ml/d)	4	4,501								
North Fenland	NFN6	Ely WRZ to North Fenland WRZ Transfer (22Ml/d)	22	26,149								
Total				**30,650**								

Table 3.7: Comparison of Solutions in AMP11

WRZ	Pre RPE and Productivity Costs (£k)											
	Least Cost Plan				Alternative Least Cost Plan				Best Value Plan			
	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex	Option Ref	Option Name	Capacity (Ml/d)	Capex
Central Lincolnshire					CLN14	Central Lincolnshire locked in DO (6 Ml/d)	6	15,182	CLN14	Central Lincolnshire locked in DO (6 Ml/d)	6	15,182
North Fenland	NFN5	Norfolk Rural North WRZ to North Fenland WRZ Transfer (20 Ml/d)	20	25,756								
North Norfolk Rural	NNR8	Norwich and the Boards WRZ to Norfolk Rural North WRZ Transfer (5Ml/d)	5	3,966								
South Essex	SEX2	Ardleigh reservoir extension	3.4	19,718								
Total				**49,439**				**15,182**				**15,182**

The plans were assessed against a number of performance criteria, these were:

- Adaptability and flexibility - is the plan flexible enough to cope with uncertain future needs? Does it include potentially 'high regret' options, or limit future choices?
- Risk and resilience - how resilient is the plan to more extreme drought scenarios and other hazards, and what are the residual risks associated with each?
- Alignment to WRE - how well does the plan align to the regional strategy?
- Customer preferences - how well does the plan align to customer preferences?
- Environmental and social impact - what are the environmental and social effects associated with each plan?
- Cost - how much does the plan cost to build and operate?

3.3.1 Adaptability and flexibility

All plans have similar new resource options with the main difference being that the desalination plant is delivered earlier in the Baseline LCP and Pyewipe scheme is required in the Alternative LCP and BVP. The impact of delivering the desalination plant in AMP7 is that this determines the direction and capacity of the transfer network in the east of the region.

All plans have a similar network of transfers in terms of linking up WRZs but they vary in direction, capacity and timing. Due to the complex planning and construction issues associated with these long transfer options they are not very scalable and it would not be expected that we would be able to lay another pipeline along the same route in the near future to increase capacity. Therefore it is essential that we assume the right balance of capacity that is future proof with business as usual operational needs. The impact of the diminishing capacity transfer route from the south to the north is that we could only develop new resources in the southern area of the network. This would limit the options to additional desalination plants or water reuse options.

In the BVP we have a consistent capacity from north to south in the eastern region. This means that we have more opportunities for developing more resources in Lincolnshire, winter storage reservoirs, trading with other water companies and other locations for desalination or water reuse (e.g. Kings Lynn). The consistent capacity transfer routes means that in the future the direction of these could be reversed if required, increasing the adaptability of the plan.

The smaller capacity transfers in the south in the Alternative LCP limit the new resource options available to meet future needs. Only new resource options in East Suffolk WRZ or South Essex WRZ (e.g. Felixstowe desalination plant, Colchester water reuse) would be available rather than the winter storage reservoir or trading options.

3.3.2 Risk and Resilience

UKWIR defines water resilience in the water industry as 'the ability of an asset or asset system to continue to withstand or to recover from the effects of an exceptional event such that acceptable service levels are maintained and/or restored quickly' (UKWIR, 2013)[2]. The Environment Agency's 'Water supply and resilience and infrastructure' report[3] published in 2015 for DEFRA highlighted that the Anglian region is one of the country's least drought-resilient regions, which could have major economic implications. Therefore, increasing water resilience is of particular importance within our region, in order to maintain long-term reliable water supplies and to minimise the risk of needing to implement water restrictions during drought periods.

The emphasis on improving water resilience within our WRMP also reflects recent political and regulatory developments, as securing resilience became a primary duty of OFWAT under the 2014 Water Act. As recommended within DEFRA's Guiding Principles, we have planned for droughts worse than those in the historic record, with 1 in 200 and 1 in 500 year events.

We have considered all plans in terms of the resilience benefits they provide to single source resilience and drought resilience.

Single source supply

We measure our resilience to long term supply outage as '% Population on Single Water Supplies', this is defined as, the proportion of household customers exposed to the risk of loss of supply due to a resilience type event. This includes treatment works failures in multiple source systems which result in the loss of supply to some customers.

The approach taken to develop the '% Population on Single Water Supplies' was to identify the resulting deficit if each water treatment works was taken out of service for a prolonged period. The deficit is then converted to an equivalent number of household customers and the % of population at risk calculated. The risk to the whole region has been summed to form the '% Population on Single Water Supplies'.

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[2] *Resilience: Making a Business Case for PR14, Report Ref. No. 13/RG/06/3, UKWIR 2013.*
[3] *Water supply and resilience and infrastructure, Environment Agency advice to Defra, October 2015.*

For each treatment works we used a top-down, all hazards, standards based approach for assessing the vulnerability of our customers to single points of failure in our supply system.

Our strategy is to reduce the number of customers on single source supply by connecting up discrete systems to provide a dual source of supply rather than building standby treatment works capacity. When developing the routes for the WRMP transfer options we ensured we considered the needs of supply system resilience to ensure that where the new transfers interface with existing infrastructure they could provide resilience benefits if required.

Table 3.8 below shows the benefits in '% of population on single source supply' for each plan within the Problem Characterisation Areas. All plans provide similar connectivity therefore the benefits are the same by the end of the planning period. However the plans do vary in terms of when the benefits are realised. For the BVP the additional capacity between Bury Haverhill WRZ to East Suffolk WRZ provides capacity to meet resilience in this area. For the Baseline LCP and Alternative LCP the desalination plant in East Suffolk WRZ provides a second source within the WRZ to customers currently supplied by a single source. The benefit in terms of '% of population on single source supply' in AMP7 is better in the BVP, see Table 3.9.

Table 3.8: Benefits in '% of population on single source supply' for each plan per Problem Characterisation Area

Problem Characterisation Area	Baseline LCP	Alternative LCP	BVP
	% population on single source	% population on single source	% population on single source
Area 1 - North	3.06%	3.06%	3.06%
Area 2 - West	0.00%	0.00%	0.00%
Area 3 - Central	0.50%	0.50%	0.50%
Area 4 - Norfolk	0.09%	0.09%	0.09%
Area 5 - Essex and East Suffolk	2.41%	2.41%	2.41%
Area 6 - Cambridgeshire and West Suffolk	1.96%	1.96%	1.96%
Total	8.02%	8.02%	8.02%

Table 3.9: Benefits in '% of population on single source supply' for each plan per AMP

	Baseline LCP	Alternative LCP	BVP
	% population on single source	% population on single source	% population on single source
AMP7	7.52%	6.42%	8.02%
AMP8	0.00%	0.00%	0.00%
AMP9	0.00%	0.00%	0.00%
AMP10	0.50%	1.60%	0.00%
AMP11	0.00%	0.00%	0.00%
Total	8.02%	8.02%	8.02%

Drought resilience

As part of the scenario testing to develop alternative plans we ran the extreme drought scenarios (approximately 1 in 500 year return period) through EBSD.

In the Baseline LCP EBSD selected to build additional resources to make up the shortfall in DO created by more extreme drought rather than move existing surplus as these were constrained by the capacity of the transfer options. Some transfers were required to be delivered earlier in AMP7 to maximise existing resources where it could.

To develop the BVP we allowed the EBSD model to flex to select the most suitable capacity of transfers to meet demand. These increased capacity transfers meant that additional resources could be developed to slot into the network of transfers in the extreme drought scenarios.

The Alternative LCP is the BVP but only with adequate capacity to meet the baseline WRMP scenario. This means that existing resource cannot be transferred around the region to meet additional deficits created by 1:500 year scenario. The only solution would be to build additional local new resources which may not be the most beneficial in term of cost and environmental impact but they would be the only options available.

Risk

All plans were tested against the risk that the demand management strategy delivered less demand savings than predicted. The limited capacities of the Baseline LCP and alternative LCP meant that new resources had to be developed to meet the additional demand as existing surpluses were unable to be transferred. Less new resources were required for the BVP plan in these demand scenarios.

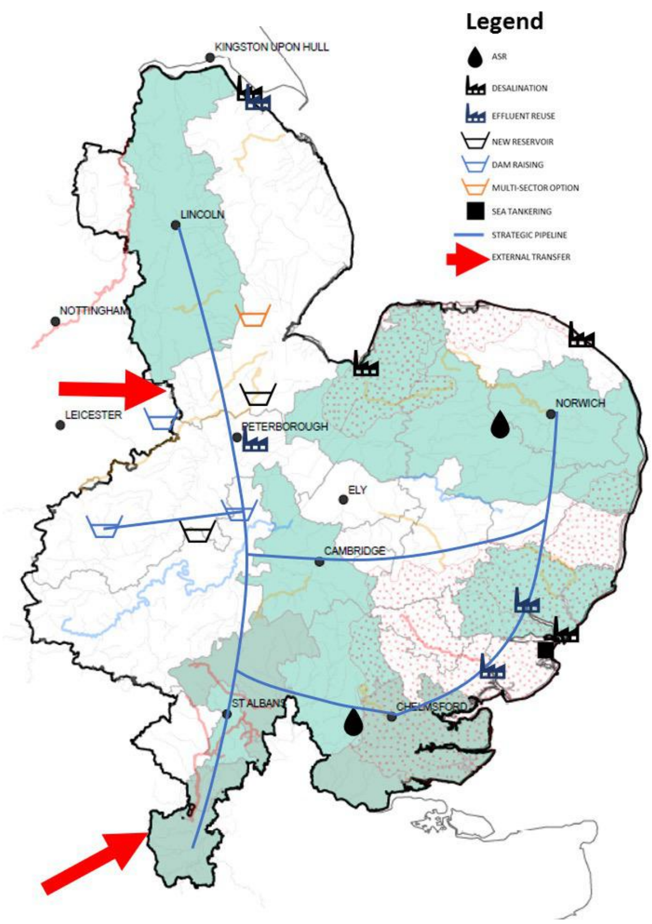
3.3.3 Alignment to Water Resources East

The transfer strategies in all plans broadly align with the Water Resources East (WRE) preliminary regional strategy, as shown in figure 3.4. For the WRE strategy the following are included:

- New reservoir storage capacity, capturing high winter flows
- Treated water imports
- Desalination and water reuse at key locations on the east coast

In the WRE the network of strategic transfers allows the sharing of resources between companies and across sectors. The main difference between the LCP and Alternative LCP/BVP is the ability to connect up and utilise the resource options identified in the WRE. In the Baseline LCP the network is incomplete, one of the supply options is selected in the short-term and the ability to accommodate future resources is limited. The Alternative LCP and BVP include a more complete network of strategic transfers across the region, delaying the need for short-term supply options and allowing the optimal utilisation of additional new resources to meet the needs of future uncertainties. In summary, the Alternative LCP and BVP are more aligned with WRE, delivering a major part of the envisaged strategic transfers, whilst retaining flexibility on resources.

Figure 3.4 WRE preliminary regional strategy



3.3.4 Customer preferences

The conclusions that we have drawn from the customer engagement results are described below.

Customers do not want a deterioration in service and all water resource options (including both demand management and supply-side) were preferable to an increase in restrictions; the one exception being sea tankering, which they did not perceive to be a credible option.

Generally, customers prefer options that make best use of existing resource and infrastructure, as opposed to options that involve developing new resources. This explains a clear preference for demand management, particularly leakage reduction. Even when customers understood that our leakage performance is industry leading, and that reducing leakage does not reduce bills, it remains an emblematic issue and a priority for investment. The reliability of water resources options is an additional important consideration to customers, and generally they prefer options that are described as having 'higher' reliability, as opposed to 'medium' or 'lower' reliability. For example, in the Water Resources Stated Preference Survey all options were defined as either 'higher', 'medium' and 'lower' reliability. Overall, leakage reduction was the highest ranked option. However, when leakage was described as 'lower' reliability, it was less preferable to some supply-side options described as 'medium' or 'higher' reliability (including water reuse and reservoir extensions).

Although customers express a preference for demand management, they also want to see a cost-effective balance of supply and demand options. When it was explained to customers that there are cheaper alternatives to leakage reduction, many felt that while leakage reduction is important, affordability should also be a key consideration.

Finally, many customers also recognise our expertise and trust us to make complex investment decisions, and choose the mix of solutions that will be most efficient and cost effective.

Overall, customer preferences are most closely aligned with the Alternative LCP and BVP because these utilise existing resources more, rather than depending on new short-term resource development.

3.3.5 Environmental and social impact

The outputs from the Strategic Environmental Assessment (SEA), Habitats Regulations Assessment (HRA), Ecosystem Services Assessment (ESA) have been used to compare the alternative plans. These are summarised below more details can be found in the main documents.

Strategic Environmental Assessment (SEA)

The SEA concluded that the Alternative LCP and BVP are likely to have an overall positive effect on delivering reliable and sustainable water supplies that are flexible to cope with future changing growth and demand. Positive effects identified include increased availability and resilience of water supplies for human use; increased availability of water within the natural environment thus increasing resilience, benefiting water dependant ecological sites, and maintaining an attractive natural landscape; reducing the need for future water supply infrastructure; and allowing customers to understand their water usage.

Where negative effects were identified in the options assessment, these have been mitigated where possible through the options design process by re-routing pipelines or using directional drilling under sensitive sites and rivers or investigated further through the HRA and WFD processes. The use of best practice construction methods will also be utilised to minimise any effects during the construction phase. Minor residual negative effects remain for the Felixstowe desalination option (ESU1) due to the predicted moderate effects on WFD objectives and effects of brine discharge on ecology. Where effects relating to greenhouse gas emissions were known, all options had minor negative effects apart from the ESU1, SHB2 and SLN6 options where major negative effects were identified. Future consideration of renewable energy options would reduce these effects.

As with the Alternative LCP and BVP, overall, the Baseline LCP is likely to have an overall positive effect on delivering reliable and sustainable water supplies that are flexible to cope with future changing growth and demand. Positive effects identified include increased availability and resilience of water supplies for human use; increased availability of water within the natural environment thus increasing resilience, benefiting water dependent ecological sites, and maintaining an attractive natural landscape; reducing the need for future water supply infrastructure; and allowing customers to understand their water usage.

Habitats Regulations Assessment (HRA)

Two options which feature in all the plans were subject to a Task II: Appropriate Assessment. These were ESU1 and SHB2. The conclusions for these options are summarised in the table overleaf.

Table 3.10: Two options which feature in the Alternative LCP and Baseline LCP

Option Ref	Option Name	Baseline LCP	Alternative LCP	BVP	Likelihood of adverse effects on the integrity of European sites?
ESU1	Felixstowe desalination	✓ (required in 2024)	✓ (required in 2034)	✓ (required in 2034)	Unknown at this stage There is a likelihood for adverse effects on the Stour and Orwell Estuaries SPA/Ramsar site and Deben Estuary SPA/Ramsar site during construction and operation of the option. Temporary construction impacts relate to pollution events resulting in adverse effects on water quality. It is assumed however that appropriate measures can be put in place to ensure there is no residual effects on the integrity of the European sites Operation impacts may cause non-toxic contamination due to changes in salinity as a result of discharged brine. The effects of increased salinity due to brine discharge will need to be explored further as this option is developed in order to demonstrate that the integrity of European sites will not be significantly adversely affected. It is reasonably assumed that assessment at lower tier plan or project level HRA will result in appropriate mitigation being developed to ensure desalination options result in no significant adverse effects on the integrity of the European sites identified.
SHB2	Pyewipe Water Reuse for non-potable use	✗	✓ (required in 2025)	✓ (required in 2025)	No Potential for temporary and permanent adverse effects on the Humber Estuary SPA/Ramsar site/SAC during construction and operation of the option have been identified. These impacts relate to possible disturbance to qualifying bird species of the SPA/Ramsar site during construction, pollution events resulting in adverse effects on water quality and entering the Humber Estuary and air pollution affecting aquatic habitats, bird and fish species of the SPA/Ramsar site/SAC. It is assumed that appropriate mitigation measures can be put in place to ensure there is no residual effects on the integrity of the European sites.

Ecosystem Services Assessment (ESA)

The options within the Baseline LCP vary in performance in terms of the ecosystem services that are considered of high importance to the WRMP 2019 (Fresh Water, Climate Regulation, Water Regulation, Disease Regulation, Natural Hazard Regulation, Water Purification, Recreation and Tourism, and Provision of Habitat). The Baseline LCP will have a positive impact on the provision of fresh water, natural hazard regulation, and water purification, and a negative impact on provision of recreation and tourism, and provision of habitat (due to land use changes). The Baseline LCP has a worse average ecosystems services score per Ml/d than the Alternative LCP and BVP.

The options within the Alternative LCP and BVP vary in performance in terms of the ecosystem services that are considered of high importance to the WRMP 2019 (Fresh Water, Climate Regulation, Water Regulation, Disease Regulation, Natural Hazard Regulation, Water Purification, Recreation and Tourism, and Provision of Habitat). Overall the Alternative LCP and BVP will have a positive impact on the provision of fresh water, natural hazard regulation, disease regulation, water regulation and water purification, and a negative impact on provision of recreation and tourism, and provision of habitat (due to land use changes). The Alternative LCP and BVP achieve a better average ecosystems services score per Ml/d than the Baseline LCP.

3.3.6 Cost

The costs for the plans were compared. The analysis only included the cost of supply-side options as the NEP options and demand management options are the same in all plans. Table 3.11 shows the different capex, opex and Totex; the opex is based on the actual utilisation within the EBSD model for each option rather than the full opex at maximum capacity.

Table 3.11: Capex, Opex, Totex for the Baseline and Alternative plans

	Baseline LCP			Alternative LCP			BVP		
	Capex (£k)	Opex Utilisation (£k)	Totex (£k)	Capex (£k)	Opex Utilisation (£k)	Totex (£k)	Capex (£k)	Opex Utilisation (£k)	Totex (£k)
AMP7	439,664	5,372	445,036	529,316	4,448	533,764	551,555	4,587	556,142
AMP8	29,933	34,889	64,822	-	40,165	40,165	-	39,193	39,193
AMP9	26,441	37,285	63,726	61,325	49,126	110,451	61,325	48,341	109,666
AMP10	30,650	41,428	72,078	-	53,957	53,957	-	54,054	54,054
AMP11	49,439	41,353	90,792	15,182	55,005	70,187	15,182	55,159	70,341
Totals	576,127	160,327	736,455	605,823	202,701	808,524	628,062	201,334	829,396

The data is also represented in a graph in figure 3.5.

Figure 3.5: Capex and Opex for Baseline and Alternative LCP per AMP

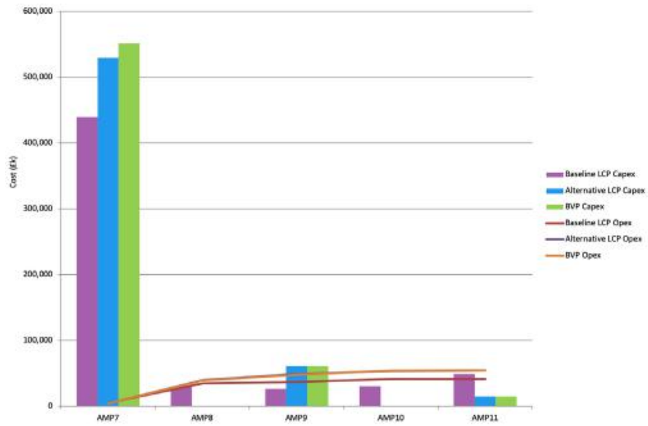
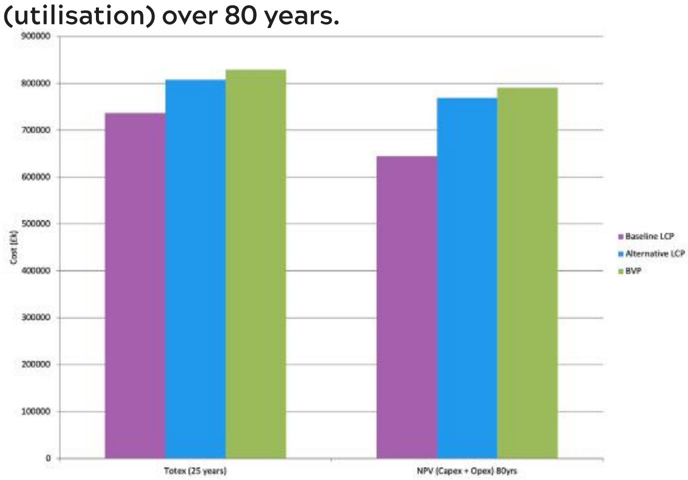


Figure 3.6: shows the comparison of Totex over 25 years and the NPV for just capex and opex (utilisation) over 80 years.



It should be noted that we have included treatment for the removal of Metaldehyde in options that transfer water from areas with an 'Undertaking' to ones without. This adds considerable additional capex and opex to those options. The options to utilise the existing surpluses in Lincolnshire all include costs to remove Metaldehyde, this is one of the reasons why the Alternative LCP and BVP are more expensive than the Baseline LCP. If the requirement to remove Metaldehyde was removed i.e. a ban of products containing the pesticide, then the Baseline LCP could look different and the additional costs associated with the Alternative LCP and BVP would be considerably less.

Aborted costs and stranded assets

The scenario testing completed in Stage 2 showed that the Baseline LCP and to a lesser degree the Alternative LCP lacked adaptability and flexibility and limited the number of future options available to meet these uncertainties. This would undoubtedly lead to redundant and/or under utilised assets in the future. The costs of these have not been quantified and used in the assessment.

3.3.7 Conclusion

The outputs from the Multi-Criteria Assessment described above, were used to inform the recommendation to our Strategic Priorities Board as part of the PR19 governance process. Our Board were satisfied that the additional costs associated with delivery of the Best Value Plan were beneficial in terms of the adaptability, flexibility and future proofing this plan provides. By delaying the new resource option development, this gives us choices in the future for more strategic sustainable resources if required. The best Value Plan then became our Preferred Plan.

Table 3.12: Performance criteria assessment for final strategy selection

Performance criteria	Baseline Least Cost Plan	Alternative Least Cost Plan	Preferred Plan (Best Value Plan)	Description of analysis (quantitative or qualitative)	Justification for score
Cost				Quantitative - using cost outputs from EBSD modelling.	The Least Cost Plan performs better as it has a lower overall capital and operating costs.
Adaptability and flexibility				Quantitative - using EBSD scenario model runs.	The Preferred Plan performs better as it allows greater flexibility for development and sharing of new resource options beyond 2025.
Risk and resilience				Quantitative - using proportion of single supply population and performance in stress testing.	All plans perform equally when considering the reduction of single supply population, but the Preferred Plan performs better in stress testing (stage 4).
Alignment with WRE				Qualitative - comparison with WRE regional strategy.	The Preferred Plan delivers better alignment with the WRE strategy due to an increase in the capacity of strategic transfers across the region.
Alignment with customer preferences				Qualitative - comparison with outputs from customer preference surveys.	The Preferred Plan performs better when compared with customer preferences as it makes best use of existing resources and defers the development of desalination which is less favourable to customers than transfers.
Environmental and social impacts				Both quantitative and qualitative analysis undertaken using the outputs from the SEA, HRA and Ecosystem Services Assessment.	All plans perform equally when compared against all SEA objectives.

3.4 Stage 4 - Stress testing the final strategy

Once our Board signed off our Best Value Plan this became the Preferred Plan. We completed a number of further stress tests of the Preferred Plan to ensure we had the right balance between adequate capacity to be future proof with actual utilisation in a business as usual scenario.

In Stage 2 we allowed the ESBD model to flex the capacity of the transfer options for each scenario, we then chose the optimal combination of capacities needed to satisfy most scenarios. For example one option may require a 10Ml/d capacity in the High climate change scenario but need 15 Ml/d in the Extreme drought scenario. However in the business as usual scenario the demand via this transfer may only be 5 Ml/d. So we may have decided on 10Ml/d being the optimal capacity.

For Stage 4 we tested the final plan (in the example above with a main of 10Ml/d capacity) in the following scenarios to see what additional options would be required to support the Preferred Plan in the future,

- Extreme drought (1:500)
- Higher Climate Change impacts
- Demand Management programme providing 15% less savings than the Extended Plus option
- Demand Management programme providing 30% less savings than the Extended Plus option
- Future potential exports to Affinity Water

In EBSD we selected the options in the Preferred Plan as 'must do', this means that the model will pick these within the planning period but it may choose to deliver them at a different date than in the original Preferred Plan. This allows the model to fully utilise the 'must do' options efficiently and then select additional options to support the Preferred Plan.

We also completed fully least cost runs for each scenario, i.e. no options were marked as 'must do', and compared these new LCPs against the original least cost version for each plan. To understand the ability of our Preferred Plan to incorporate a future strategic winter storage reservoir we ran the Preferred Plan with an option set that contained 'minimum cost' reservoirs. This allowed the ESBD model to select one or more reservoirs to support the network of transfers in the Preferred Plan and identified where additional options would be required in each scenario.

Table 3.8 summarises the additional options required for each scenario compared to the original least cost version of each plan.

Table 3.13: Additional option summary

Problem Characterisation Area	Scenario	Least Cost Analysis compared against Baseline Least Cost Plan	Options required in scenario in addition to Alternative LCP	Options required in scenario in addition to Preferred Plan	Options required in addition to Preferred Plan if a strategic supply-side option was developed
Area 1 - North	Extreme Drought	T: ✓ R: > (Pyewipe)	T: ✓ R: ✓	T: ✓ R: ✓	T: ✓ R: ✓
	High Climate Change	T: ✓ R: > (Pyewipe)	T: ✓ R: ✓	T: ✓ R: ✓	T: ✓ R: ✓
	Demand Management - 15% less savings	T: ✓ R: > (Pyewipe)	T: ✓ R: ✓	T: ✓ R: ✓	T: ✓ R: ✓
	Demand Management - 30% less savings	T: ✓ R: > (Pyewipe)	T: ✓ R: ✓	T: ✓ R: ✓	T: ✓ R: ✓
	Affinity Export	T: ✓ R: > (Pyewipe)	T: ✓ R: ✓	T: ✓ R: ✓	T: ✓ R: ✓
Area 2 - West	Extreme Drought	T: > (Ruthamford North to South, South Fenland to Ruthamford North) R: > (Trent, imports, water reuse)	T: > (Ruthamford North to South) R: > (Trent, imports, water reuse)	T: > (Ruthamford North to South) R: > (Trent, imports, water reuse)	T: > (Ruthamford North to South) R: > (Trent, imports, water reuse)
	High Climate Change	T: > (Ruthamford North to South) R: > (Trent, import)	T: > (Ruthamford North to South) R: > (Trent, imports)	T: > (Ruthamford North to South) R: > (Trent, imports)	T: > (Ruthamford North to South) R: > (Trent, imports)
	Demand Management - 15% less savings	T: ✓ R: ✓	T: ✓ R: > (import)	T: ✓ R: > (import)	T: ✓ R: > (Winter storage reservoir)
	Demand Management - 30% less savings	T: ✓ R: ✓	T: > (Ruthamford North to West, West to Central) R: > (Trent, imports)	T: > (Ruthamford North to South) R: > (Trent)	T: > (Ruthamford North to South) R: > (Winter storage reservoir)
	Affinity Export	T: > (Ruthamford North to South) R: > (import)	T: > (Ruthamford North to West, West to Central) R: > (Trent, imports, water reuse)	T: > (Ruthamford North to South) R: > (Trent, imports)	T: > (Ruthamford North to South) R: > (Winter storage reservoir)

Problem Characterisation Area	Scenario	Least Cost Analysis compared against Baseline Least Cost Plan	Options required in scenario in addition to Alternative LCP	Options required in scenario in addition to Preferred Plan	Options required in addition to Preferred Plan if a strategic supply-side option was developed
Area 3 - Central	Extreme Drought	T: < R: > (Desalination)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)
	High Climate Change	T: < R: > (Desalination)	T: < R: > (Desalination)	T: < R: > (Desalination)	T: ✓ R: > (winter storage reservoir)
	Demand Management - 15% less savings	T: < (better utilisation of West to Central link) R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)
	Demand Management - 30% less savings	T: < R: ✓ (None)	T: ✓ R: > (None)	T: ✓ R: > (Desalination)	T: ✓ R: > (winter storage reservoir)
	Affinity Export	T: ✓ R: v (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)
Area 4 - Norfolk	Extreme Drought	T: < R: ✓ (None)	T: > (Central to Norfolk) R: ✓ (None)	T: < R: ✓ (None)	T: < R: ✓ (None)
	High Climate Change	T: < R: ✓ (None)	T: > (Central to Norfolk) R: ✓ (None)	T: > (Central to Norfolk) R: ✓ (None)	T: > (Central to Norfolk) R: ✓ (None)
	Demand Management - 15% less savings	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)
	Demand Management - 30% less savings	T: ✓ R: ✓ (None)	T: > (Central to Norfolk) R: ✓ (None)	T: > (Central to Norfolk) R: ✓ (None)	T: > (Central to Norfolk) R: ✓ (None)
	Affinity Export	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)

Problem Characterisation Area	Scenario	Least Cost Analysis compared against Baseline Least Cost Plan	Options required in scenario in addition to Alternative LCP	Options required in scenario in addition to Preferred Plan	Options required in addition to Preferred Plan if a strategic supply-side option was developed
Area 5 - Essex and East Suffolk	Extreme Drought	T: ✓ R: < (Ardleigh extension not required)	T: ✓ R: < (Ardleigh extension required)	T: ✓ R: ✓	T: ✓ R: ✓
	High Climate Change	T: ✓ R: < (Ardleigh extension not required)	T: ✓ R: < (Ardleigh extension required)	T: ✓ R: ✓	T: ✓ R: ✓
	Demand Management - 15% less savings	T: ✓ R: ✓	T: ✓ R:> (Ardleigh extension required)	T: ✓ R: ✓	T: ✓ R: ✓
	Demand Management - 30% less savings	T: > (transfer to Central Essex) R: ✓	T: > (transfer to Central Essex) R: > (Ardleigh extension required)	T: > (transfer to Central Essex) R: ✓	T: > (transfer to Central Essex) R: ✓
	Affinity Export	T: ✓ R: ✓	T: ✓ R: ✓	T: ✓ R: ✓	T: ✓ R: ✓
Area 6 - Cambridgeshire and West Suffolk	Extreme Drought	T: > R: ✓ (None)	T: > (Ruthamford to Newmarket) R: ✓ (None)	T: > (Ruthamford to Newmarket) R: ✓ (None)	T: > (Ruthamford to Newmarket) R: ✓ (None)
	High Climate Change	T: > R: ✓ (None)	T: ✓ R: ✓ (None)	T: > (Ruthamford to Newmarket) R: ✓ (None)	T: > (Ruthamford to Newmarket) R: ✓ (None)
	Demand Management - 15% less savings	T: ✓ R: ✓ (None)	T: > (Ruthamford to Ely) R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)
	Demand Management - 30% less savings	T: > some larger and in different direction R: ✓ (None)	T: > (Ruthamford to Newmarket) R: ✓ (None)	T: > (Ruthamford to Newmarket) R: ✓ (None)	T: > (Ruthamford to Newmarket) R: ✓ (None)
	Affinity Export	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)	T: ✓ R: ✓ (None)

Key: T=Transfers, R=Resource options, ✓=same capacity or resource options, >=larger capacity transfers or additional resource options, <=smaller capacity transfers or resource schemes not required.

We found that in all areas the transfers within the Preferred Plan provide adequate capacity for meeting the demand of future scenarios. In the West, Norfolk and Cambridgeshire and West Suffolk areas additional transfers would be required to address new deficits generated by the stress testing scenarios. This additional investment would enhance the strategic grid in the Preferred Plan and could be delivered at a later date without impacting the Preferred Plan schemes required in AMP7. To meet the higher demands of the scenarios tested additional resources would also be required.

The stress testing shows that these demands could be met by a number of smaller options (e.g. Water company imports, desalination or raw water transfers) or a larger single strategic option such as a winter storage reservoir conveyed between areas by the transfer options.

We have also assessed our Preferred Plan over two extended durations 45 years (up to 2065) and 65 years (up to 2085) and for two supply forecast scenarios (with and without Affinity Water trade options). The results are shown in the matrix below.

Table 3.14: Extended assessment of the preferred plan

Duration	Supply Forecast Scenario	Resource options required in scenario in addition to Preferred Plan	Resource options required in addition to Preferred Plan if a strategic supply-side option was developed
45 years up to 2065	Without trade to Affinity Water	• South Lincolnshire reservoir (RTN1) in 2042	• South Lincolnshire reservoir in 2038
65 years up to 2085		• STW import 2044 • South Lincolnshire reservoir (RTN1) 2058 • Water reuse 2068 • Fenland Reservoir 2080	• South Lincolnshire reservoir 2038
45 years up to 2065	With 50Ml/d trade to Affinity Water	• STW import 2032 • Water reuse 2032 • South Lincolnshire reservoir (RTN1) in 2037	• South Lincolnshire reservoir in 2032
65 years up to 2085		• STW imports 2032, 2037 • Water reuse 2032, 2062, 2068 • South Lincolnshire reservoir (RTN1) in 2055	• South Lincolnshire reservoir in 2032 • Water reuse 2067

In addition to the resource options in the Preferred Plan the South Lincolnshire reservoir option RTN1 (maximum deployable output 76Ml/d) was selected along with a number of other smaller resource options in all scenarios. We then tested if a single larger reservoir (up to 200Ml/d) would meet demand as an alternative to the least cost selection of smaller options.

The trade with Affinity Water impacted the timing of when new resource options would be required.

3.4.1 Conclusion

For this stage we completed 28 EBSD runs that tested the performance of the Preferred Plan. We found that the Preferred Plan performed well in each scenario and that it was adaptable enough to allow other options to slot into the Plan in the future if required.

3.5 Summary

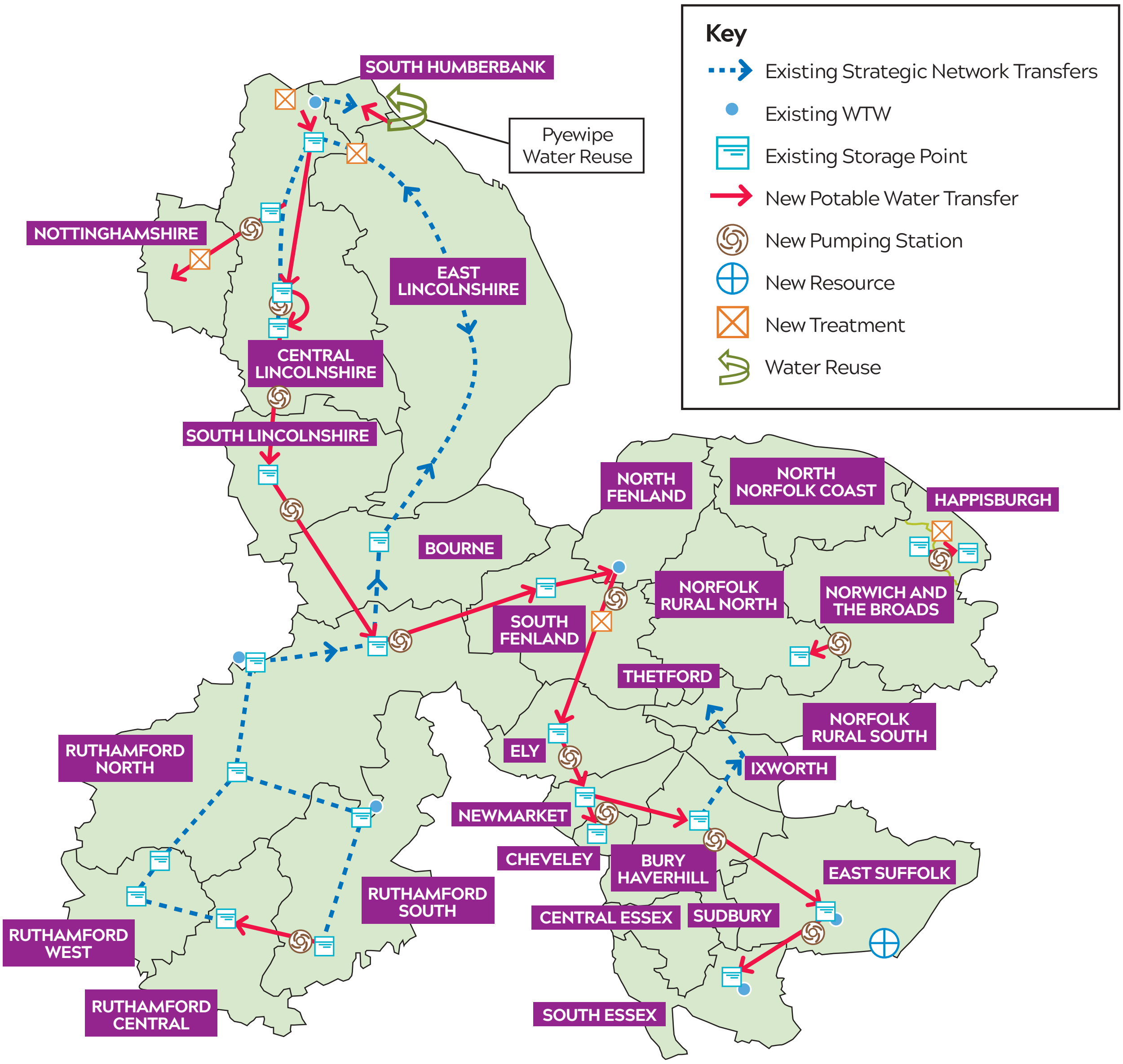
This section summarises the differences between the Baseline LCP and the Best Value Plan our Preferred Plan and the outcomes of the Multi-Criteria Assessment.

Table 3.15: Differences between Baseline LCP and Preferred Plan

Water Resource Zone	Option reference	Option type	Comments	Justification
East Suffolk	ESU1	Desalination	Deferred from AMP7 (2024-25) in bLCP to AMP9 (2033-34) in Best Value Plan (BVP). Replaced by Water Reuse scheme early in the planning period.	By maximising the use of existing resources, we have delayed the development of new resources. This gives us future choices to develop smaller localised resources or larger strategic resources such as winter storage reservoirs.
South Humber Bank	SHB2	Water reuse	New resource option only selected in BVP, replacing the development of desalination in early in the planning period in the bLCP.	Pyewipe water reuse option would supply non-potable customers, offsetting the need to abstract and treat river water for non-potable demand. This offset existing river source could be treated to potable standards and put into supply.
Central Lincolnshire	CLN13a	Treatment	Upsized from 10 Ml/d in bLCP to 31 Ml/d in BVP.	In the bLCP, the option only treats (to potable standards) the surplus non-potable resource (10 Ml/d) from the South Humber Bank WRZ. The selection of the Pyewipe water reuse option in the BVP means that a larger surplus is available (31 Ml/d) for treatment.
South Fenland	SFN4	Potable water transfer	Upsized from 22 Ml/d in bLCP to 40 Ml/d in BVP.	The stress testing showed that increasing the capacity of the transfer would allow existing/new resources to be fully utilised and transferred east towards Norfolk in more severe drought scenarios.
Bury Haverhill	BHV5	Potable water transfer	Upsized 10 Ml/d in bLCP to 20 Ml/d in BVP.	The bLCP selected new resource development in East Suffolk. This led to a strategy of transfers going from South East to North West with diminishing capacity. The BVP utilises existing resources in the north which reverses the direction and increases the required capacity of the transfers.
Newmarket	NWM6	Potable water transfer	Upsized from 10 Ml/d in bLCP to 20 Ml/d in BVP.	As described above for Bury Haverhill, this gives the greatest flexibility to meet future uncertainties. These transfers in the east to move supplies to areas where there are no new resource options cover considerable distance. The option of laying a duplicate main later on in the plan to meet future uncertainties would not be economical.
Ely	ELY9	Potable water transfer	Upsized from 4 Ml/d in bLCP to 20 Ml/d in BVP.	As described above with Newmarket, this gives the greatest flexibility to meet future uncertainties.

The Preferred Plan is described in the figure below.

Figure 3.7: Preferred plan for the Anglian Water Region



4. Final Conclusions

This document has summarised our approach to option appraisal for the WRMP. It has described how we have engaged with regulators and addressed consultation feedback.

Whilst our starting point was the development of a least cost plan, we have created and applied a set of 'best value' criteria to ensure our Preferred Plan represents best value incorporating flexibility, alignment to regional plans, resilience, deliverability, customer preferences and environmental and social impacts.

By testing a set of alternative least cost plans, we have come up with a Preferred Plan which delays the need for new resource development, but which ensures our extended network is joined up, maximising the use of existing resources and building flexibility to accommodate a range of potential new resources.

The overall comparison of strategic options is presented in table 4.1. We have stress-tested our Preferred Plan using a range of demand and supply-side uncertainties, which demonstrates its robustness to the future.

Table 4.1: Comparison of assessed options against our selection criteria

Supply / Demand	Demand options			Supply options		
Criteria	Extended Option	Extended Plus Option (Preferred)	Aspirational Option	Least Cost Plan	Best value Plan (Preferred)	Alternative Least Cost Plan
Meets Customer expectations / preference						
Cost						
Mitigates Growth						
Fulfils Regulatory Obligations						
Aligns with WRE						
Is deliverable / achievable						
Meets SEA requirements						
Adaptability and Flexibility						
Risk and Resilience						

Cover photo shows Rutland Water

Rutland Water is a reservoir in Rutland, England, east of the county town, Oakham. It is filled by pumping from the River Nene and River Welland and provides water to the East Midlands. It is one of the largest artificial lakes in Europe.

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