WATER RESOURCES MANAGEMENT PLAN 2015

love every drop
anglianwater

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Key Points

This is our 2015 Water Resource Management Plan (WRMP). It shows how we are going to maintain the balance between supply and demand over the next 25 years, as well as deal with the longer term challenge of population increase, climate change and growing environmental needs.

We supply water to approximately 2 million households in East Anglia, the adjacent areas of the South East, Midlands, Yorkshire, Humberside and to households in Hartlepool. Rainfall in most of our supply area is significantly less than the national average. We are classed as an area of severe water stress and have many wetland and conservation sites of national and international importance. Safeguarding these vital assets and maintaining supplies to customers are the two objectives of this plan.

Over the next 25 years, our supply-demand balance is at risk from growth, climate change and the reductions in deployable output that we will make to restore abstraction to sustainable levels. In the worst case combination, the impact could approach 567Ml/d, equivalent to approximately 50% of the water we put into supply in 2012/13. We also have to manage risks from drought, deteriorating raw water quality and the impact of cold, dry weather on our distribution system and customer supply pipes.

Although customers recognise these challenges, they have told us that they do not expect any severe restrictions on supplies and that they are willing to pay to avoid these. They think that we should be planning ahead, taking action now to build resilience and prevent problems for the future. Reducing leakage and using water more efficiently are things that customers expect us to do to maintain the future balance between supply and demand.

In response, we have developed a flexible and adaptive plan that commits us to reducing leakage and consumption by at least 139Ml/d. It also increases the volume of water we trade and transfers resources from areas of surplus to areas of deficit. The demand management measures that we will deliver are cost-beneficial, while our supply-side schemes are the most cost-effective of a large number of alternative options. In AMP6, we will deliver a Habitats Regulations compliant scheme to restore the River Wensum to a favourable hydro-ecological condition.

Ultimately, these measures may not be enough to meet our long-term future supply-demand needs. To prepare for this possibility we are promoting the Water Resource East Anglia (WREA) project. This innovative water resource planning initiative will be completed in AMP6 and follows from work with the National Drought Management Group and projects completed with the Cambridge Institute for Sustainability Leadership

Through the WREA project, we will work in partnership with the Environment Agency, Natural England and others to increase the resilience of our region to the effects of drought, climate change and growth. From AMP7 onwards, this could include delivering schemes for winter storage reservoirs, aquifer storage and recovery, water reuse and strategic raw water or treated water transfers. Together with our commitment to manage demand and increase water trading, this approach delivers a sustainable and affordable balance between the future needs of customers and the environment.

Background, technical approach, objective and scope

This is our 2015 WRMP. It covers the period from 2015 to 2040 and shows how we are going to maintain the balance between water supplies and demand. It also shows how we are going to meet the longer term challenge of population increase, climate change and growing environmental need.

In preparing this plan, we have been guided by the policy objectives of Government. In the face of population increase, climate change and the need to reduce abstraction to more sustainable levels, the Government aims to support growth and protect the environment. The plan we have produced is consistent with these objectives. By implementing it, we will deliver a sustainable and affordable system of supply which meets the current and future needs of our customers and the environment.

The Environment Agency (EA), Ofwat, Defra and the Welsh Government publish technical guidance to assist in the preparation of Water Resource Management Plans. The requirements of this include:

- Take a long-term perspective, beyond the 25 year planning horizon, to help make supply systems resilient to future uncertainties
- Take better account of the value of water, reflecting its scarcity as well as the environmental and social costs of abstraction and use
- Consider all options for maintaining the supply-demand balance, including water trading and supplies from third parties
- Significantly reduce the demand for water by managing leakage and providing services to customers that help them to use water more efficiently, and
- Ensure that customer views are taken into account on levels of service and costs.

We have used the following approach to meet these objectives:

1. For our principal supply-demand needs, we have applied established cost-benefit and cost-effectivesness water resource planning methods. These are based on a single deterministic forecast of the future balance between supply and demand. In this, uncertainties are taken into account through the use of target headroom allowances, and
2. To better manage our long-term risk, we are promoting a strategic water resource planning project with other companies in the region and the EA – the AMP6 Water Resources East Anglia (WREA) project. This is based on an emerging approach to water resource planning, robust decision making (RDM), in which the effects of uncertainty are taken into account by assessing how well our plans perform in a variety of plausible future scenarios.

Our AMP6 WREA RDM project builds on collaborative planning work that we have led as part of our response to the recent drought. This includes:

- Early engagement with the EA on the need for a more flexible and adaptive approach to water resource planning. In this, the need for 50-year planning horizons and for improvements to the way we manage uncertainty and risk were recognised. For many of the challenges we face, the current planning methods underperform in these areas
- The National Drought Management Group (NDMG): organised to develop contingency plans for mitigating the worst impacts of the recent drought, this comprised representatives from water companies, industry regulators and other third parties. A

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key recommendation from the NDMG, contained in the EA's review of the drought and water resource prospects report, was to progress appropriate levels of resilience through the existing water resource and drought planning processes, and

- Two drought workshops, one of which was sponsored by Anglian Water. At these, a consensus emerged on the need for developing an approach to water resource planning in which the need for resilience could be recognised. This would see investment need extend from simple level of service considerations to measures which will protect our economy and the environment from the worst effects of drought, climate change and population increase.

Defra's strategic policy statement to Ofwat (March, 2013) reinforces the value of this type of work, stating that Defra expects Ofwat to incentivise companies to think and act long-term, reflecting the broader context of supply challenges through to 2050.

Key to all of these initiatives is the need to improve the way that we manage uncertainty and risk. In respect of the approach we have used:

- The existing methods perform well in circumstances where uncertainty and risk are well characterised and where there is a broad consensus on the most cost-effective strategy for maintaining levels of service. This is consistent with the short to medium term elements of our plan, and
- The WREA RDM type methodologies perform better where long-term uncertainties and risk are significant, where the scale of investment needed to manage the risk is large and where multiple stakeholders have different views about successful outcomes. This is consistent with our need to take a longer term view and to consider the broader context for water resource planning.

Outputs from our WREA RDM project will enable decision makers and stakeholders to make well-informed trade-offs between different economic, social and environmental objectives. For situations characterised by significant uncertainty and risk, such as the timing and scale of climate change impacts, this typically leads to plans which:

- Perform robustly
- Are flexible and adaptive
- Minimise regret from stranded assets, under-utilised assets or from the late delivery of assets, and
- Are better aligned with the outcomes that customers and others desire.

We will use the AMP6 WREA RDM project to evaluate the need for investment in strategic water resource schemes such as winter storage reservoirs, aquifer storage and recovery, water reuse and desalination. We will also use it to increase connectivity and determine appropriate long-term targets for leakage and consumption. Through related projects, models for trading the resources which are created will be developed. Overall, our objective is to develop a flexible and adaptive water resource management system in our region, in which the needs of customers and the environment are balanced in a sustainable and affordable way.

This plan is a summary technical document. It presents material which is intended to:

- Show how we have complied with the technical requirements of our regulators in preparing the plan

- Show how customer views and feedback have influenced the development of the plan, and
- Inform use of the planning tables which accompany this plan

For interested customers and other non-technical stakeholders we have produced a non-technical summary that is available on our website. For planning professionals, the EA, Ofwat and Defra detailed technical reports are also available.

Scale of our future challenge

Through a combination of high population density and relatively low rainfall, the Anglian region is already classed as being in severe water stress. Over the next 25 years, we face additional challenges from growth in demand and target headroom requirements, climate change and the reductions in deployable output that we will make to restore abstraction to sustainable levels. The impact of these on our supply-demand balance is shown in the figure below. Under dry year annual average conditions and without investment to maintain the supply-demand balance, we forecast that the following resource zones (RZs) will be in deficit by 2039-40:

- Ruthamford South (including Milton Keynes, Bedford and Huntingdon)
- Hunstanton
- Fenland (Kings Lynn and Wisbech)
- Norwich and the Broads (Norwich)
- Cheveley
- Ely
- West Suffolk (Bury St Edmunds)
- East Suffolk (Ipswich)
- South Essex (Colchester), and
- Central Essex (Halstead).

Under critical period (peak) conditions, the deficits are restricted to our Norwich and the Broads RZ, Cheveley RZ and Ruthamford South RZ. Specific issues include:

- Increase in population. Over the forecast period, the population may increase by as much as 1,000,000. Even if highly water efficient rates of per capita consumption (PCC) are achieved, growth of this magnitude will be equivalent to an extra 80Ml/d of demand. Including target headroom requirements and other changes, our overall demand is forecast to increase by 144Ml/d
- Sustainability reductions. Where it is shown that our abstractions have an adverse impact on the environment, we are required to reduce this to more sustainable levels. This may include relocating our source works. For this round of planning, the EA has specified a series of sustainability reductions which in total are equivalent to 110Ml/d, and
- Climate change. Including target headroom requirements and effects on demand, mean estimates of the impact of climate change are of the order of 50Ml/d. Sources which rely on abstraction from rivers are primarily affected.

Although subject to significant uncertainty, we are potentially at risk from a further 71Ml/d of currently unknown sustainability reductions and a worst case climate change impact of 154Ml/d. Details of RZs that may be affected are also given below:

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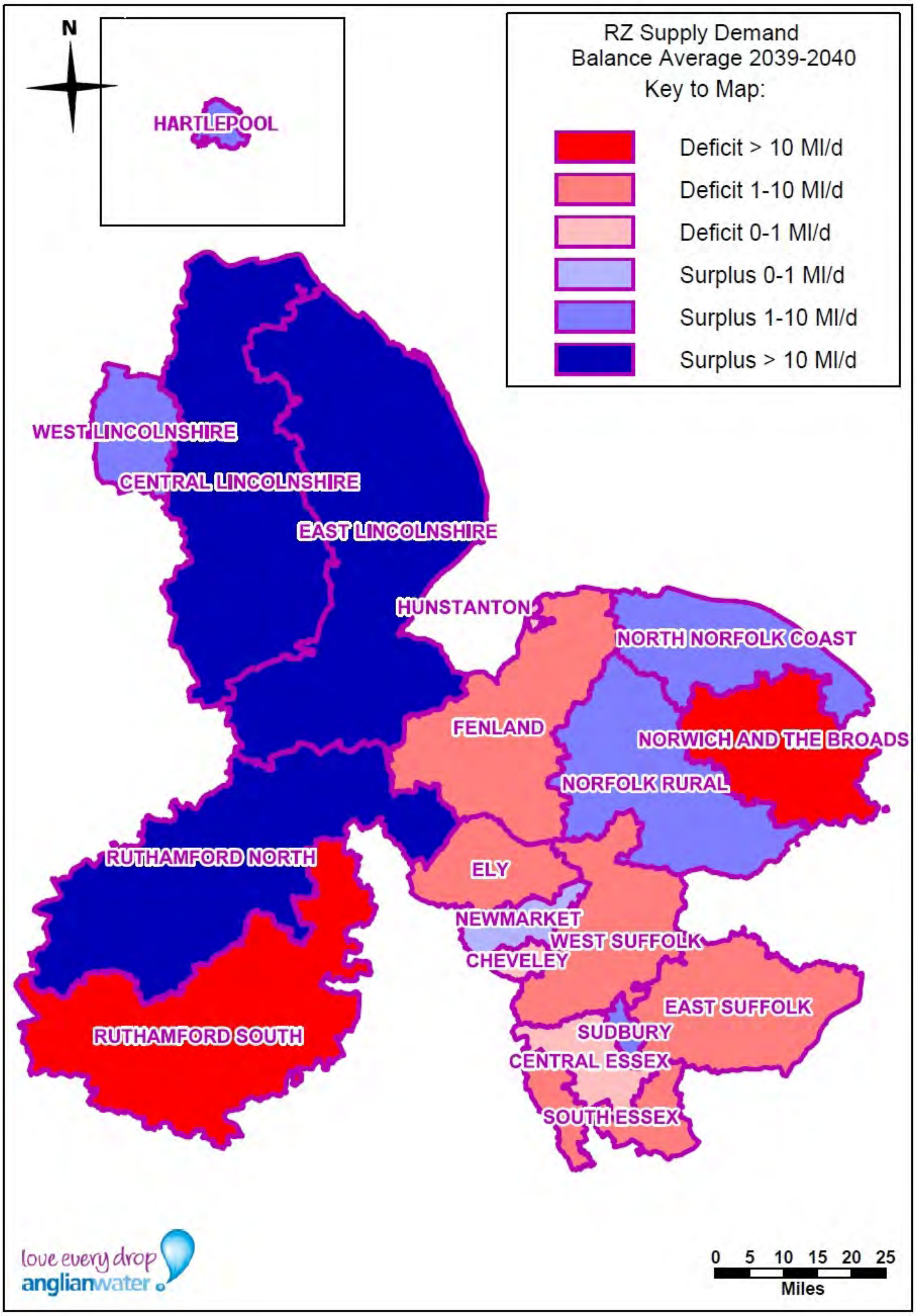
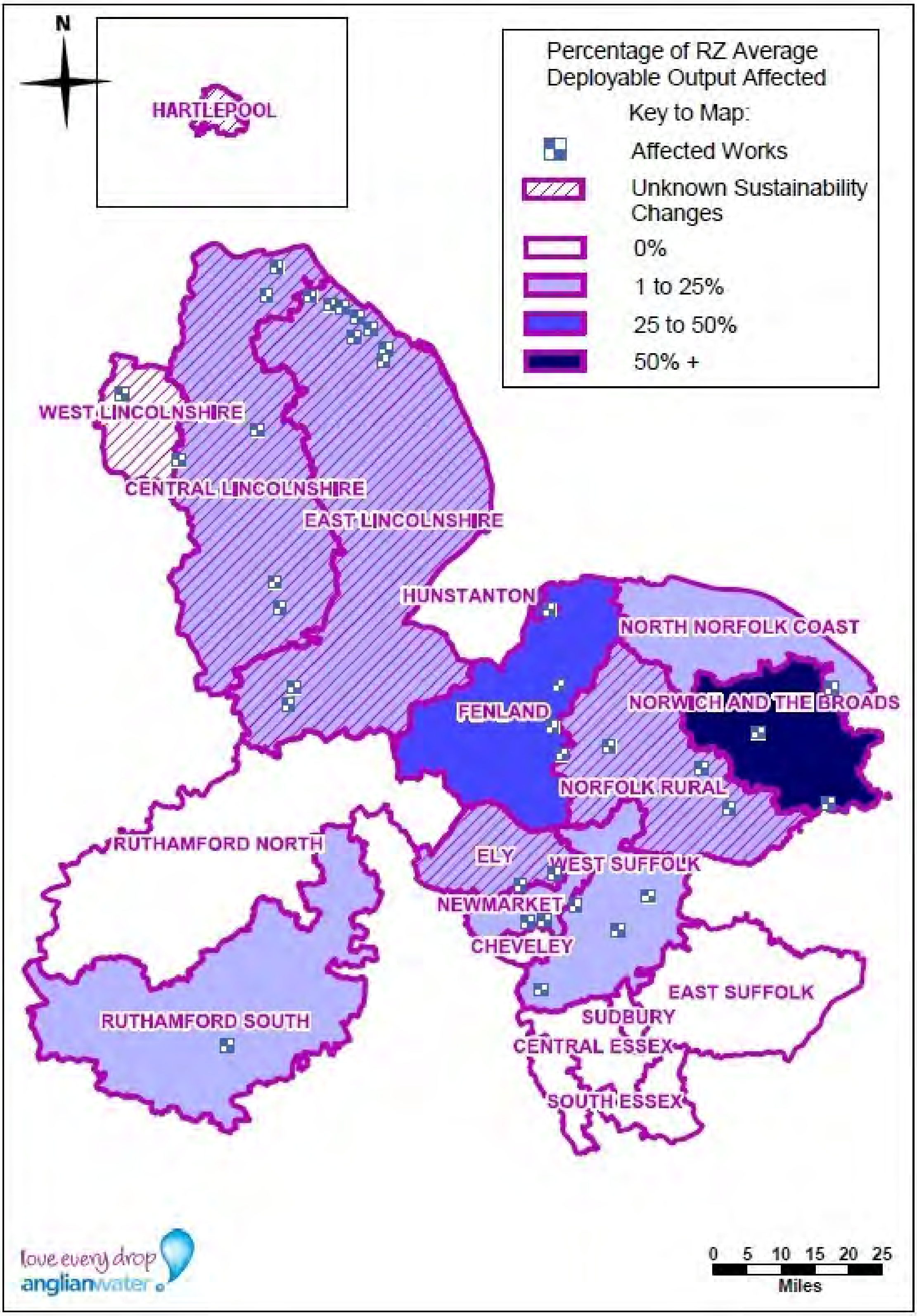


Baseline Average supply-demand balance 2039-40



Impact of confirmed, likely and unknown SR's (% average daily source works output)

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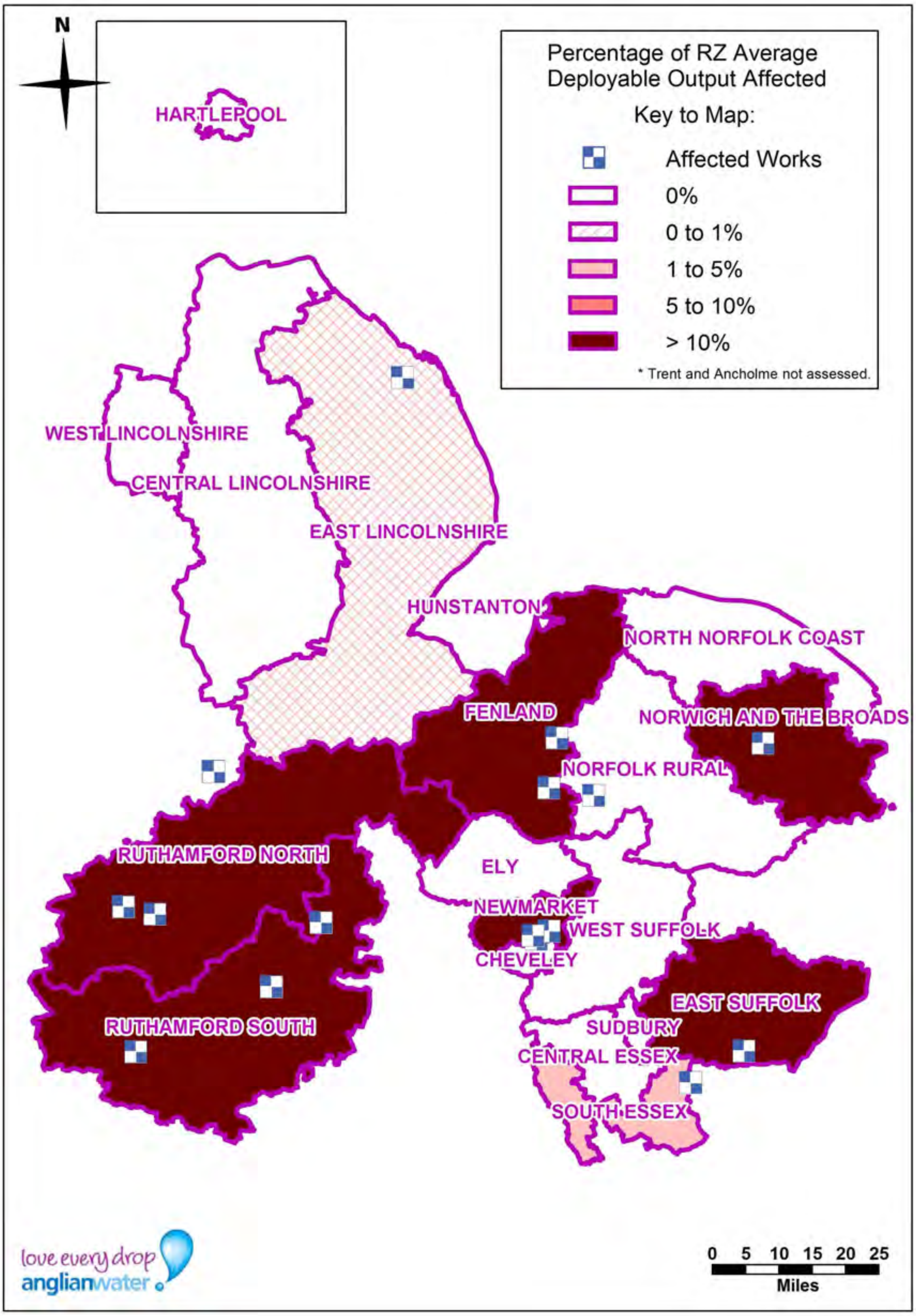

Worst case climate change impact excluding demand effects (as a % of daily sourceworks output)

Our supply-demand balance is also affected by deteriorating raw water quality. Diffuse pollution is most commonly associated with the fertilisers and pesticides that are used in agriculture. These leach into water percolating through the ground and are transported to our groundwater and surface water sources. The vulnerable nature of the groundwater systems in East Anglia mean that we are similarly at risk from point source pollution. To secure the supplies that we need, we invest to maintain full compliance with drinking water quality standards. The related schemes are delivered via a separate Water Quality program and recently, this has been extended to include measures to control water quality risks "at source" in our groundwater and surface water catchments.

Hartlepool Water

We forecast a surplus in our Hartlepool RZ to 2039-40, with no significant risks from growth, climate change or sustainability reductions. A threat to the quality of the water abstracted from our groundwater sources is being monitored and if required, will drive investment to maintain compliance with drinking water standards.

Our 25-year plan to maintain the supply demand balance

We have used the following approach to determine the investment needs for our plan:

- We consulted with customers about issues related to supply-demand risk, levels of service and the options that we should use to maintain the supply-demand balance. This included completing an extensive willingness to pay survey that showed:
    - Customers recognise that the Anglian region is vulnerable to the effects of population growth and climate change
    - Despite this, they do not expect to experience severe restrictions on supplies and are willing to pay to avoid these
    - They think that we should be planning ahead, taking action now to build resilience and avoid storing up problems for the future, and
    - That leakage reduction and measures to reduce consumption are activities that customers expect us to do to maintain the balance between supply and demand
- From this, we have based our plan on the delivery of a series of cost-beneficial demand management schemes. These include reducing leakage from our Ofwat AMP5 target of 211Ml/d to 172Ml/d by 2020; installing 85,000 smart household meters and completing 180,000 water efficiency audits, with free fitting of water saving devices, and
- For resource zones that remain in deficit, we have used the most cost-effective options for maintaining the supply-demand balance. These were selected from a large number of feasible resource development, transfer and water trading options. To fully appraise these, social and environmental costs were included in our analysis. In AMP6, this results in the delivery of the following:
    - For a deficit in the Norwich and the Broads RZ that results from a sustainability reduction at our intake on the River Wensum, we are relocating the intake, and
    - For a deficit in our Hunstanton RZ that results from a sustainability reduction in the North Norfolk Chalk, we will transfer resources from the adjacent RZ.

Since we consulted on the draft version of this plan, we have completed detailed work that shows that each of these schemes comply with the requirements of the Habitats Regulations and the Water Framework Directive.

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To enhance levels of service in the Ruthamford supply system, we will also start work in AMP6 on the detailed design for a raw water transfer from the River Trent. This drought resilience scheme is needed to remove the threat of rota-cuts and standpipes from customers who are supplied from a small number of large reservoirs that are vulnerable to the effect of three successive dry winters. Subject to feasibility and affordability, the scheme will be delivered in AMP7.

The extension of our least-cost program to include cost-beneficial leakage, metering and water efficiency measures allows us to support the following elements of our overall supply-demand strategy:

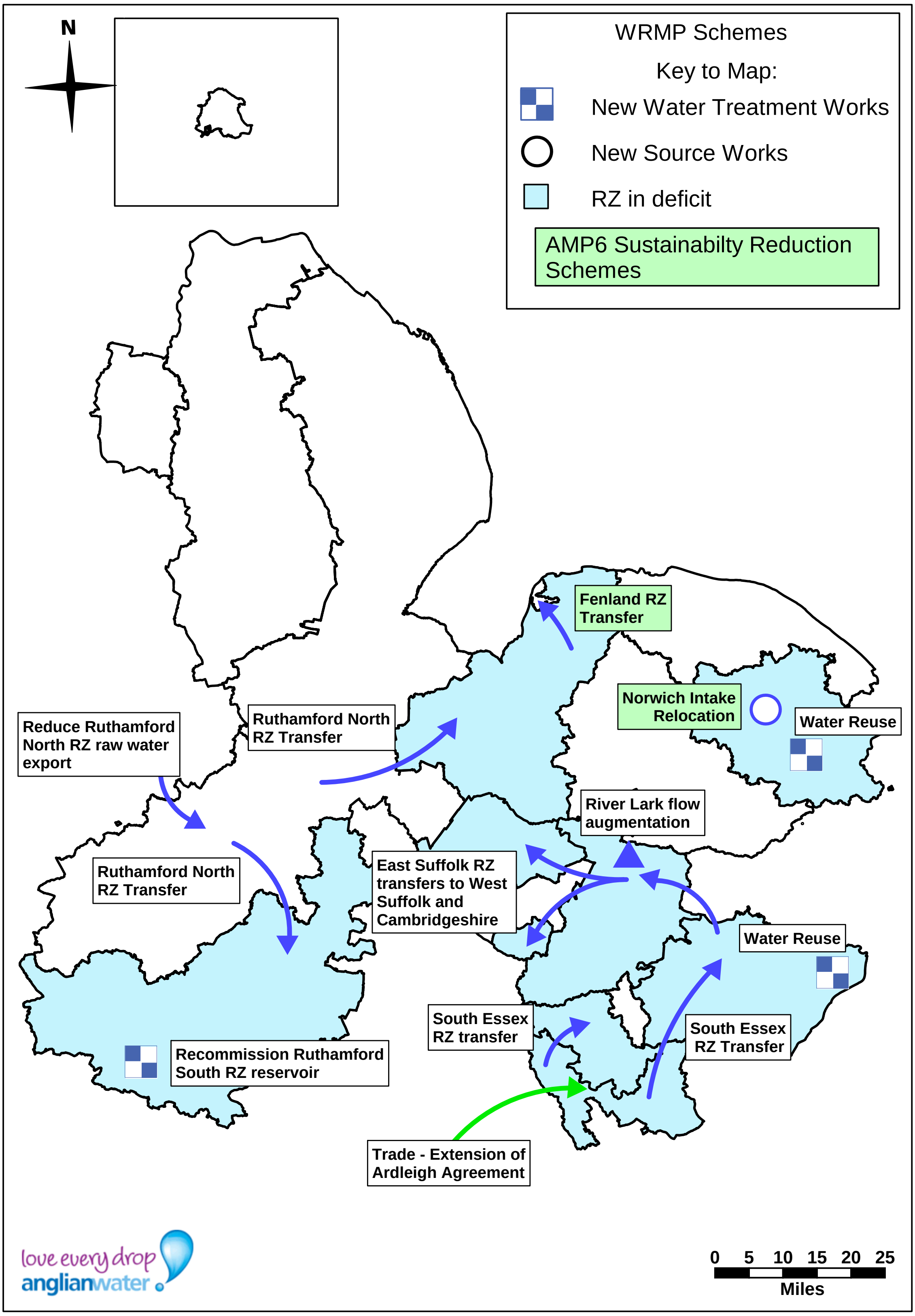
- Our target for achieving full meter penetration during the forecast period, without resorting to compulsory metering
- Our strategy for mitigating the risk of drought. Customers who are billed on the basis of measured supplies generally use less water than unmeasured customers. Large reductions in leakage also increase our resilience to the effects of drought, and
- Our "Love Every Drop" goal to increase customer awareness about the value of water in our region.

With the exception of our Norfolk RZs, all of our RZs have already been targeted for enhanced metering. Delivering an AMP6 (2015-20) programme in these remaining areas means that the benefits of the program can be extended to all of our customers. This includes giving them the opportunity to reduce bills where this is possible by switching from unmeasured to measured supplies.

Since we are in an area of severe water stress, we have also assessed the costs and benefits of compulsory metering. The results show that compared to our preferred metering strategy, compulsory metering is less cost-beneficial. Our preferred metering strategy is based on enhanced metering, meter options and a small number of selective (complusory) meter installations. In total, we will install over 160,000 meters in AMP6.

Details of the full 25 year plan (excluding the WREA RDM project) are given below. Key features include:

- Demand management in all RZs, including leakage control, water efficiency and metering
- A river augmentation scheme
- The transfer of resources from areas of surplus to areas of deficit
- The selection of a trading option, and
- The deferral of resource development options to the end of the forecast period. The options selected include water reuse schemes and the recommissioning of a reservoir.



25-year Supply-Demand Strategy (Supply side schemes only)

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Resource Zone	Scheme	Delivery
Central Essex	South Essex RZ transfer	AMP8
Cheveley	Newmarket RZ transfer	AMP8
East Suffolk	South Essex RZ transfer	AMP8
	Ipswich water reuse	AMP9
Ely	Newmarket RZ transfer	AMP7
Fenland	Ruthamford North RZ transfer	AMP7
Hunstanton	Fenland RZ transfer	AMP6
Newmarket[(1)]	West Suffolk RZ transfer	AMP7
Norwich and the Broads	Norwich intake to existing bankside storage	AMP6
	Norwich reuse	AMP8
Ruthamford North	Reduction of Ruthamford North raw water export	AMP10
Ruthamford South	Ruthamford North transfer	AMP8
	Foxcote	AMP10
South Essex	Amendment to Ardleigh Agreement	AMP9
West Suffolk	East Suffolk RZ Resilience Transfer	AMP7
	River Augmentation Scheme	AMP7

Summary of schemes

1. Newmarket is not the recipient of any additional resource; the transfer scheme includes transferring water from West Suffolk via Newmarket into Ely and Cheveley

Overall, our plan will increase emissions of greenhouse gases by 37,000 tonnes of CO_2e by 2039-40. However, thanks to the effect of our baseline water efficiency savings and our AMP6 demand management programme, this is around 65,000 tonnes CO_2e less than would otherwise be expected.

Water trading and collaborative water resource planning

The trades in our plan include:

- Cambridge Water: a trade in our West Suffolk RZ to support an existing supply-demand scheme for Bury St Edmunds, and
- Affinity Water: a trade based on sharing the resources of Ardleigh reservoir. There are two elements to this – an existing trade which increases our take of the deployable output from 50/50 to 70/30 and a future trade which would extend this to 80/20.

We are also working with Severn Trent Water to develop an option to trade the resources we currently share from Rutland Water. Whilst feasible in theory, more work is needed to understand the engineering required in the Severn Trent system to support the trade.

From our work on trading, it is clear that our ability to make trades could be constrained by the sustainability reductions that need to be made. In addition to confirmed and likely reductions, we are at significant risk from unknown reductions and from reductions to comply with Water Framework Directive no-deterioration requirements. These could affect trades that increase abstraction from previously under-utilised sources.

As well as our work with other water companies, we are also working on other projects that are likely to increase water trading. These include:

- A pilot trading related project with the Cambridge Institute for Sustainability Leadership (CISL). This was based on the catchment of the River Ouse
- Water Resources East Anglia project, and
- A project in the Wissey catchment to determine how to optimise use of the available resources, including how to mitigate drought risk.

AMP6 Water Resources East Anglia project

To mitigate long-term supply-demand risk from climate change, population growth and the reductions in deployable output that we need to make to restore abstraction to sustainable levels, we are promoting the AMP6 Water Resources East Anglia (WREA) project. This multi-company, multi-sector planning initiative will develop a robust long-term water resources strategy for the Anglian region, which will increase the resilience of our supply-systems.

Specific activities that will be undertaken include:

- Groundwater and surface water investigations: these are needed to determine the longer term impacts of climate change and the feasibility of water resource development and management schemes
- Engineering appraisals: once our investment needs for each scenario have been confirmed, we will need to develop schemes for maintaining the supply-demand balance, and
- Model development: to complete the testing and evaluation of future supply-demand strategies, further model development will be required.

The WREA project will be based on an approach to planning known as Robust Decision Making or RDM. RDM seeks plans which perform well in many different plausible future scenarios, rather than optimally in a few. These plans are typically flexible and adaptive and are developed through trade-offs between multiple success criteria. Recently a large RDM water resource study has been completed in the western US, looking at supply-demand management strategies for the Colorado Basin.

Summary

Over the 25-year period between 2015 and 2040, our supply-demand balance will be adversely affected by a combination of growth, climate change and the reductions in deployable output that we will need to make to restore abstraction to sustainable levels. In total, we forecast that the dry year annual average supply-demand balance will reduce by 249 Ml/d. In response, we will need to relocate some of our sources, transfer resources from areas of surplus to areas of deficit, increase the volume of water we trade and reduce levels of leakage and consumption. Towards the end of the forecast period, we will also have to develop new resources.

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In AMP6, we will deliver the following combination of cost-beneficial demand management measures and cost-effective supply-side schemes:

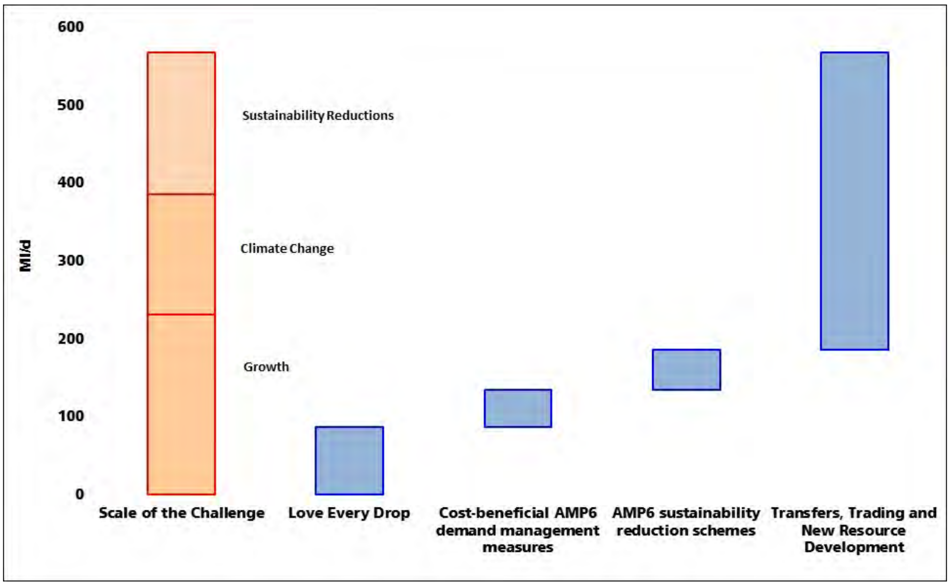
- A reduction in leakage from our current 2014-15 SELL of 211 Ml/d to 172Ml/d
- The installation of 85,000 household meters, with switching on demand or change of occupancy. This is in additional to 76,000 meter optants and around 1,500 selective (compulsory) meter installations
- Completion of 180,000 water efficiency audits with free fitting of water saving devices
- We will relocate one of our intakes on the River Wensum, restoring favourable hydro-ecological conditions in the river, and
- We will transfer additional resources into our Hunstanton RZ, restoring sustainable abstraction to the North Norfolk Chalk.

In addition, we will start detailed planning for the delivery of a scheme that will remove the threat of rota-cuts and standpipes for customers in the Ruthamford system. Subject to feasibility and affordability, the rest of this scheme will be delivered in AMP7.

In developing our plan, we have had to take account of uncertainty in the current assessments of climate change, growth in demand and sustainability reductions. In the worst case combination, these may reduce our supply-demand balance by 567Ml/d. This assessment excludes Hartlepool Water, where supply-demand risks are much lower.

Taking this into account our overall plan for maintaining the supply-demand balance can be summarised as follows (see figure also):

- Around 15% of our current and future supply-demand challenge will be managed through baseline water efficiency and leakage reduction savings (“Love Every Drop”)
- Around 17% will be managed using the cost-beneficial demand management measures and cost-effective schemes that we are planning to deliver in AMP6, and
- For the remaining 67% of the challenge, we will need to plan for the delivery of additional resources, transfers, trading as well as possible further reductions in consumption and leakage. This work will be planned, in large part, through our AMP6 Water Resources East Anglia project.



AMP6 Strategy

Overall, this plan will deliver a flexible and adaptive water resource management strategy for the region, which increases resilience to the effects of drought, climate change and growth. The approach we have used is affordable and sustainable, and balances the future needs of water abstractors, customers and the environment.

1 Introduction

Key Points

- This is our 2015 Water Resource Management Plan
- The plan has been produced in accordance with the requirements of the Water Resource Planning guideline. It is a technical summary of the related work and it is intended to present key messages, show how we have complied with the guidelines and aid interpretation of the planning tables which accompany the plan
- To help customers and other non-technical stakeholders, we have published a non-technical summary of the plan
- For regulators and other technical stakeholders, detailed technical reports are also available. These include a Strategic Environmental Assessment and Habitats Regulation Assessment, which has also been published for public consultation.

1.1 Purpose of the plan

1.1.1 This is our 2015 Water Resource Management Plan (WRMP or 'plan'). It describes how we will manage the balance between water supply and demand over the 25 year period from 2015 to 2040. This includes:

- Using cost-effective demand management, transfer, trading and resource development schemes to meet growth in demand from new development and to restore abstraction to sustainable levels ('sustainability reductions'), and
- In the medium to long term, ensuring that sufficient water continues to be available for growth and that our supply systems are flexible enough to adapt to climate change.

1.1.2 In preparing our plan, we have been guided by the policy objectives of the Government. In the face of challenges from population increase, climate change and sustainability reductions, the Government aim to support growth and protect the environment. The plan we have produced is consistent with these objectives. It delivers a reliable, sustainable and affordable supply system which meets the current and future needs of customers and the environment.

1.1.3 The plan has been subject to a formal consultation process. This has allowed interested stakeholders and customers to review our proposals and comment upon them. It is accompanied by a Strategic Environmental Assessment (SEA) and a Habitats Regulations Assessment; both were subject to statutory consultation.

1.1.4 Given the challenges we face, we have consulted on a number of key supply-demand issues:

- Should we invest to improve levels of service for a large group of customers who currently have levels of service lower than most of our other customers?
- By how much more should we reduce leakage?
- Should we promote metering and water efficiency across the whole of our region, instead of only in those areas where we forecast supply-demand deficits?
- What is the best approach to restoring sustainable levels of abstraction?

1.1.5 The results of the consultation have been incorporated in this plan, which is a summary technical document designed to:

- Present the key consultation issues; the responses that we have had and the way that these have influenced the development of the plan
- Demonstrate compliance with the WRP guideline, and
- Inform use of the planning tables that accompany the plan.

1.1.6 For interested customers and other non-technical stakeholders, we have also produced an updated non-technical summary of the plan. For planning professionals, the Environment Agency (EA), Ofwat and Defra, detailed technical reports are available. A summary of the documentation available with this plan is given in the Appendices.

1.2 Structure of the plan

1.2.1 This plan has been structured on the basis of the following:

Plan Section	Content
Section 2	The current legislative and policy framework for water resource planning. Includes a summary of the approach we have used in developing this plan
Section 3	Our baseline supply-demand forecast, including an assessment of the sensitivity of our baseline forecast to various planning scenarios
Section 4	A summary of the feasible options for maintaining the supply-demand balance
Section 5	Customer views on options for maintaining the supply-demand balance
Section 6	A summary of our preferred plan, including how the preferred plan delivers key Government objectives such as increasing connectivity and significantly reducing levels of consumption
Section 7	Testing of the preferred plan
Section 8	Details of the strategic water resource planning project we have set up with other companies and the EA in the region, to help us make long-term plans for dealing with the challenges of climate change, growth and sustainability reductions
Section 9	WRMP Summary
Section 10-29	Details of the baseline supply-demand balance and preferred plan for each of our new resource zones. There are now 19 of these, an increase of 7 from our 2010 WRMP, reflecting application of the new resource zone (RZ) integrity guidelines
Appendix 1	WRP tables
Appendix 2	Improvements that we have made to our planning process since the last WRMP we published. These were detailed in our Defra Improvement Plan
Appendix 3	The technical approaches we used to prepare our plan
Appendix 4	A summary of the work we have completed to identify and appraise options for water trading

Table 1.1 Structure and content of the 2015 WRMP

1.2.2 The appendices contain the water resource planning tables and a list of technical reports and other documents that are available in support of this summary.

1.2.3 For more information on the plan please contact:

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2 Legislative and Policy Framework

Key Points

- We have a statutory duty to supply water and to publish a 25 year Water Resource Management Plan showing how we will do this
- Government policy for the water sector is to support growth and protect the environment. The Government recognise that our ability to maintain the balance between supply and demand will be challenged by a combination of climate change, population increase and sustainability reductions
- To deliver policy objectives, the Government expects us to take a long-term view, take more account of the value of water, increase connectivity and water trading, reduce levels of consumption and reflect the views of our customers
- To meet these requirements we plan to use a twin-track approach to water resource planning. Our supply-demand needs over the next 25 years have been evaluated using existing, approved methodologies. To evaluate our needs in the longer term we are using an innovative regional scale, multi-company, multi-sector approach – the Water Resources East Anglia (WREA) project.

2.1 Overview

2.1.1 The general duties of water undertakers are defined in Section 37 of the Water Industry Act 1991 and include:

- To develop and maintain an efficient and economical system of water supply
- To provide supplies of water to premises and make such supplies available to persons who demand them, and
- To maintain, improve and extend water mains and other pipes.

2.1.2 Each water undertaker is also responsible for ensuring that their water resources are adequate to meet the present and future demands of their customers. To confirm this, each company publishes a 25 year WRMP.

2.1.3 The requirement for a WRMP is set out in sections 37A to 37D of the Water Industry Act 1991 (as amended by Section 62 of the Water Act of 2003). Further detail is specified in the Water Resources Management Plan Regulations 2007 and the Water Resource Management Plan Direction 2012. The purpose of the WRMP is to:

- Look 25 years ahead and show how water companies will meet future projections of demand, and
- Secure a long-term sustainable supply-demand balance for the supply of water.

2.1.4 This WRMP is accompanied by a Strategic Environmental Assessment (SEA) and a Habitats Regulation Assessment (HRA). The requirement for a SEA is specified in The Environmental Assessment of Plans and Programmes Regulations (2004. The preparation of seasonal HRAs is subject to guidance recently issued by UKWIR ("Strategic Environmental Assessment and Habitats Regulations Assessment - Guidance for Water Resource Management Plans and Drought Plans" UKWIR 2012, Ref: 12/WR/02/7).

2.2 Water for life

2.2.1 Government policy for the water sector is described in the water white paper "Water for Life". This was published in December 2011.

2.2.2 Water for Life makes clear that the goal of the water industry is to deliver a reliable, affordable and sustainable system of supply, which is resilient to the possible future effects of climate change and population growth. The outcomes that are desired include:

- High quality drinking water
- Secure supplies to households and business
- Effective removal of wastewater, and a
- Flourishing water environment.

2.2.3 Water for Life records evidence from the EA that water resources in parts of the UK are already under pressure and that all modelled future scenarios predict less water available for people, business and the environment. Overall, the future balance between supply and demand will be severely tested and to achieve Government targets of supporting growth and protecting the environment it will be necessary to:

- Prepare for change
- Make the water sector more sustainable, and
- Maintain affordability.

2.3 Water resource planning guideline

2.3.1 An updated Water Resource Planning (WRP) guideline was published jointly by the EA, Ofwat, Defra and the Welsh Government in June 2012. This was in three parts: a set of guiding principles, the main technical guidelines and a set of guidelines for completing the planning tables that accompany each plan. Key messages from the guiding principles include:

- WRMPs should ensure the efficient and sustainable use of water resources, delivering the outcomes that customers want while reflecting the value that society places on the environment
- The WRP process works alongside the process for setting water company price limits (business plan submission), and
- Customers and other stakeholders must be engaged in water company processes for preparing WRMPs and business plans.

2.3.2 The guiding principles confirm that the key policy priorities of Government are about providing sustainable, secure and affordable supplies to customers. In terms of water resource planning, this includes:

- Taking a long-term perspective, beyond the 25 year planning horizon, to make supply systems more resilient to future uncertainties. This includes assessing vulnerability to the possible future effects of climate change and population growth, and developing efficient and sustainable plans that meet the needs of customers and the environment
- Taking better account of the value of water by reflecting its scarcity and the environmental and social costs of abstraction
- Considering all options for maintaining the supply-demand balance, including water trading, cross boundary solutions and supplies from third parties

- Reducing the demand for water by managing leakage and providing services that help customers use water more efficiently. This includes achieving a significantly downward trend in demand where:
    - The water company is in a water stressed area
    - Demand is higher than the national average of 147 l/person/day, or
    - An increase in population or industrial demand leads to an increase in total demand.
- To achieve the required reductions in consumption, the wider social and environmental benefits must be taken into account when assessing demand management options. In water stressed areas, the option for compulsory metering must also be assessed and investment to further reduce leakage must be "efficient". Leakage must not rise at any point during the planning period, and
- Ensure that the views of customers are taken into account on service levels and costs.

2.3.3 In summary, to deliver the objectives of Water for Life, the guiding principles state that Government is particularly looking to water companies to:

- Set ambitious targets for reducing water consumption
- Increase connectivity and make greater use of water trading.

2.4 Meeting policy and regulatory expectations

2.4.1 The preceding sections describe how a step change in water resource planning is required if customer and environmental needs are to be met in a future where impacts from climate change and population growth are expected but are uncertain.

2.4.2 In the WRP guidelines, a technical framework is specified within which this challenge should be met. This includes:

- Application of improved forecasting and option appraisal techniques to determine the most cost effective plan for maintaining the supply-demand balance over the next 25 years. Although improved, these techniques are based on an established framework for water supply-demand planning ("The Economics of Balancing Supply & Demand (EBSD) Guidelines" UKWIR 2002, Ref: 02/WR/27/4 updated 2012). In this, supply-demand risk is accounted for through the use of a planning allowance, target headroom
- Amendment of the least-cost plan to take account of the social and environmental costs of water abstraction and use
- Evaluation of the sensitivity of the resulting plan to alternative supply-demand scenarios. These are based on possible levels of service, climate change and sustainability reduction effects, and
- From the above, the selection and justification of a preferred plan.

2.4.3 This approach may be referred to as a modified EBSD approach; it is based on the approach that we used to develop our 2010 WRMP.

2.4.4 The modified EBSD approach is an efficient and well-understood method which is best suited for situations in which (a) levels of uncertainty and risk are well-understood, and (b) where a water company is acting to meet clearly defined needs in the most cost-effective manner. We think that this applies to the short to medium term elements of our plan, where we have a few large deficits and the associated uncertainties are well described by target headroom. For this reason, the main part of our 2015 WRMP is based on the modified EBSD approach.

2.4.5 However, Government policy and the WRP planning guideline also challenge us to develop robust plans for mitigating longer term supply-demand risk. Related to this, we are expected to work more effectively with neighbouring water companies and other third parties and to transition from an output based incentive system to one which is based on outcomes. The longer term policy and technical requirements are thus for a broader decision making and cost-benefit process, in which multi-company and multi-sector needs are evaluated in the context of deep uncertainty. In practical terms, where future-proofing our supply system could involve building one or more winter storage reservoirs, this means avoiding:

- Building assets that are under-utilised, if the perceived threats do not materialise
- Stranded assets, as planning priorities or strategies change in response to the emergence of new data, and
- Severe reductions in levels of service or significant environmental damage, as investment in extra supply capacity is delayed so that evidence on risk or the performance of demand management activities can be collected and then evaluated.

2.4.6 To avoid these risks and to meet our longer-term requirements, we are piloting an innovative, strategic water resource planning project – the Water Resources East Anglia (WREA) project.

2.4.7 The WREA is based on an emerging scenario based approach to water resource planning, robust decision making (RDM). Output from an RDM project enables decision-makers to make well informed trade-offs between different economic, social and environmental objectives. This leads to the development of plans that typically:

- Perform robustly over a wide variety of possible scenarios, rather than optimally in a few
- Are flexible and adaptive
- Minimise regret from under utilised or stranded assets, or from the late delivery of assets, and
- Are better aligned to the outcomes that customers and other stakeholders desire.

2.4.8 An approach based on RDM has recently been used by the US Bureau of Reclamation to complete a large planning study on the Colorado Basin. Water resources in the basin are subject to intense pressure from development, drought and climate change and to maintain the balance between supply and demand significant investment is likely to be required. RDM was used in the study to test the different investment strategies.

2.4.9 The current WREA project is a collaborative planning effort between water companies in the Anglian region and the EA. The project is in the early stages of development and a significant extension is planned for AMP6.

2.4.10 In summary:

- The main part of our plan deals with a few large deficits in the short to medium term and evaluates how our preferred solutions perform in a relatively small number of levels of service, climate change and sustainability reduction scenarios. This plan is based on the modified EBSD approach and is restricted to the next 25 years, and

- In AMP6, we will progress development of the WREA project. The AMP6 WREA project will be a collaborative effort with other water companies in the region, other abstractors, the EA, Natural England and other stakeholders. It will deal with long-term, regional scale strategic water resource issues.

3 Baseline Supply Demand Balance

Key Points

- We forecast AMP6 deficits in the Hunstanton and Norwich and the Broads RZs, both of which result from sustainability reductions under the Habitats Review of Consents
- A combination of growth, confirmed and likely sustainability reductions and the mean impact of climate change are projected to result in numerous other deficits in RZs in the south and east of our system by 2039-40
- In the worst case combination, we are exposed to 567Ml/d of supply-demand risk over the period to 2039-40. This is approximately 50% of the water we put into supply on an average day and arises from:
    - Growth in demand and target headroom requirements (231Ml/d)
    - Worst case climate change impacts (154Ml/d), and
    - Confirmed, likely or unknown sustainability reductions (182Ml/d).

3.1 Overview

3.1.1 We supply treated water to approximately 2 million households in East Anglia, the adjacent parts of the East Midlands, the South East, Yorkshire and Humberside and Hartlepool. In 2012/13, the volume of water we put into distribution averaged 1,098Ml/d or 1,098,000,000 litres/day.

3.1.2 Recent trends in distribution input (DI) are given in the figure below.

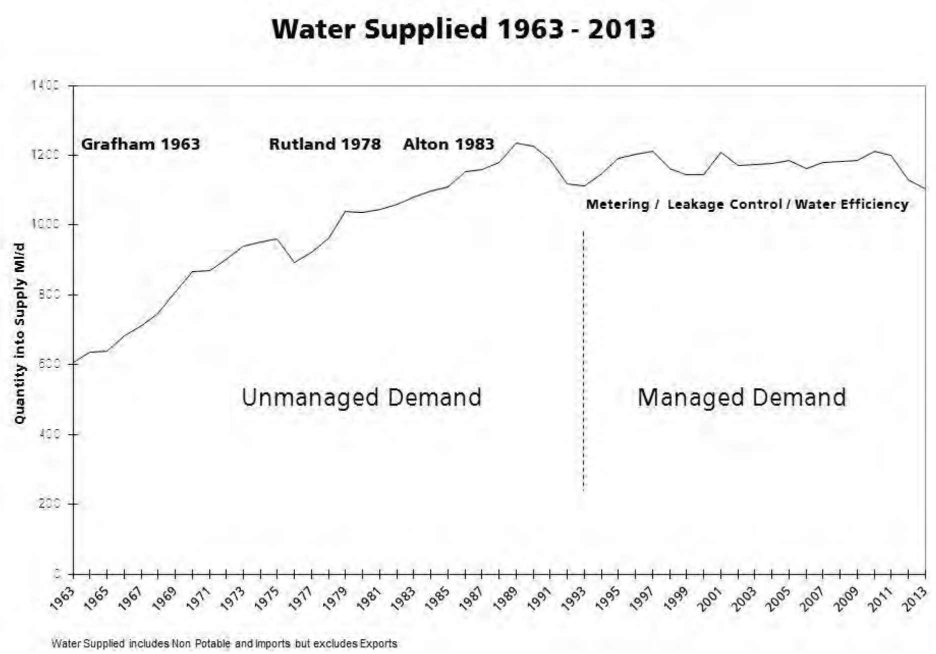


Figure 3.1 Water supplied graph 1963 - 2013

3.1.3 Figure 3.1 shows growth in demand which stabilises after the industry was privatised. This has occurred despite a 20% increase in the number of households we serve since 1989 and reflects:

- A long-term reduction in the volume of leakage. The amount of water that leaks from our distribution system and from customer supply-pipes is currently less than 200Ml/d. This compares to leakage of nearly 300Ml/d before privatisation
- A progressive increase in the proportion of our customers who are metered and the effect that this has had on reducing levels of consumption. Over 70% of our household customers are billed on the basis of measured supplies. Almost all of our non-household customers are measured, and
- A reduction in the amount of water that we supply to heavy industry. As the volume of manufacturing in our region has reduced and the remaining companies have become more efficient, so the demand for water from this sector has declined.

3.1.4 Monthly distribution input for the period 2005-2013 is given below.

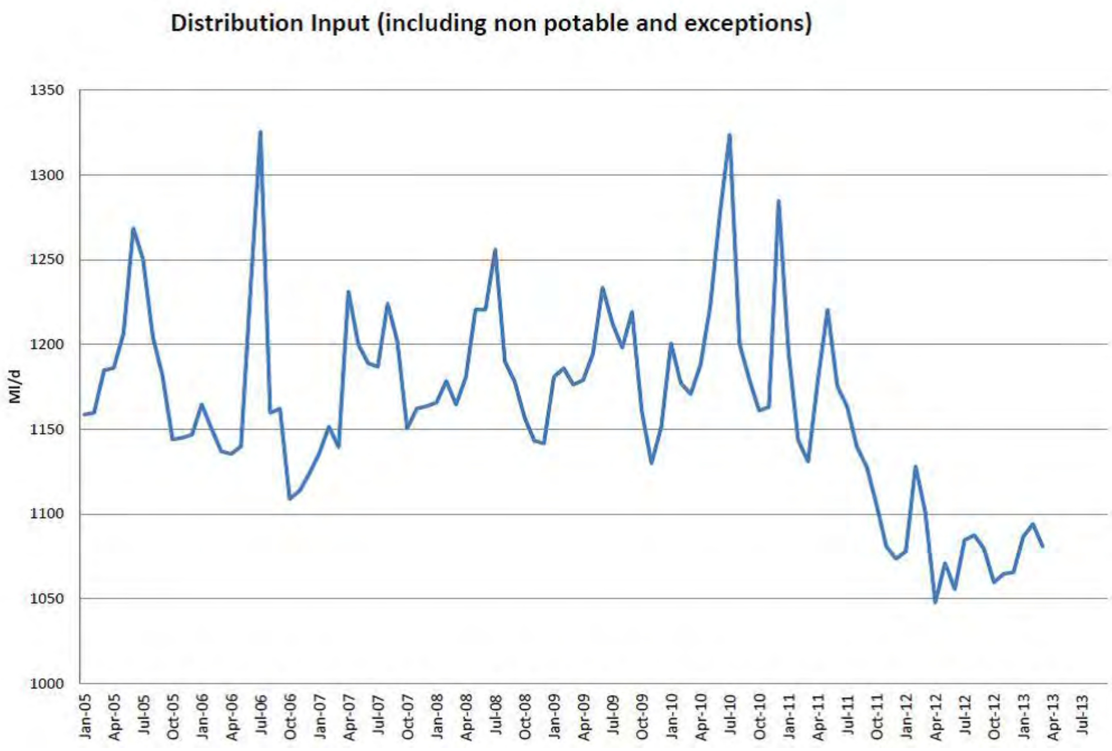


Figure 3.2 Monthly DI at regional level

3.1.5 Distribution input in our region peaks in the summer and occasionally, in the winter. The summer peaks reflect increased use by our household customers during extended periods of hot, dry weather; the winter peaks reflect increased leakage resulting from burst mains and pipes. This effect was particularly severe during the period 2010-11 and as a consequence, we include weather related leakage effects in our target headroom allowances. Overall, peaking effects have become less significant since 1985. Most likely this reflects our progressively high rates of meter penetration and the moderating effect that this has on demand.

3.1.6 The Anglian region is the driest in the UK, with average annual rainfall approximately 71% of the long-term average for England. The region also contains a significant number of internationally important wetland sites and other water dependent habitats. These include Rutland Water, the River Wensum, the River Nar and the Norfolk and Suffolk Broads. Protecting these important natural resources from the effects of population growth and climate change is a key objective of this plan.

3.1.7 Owing to the large number of customers we serve and the vulnerability of our natural resources, we are designated an area of serious water stress.

3.2 Our recent achievements

3.2.1 Following £100m of investment to increase supplies in our Ruthamford RZ by 90 Ml/d, our Security of Supply Index (SoSI) is 100 for dry year annual average and critical period (peak) demand conditions. This means that we have no deficits against target headroom in any of our 2012/13 RZs and that levels of service are being maintained.

3.2.2 Other supply-demand investments that we have recently made or are in the process of making include:

- Several new sources of supply. These are currently being developed to meet growth in industrial demand and to meet demand from new housing developments and include:
    - A new 20Ml/d surface water treatment works in the Central Lincolnshire RZ
    - A 15Ml/d extension to a non-potable water treatment works, also in the Central Lincolnshire RZ
- Increasing connectivity. New transfers are being built so that we can deploy our existing resources in areas where demand is expected to grow but there are no local resources available to develop. We are also increasing connectivity in areas where we need to improve the resilience of our supply systems, and
- Demand management. This includes reducing leakage to below our SELL, increasing the level of metering and delivering a large water efficiency programme.

3.2.3 In total, over 125Ml/d of supply-side capacity will be delivered by these schemes. The equivalent volume of additional transfer capacity will be 141Ml/d. These investments increase the volume of water that we have available to support growth, increase flexibility and resilience in our supply system and ensure that we can make more efficient use of our available resources.

3.3 Minimising the environmental impact of abstractions

3.3.1 Overview

3.3.1.1 We continue to work closely with the EA and Natural England to ensure that our existing abstractions do not have a detrimental impact on the environment.

3.3.1.2 Since privatisation and as a result of the outcome of extensive environmental assessments, Anglian Water has made significant investment to help understand and minimise the impacts of our abstractions. As a result, we have reduced output from, relocated or closed a number of our abstraction sources. Recent examples include:

- Closure and relocation of Strumpshaw groundwater source

- Closure and relocation of East Ruston groundwater source, and
- Planned part closure and relocation of Sheringham groundwater source.

3.3.1.3 We have also completed a wide range of environmental mitigation measures, the most notable of which was the creation during the AMP4 investment period of the 30 hectare wildlife lagoons at Rutland Water.

3.3.1.4 We currently operate 15 river support schemes, of which 12 are directly associated with one of our abstraction licences (see Figure 3.3). The river support schemes comprise boreholes that are pumped to enhance flows and river ecology at times of environmental stress, or as advised by the EA.

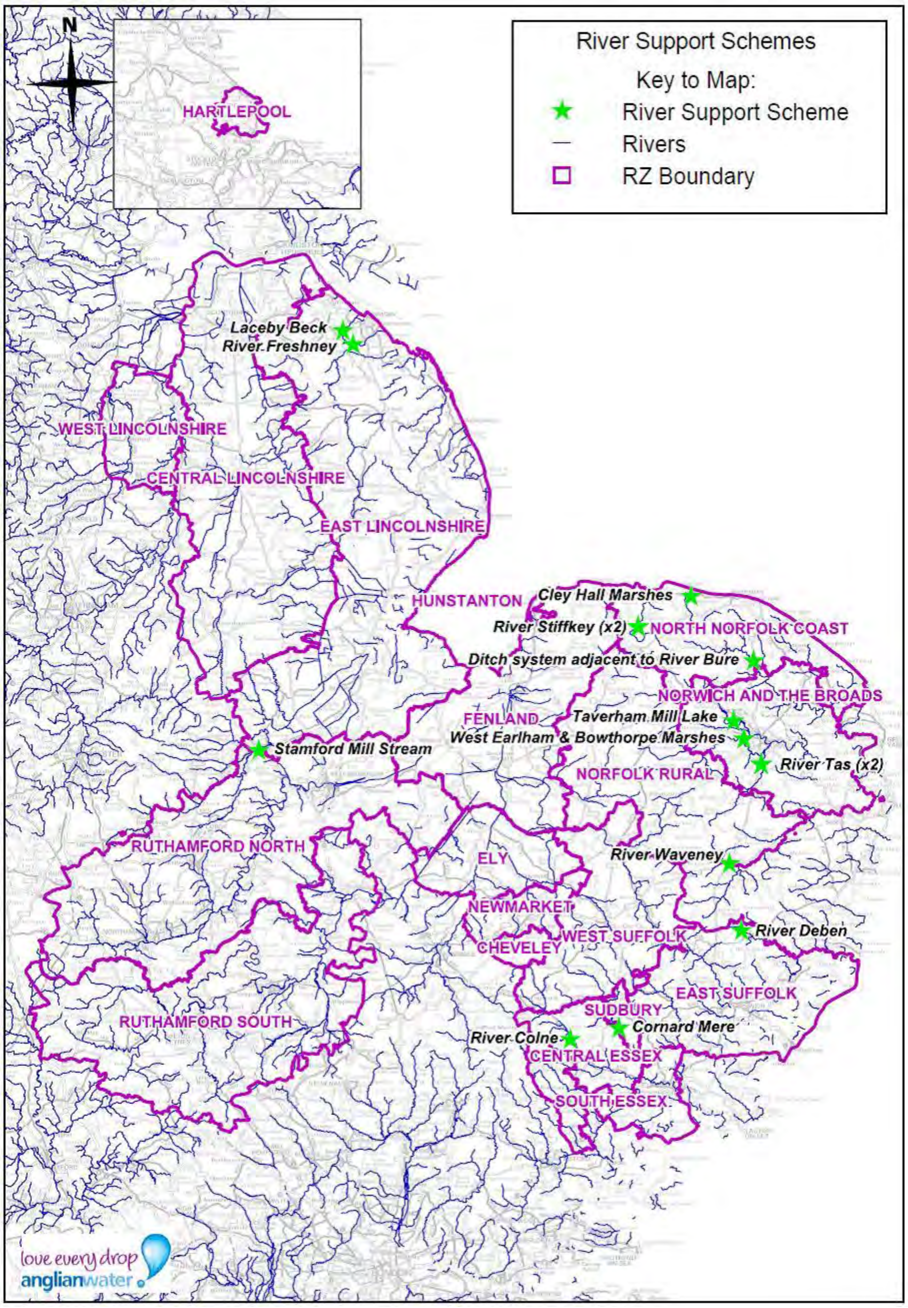


Figure 3.3 Anglian Water operated river support schemes

3.3.1.5 In addition to these existing mitigation measures, a significant proportion of our abstraction licences include conditions requiring us to monitor environmental impact which we report on annually. If the results of this monitoring indicate any deterioration, then we remain committed to addressing the issue.

3.3.1.6 During the AMP5 period we carried out a number of hydrological investigations and options appraisals to support the Water Framework Directive (WFD) objective that all watercourses will achieve ‘good’ chemical and ecological status by 2027. The AMP5 Water Resources National Environment Programme (NEP) is defined in Table 3.1.

Site	Scope
Skitter Beck/East Halton Beck	Hydrological impact assessment & options appraisal
Laceby Beck	Hydrological impact assessment & options appraisal
Far Ings Drain	Hydrological impact assessment
Barrow Beck	Hydrological impact assessment
Millbridge Common Drain	Hydrological impact assessment
Broughton Brook	Hydrological impact assessment & options appraisal
River Lark	Options appraisal
River Stiffkey	Options appraisal
Chippenham Fen	Pilot study
Ranskill Brook	Hydrological impact assessment (with Severn Trent Water)
River Poulter	Hydrological impact assessment

Table 3.1 AMP5 Water Resources National Environment Programme (NEP)

3.3.2 Water Resources National Environment Programme (AMP6)

3.3.2.1 Within the AMP6 Water Resources NEP we have identified five sites requiring mitigation measures and 21 sites requiring an options appraisal. Details of the mitigation schemes are included in Table 3.2 and Figure 3.4.

Name	Description	Period
River Nar	River restoration & enhancement (3 km)	AMP6
Skitter Beck	River restoration & enhancement (15 km)	AMP6
Laceby Beck	River restoration & enhancement (4 km)	AMP6
Geldeston Meadows	River support scheme (borehole with iron removal or de-chlorinated mains water) – with Essex & Suffolk Water (part-funding)	AMP6
River Lark	River augmentation via new 7km pipeline	AMP7

Table 3.2 Water Resources NEP mitigation schemes

River Nar

3.3.2.2 The EA has modelled the impact of our surface water and groundwater abstraction sources against the conservation flow objectives for the River Nar. The preliminary results from this assessment have identified the requirement for a significant sustainability reduction to address impacts to the river immediately downstream from our abstraction point. Any change to our current abstraction regime in this RZ is likely to require significant investment and will be assessed further during AMP6 through the WREA.

3.3.2.3 It has been agreed with the EA and Natural England that we will implement an interim river restoration and enhancement solution for the River Nar during AMP6. We will work closely with the River Restoration Centre to develop the scope for this option.

Skitter Beck & Laceby Beck

3.3.2.4 The impacts of our Northern Chalk groundwater abstractions are the subject of ongoing modelling and investigation by the EA. Our work during AMP5 identified and appraised different options to enable the Skitter Beck and Laceby Beck watercourse achieve good status.

3.3.2.5 It has been agreed with the EA that solutions for these water bodies will be phased, whereby the most practical and cost-effective actions are implemented first.

3.3.2.6 The preferred solution for AMP6 is a programme of river restoration and enhancement, with additional or optimised river support. In addition to the EA, we will work closely with the River Restoration Centre and the Lincolnshire Chalk Rivers Project to develop the scope for this option.

3.3.2.7 We will continue to monitor flows and ecology to assess the impact of these measures and performance against the WFD objectives. This will be used to further inform the EA's modelling with the aim of defining more accurate, locally relevant and cost-effective abstraction related measures during AMP6.

Geldeston Meadows

3.3.2.8 The impact of our Kirby Cane groundwater abstraction source in combination with an Essex and Suffolk Water source was assessed during the AMP4 period and an options appraisal completed in AMP5. The preferred option is to install a pipeline to allow for river support pumping from an existing Essex and Suffolk Water groundwater source. Natural England has recently confirmed the need for iron removal treatment and so costs are now being re-assessed against the cost of supporting river flows with de-chlorinated mains water. This scheme is being delivered by Essex and Suffolk Water and we are not reporting this as a sustainability reduction.

River Lark

3.3.2.9 Following investigations during AMP3, the EA determined that our groundwater abstractions in and around Bury St Edmunds were likely to be having an impact on flow in the River Lark. In AMP5 we completed an Options Identification and Appraisal report which has enabled the EA to complete cost benefit analysis. The EA has now confirmed that we need to implement a solution and we have agreed to carry out further more detailed appraisal of the preferred options in AMP6 for delivery in AMP7.

3.3.2.10 The EA has concluded that the most cost effective solution is a river augmentation scheme which will divert water from our water recycling works upstream. If this is not feasible, then the next best option is through river support which would result in a sustainability reduction. We will also be considering alternative supply options.

Long-term strategic planning for sustainability reductions

3.3.2.11 It has been agreed with the Environment Agency and Natural England to defer the sustainability reduction schemes required for the River Nar and the River Lark from AMP6 (2015-20) to AMP7 (2020-25). Reasons for the deferral include:

- The sensitivity of our plan to uncertainty about future sustainability reductions and climate change. Different planning assumptions currently lead to large differences in the type and capacity of the options which are selected. Arising from this, there are substantial risks from the stranding of assets and aborted or otherwise inefficient investment, and
- The possibility that successful outcomes for the demand management and river restoration works will allow smaller, more cost-effective and sustainable (supply-side) options to be developed.

3.3.2.12 To mitigate the risk of environmental deterioration in the meantime, we have proposed measures to restrict growth in demand (leakage reduction, metering and water efficiency) and to undertake river restoration works.

3.3.2.13 The WREA project allows for a detailed appraisal of these issues and so will reduce planning related risk. Through avoiding aborted or otherwise inefficient expenditure, it will also increase the overall affordability of our supply-demand programme.

Options appraisals

3.3.2.14 In addition to 11 sites where a likely impact has been identified, we have included 10 sites from 43 identified by the EA in Phase 3 of the AMP6 NEP, where the impact is currently unknown but we need assurance that alternative options have been considered in any assessment. The final list will be subject to agreement and will be defined through the EA Book of Obligations.

3.3.2.15 It is expected that the options appraisals will inform future investment programmes. Where a solution is required to meet WFD objectives, the current guidance we have is that Government will make the final decision as to whether or not a solution is cost-beneficial.

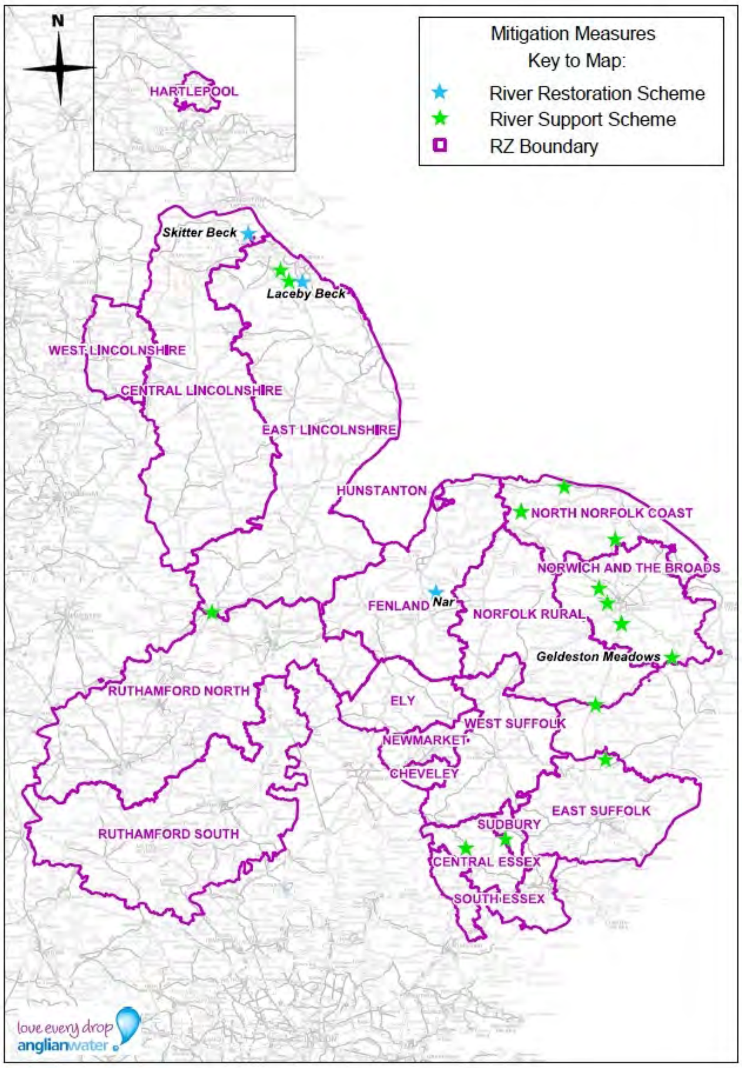


Figure 3.4 AMP6 environmental mitigation measures

3.3.3 Water Framework Directive

3.3.3.1 In May 2013, the EA issued a technical briefing note with guidance about how the WFD objective of 'no deterioration' applies to public water supply.

3.3.3.2 To meet this objective we must satisfy ourselves that the options we present in our WRMP that require a change in abstraction do not pose a likely risk of deterioration of water body status. A change in abstraction may include a new abstraction source or an increase above recent actual abstraction levels, within existing licence quantities.

3.3.3.3 We have completed detailed 'no deterioration' assessments for the options that were included in the AMP5 baseline supply demand balance as summarised in Table 3.3.

Source	WFD 'no deterioration' assessment	Outcome
Foxcote Reservoir	Low risk of deterioration for River Great Ouse. Potential water quality impacts in reservoir will need to be addressed through mitigation measures.	Feasible option

Source	WFD 'no deterioration' assessment	Outcome
Pulloxhill	No risk of deterioration for River Flit. Low risk of impact to Flitwick Moor SSSI will require future groundwater level monitoring.	Feasible option
High Oak (Wicklewood)	Unable to conclude no risk of deterioration. May require mitigation measures at recent actual abstractions	Not feasible

Table 3.3 No deterioration assessments

3.3.3.4 The SEA incorporated results from the WFD screening assessments for the feasible supply options we are considering in the plan. As part of our licensing strategy, we have also considered the potential impact of the WFD objective for our remaining abstraction licences.

3.3.3.5 To date, the EA's Restoring Sustainable Abstraction (RSA) and WFD assessments have been based on 'recent actual' abstraction figures or 'business as usual'. To enable us to understand the residual risk that the WFD no deterioration objective presents, we have extended the screening process undertaken for the feasible supply options, and have assessed all of our abstraction licences at their fully authorised abstraction rates.

3.3.3.6 The detailed screening process was developed in conjunction with the EA and builds on their work carried out for the NEP and the National WFD Risk Assessment in June 2013.

3.3.3.7 The methodology uses the National WFD Risk Assessment as a starting point, and identifies, for each abstraction licence, the water bodies at potential risk of deterioration.

3.3.3.8 The EA's Resource Assessment and Management (RAM) framework has then been used to assess the impact on each water body of increasing the abstraction rate from recent actual volumes to fully licensed.

3.3.3.9 The Catchment Abstraction Management Strategy (CAMS) assessments define a status (by colour) for the full flow range (Q30, Q50, Q70 and Q95 flows) at the primary Assessment Point for 'recent actual' abstraction rates. We have used the RAM ledgers to assess how the status changes as a result of increasing the abstraction rate. If the status does not change, or the impact does not breach the Environmental Flow (EFI) Indicator, then the risk of deterioration is identified as low.

3.3.3.10 Each water body has then been cross referenced with the information included within the NEP tables and assigned a risk score dependent on whether or not it has been included in the NEP, and the outcome of any investigations to date.

3.3.3.11 The screening methodology then assigns an overall risk score for each abstraction point. We have used the output from this assessment to identify the licences where the residual risk is highest. We have screened 219 abstraction points of which 46 are considered to be at higher risk of causing deterioration. Four of these have been discounted as one site is now closed, two are river support boreholes and one related to the wildlife lagoons at Rutland Water.

3.3.3.12 For the past 20 years the EA's Anglian region has implemented a policy of time limiting all new abstraction licences and licence variations. As a result, time limits apply in whole or in part to approximately half of our abstraction licences. We have 108 licences that are due for renewal during the AMP6 period.

3.3.3.13 Our screening has identified 20 time limited licences that are potentially at risk as detailed in Table 3.4.

Site Name	Time limit (Expiry)	WFD assessment comment
Playford	31/03/2014	Current renewal
Sproughton	31/03/2014	Current renewal
Westerfield	31/03/2014	Current renewal
Newbourne	31/03/2014	Current renewal
Hillington	31/03/2015	WFD assessment required with licence renewal (<10% headroom)
Bury St Edmunds	31/03/2015	WFD assessment required with licence renewal (<10% headroom)
Costesssey Groundwater	31/03/2015	Drought Plan WFD assessment
Isleham	31/03/2015	WFD assessment required with licence renewal
Welton le Marsh	31/03/2016	WFD assessment required with licence renewal
Wixoe	31/03/2016	Due to be replaced in AMP6 - no WFD assessment required
Candlesby	31/03/2016	WFD assessment required with licence renewal
Aldham	31/03/2016	WFD assessment required with licence renewal
Halstead	31/03/2016	WFD assessment required with licence renewal
Swaton	31/12/2016	WFD assessment required with licence renewal

Table 3.4 Time limited licences potentially at risk of WFD no deterioration

3.3.3.14 The remaining 22 sites are detailed in Table 3.5:

Site Name	WFD assessment comment
High Oak	WFD assessment complete - may require mitigation measures at recent actual
Pitsford Reservoir	See WRMP WFD assessment – low risk of deterioration
Rutland Water	See WRMP WFD assessment – low risk of deterioration
Wensum at Norwich	Drought Plan WFD assessment
Norwich Pits	Drought Plan WFD assessment
Marham Groundwater	AMP6 NEP - will include WFD assessment
Marham River	AMP6 NEP - will include WFD assessment

Site Name	WFD assessment comment
Beachamwell	AMP6 NEP - will include WFD assessment
Hollowell Reservoir	WFD assessment may be required
Rushall	WFD assessment may be required
Birchmoor	WFD assessment may be required
Warren Hill	WFD assessment may be required
Gayton	WFD assessment may be required
Lower Links	WFD assessment may be required
Newmarket 2	WFD assessment may be required
Moulton	WFD assessment may be required
Long Hill	WFD assessment may be required
Battlesdon	WFD assessment may be required
Pinchbeck	WFD assessment unlikely (<10% headroom)
Wilsthorpe	WFD assessment unlikely (<10% headroom)
Tallington	WFD assessment unlikely (<10% headroom)
Bourne	WFD assessment unlikely (<10% headroom)

Table 3.5 Non-time limited licences potentially at risk of WFD no deterioration

3.3.3.15 Of these, three assessments have been completed and five will be considered further through either our drought planning process or the NEP appraisals. Four of the sites have been screened out on the basis that the recent actual use is within 10% of the licence such that any potential deterioration issues as a result of potential increased use will be minimal.

3.3.3.16 We will continue to work closely with the EA and will take a risk based approach for the remaining sites. We have considered the impact that the WFD no-deterioration objective could have on our supply-demand balance as a scenario with all licences capped at recent actual abstraction rates.

3.3.4 Abstraction reform

3.3.4.1 In the Water White Paper, Government committed to reforming the current system of abstraction licensing. In their joint report with Ofwat, 'The case for change – reforming water abstraction management in England', the EA concluded that the current regulatory regime needs more flexibility to improve the link between availability and use of water, when faced with the future pressures from climate change and population growth.

3.3.4.2 We have contributed to the debate through the publication of two reports, 'Trading Theory for Practice' and 'A Right to Water'. In Trading Theory for Practice, we completed a detailed technical appraisal with Cambridge Water and Essex and Suffolk Water to review trading options. In 'A Right to Water' we explored the current and future challenges to water allocation between different users.

3.3.4.3 We continue to actively and constructively support the discussions with Defra and other stakeholders through the Abstraction Reform Advisory Group and the various catchment workshops. Our work with the Cambridge Institute for Sustainable Leadership (CISL) Water Stewardship Collaboratory rural lighthouse project is also assessing multi-sector approaches to water resource management and allocation in the Wissey catchment.

3.3.4.4 We will continue to work with Defra as they develop their abstraction reform policy options.

3.3.5 Abstraction incentive measure

3.3.5.1 During 2013, discussions took place between ourselves, the Environment Agency and Ofwat, over the possibility of developing a financial Abstraction Incentive Mechanism.

3.3.5.2 Our business plan submitted in December 2013 included an Abstraction Incentive Mechanism; a financial, penalty-only mechanism based on the sites identified as being at environmental risk due to abstraction at low flows.

3.3.5.3 In early 2014, Ofwat confirmed that it would not be pursuing a financial mechanism for this period and would review the situation at PR19. In the meantime, it states its intention to further develop a reputational incentive mechanism during 2015, once the price review has been completed.

3.3.5.4 In our revised business plan, submitted in June 2014, we reviewed our incentive package, and in line with Ofwat's guidance, and the incentives included in the four Determinations issued at that time, we decided to withdraw that financial incentive.

3.3.5.5 We will continue to work with Ofwat and the EA to develop the reputational incentive in 2015.

3.4 Baseline supply forecast

3.4.1 Overview

3.4.1.1 In 2012/13, the water we put into supply came from a number of different sources:

- Groundwater sources of supply. Around 53% of our available supplies are from groundwater. We operate over 450 groundwater sources, pumping groundwater from aquifer types including chalk, limestone, sandstone and superficial sands and gravels. Yields from our groundwater sources vary significantly, from around 1Ml/d in systems feeding small populations in rural Norfolk to over 50Ml/d from a wellfield in the Sherwood Sandstone that is used to supply Lincoln
- Reservoirs. We operate a number of winter storage reservoirs in the region. Most of these receive water which is pumped into them from a nearby river. Our reservoir sources account for approximately 40% of our available supplies. The yields that are available from them vary in proportion to the volumes stored and range from 13Ml/d to over >300 Ml/d. Rivers that we use to support our reservoirs include the Trent, Witham, Ancholme, Welland, Nene, Great Ouse, Colne and Gipping, and
- Direct river abstractions. These differ from our reservoir sources in that the water which is abstracted is effectively pumped directly into treatment and then into distribution. Where bank-side storage is available, this tends to be relatively small and used to mitigate water quality risk. The direct abstractions account for approximately 6% of our available supplies. Yields vary from less than 20Ml/d to over 50Ml/d and the sources

are found on the Great Ouse, the Witham, the Ancholme, the Nar, the Wissey and the Wensum.

3.4.1.2 Less than 1% of our 2012/13 supplies were imported from adjacent water companies including Yorkshire Water, Essex and Suffolk Water, Thames Water, Cambridge Water and Severn Trent Water. These imports are small, typically being much less than 1Ml/d, and are used to support isolated customers in locations which border the adjacent companies.

3.4.1.3 In 2012/13, the volume of water available for use (WAFU) was 1,461Ml/d at average and 1,980Ml/d at peak. From this, we have agreements to export up to 91Ml/d at average and 109Ml/d at peak to Affinity Water and 18Ml/d at average and peak to Severn Trent Water. These supplies are taken from our Ruthamford RZs.

3.4.1.4 A summary of the forecast changes in deployable output from the end of AMP6 is given below in Table 3.6:

		WAFU (Ml/d)					
		Base year	2019/20	2024/25	2029/30	2034/35	2038/39
Regional Summary	Dry year annual average	1484	1458	1392	1389	1388	1387
	Critical period	2042	1980	1967	1967	1967	1967

Table 3.6 Forecast changes in deployable output

3.4.1.5 From Table 3.6, base year supplies available under dry year annual average conditions (DYAA) are forecast to reduce overall by 97Ml/d. Factors responsible for this include:

- 13Ml/d reduction from climate change
- 110Ml/d reduction from confirmed and likely sustainability reductions, and
- 26Ml/d of new resource development including new water treatments works in the Ruthamford South, Central Lincolnshire and Norwich and the Broads RZs.

3.4.1.6 Equivalent supplies available under critical period (CP) conditions are forecast to reduce by 75Ml/d. This reflects the net effect of

- Reductions from confirmed and likely sustainability reductions, and
- New resource development.

3.4.2 Deployable output and levels of service

3.4.2.1 Our existing company-wide levels of service include:

1. Temporary Use Ban: 1 in 10 years (includes hosepipe bans)
2. Non-essential Use Ban: 1 in 40 years
3. Rota-cuts and Standpipes: 1 in 100 years.

3.4.2.2 These restrictions are used to conserve water and protect the environment during extended periods of dry weather and droughts. They are typically triggered by falling water levels in reservoirs and the frequency with which they are needed is estimated from the following:

- An assessment of the volume of water which is saved
- The effect of this on reservoir storage levels
- The historical flow record for rivers from which the water stored in the reservoirs is derived, and
- The yield available from the reservoir.

3.4.2.3 By iterative analysis of this data, combinations of restrictions that allow supplies to be maintained over the period of the historical flow record are determined. The preferred combination is then selected and used as for specifying levels of service. The level of service modelling is also used to determine the reservoir yields.

3.4.2.4 From this:

1. Our levels of service restrictions are a function of reservoir performance and historical flow data in the supporting catchments, and
2. Although levels of service restrictions are also applied to groundwater and direct river abstraction systems, the analysis does not directly account for the performance of these during droughts. Instead, yields for these are set at the minimum levels in the historic record. This implies a "no-restriction" level of service for these systems.

3.4.2.5 For each of our RZs we have determined the sensitivity of our deployable output estimates to level of service restrictions. The work was completed using our strategic MISER model and is reported in Table 3.7 below. In this we give the net effect of varying the frequency of the restrictions on surpluses and deficits at RZ level. From these, the equivalent impact on RZ level deployable output is inferred:

Resource Zone	Increase in the frequency of Non-essential Use Ban (Ml/d)	Decrease in the frequency of non-essential Use Ban (Ml/d)	Effect of No Restrictions Levels of Service (Ml/d)
West Suffolk	No significant effect	No significant effect	No significant effect
Cheveley			
Central Essex			
Central Lincolnshire			
East Lincolnshire			
East Suffolk			

Resource Zone	Increase in the frequency of Non-essential Use Ban (Ml/d)	Decrease in the frequency of non-essential Use Ban (Ml/d)	Effect of No Restrictions Levels of Service (Ml/d)
Fenland			
Hunstanton			
North Norfolk Coast			
Norfolk Rural			
Norwich and the Broads			
Ruthamford North			
South Essex			
West Lincolnshire			
Hartlepool			
Newmarket			
Sudbury			
Ely			
Ruthamford South	+21Ml/d	-4Ml/d	-16Ml/d

Table 3.7 Levels of Service sensitivities

3.4.2.6 From Table 3.7:

- With the exception of the Ruthamford South RZ, varying level of service restrictions has no significant effect on deployable output and surpluses/deficits at RZ level
- For the Ruthamford South RZ, increasing the frequency of non-essential use bans could increase deployable output by 21Ml/d, while
- Decreasing the frequency of non-essential use bans or moving to a no-restriction level of service would reduce deployable output by 4Ml/d and 16Ml/d respectively.

3.4.2.7 No data is included in Table 3.7 for temporary use bans, since no sensitivities to these were identified. In our models, no account is taken of the effect of rota-cuts and standpipes. This reflects customer preferences for avoiding severe restrictions and that the length of our historical record is relatively short and so does not include the type of severe drought that might make these necessary.

3.4.3 Impact of climate change on deployable output

3.4.3.1 In our plan we have allowed for the possible future effect of climate change on water available for use.

3.4.3.2 Our climate change modelling shows that there are a large number of plausible climate change futures, each with a different impact on the availability of water resources. In the plan, we have adjusted the average daily source works output (ADSO) by the mean of the impacts that we estimate and we made a related allowance in target headroom. The worst case climate change impacts have been used to test the robustness of our final plan. All of the modelling that we have done is in accordance with current best practice; details are given in the Technical Approach appendix.

3.4.3.3 The mean impacts included in our plan are summarised below in Table 3.8. Note that this excludes effects associated with target headroom:

RZ	Source works	Source	Mean Impact on ADSO (Ml/d)
Ruthamford North	Ravensthorpe	River Nene	0.9
Ruthamford South	Grafham	Bedford Ouse	6.6
Fenland	Stoke Ferry	River Wissey	0.2
Norwich and the Broads	Norwich	River Wensum	5.0
		Total	**12.7**

Table 3.8 Mean climate impacts (2039-40)

3.4.3.4 The distribution of the mean 2039-40 ADSO impacts is given in Figure 3.6 below:

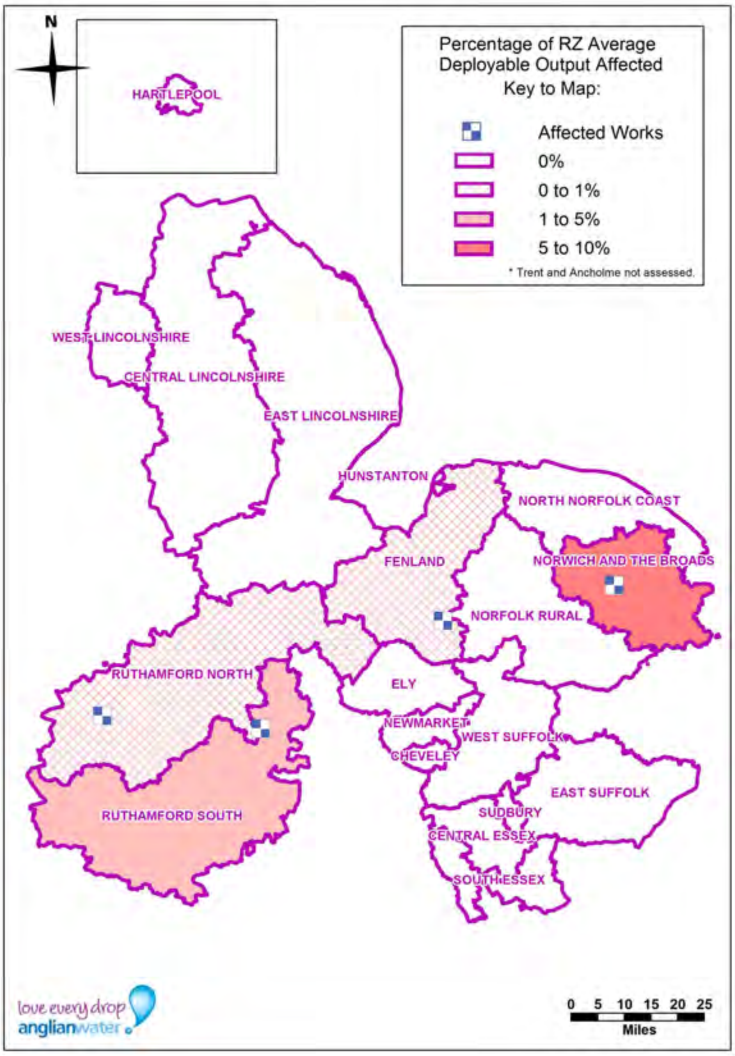


Figure 3.5 Mean climate change impacts (as % of daily sourceworks output))

3.5 Baseline demand forecast

3.5.1 Overview

3.5.1.1 Our customer base is divided into households billed on the basis of the volume of water that they use (measured households); households billed on the basis of the rateable value of their house (unmeasured household) and non-household or industrial customers. Nearly all of our non-household customers are measured. Excluding Hartlepool Water, base year (2012/13) consumption is characterised by the following:

- 43% of delivered supplies were to measured households. These comprise 73% of our household customers. Excluding supply-pipe leakage, average PCC for this segment was 124 l/person/day
- 27% of delivered supplies were to unmeasured households. These comprise the remaining 27% of our household customers. Excluding supply-pipe leakage, average per capita consumption for this segment was 150 l/person/day

- The equivalent base year average PCC for our household customers was approximately 133 l/person/day, and
- 30% of our delivered supplies were to measured non-household customers. This is a diverse group that includes service and manufacturing industry and the public sector. The average per property consumption for this segment is 2,331 l/household/day.

3.5.1.2 Less than 1% of our delivered supplies were to unmeasured non-household customers.

3.5.2 Household demand

3.5.2.1 From Figure 3.7, average household consumption is dominated by personal washing and toilet flushing. Personal washing includes shower, bath and hand-basin use.

3.5.2.2 The amount used by measured households for these purposes are each in excess of 40 1/person/day; the equivalent volumes for unmeasured households are in excess of 50 l/person/day. Approximately equal volumes are used for the remaining clothes washing, dish washing, miscellaneous internal use and external use components. For measured customers these average 10 l/person/day. For unmeasured customers, the equivalent volumes are marginally in excess of 10 l/person/day.

3.5.2.3 General trends apparent from our micro-component analysis indicate that the following changes in household use are likely to occur:

- Measured household customers: decrease in toilet use
- Unmeasured household customers: general increase in toilet use, with selected areas also showing a increase in clothes washing and external use. These effects are likely to be linked to the switching of unmeasured customers to measured supplies and a progressive increase in the significance of a residual high water-using body of unmeasured customers.

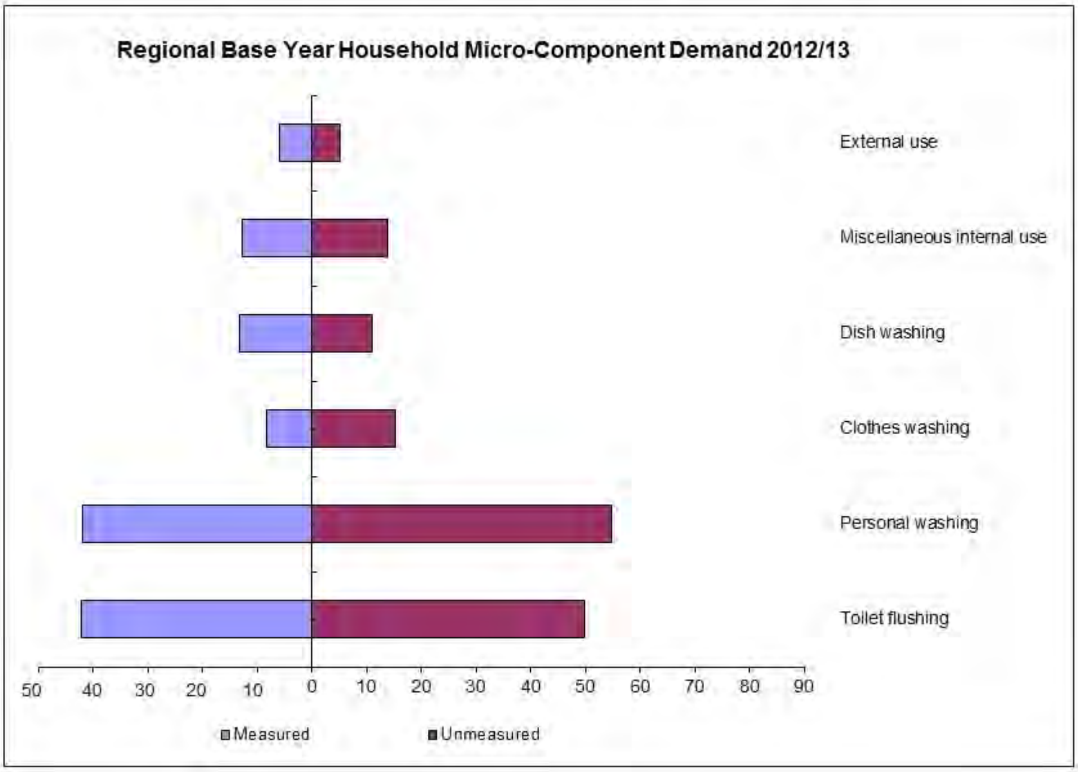


Figure 3.6 Base year average regional micro-component per capita consumption analysis (litres/person/day)

3.5.3 Non-household demand

3.5.3.1 Our non-household demand originates from a wide variety of businesses and industry. Figure 3.8 shows the distribution at RZ level for 2012-13 as a percentage of total non-household demand. The data is based on our billing data and standard industrial classification (SIC) codes

3.5.3.2 From Figure 3.8:

- Our NHH demands are dominated by a combination of the following uses:
  - Agriculture, forestry and fishing
  - Manufacturing, and
  - Wholesale, retail trade, food, accommodation and other services
- Non-household demands in the Hartlepool and Ruthamford North RZs are dominated by manufacturing
- Non-household demands in the Newmarket, Sudbury, Fenland and Cheveley RZs are dominated by agriculture, forestry and fishing
- Non-household demands in the Norfolk Rural, North Norfolk Coast and Hunstanton RZs are dominated by Wholesale, retail trade, food, accommodation and other services.

3.5.3.3 The remaining RZs contain a broad mix of non-household demands.

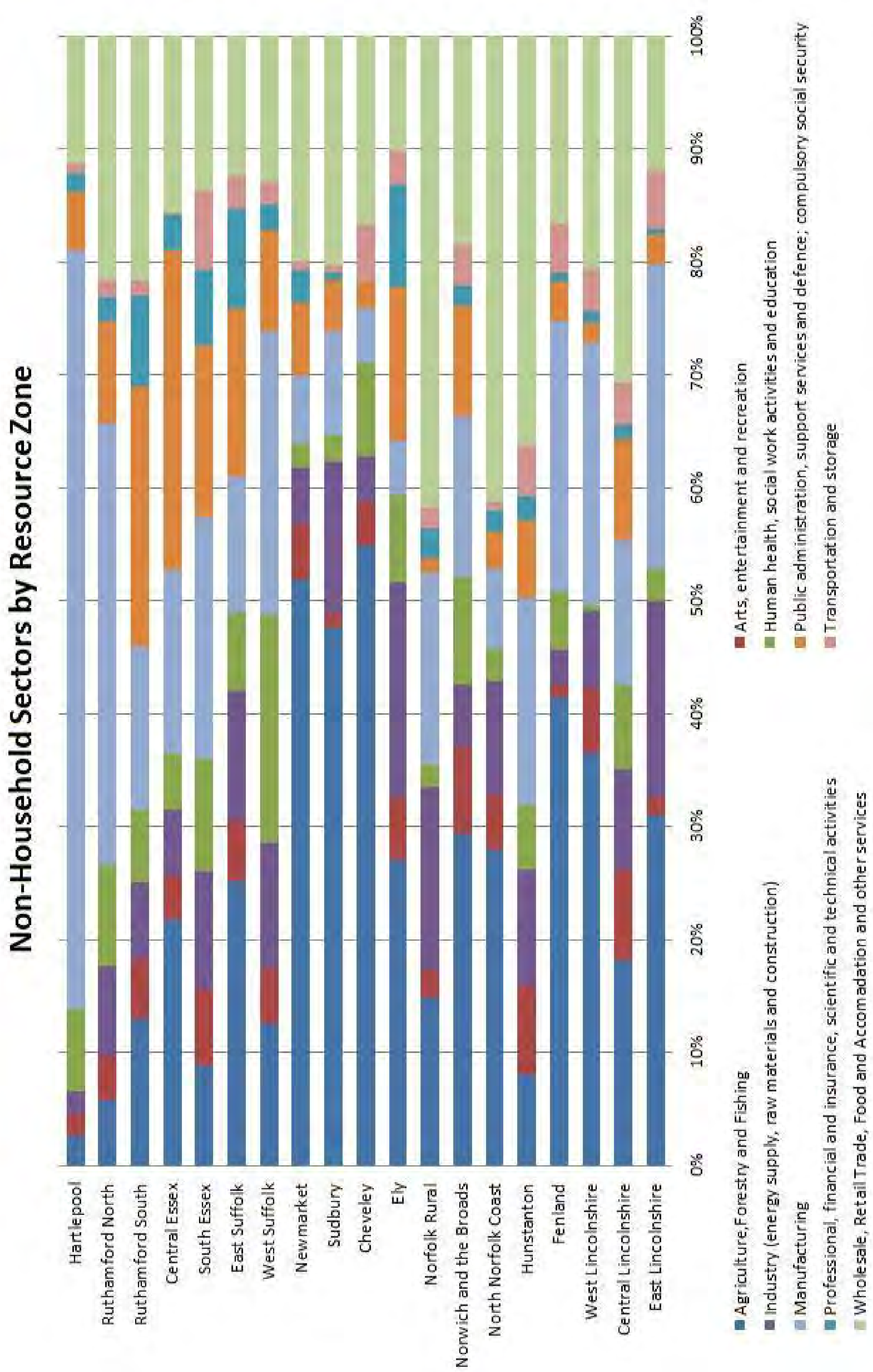


Figure 3.7 Base year non-household demand

3.5.3.4 The base year non-household demands are estimated from billing data. Analysis of this shows a correlation with gross domestic product (GDP), and future demands are forecast on the basis of a projection of this. The regression analysis we use produces reasonable estimates of the general level of non-household consumption that we amend where there is specific information about new developments.

3.5.4 Impact of climate change on demand

3.5.4.1 In our plan we have accounted for the possible future effects of climate change on demand. The effect is relatively modest and grows over the period to 2039-40 to around 1% for household demand and 2% for non-household demand. Details are given in Figure 3.9 below:

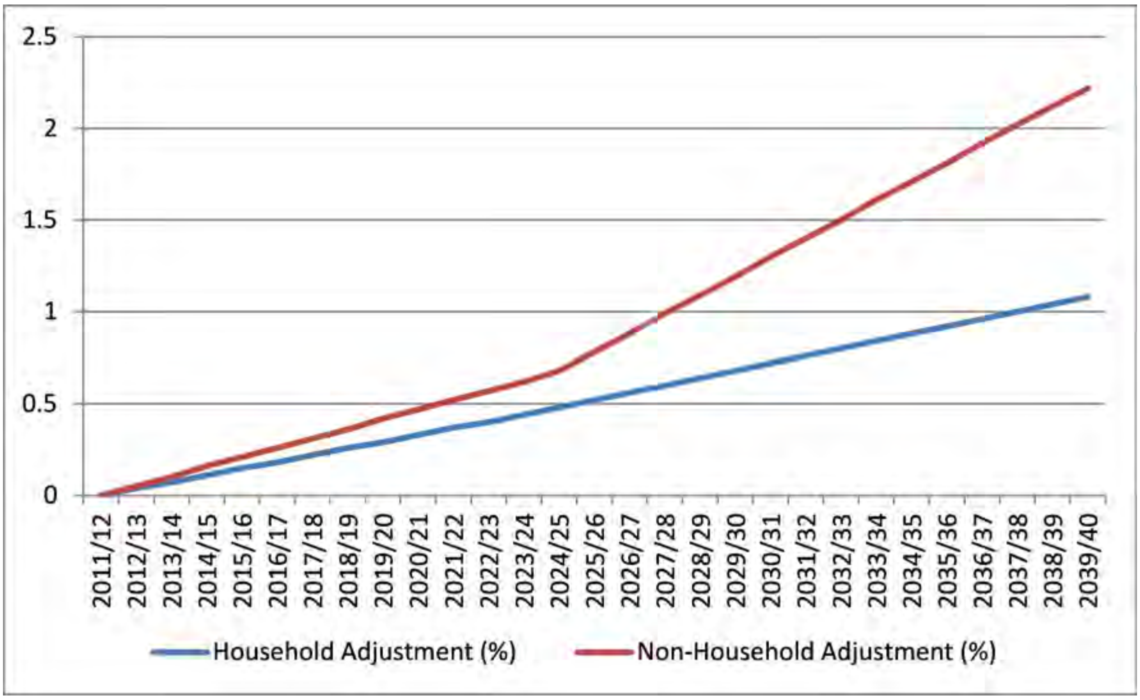


Figure 3.8 Climate change impact on demand

3.5.4.2 To derive these factors, we use an approach based on the Climate Change and Demand for Water report (CCDeW). Details are given in the Technical Approach appendix.

3.5.5 Leakage

3.5.5.1 Approximately 13% of the water we put into supply is lost through leakage from our distribution system and a further 4% leaks from customers supply pipes. Until now we have aimed to limit leakage to the sustainable economic level of leakage (SELL). This is currently around 211Ml/d. At this level it is cheaper for society as a whole for us to build new sources of supply rather than make further leakage reductions.

3.5.5.2 In response to the threat of drought in 2011 and 2012 we made a significant effort to reduce leakage: one of the actions taken to reduce the risk of interruptions to supply. As a result the annual average leakage level was reduced to 199 Ml/d in 2011/12: 12Ml/d below the SELL leakage target. This leakage reduction is planned to be maintained and enhanced for the remainder of the AMP5 period. This level of leakage is consistent with that required to maintain the supply-demand balance in a severe drought. This experience demonstrates that within certain limits it is possible to reduce leakage in response to a drought situation in order to maintain the supply demand balance.

3.5.5.3 Our research and that of CCWater has produced consistent responses from customers about attitudes to leakage management. Customers have indicated that they believe that water companies should do more to save water and that there is a link between customers' willingness to reduce their consumption and water companies being seen to do their bit by reducing their leakage. We recognised and used this link in the "drop 20" campaign during the 2012 drought, where we made an explicit link between our appeal for customers to reduce their consumption and the efforts that the company made to reduce leakage.

3.5.5.4 Customers have clearly demonstrated a preference for leakage reduction options and, to a lesser extent, customer metering options in customer preference surveys. These options are preferred over resource development options and over wastewater re-use or water transfer from other regions. Analysis of customer surveys has also indicated the extent of leakage reduction that customers are willing to support. This is a reduction to a leakage level of around 172Ml/d (see Figure 3.10).

3.5.5.5 We have made an assessment of the leakage reduction that is practicable in the next AMP period. Four options were considered including maintaining leakage at 211Ml/d, maintaining the 199Ml/d level, a reduction to 172Ml/d over the period or a reduction to 155Ml/d over the period. We rejected the 155Ml/d option as not practicable in the time available. The leakage maintenance options at 211Ml/d or 199Ml/d are clearly not acceptable to customers or regulators. The 172Ml/d option appears to be practicable in the time available and appears to have the support of customers.

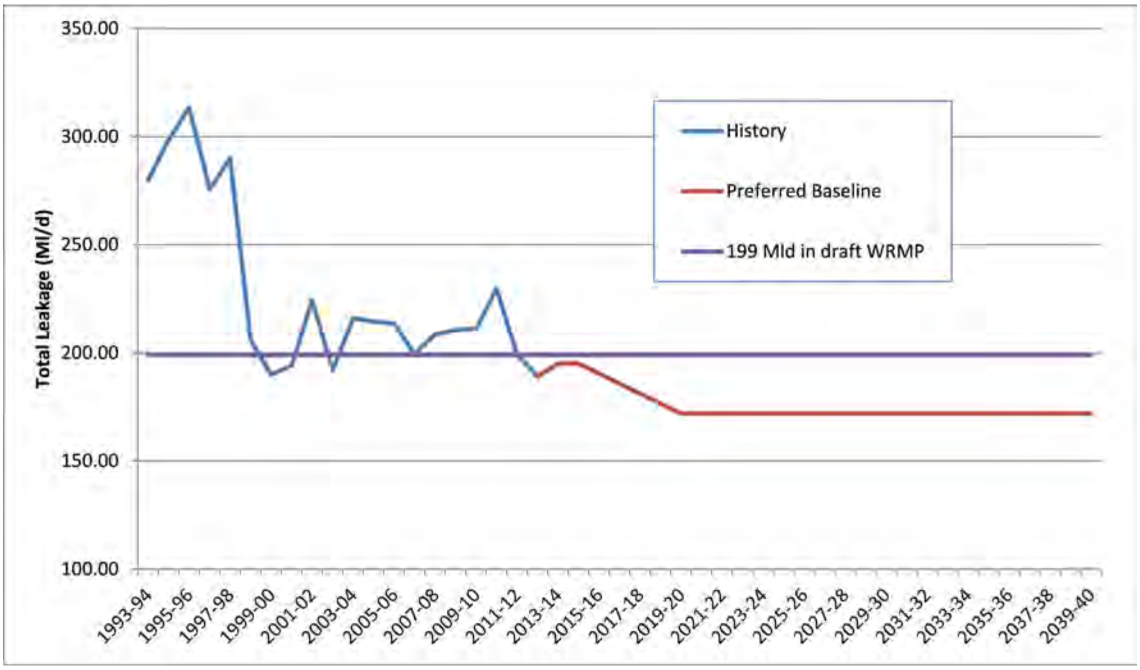


Figure 3.9 Baseline leakage forecast

3.5.5.6 Our long term aspiration is to achieve a much lower level of leakage of 93Ml/d by 2040. However it is not yet clear that 93Ml/d is achievable and customer support for such large reductions is not yet established. Therefore we have used a baseline leakage forecast of a reduction to 172Ml/d in 2019/20 and then a constant leakage level to the end of the period. This does not preclude further leakage reductions in specific resource zones where the economics of balancing supply and demand (EBSD) process identifies them, but it avoids the risk of over-reliance on large and uncertain leakage reductions in long term planning.

3.5.6 Consumption forecast summary

3.5.6.1 A summary of the regional consumption forecast is given below:

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Distribution Input	1098.90	1046.02	1058.72	1074.90	1091.48	1108.09
Target Headroom	36.51	72.30	99.32	128.52	149.78	172.22
Total	1135.42	1118.33	1158.05	1203.42	1241.27	1280.30

Table 3.9 Regional baseline demand forecast summary (Dry year annual average)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Distribution Input	1371.54	1296.64	1306.98	1322.88	1340.09	1357.71
Target Headroom	45.57	89.91	122.75	158.27	184.07	211.26
Total	1417.11	1386.56	1429.73	1481.14	1524.16	1568.97

Table 3.10 Regional baseline demand forecast summary (Critical period)

3.5.6.2 From the tables:

- Total demand and target headroom requirements are forecast to increase by 144Ml/d under dry year annual average conditions
- The equivalent increase for critical period conditions is 153Ml/d, and
- The overall increase reflects a combination of the following:
    - An increase in measured household consumption. This is a function of household switching from unmeasured to measured supplies and projected levels of population increase and new development
    - A significant reduction in unmeasured household consumption, as a consequence of switching
    - A marginal reduction in non-household consumption, and
    - A progressive increase in target headroom requirements. At the end of the forecast period, these average 16% of DI.

3.6 Supply demand balances

3.6.1 The regional level supply-demand balance is illustrated in Figure 3.11 (DYAA scenario) and Figure 3.12 (CP scenario). The equivalent data are summarised in Table 3.12 and Table 3.13. This data excludes Hartlepool Water.

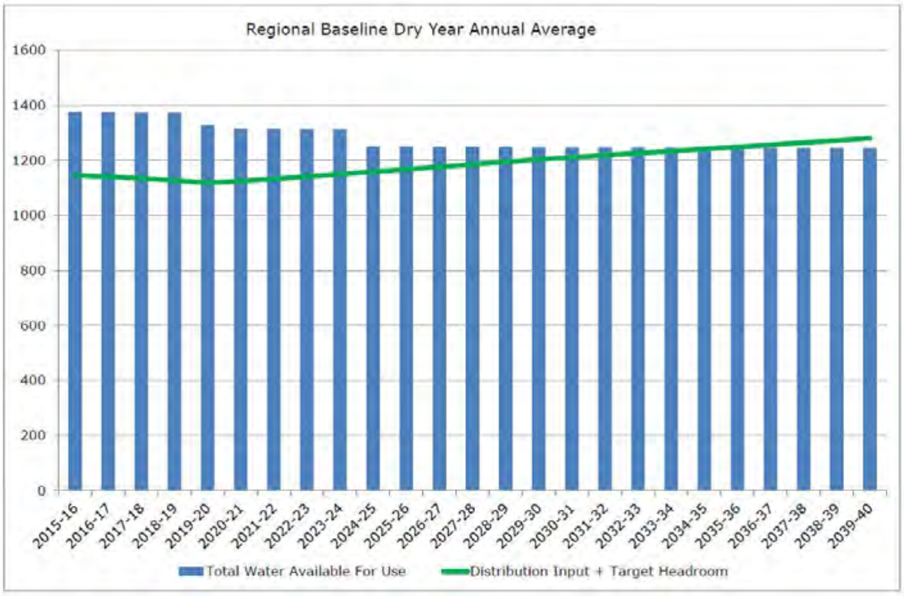


Figure 3.10 Regional level supply-demand balance baseline dry year annual average (Ml/d)

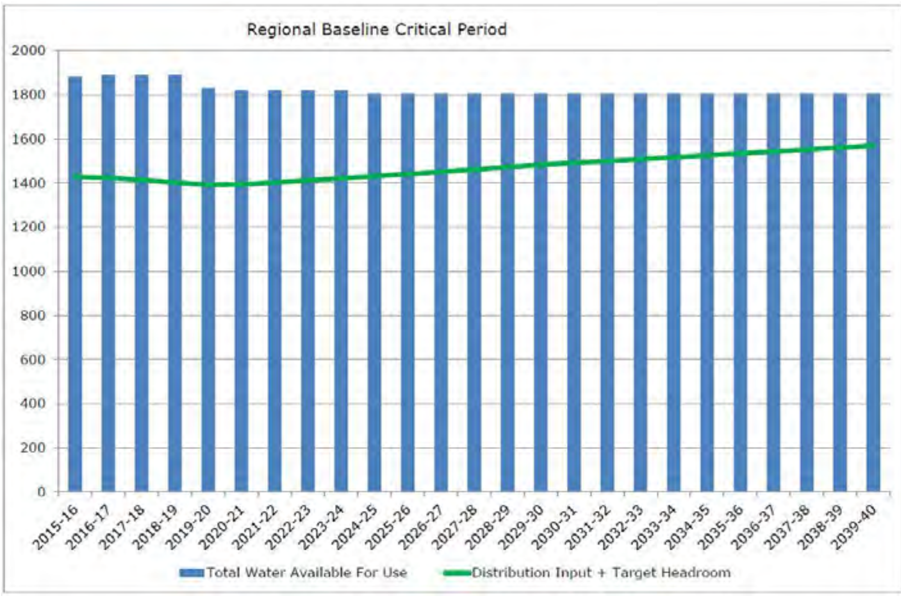


Figure 3.11 Regional level supply-demand balance baseline critical period (Ml/d)

	2012-13	2019-20	2024-25	2029-30	2034-35	2039-40
Distribution Input	1073.89	1020.72	1033.45	1049.61	1066.16	1082.73
Target Headroom	35.71	71.17	97.90	126.77	147.70	169.79
Water Available for Use	1310.21	1292.61	1214.63	1212.85	1212.46	1212.25
Supply-Demand Balance	200.61	200.71	83.28	36.47	-1.40	-40.26

Table 3.11 Regional level supply-demand balance baseline dry year annual average (Ml/d)

	2012-13	2019-20	2024-25	2029-30	2034-35	2039-40
Distribution Input	1340.26	1264.81	1275.27	1291.24	1308.51	1326.18
Target Headroom	44.56	88.49	120.97	156.08	181.48	208.24
Water Available for Use	1808.89	1786.38	1760.15	1760.15	1760.26	1760.24
Supply Demand Balance	424.06	433.09	363.92	312.96	270.27	225.82

Table 3.12 Regional level supply-demand baseline critical period (Ml/d)

3.6.2 The RZ level supply demand balances are summarised in the following Figures:

- Figure 3.13 2019-20 (AMP6) DYAA surpluses and deficits
- Figure 3.14: 2019-20 (AMP6) CP surpluses and deficits
- Figure 3.15: 2039-40 (AMP10) DYAA surpluses and deficits, and
- Figure 3.16: 2039-40 (AMP10) CP surpluses and deficits.

3.6.3 From these, there are AMP6 deficits in the following RZs. These result from sustainability reductions:

- Hunstanton: 0.7Ml/d DYAA, no deficit at CP, and
- Norwich and the Broads: 33.8Ml/d DYAA and 40.5Ml/d CP.

3.6.4 The following RZs are also in deficit at the end of the forecast period. These result from a combination of growth in demand and target headroom requirements, sustainability reductions and climate change:

- Fenland: 7.1Ml/d in the DYAA scenario, no deficit in the CP scenario
- Cheveley: 0.2Ml/d in the DYAA scenario, 0.2Ml/d for CP
- Ely: 3.9Ml/d in the DYAA scenario, no deficit in the CP scenario
- East Suffolk: 5.6Ml/d in the DYAA scenario, no deficit in the CP scenario
- West Suffolk: 3.1Ml/d in the DYAA scenario, no deficit in the CP scenario
- Central Essex: 0.9Ml/d in the DYAA scenario, no deficit in the CP scenario
- South Essex: 1Ml/d in the DYAA scenario, no deficit in the CP scenario, and
- Ruthamford South: 18.0Ml/d in the DYAA scenario and 4.2Ml/d in the CP scenario.

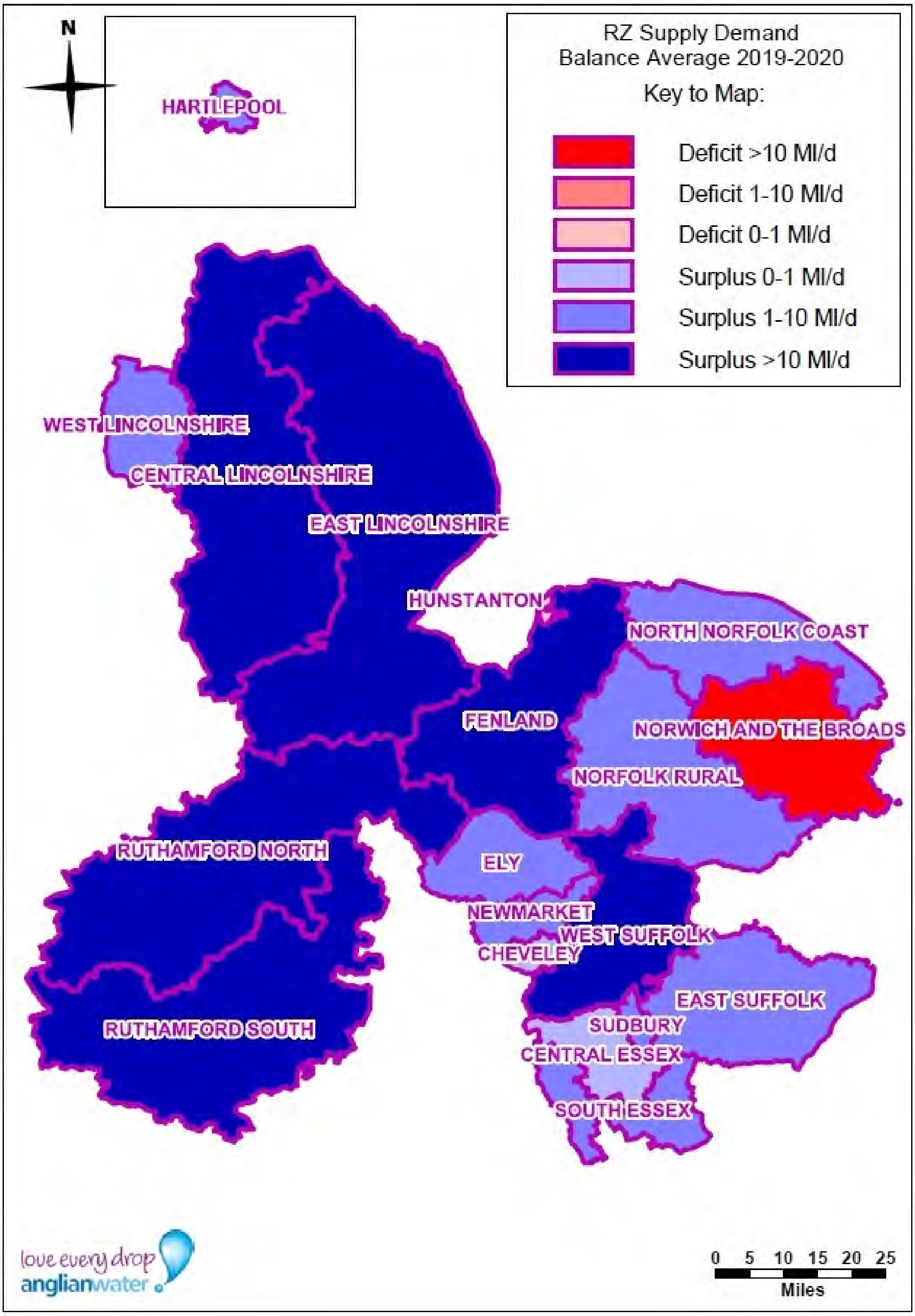


Figure 3.12 Baseline supply-demand balances dry year annual average scenario (2019-20)

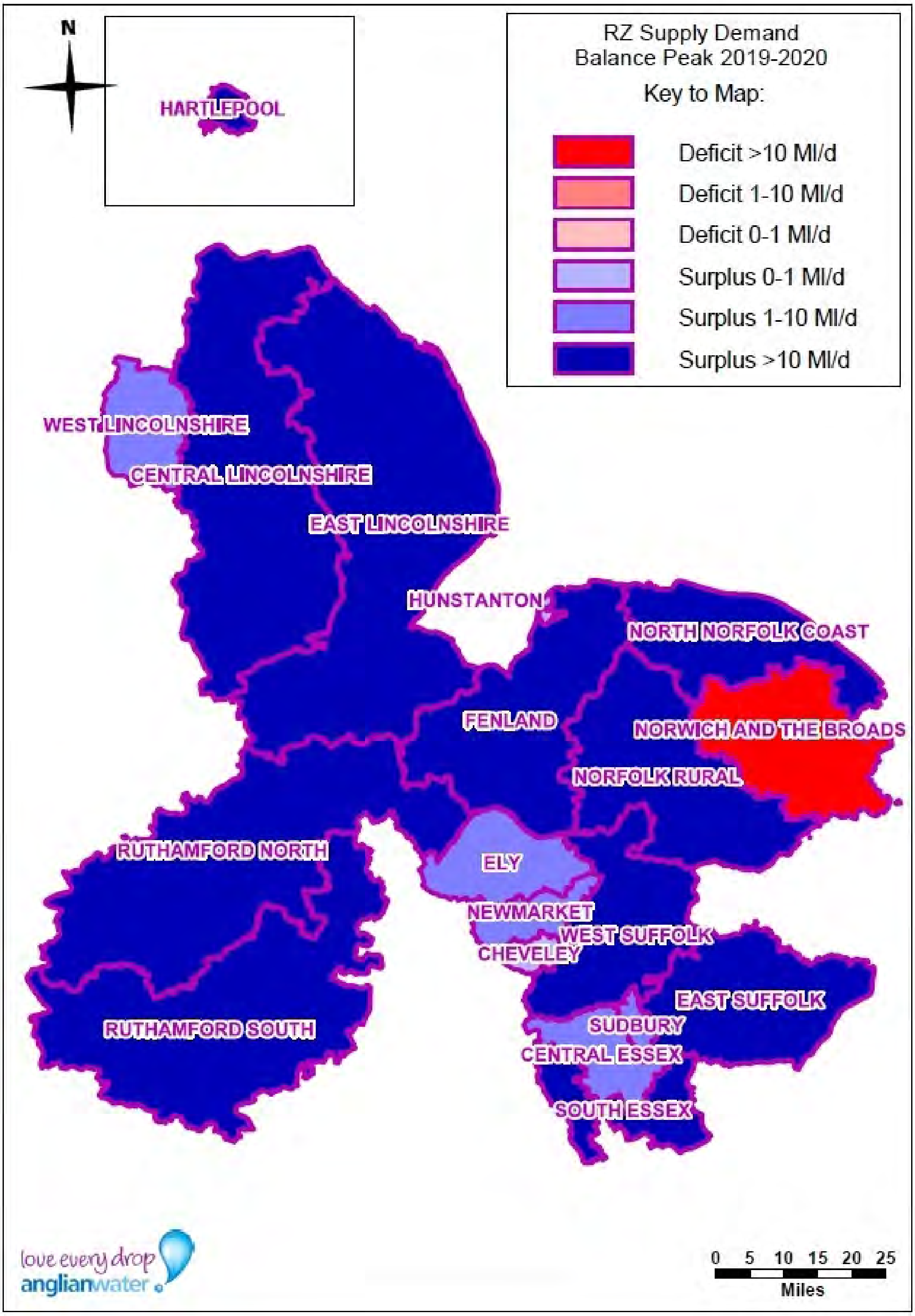


Figure 3.13 Baseline supply-demand balances critical period scenario (2019-20)

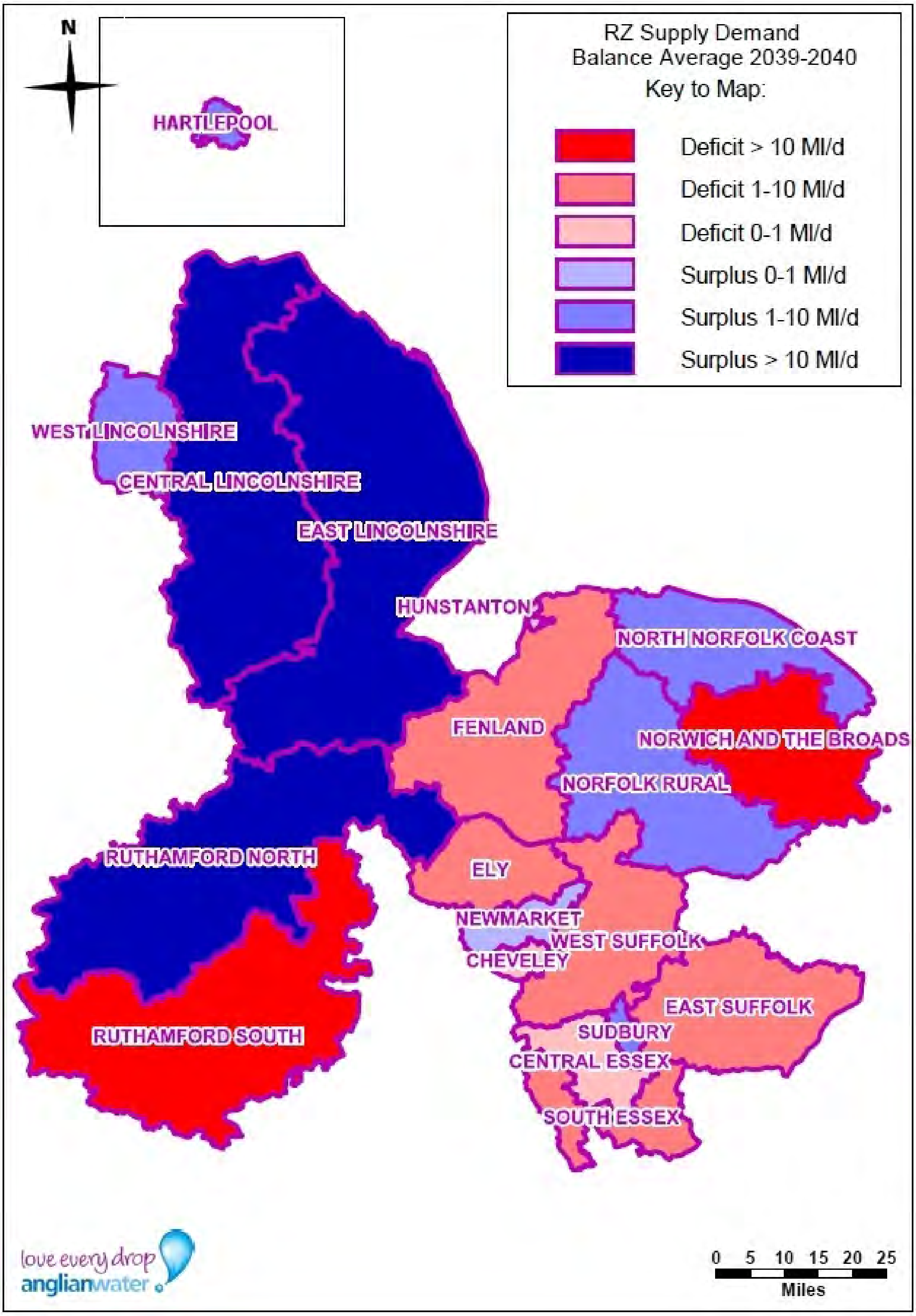


Figure 3.14 Baseline supply-demand balances dry year annual average (2039-40)

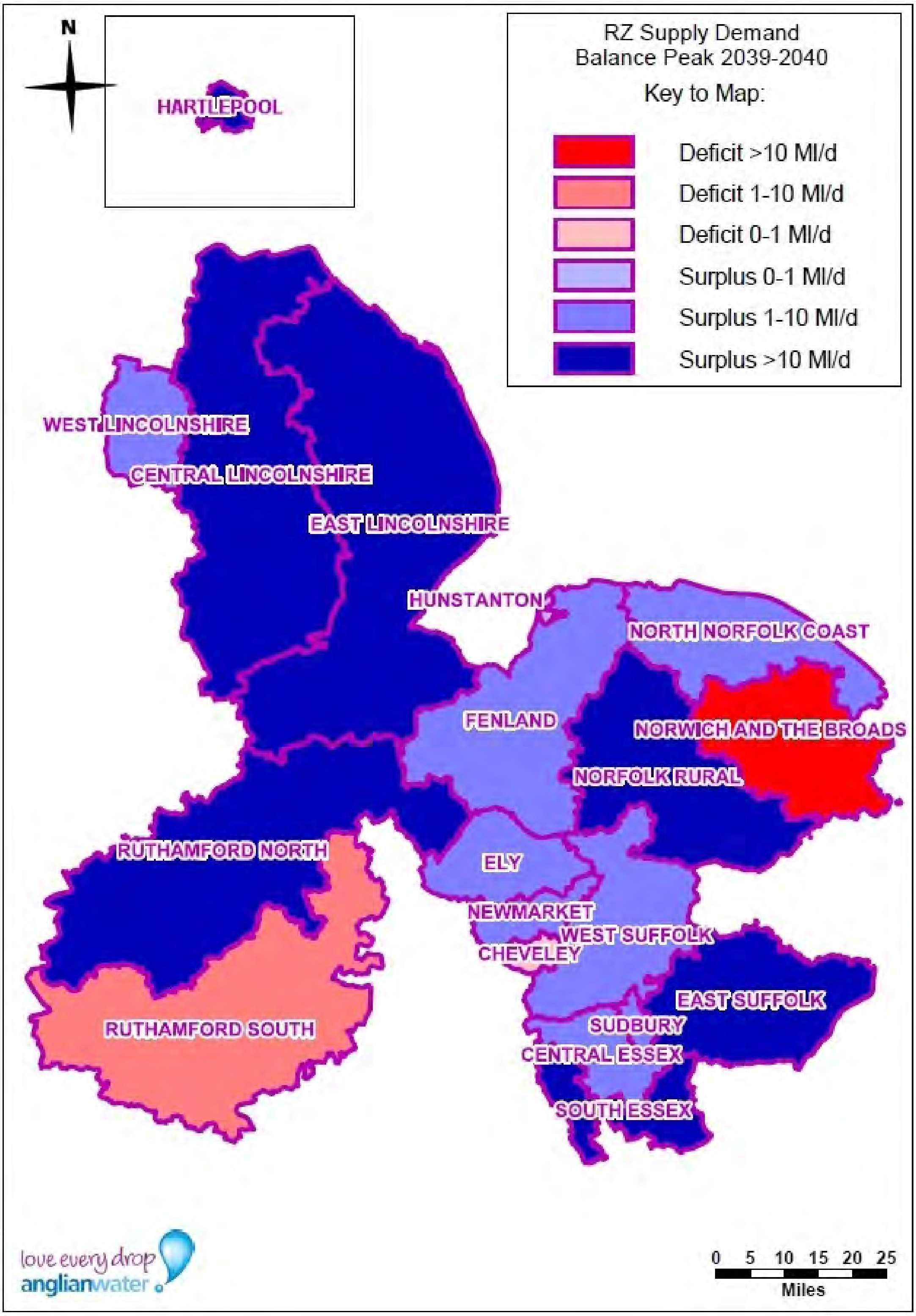


Figure 3.15 Baseline supply-demand balances critical period (2039-40)

3.6.5 Summary supply-demand data for the Hartlepool Water RZ is given in Table 3.14 and 3.15 below:

	2012-13	2019/20	2024/25	2029/30	2034/35	2039/40
Distribution input	25.01	25.30	25.27	25.29	25.32	25.36
Target headroom	0.8	1.13	1.42	1.75	2.08	2.43
WAFU	35.91	35.90	35.90	35.89	35.89	35.89
SD balance	10.09	9.47	9.20	8.85	8.49	8.11

Table 3.13 Hartlepool Water DYAA baseline supply-demand forecast (Ml/d)

	2012/13	2019/20	2024/25	2029/30	2034/35	2039/40
Distribution input	31.28	31.83	31.71	31.64	31.58	31.53
Target headroom	1.01	1.42	1.79	2.19	2.59	3.02
WAFU	44.91	44.89	44.89	44.90	44.90	44.90
SD balance	12.63	11.63	11.39	11.07	10.73	10.35

Table 3.14 Hartlepool Water CP baseline supply-demand forecast (Ml/d)

3.6.6 From Tables 3.13 and 3.14, the Hartlepool RZ remains in surplus under both DYAA and CP conditions to the end of the forecast period. In addition, no climate change or sustainability reduction sensitivities have been identified.

3.6.7 The water available for use in the Hartlepool RZ is potentially at risk from a plume of sulphate contaminated groundwater, which is migrating in the direction of the groundwater sources used by Hartlepool Water. The progress of the plume is subject to on-going monitoring and work to quantify the related supply-demand risk is planned for AMP6. Investment in a water quality scheme may be required in subsequent AMPs. In the short-term, however, the risks are considered to be marginal.

3.7 Overview of our future challenges

3.7.1 Existing supply-demand pressure in the Anglian region will increase in future as a consequence of growth, climate change, sustainability reductions and deteriorating raw water quality. Summarising from work completed for this plan:

- Over 500,000 new properties are forecast to be built in the region in the period between 2015 and 2040. These will be built at an average rate of approximately 21,000 properties per year, with the build rate in the early part of the forecast period suppressed by the effects of the current down-turn in the housing market
- Over the same period, the population is forecast to grow by over 1,000,000, or 20% from population levels in 2011/12. Even if highly water efficient rates of per capita consumption (PCC) are achieved, this growth is equivalent to an additional 72Ml/d of demand. Including target headroom requirements and other changes, our overall demand is forecast to increase by 144.3Ml/d. This excludes 87.5Ml/d of water savings from leakage, metering and water efficiency activity in our baseline forecast
- Mean impacts of climate change, including target headroom requirements and effects on demand, are of the order of 50Ml/d
- In the worst case, climate change impacts may reduce our average daily source works output (ADSO) by 154Ml/d. The majority of the impact is predicted to affect our reservoir

and direct intake sources, with the worst case reductions in our Ruthamford system alone accounting for 87Ml/d (60%) of the total impact, and

- From on-going discussion with the EA, up to 30 of our sources are subject to confirmed, likely or unknown sustainability changes. This is equivalent to 13% of the total number of sources we operate. In total, up to 182Ml/d may be affected.

3.7.2 Overall, our supply-demand balance is potentially at risk from adverse changes which may be as large as 567Ml/d, or approximately 50% of our 2012/13 DI. Since the equivalent available headroom in 2012/13 was only 362Ml/d, the scale of the potential threat is significant.

3.7.1 Sustainability changes and reductions

3.7.1.1 The EA has defined a list of sites on the AMP6 Water Resources National Environment Programme (NEP) where there is still some concern that our abstractions may be having an unacceptable environmental impact. The sites have been classified as having a confirmed impact, a likely impact or a (currently) unknown impact.

3.7.1.2 Where the EA has confirmed the impact, we are expected to implement a solution to reduce abstraction or provide mitigation measures. If the solution results in a reduction to the deployable output of a source then it is referred to as a sustainability reduction.

3.7.1.3 Where the EA has concluded a likely impact, we are required to complete an options appraisal report. The report must appraise and cost all reasonable options that can, alone or in combination, help to mitigate the effects of Anglian Water abstractions on low flows.

3.7.1.4 The WRP guidance states that we should convert both confirmed and likely sustainability changes to reductions in deployable output and include any reductions in our baseline supply-demand balance.

3.7.1.5 Details of the sources identified for sustainability reductions are given in Table 3.15, Figure 3.17 and 3.18 and show the following:

Resource Zone	Site	Source	Confirmed (Ml/d)	Likely (Ml/d)	Unknown (Ml/d)	RZ Total (Ml/d)
Central Lincolnshire	Slea New	Aswarby		0.90		24.05
	Slea New	Clay Hill		0.90		
	River Poulter from Millwood Brook to River Maun	Newton			17.50	
	Barlings Eau	Welton			4.75	
East Lincolnshire	Laceby Beck	Habrough	20.00			59.07
	Skitter Beck source to Ulceby	Healing	4.47			
	East Glen,Glen,Grimsthorpe Park Brook	Wilsthorpe			17.10	

Resource Zone	Site	Source	Confirmed (Ml/d)	Likely (Ml/d)	Unknown (Ml/d)	RZ Total (Ml/d)
	East Glen,Glen,Grimsthorpe Park Brook	Bourne			17.50	
Ely	River Kennett-Lee Brook	Isleham		1.54		5.64
	R Lark u/s Mill St Bridge	St Helena			4.10	
Fenland	Nar	Marham	9.12			19.00
	Nar	Ryston	6.92			
	Old Carr Stream	Ryston		0.00		
	Stringside Stream	Ryston		0.44		
	Gaywood River	Gayton		2.52		
Hunstanton	Sedgford Sands	Ringstead	1.30			1.30
Newmarket	Cavenham Stream	Moulton		1.00		2.47
	Tuddenham Stream	Moulton		0.90		
	Lee Brook	Long Hill		0.57		
Norfolk Rural	River Gadder	North Pickenham		0.18		2.92
	Tiffey	Wicklewood - High Oak			1.38	
	Tas	Bunwell			1.36	
North Norfolk Coast	Ant Broads and Marshes SSSI	Ludham - Catfield		1.34		1.34
Norwich & the Broads	Geldeston Meadows SSSI	Kirby Cane	0.00			46.20
	River Wensum SSSI	Total Heigham	46.20			
Ruthamford South	Broughton Brook	Birchmoor - Asley Guise		2.37		2.37
West Lincolnshire	Ranskill Brook	Everton			7.60	7.6
West Suffolk	River Lark	Rushbrooke	4.50			9.84
	River Linnet	Rushbrooke		1.00		
	Tuddenham Stream	Risby		1.05		
	Sapiston River	Ixworth/Stanton		1.79		
	Stowlangtoft Stream	Ixworth/Stanton		0.00		
	Bumpstead Brook	Gt.Wratting		1.50		

Resource Zone	Site	Source	Confirmed (Ml/d)	Likely (Ml/d)	Unknown (Ml/d)	RZ Total (Ml/d)
Total			**92.51**	**18.00**	**71.29**	**181.80**

Table 3.15 NEP Phase III Sustainability Reductions

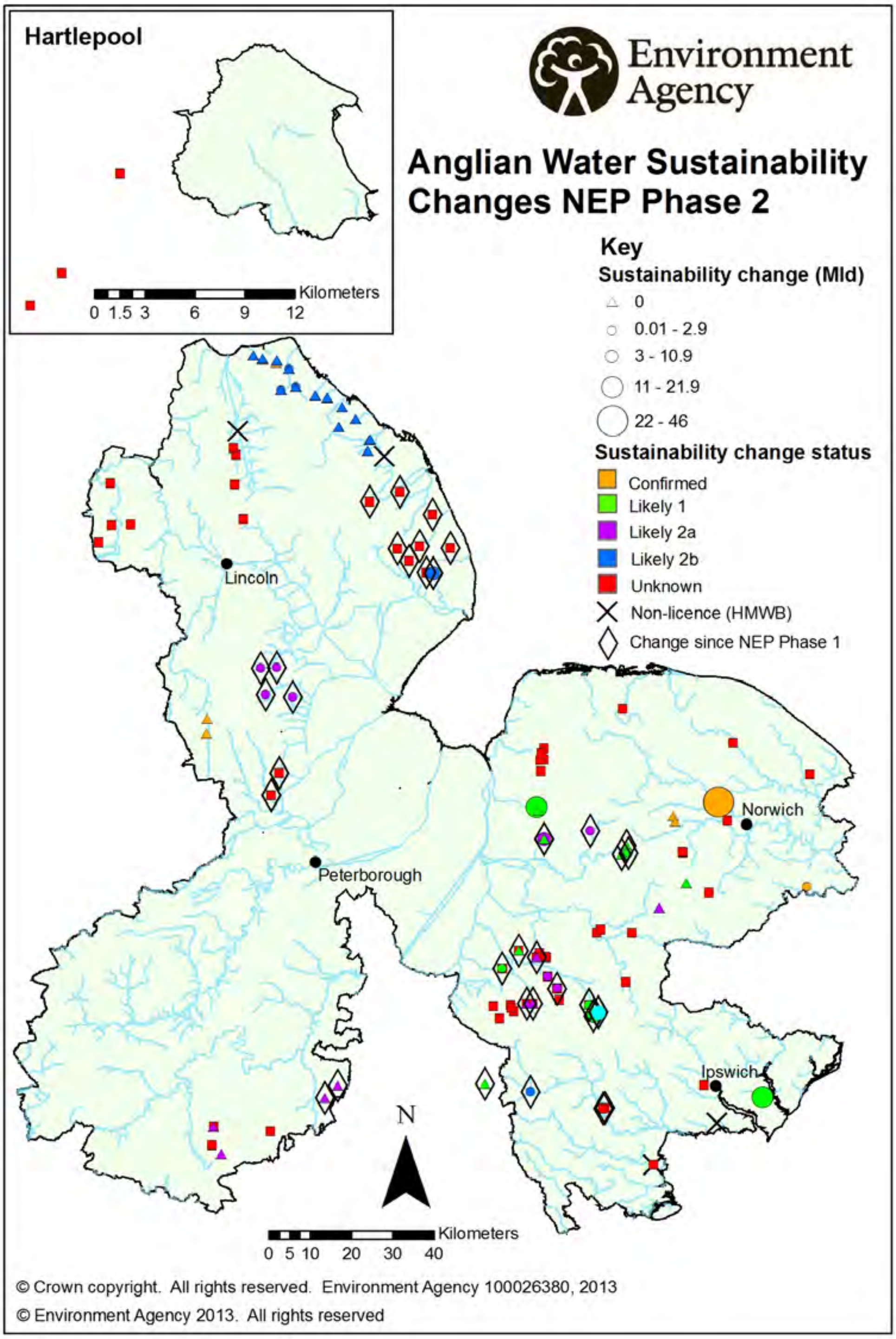


Figure 3.16 Sources identified for sustainability changes

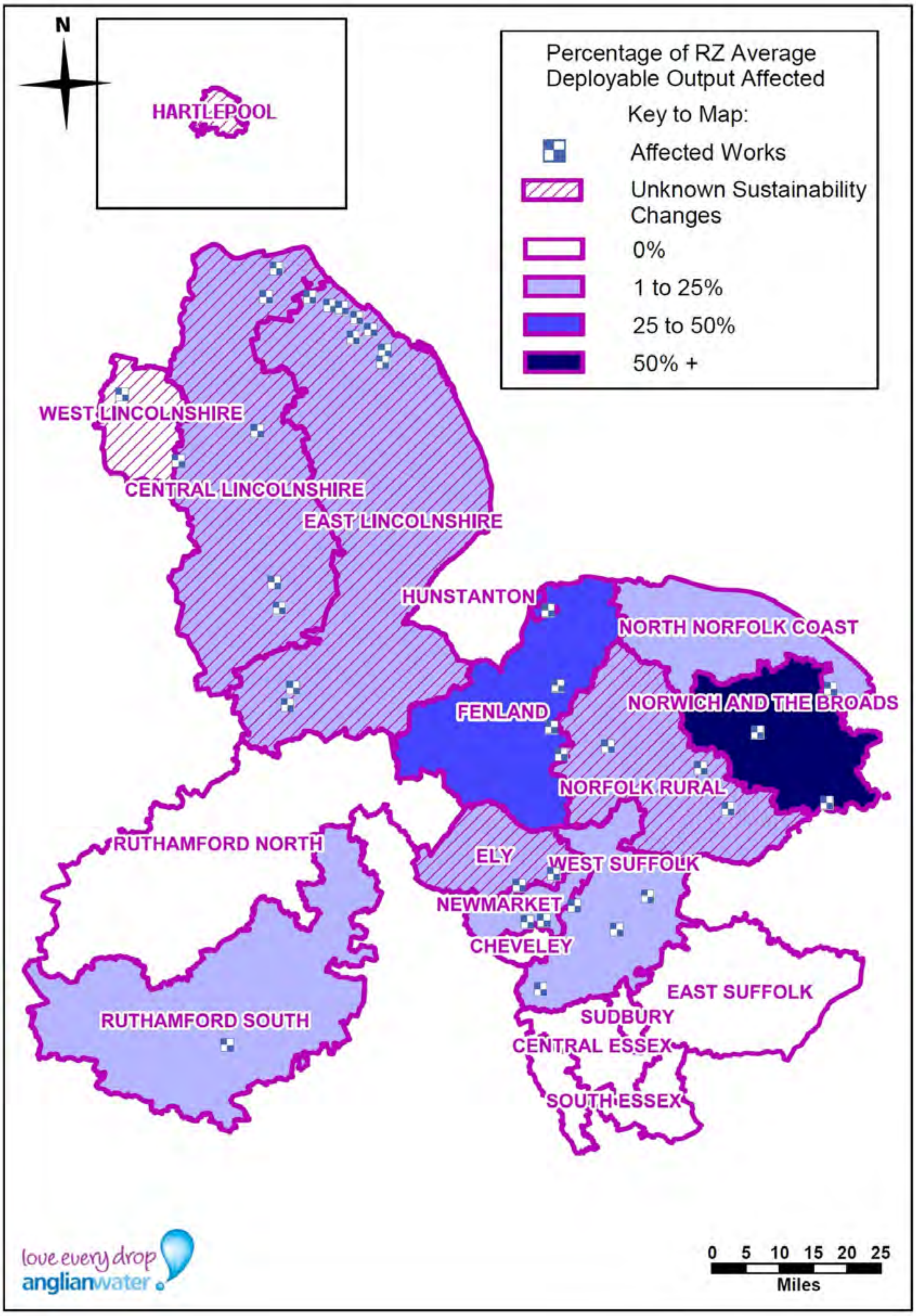


Figure 3.17 SR impacts on ADSO (% of ADSO)

3.7.2 Deteriorating raw water quality

3.7.2.1 Water quality deterioration due to diffuse source contamination from agriculture will continue to be an issue going forward. Nitrate concentrations will continue to rise in many parts of our groundwater system and are unlikely to decline anytime in the next 20 to 50 years. Catchment management solutions to deal with high nitrates are very expensive and are ineffective in the short to medium term. We will, however, continue to model the movement and persistence of nitrates using the advanced modelling techniques developed in AMP5 and continue to raise awareness at catchment and farm level on the impact of land use practices on raw water quality.

3.7.2.2 Concentrations of pesticides in raw water increased markedly in the period following the 2011/2012 drought and in response to high levels of catchment runoff in October 2013. In the current AMP, we have developed models to predict the impact of land use change on pesticide concentrations in surface waters. The outputs of these models allow us to identify the areas within catchments that carry the highest risks in terms of migration of pesticides to rivers either through direct run-off or via by pass flow. Our strategy going forward involves catchment officers working at farm and catchment level to provide advice and education and to carry out catchment monitoring. In a few of the catchments classified as high risk under the modelling program, including those that directly support reservoirs, we plan to investigate the effectiveness of subsidising farmers to use alternative products. Our strategy will also focus on the future impact of emerging pesticides on raw water quality in the groundwater and surface water systems operated by Anglian Water.

3.7.2.3 We are also at risk of point source contamination due to the vulnerable nature of groundwater systems in East Anglia. Risks to the security of supply are identified and managed through our Drinking Water Safety Planning (DWSP) approach and, where appropriate, we have invested in additional monitoring and treatment. In addition, subtle changes to natural raw water chemistry have been identified through our intensive raw water monitoring programme. These changes are due to complex hydro-geochemical processes operating in aquifers, some triggered by extreme hydrological events and changes to abstraction. Where appropriate, investment is planned to maintain full compliance with drinking water standards.

3.7.3 Climate change

3.7.3.1 A summary of our worst case climate change impacts on supply are given in Figure 3.19. This shows particular vulnerabilities in the following RZs:

- Ruthamford North (33.4Ml/d)
- Ruthamford South (61.1Ml/d)
- Norwich and the Broads (32Ml/d)
- Fenland (8.8Ml/d)
- East Suffolk (11.5Ml/d)
- East Lincolnshire (2Ml/d)
- Newmarket (2.6Ml/d), and
- South Essex (2.8Ml/d).

3.7.3.2 In each case, it is the deployable output from our reservoir and direct river intakes which is threatened.

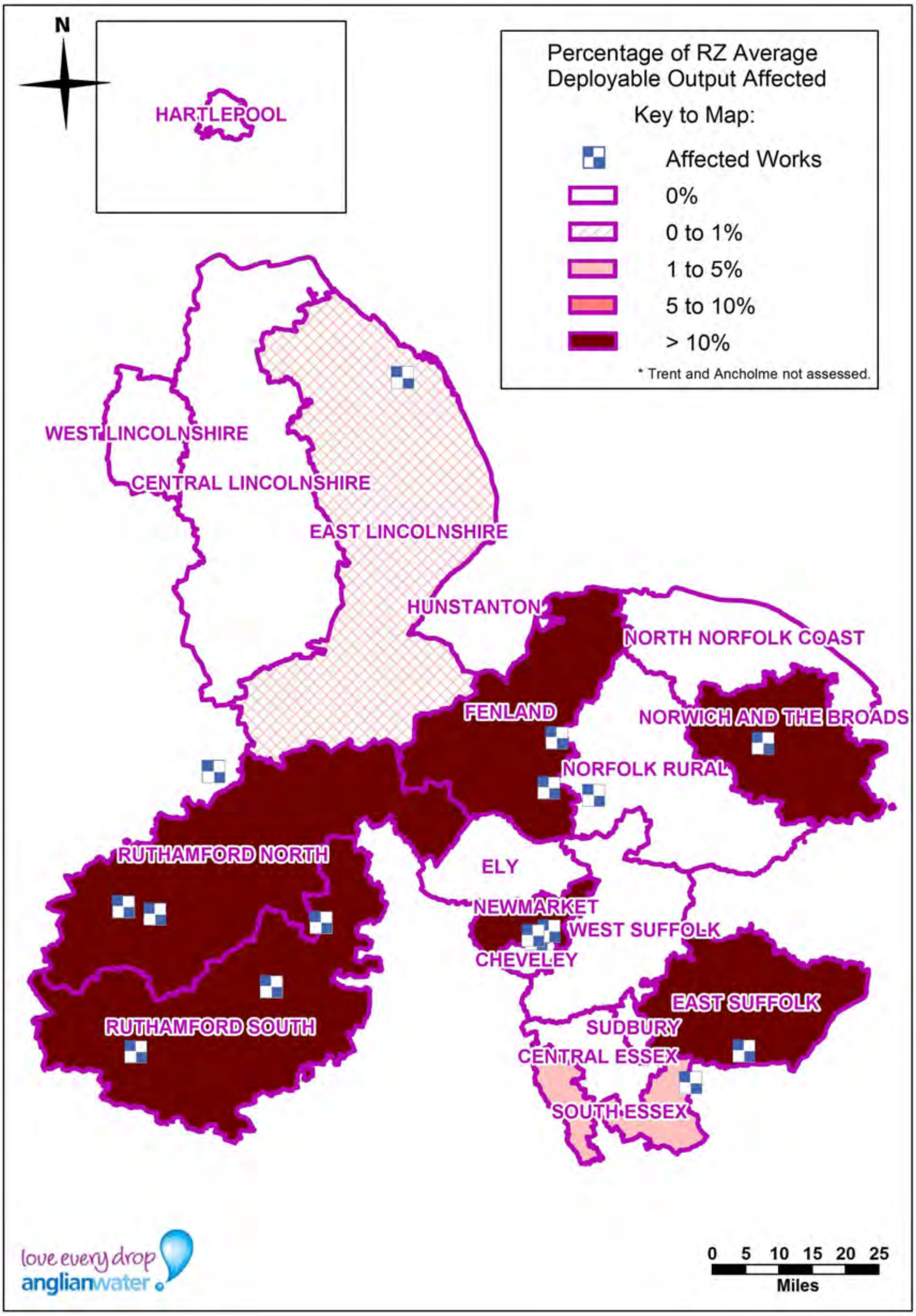


Figure 3.18 Worst case climate change impact excluding demand effects (as a % of daily sourceworks output)

4 Feasible Options

Key Points

- The WRP guideline process for developing feasible options for maintaining the supply-demand balance has been followed. This includes starting from an unconstrained list of all possible options
- The climate change vulnerability of each feasible option has been assessed
- The Benefits Assessment Guidance has been used to determine the social and environmental costs associated with each feasible option
- The Strategic Environmental Assessment and Habitats Regulations Assessment have been used iteratively to inform the option development process. Options likely to result in damage to the environment have either been modified or removed from the option selection process
- A number of trades with adjacent water companies have been identified. These are consistently reported in each company WRMP.

4.1 Option appraisal process

4.1.1 For RZs in deficit, the Water Resource Planning guideline specifies a comprehensive process for identifying the preferred options for maintaining the supply-demand balance. The approach that we used is based on this and included the following:

1. The development of an unconstrained list of options, taking account of Government policy and aspiration. This activity was based on a generic template listing all possible options
2. Screening of the unconstrained option set to identify feasible options. This was followed by:

    - The development of capex and opex estimates and estimates of social and environmental costs. The latter were generated using an approach based on the EA's Benefits Assessment Guidance (BAG)
    - An assessment of the climate change vulnerability of each option, and
    - An assessment of customer willingness to pay for each option

3. Evaluation of the feasible options using a Strategic Environmental Assessment (SEA) and Habitats Regulations Assessment (HRA), and then
4. Cost-effectiveness and cost-benefit modelling of the feasible option set to determine the preferred option set. This is the best value for customers and the environment and has been justified by scenario testing.

4.1.2 In this section the feasible option set is described. Development of the unconstrained option set was completed at a series of workshops held in 2012 with representatives from our Asset Planning, Water Resource Management, Water Operations and Capital Delivery teams. The results are reported in our Options Appraisal report, which is referenced in the Appendix. Following screening to identify potentially feasible options, these were appraised to confirm feasibility and the capex and opex requirements for each. Details of the main appraisals completed are given in Table 4.1.

PART ONE
Feasible Options

Option	Sub-option	Appraisal
Reservoirs	Existing capacity assessment	Task 1 - Reservoir Options a) Existing capacity assessment, AWS, August 2012
	Increase yield	Task 1 - Reservoir Options b) Increase yield/intakes/improve efficiency, AWS, September 2012
	Increase capacity	Task 1 - Reservoir Options c) Increase capacity - Raising/dredging – Part 1, AWS September 2012 Task 1 - Reservoir Options c) Increase capacity - Raising/dredging – Part 2, Alliance, December 2012
	Previous new reservoir options	Task 1 - Reservoir Options d) Review previous new reservoir options- Part 1, AWS, September 2012 Task 1 - Reservoir Options d) Review previous new reservoir options - Part2, Alliance, December 2012
	New reservoir options	Task 1 - Reservoir Options e) Assess new reservoir options – Part 1, AWS, September 2012 Task 1 - Reservoir Options e) Assess new reservoir options – Part 2, Alliance, December 2012
Transfers	Transfers	Task 2 Transfers, Alliance, May 2013
Water Reuse	Review previous studies	Task 3 – Water Reuse, Alliance, May 2013
	Assess new options	Included in Task 3 report above
	Assess backwash reuse	Included in Task 3 report above
Groundwater Development	Review spare capacity on licence	Included in preparation of WRMP - no separate report available
	Review group licences	Included in preparation of WRMP – no separate report available
	Review abandoned or unused boreholes	Task 4 – Groundwater Review c) Review abandoned / unused boreholes, AWS, December 2012
	Review blending requirements	Task 4 – Groundwater Review e) Review blending requirements, AWS, November 2012
CAMS Review	Assess potential river abstraction options	Task 6 – CAMS Review Assess potential river abstraction options, AWS, October r2012
	Assess potential groundwater abstraction options	Task 6 – CAMS Review b) Assess potential groundwater abstraction options, AWS, November 2012
Sizewell	Sizewell B	Task 7 – Sizewell B, AWS, May 2013
Aquifer Storage and Recovery	a) Aquifer Storage Recovery (ASR)	Task 8 - Aquifer Storage Options, Alliance, December 2012
	b) Infiltration galleries	Task 8 - Aquifer Storage Options, Alliance, December 2012

Option	Sub-option	Appraisal
	c) Aquifer Recharge	Task 8 - Aquifer Storage Options, Alliance, December 2012
Trent resources study	Trent resources study	Lower Trent Resources - 2012 Update Briefing Note, AWS, July 2012
Flood Management Options	Internal Drainage Boards	Task 10 – Flood Management Options, Alliance, November 2012
	Sustainable Urban Drainage Systems (SUDS)	Task 10 – Flood Management Options, Alliance, November 2012
	Other flood management schemes	Task 10 – Flood Management Options, Alliance, November 2012
Desalination	Review existing options	Task 11 – Desalination, Alliance, May 2013
	Assess new options	Task 11 – Desalination, Alliance, May 2013
Tankering	Tankering (Ocean)	Task 15 – Review of tankering options, AWS, February 2013
Clapham increased abstraction	Clapham increased abstraction	Task 16 - Clapham increased abstraction, Alliance, May 2013
Norwich – Heigham Options	Norwich – Heigham Options	Task 17: Norwich – Heigham (Options NB6, NB7, NB8), Alliance, May 2013

Table 4.1 Option appraisal reports

4.2 Feasible options

4.2.1 Details are given below of each of the feasible options that have been assessed in our cost-benefit and cost-effectiveness modelling. This includes details of the yield; capex requirements; opex requirements; social and environmental costs and sensitivity to climate change.

4.2.2 The social and environmental costs have been developed using the BAG methodology recommended by the EA. Details of our approach are given in the appendix (Technical Approach), along with a summary of the approach we have used to assess vulnerability to climate change.

4.2.3 In the tables that follow, climate change sensitivity scores of 1, 2 and 3 denote low sensitivity, limited sensitivity and sensitivity respectively. Feasible schemes are listed for those RZs forecast to enter deficit during the planning period.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
F1	King's Lynn and Wisbech water reuse	12	130,700	2,830	11	256	1
F2	King's Lynn desalination	12	54,000	3,970	5	307	1
F4	Ruthamford North RZ transfer (12 Ml/d)	12	22,100	220	3	16	2
F5	Ruthamford North RZ transfer (25 Ml/d)	25	34,200	250	5	18	2
Fen1	Leakage	0.5	145	20	17	0.8	1
Fen2	Leakage	0.5	155	29	18	1.8	1
Fen3	Leakage	0.5	236	37	19	1.7	1
Fen4	Leakage	0.5	214	70	21	5.6	1
Fen5	Leakage	0.2	1,655	-4	78	-1	1
Fen6	Enhanced Metering	0.74	3,602	54	-	-	1
Fen7	Water Efficiency Audits (measured households)	0.30	563	-	-	-	1
Fen8	Water Efficiency Audits (unmeasured households)	0.07	126	-	-	-	1

Table 4.2 Fenland RZ feasible supply-side and demand management options

4.2.4 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
H1	Fenland RZ transfer	1.5	1,700	20	0	1	2
H2	Heacham water reuse	1	15,600	140	0	10	1

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
H3	Wash desalination	1	16,600	330	0	19	1
H4	Hunstanton RZ groundwater development	1	3,900	60	0	4	2
Hun1	Leakage	0.02	8	0.2	1	-0.1	1
Hun2	Leakage	0.02	11	1.0	1	-0.1	1
Hun3	Leakage	0.02	11	1.3	1	0.0	1
Hun4	Leakage	0.02	35	1.1	2	-0.2	1
Hun5	Leakage	0.01	105	-0.2	36	-0.1	1
Hun6	Enhanced Metering	0.03	136	2	-	-	1

Table 4.3 Hunstanton RZ feasible supply-side and demand management options

4.2.5 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
NB1	Bacton desalination (46 Ml/d)	46	150,100	15,500	0	1,230	1
NB5	Norwich storage	46	67,200	510	142	42	3
NB10	Norwich intake to existing bankside storage	46	21,700	290	0	25	3
NB11	Norwich water reuse	11	79,300	1,780	0	86	1
NB12	Bacton desalination (11 Ml/d)	11	65,400	3,430	0	260	1
NTB1	Leakage	0.4	150	13	18	-0.3	1
NTB2	Leakage	0.5	162	18	19	0.1	1

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
NTB3	Leakage	0.4	182	24	19	0.7	1
NTB4	Leakage	0.5	202	40	19	2.1	1
NTB5	Leakage	0.1	180	20	8	1.4	1
NTB6	Enhanced Metering	1.3	6,480	90	-	-	1
NTB7	Water Efficiency Audits (measured households)	0.5	954	-	-	-	1

Table 4.4 Norwich and the Broads RZ feasible supply-side and demand management options

4.2.6 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
ES3	Ipswich water reuse	11	64,900	1,700	115	138	1
ES4	Felixstowe desalination	11	55,200	3,620	94	281	1
ES6	East Suffolk RZ groundwater development	0.8	4,500	80	10	3	2
ES10	South Essex RZ transfer	6.0	8,300	80	23	6	2
ESU1	Leakage	0.3	105	13	12	0.2	1
ESU2	Leakage	0.3	102	16	12	0.7	1
ESU3	Leakage	0.2	87	22	10	1.5	1
ESU4	Leakage	0.3	396	40	123	2.8	1
ESU5	Leakage	0.1	535	26	181	2.5	1
ESU6	Water Efficiency Audits (measured households)	0.53	990	-	-	-	1

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
ESU7	Water Efficiency Audits (unmeasured households)	0.09	160	-	-	-	1

Table 4.5 East Suffolk RZ feasible supply-side and demand management options

4.2.7 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
SE1	Colchester water reuse	16	74,400	1,540	0	146	1
SE2	East Suffolk RZ transfer (12 Ml/d)	12	11,300	140	0	10	2
SE4	Amendment to Ardleigh agreement	2.7	0	240	0	4	1
SE6	South Essex RZ groundwater development	1	3,100	60	0	1	2
SE7	Ardleigh reservoir extension	2	10,700	190	0	11	3
SE8	East Suffolk RZ Transfer (2Ml/d)	2	6,000	40	0	2	2
SEX1	Leakage	0.2	78	6	10	-1.2	1
SEX2	Leakage	0.2	76	8	10	-1.0	1
SEX3	Leakage	0.2	72	12	9	-0.5	1
SEX4	Leakage	0.2	76	18	10	0.2	1
SEX5	Leakage	0.1	37	7	10	0.3	1
SEX6	Water Efficiency Audits (measured household)	0.38	709	-	-	-	1

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
SEX7	Water Efficiency Audits (unmeasured household)	0.06	118	-	-	-	1

Table 4.6 South Essex RZ feasible supply-side and demand management options

4.2.8 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
CE1	South Essex RZ transfer	1.5	3,700	30	0	1	2
CE2	West Suffolk RZ Transfer	1.5	8,500	80	0	4	2
CEX1	Leakage	0.1	24	4.1	2	0.2	1
CEX2	Leakage	0.1	22	4.7	2	0.3	1
CEX3	Leakage	0.1	9	2.5	1	0.2	1
CEX4	Leakage	0.1	455	-1.4	205	-0.4	1
CEX5	Leakage	0.1	407	-0.9	183	-0.3	1
CEX6	Water Efficiency Audits (measured households)	0.06	115	-	-	-	1
CEX7	Water Efficiency Audits (unmeasured households)	0.02	36	-	-	-	1

Table 4.7 Central Essex RZ feasible supply-side and demand management options

4.2.9 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
CVY1	Newmaket RZ Transfer	1	1,100	20	0.1	1	2
CVY2	West Suffolk RZ Transfer	1	3,100	30	0.4	1	2
CVY3	Water Efficiency Audits (measured households)	0.01	14	-	-	-	1
CVY4	Water Efficiency Audits (unmeasured households)	0.002	4	-	-	-	1

Table 4.8 Cheveley RZ feasible supply-side and demand management options

4.2.10 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
E1	Fenland RZ transfer	15	23,400	160	4	12	2
E2	Newmarket RZ transfer	5	3,900	0	0.5	0	2
ELY3	Leakage	0.1	1,429	-1.4	648	-0.8	1
ELY5	Leakage	0.1	970	-0.9	440	-0.5	1
ELY6	Enhanced Metering	0.28	1,457	20	-	-	1
ELY7	Water Efficiency Audits (measured households)	0.14	260	-	-	-	1
ELY8	Water Efficiency Audits (unmeasured households)	0.02	46	-	-	-	1

Table 4.9 Ely RZ feasible supply-side and demand management options

4.2.11 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
WS1	Newmarket RZ transfer	8.5	11,000	70	2	4	2
WS2a	East Suffolk RZ transfer (15Ml/d)	15	28,000	180	5	13	2
WS2b	East Suffolk RZ transfer (resilience scheme)	4.7	0	50	0	4	2
WS3	Bury St Edmunds water reuse	5	33,600	360	2	34	1
WS4	Thetford water reuse	2.9	21,200	710	2	17	1
WS5	River Lark flow augmentation	4.5	3,000	10	1	1	1
WS6	South Essex RZ transfer	15	23,400	140	4	10	2
WSU1	Leakage	0.3	91	6	10	0	1
WSU2	Leakage	0.3	91	13	10	0.6	1
WSU3	Leakage	0.3	102	20	11	1.3	1
WSU4	Leakage	0.3	459	26	183	2.1	1
WSU5	Leakage	0.1	1,279	-1.1	575	-0.3	1
WSU6	Water Efficiency Audits (measured households)	0.28	525	-	-	-	1

Table 4.10 West Suffolk RZ feasible supply-side and demand management options

4.2.12 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
RHFA2	Peterborough water reuse	20	103,500	4,400	9	350	1
RHFA3	Rutland Dam Raising	16	107,800	400	499	27	3

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
RHFA5	Pitsford Dam Raising	11	58,900	430	186	27	3
RHFA6	Canal Transfer	13	73,100	1,470	6	103	1
RHFA15	Reduce Ruthamford North RZ raw water export	8	0	160	0	12	2
RTN1	Leakage	0.9	527	68	148	4.1	1
RTN2	Leakage	0.9	354	98	38	7.2	1
RTN3	Leakage	0.9	890	105	267	7.3	1
RTN4	Leakage	0.8	1,752	118	605	9.0	1
RTN5	Leakage	0.4	6,127	-14	2,489	-0.4	1
RTN6	Enhanced Metering	0.07	361	5	-	-	1
RTN7	Water Efficiency Audits (measured households)	1.45	2,725	-	-	-	1
RTN8	Water Efficiency Audits (unmeasured households)	0.26	485	-	-	-	1

Table 4.11 Ruthamford North RZ feasible supply-side and demand management options

4.2.13 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
RHFA1	Ruthamford North RZ Transfer 1 (24Ml/d)	24	30,400	320	5	27	2
RHFA7	Grafham dam raising	40	92,900	680	759	51	3
RHFA8	New Ruthamford South Reservoir	26	274,500	930	684	495	3

Opt. Ref	Option Name	Average capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Environmental & Social Costs (Including carbon)		Climate Change Sensitivity Score (1-3)
					Fixed Costs (£k)	Variable (£k/yr)	
RHFA11	Recommission Ruthamford South RZ reservoir	9	19,800	520	2	32	3
RHFA13	Ruthamford North RZ Transfer 2 (39Ml/d)	39	75,300	640	11	53	2
RHFA14	Huntingdon water reuse	5.4	41,000	670	3	57	1 or 2
RTS1	Leakage	1.8	629	65	69	1.2	1
RTS2	Leakage	1.8	631	98	70	5.1	1
RTS3	Leakage	1.8	1,102	119	271	6.3	1
RTS4	Leakage	1.8	1,417	211	229	14.4	1
RTS5	Leakage	0.5	5,758	33	2,163	-2.9	1
RTS6	Enhanced Metering	1.17	6,040	85	-	-	1
RTS7	Water Efficiency Audits (measured households)	1.32	2,503	-	-	-	1
RTS8	Water Efficiency Audits (unmeasured households)	0.21	394	-	-	-	1

Table 4.12 Ruthamford South RZ feasible supply-side and demand management options

4.2.14 It is assumed that there are no significant social, environmental and carbon costs for the enhanced metering and water efficiency options. In addition, it is assumed that there are no on-going opex costs associated with water efficiency audits.

4.3 Trading options

4.3.1 Details of the main trades and bulk transfers that are included in the plan are given in Table 4.13 below:

Company (from)	Company (to)	Trade	Volume (Ml/d) Average	Volume (Ml/d) Peak	Start Date (in plan)
Cambridge Water	Anglian Water	Barnham Cross	0.25	(-)	2015-16
Affinity East	Anglian Water	Baseline Ardleigh Agreement (70/30 split)	5.2	7.2	2012-13
Affinity East	Anglian Water	Amended Ardleigh Agreement (80/20 split)	7.8	10.8	2032-33

Company (from)	Company (to)	Trade	Volume (Ml/d) Average	Volume (Ml/d) Peak	Start Date (in plan)
Anglian Water	Affinity Water	Grafham Export	91	109	2012-13
Essex and Suffolk Water	Anglian Water	Tiptree bulk supply	3.0	4.5	2012-13
Anglian Water	Severn Trent Water	Rutland Export	18	18	2012-13

Table 4.13 Summary details of principal water trades between companies

4.3.2 The bulk supply from Cambridge Water will be available on delivery of our AMP5 Barnham Cross transfer scheme.

4.3.3 We are also progressing discussions with Severn Trent Water about a trade based on a statutory requirement that we have to export water to them from our Ruthamford North RZ. The volume of the export is for 18Ml/d at average and peak and the trade would involve us retaining this water for use in our own supply systems. To enable the trade to happen, Severn Trent need to provide an alternative source of supply to customers in those parts of their system that currently receive the export.

4.3.4 There is currently some uncertainty about the infrastructure required in the Severn Trent system for the alternative source of supply and so although the option is technically feasible, the costs and terms of a bulk supply agreement have yet to be agreed. For this reason the trade has not been modelled in our least-cost modelling. The significance of this is limited, as our modelling shows that no additional resources are likely to be required in our Ruthamford North RZ until AMP10.

4.3.5 Table 4.13 does not include the minor cross-border connections that exist between adjacent water companies. These are referenced in the Appendix on our trading related discussions.

4.4 Protecting the environment

4.4.1 In developing our preferred plan we have framed our assessment of water resources within the context of protecting the environment. We believe that this is in accordance with Government's aspiration to achieve positive environmental outcomes through the WRMP process, as presented in Water for Life.

4.4.1 Strategic Environmental Assessment & Habitats Regulations

4.4.1.1 We have assessed the environmental impact of our WRMP, with particular reference to the each of the demand management and supply scheme options. We have completed a Strategic Environmental Assessment (SEA) of the plan in accordance with UKWIR Guidance 'Strategic Environmental Assessment and Habitats Regulations Assessment – Guidance for Water Resources Management Plans and Drought Plans' (ref. 12/WR/02/7); and the Office of Deputy Prime Minister (ODPM) (now the Department for Communities and Local Government (DCLG)) Guidance 'A Practical Guide to the Strategic Environmental Assessment Directive' (September 2005).

4.4.1.2 We have also completed a Habitats Regulations Assessment (HRA) and a WFD assessment. These assessments are presented in separate reports but the results have all fed into the SEA. Figures 4.1 to 4.3 show the interaction between the different assessments and the WRMP.

4.4.1.3 The main written output from the SEA process is the Environmental Report which is available under separate cover. The Environmental Report presents information on the likely significant effects of options presented in our WRMP, and has been used to inform our decision on the selection of our preferred options. The SEA includes details of the schemes that were discounted on environmental grounds.

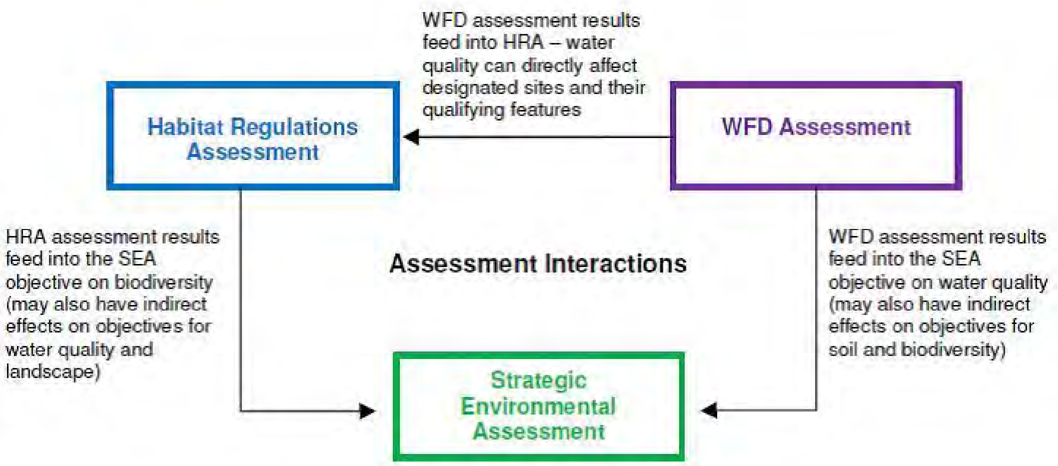


Figure 4.1 Assessment interactions

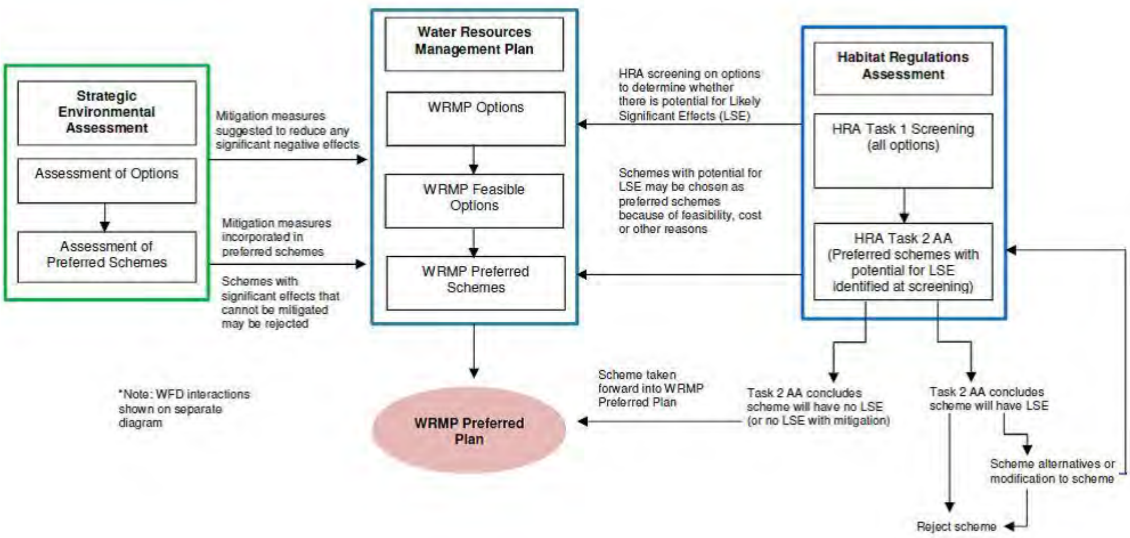


Figure 4.2 Interactions between the WRMP, the SEA and HRA

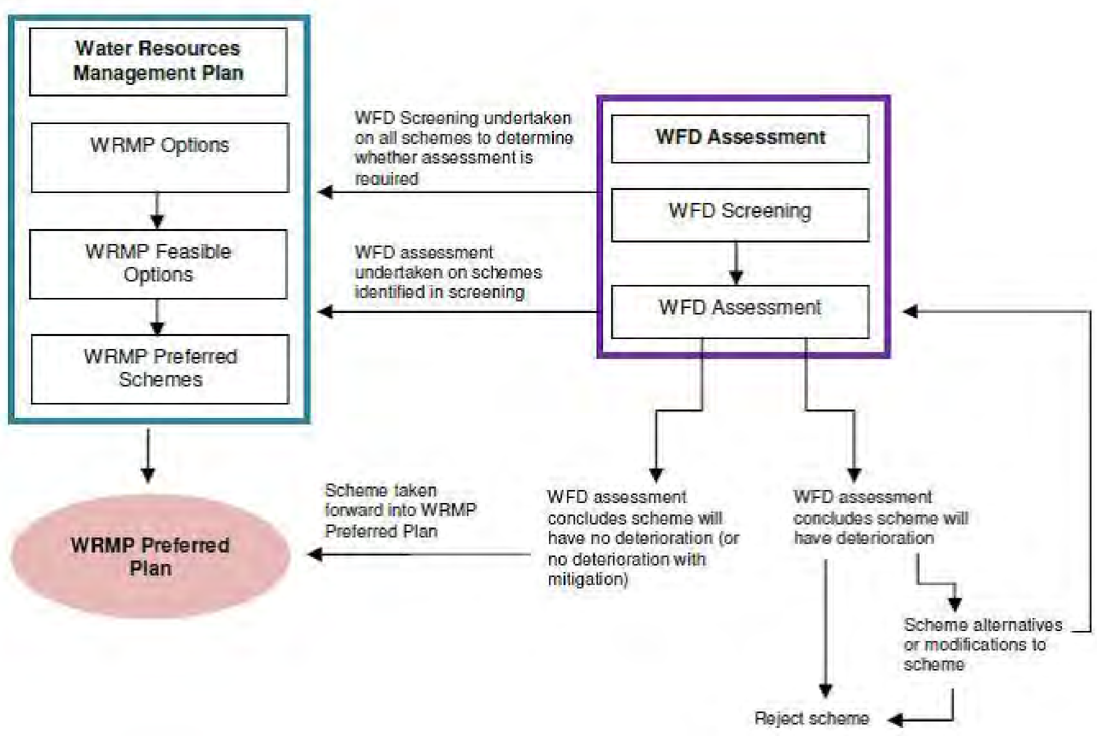


Figure 4.3 Interactions between the WRMP and WFD Assessments

4.4.1.4 The HRA process has included an assessment for the supply options to determine whether there was potential for likely significant effects on any European sites (of environmental importance). Where this assessment demonstrated potential for any of the preferred options, then a further stage of Appropriate Assessment was completed to confirm that the schemes would not cause any adverse impact to the European sites.

4.4.1.5 An Appropriate Assessment was completed for the Norwich Discharge Reuse scheme (NB11) and the Ruthamford North Transfer (RHFA1), and both concluded no likely significant effect.

4.4.1.6 The WFD assessment followed the EA's national screening approach to determine the level of risk from the proposed schemes to WFD status and objectives of water bodies. In accordance with the EA's guidelines, we have not completed a WFD assessment for the options that rely on a bulk transfer from another water company. Where the screening has identified a potential risk we have identified the information required or investigation needs to complete a full WFD assessment.

4.4.2 Discounted schemes

4.4.2.1 The SEA includes a full assessment of all of the feasible options that we have considered through the WRMP process from draft for consultation through to the final preferred plan. The scheme options have been refined and amended based on a number of criteria including capacity to meet demand, and feasibility in terms of cost and environmental implications. The schemes listed in Table 4.14 have been discounted for the reasons described and were therefore not considered further in developing the preferred plan.

Scheme Name	Reason for discounting scheme
Norwich water reuse (NB2)	Scheme NB2 is a sustainability reduction scheme which provided an alternative raw water source to the Wensum. However this option did not provide adequate resource to fully satisfy the sustainability reduction so was discounted. A smaller Norwich water reuse option has been developed (NB11) which includes additional water treatment capacity and therefore provides additional DO.
Cantley desalination (NB3)	Rejected due to potential significant environmental effects of brine discharge and effects on designated sites.
Lowestoft water reuse (NB4)	Discounted as this option did not provide adequate resource to fully satisfy the sustainability reduction and the potential environmental effects on designated sites.
Norwich intake with pre-treatment (NB6)	Since the publication of the draft WRMP Anglian Water has been working with the Environment Agency and Natural England to resolve concerns about the preferred option for delivering the Wensum sustainability reduction (NB10). As part of this work all the Norwich and the Boards RZ options have been revisited to ensure that a common approach is taken for all options. The preferred option (NB10) is to reinstate the downstream intake with transfer back to the existing storage pits. Therefore as the risks (water quality, low flow etc) can be managed and are considered acceptable for NB10 then the option to add additional upfront treatment process (NB6) is not required and therefore discounted.
Norwich intake with lining existing bankside storage (NB7)	As stated above all Norwich and the Boards RZ options have been revisited. A hydrological assessment of the storage pits concluded that normal operation does not impact the River Wensum SAC. There is no requirement to line the pits for continued use and therefore this option has been discounted.
Norwich intake with new bankside storage (NB8)	This option to provide new bankside storage (NB8) was developed as an alternative to utilising the existing storage pits if the risks associated with continued operation of the pits were deemed unacceptable. Normal operation of the pits is acceptable and so this option has been discounted.
Grafham intake refurbishment (RHFA9)	This option was not presented in the draft WRMP. It was discounted before the publication of the draft as it was assumed that the work required to restore the intake will be carried out as asset maintenance. Therefore the baseline DO was calculated assuming the intake had been refurbished and the option discounted.
RHF North Transfer 3 (RHFP1), RHF North Transfer 4 (RHFP2), RHF North Transfer 5 (RHFP3), Clapham WTW (RHFP1), Ruthamford North RZ transfer (RHFP5)	The original option set for Ruthamford was developed using an early version of the supply demand balance which showed a peak deficit greater than the average deficit. Therefore a set of peak specific options were developed (denoted RHFP1, P2 etc). However the final supply demand balance used for the draft WRMP and the revised draft WRMP shows a smaller peak deficit than at average. Therefore the option set developed for average are adequate to satisfy the peak deficits and the peak specific options have been discounted.
Thetford PZ transfer (CWS1)	Following further review of RZ integrity Cambridgeshire and West Suffolk RZ has been split into a number of new RZs for the revised draft WRMP. This option is no longer applicable to the new configuration of RZs.
Sudbury PZ transfer (CWS3)	As above, this option is no longer applicable to the new configuration of RZs.
Haverhill water reuse (CWS6)	As above, this option is no longer applicable to the new configuration of RZs.
Fenland RZ transfer (CWS11)	As above, this option is no longer applicable to the new configuration of RZs.

Table 4.14 Discounted supply options

4.4.3 Strategic options

4.4.3.1 We have previously considered a wide range of strategic water resource options including new winter storage reservoirs, a regional scale aquifer storage and recovery (ASR) scheme, additional water reuse schemes and desalination options. Our plan shows that over the forecast period we are likely to be able to maintain the supply-demand balance without these. Our requirement for them is in the long-term or if the impacts from worst case climate change, high population growth, worst case sustainability reductions and worst case combination scenarios are realised. Given the strategic significance of such options and the uncertainty inherent in worst case assessments, we believe that they are best considered as part of the multi-company, multi-sector WREA project. Sustainable management of water resources and the freshwater environment will be a central part of the WREA project, and enable a robust long-term water resources strategy to be developed for East Anglia.

4.4.3.2 We have not included any detailed environmental assessment of these strategic options in the current plan or the accompanying SEA. However, it is worth noting that a number of these strategic options were considered in more detail in the environmental reports and SEA which accompanied the 2010 WRMP.

5 Consultation Issues and Customer Views

Key Points

- Customer attitudes to supply-demand risk and levels of service have been explored through consultation on the PR14 Business Plan and draft WRMP
- From this a cost-benefit analysis has been completed for proposals to enhance levels of service in our Ruthamford RZs; extend our demand management programs and defer a limited number of sustainability reductions from AMP6
- Related to the demand management proposals, we have also assessed the costs and benefits of compulsory metering
- The results of this work show that customers value the benefits of the level of service enhancements and extended demand management programmes more than the costs and that these investments are cost-beneficial
- Compulsory metering is shown not to be cost-beneficial compared to our preferred metering strategy, and
- Deferring the sustainability reductions avoids a significant risk of stranding expensive new assets. The short-term environmental risks that result from this will be offset by our extended demand management programme, NEP Phase III river restoration works and by piloting an abstraction incentive mechanism.

5.1 Customer engagement

5.1.1 Love Every Drop

5.1.1.1 Given the threat posed by climate change, growth and sustainability reductions, we have developed our Love Every Drop campaign to raise awareness about the value of water. We want to get people thinking as responsibly about water as many millions already do about recycling.

5.1.1.2 Our overall ambition is to reduce consumption, stop pollution, cut carbon and eliminate waste. To achieve this, Love Every Drop encourages new and different attitudes to water, leading our customers to adopt more responsible behaviours. Love Every Drop goals that are relevant to our WRMP include:

- Be the frontier performer in our industry, including best performer on leakage, a drive to be the most efficient water company and championing innovation
- No pollutions. Successfully treating wastewater and returning high quality effluent to rivers allows us to support base flows and so mitigate the impact of extended periods of dry weather
- Halve embodied carbon in the building of new assets by 2015 and reduce operational carbon by 10%. Achieving these targets will require work with customers and communities to promote better understanding about the link between water and carbon, and
- Effective management of climate change and growth. This includes campaigning to help people save water and energy, understanding embedded water in business customer products, working with local authorities to put water sustainability at the heart

of the planning process, protecting and enhancing biodiversity and encouraging efforts to care for our environment.

5.1.2 Key consultation issues

5.1.2.1 In developing this plan, we have consulted widely with our customers and other stakeholders on issues related to the management of water resources. This has included the following:

- Publishing a draft version of this plan
- Publishing draft versions of the related Strategic Environmental Assessment and Habitats Regulation Assessment
- Hosting a Water Summit, at which stakeholders were engaged on the challenges we face in our region and the key consultation issues
- Engaging with other abstractors at a strategic water resource management workshop
- Meeting with local authorities in our region to brief them on the plan and on the key consultation issues, and
- Customer engagement on the supply-demand investments which are contained in our PR14 Business Plan

5.1.2.2 The development of the plan has also been influenced by the 2010-12 drought and the collaborative planning efforts that emerged from this. These included:

- Engagement with the EA on the need for a more flexible and adaptive approach to long-term water resource planning in which it was recognised that there need to be improvements in the way that we manage uncertainty and risk
- Work with the National Drought Management Group (NDMG). Organised to develop contingency plans for a third dry winter, this comprised representatives from the water companies, regulators and other third parties. A key recommendation from the NDMG was to progress appropriate levels of resilience through the existing water resource and drought planning processes, and
- Two drought workshops, one of which was sponsored by Anglian Water. At these a consensus was developed on the need for water resource planning to increase the resilience of our supply systems to the possible future effects of drought, climate change and population growth.

5.1.2.3 The PR14 customer engagement process was based on a wide range of activities and involved using the views of our customers to shape the options in our business plan; test choices and test the acceptability of our final strategy and plan, including in respect of water resource management issues. Key features included:

- 15 focus groups with household customers and 45 in-depth interviews with business customers and other stakeholders
- Our Discover, Discuss, Decide interactive website and social media campaign, which produced over 4,800 responses
- A Water View budget simulator
- Willingness to pay surveys. There were two of these: a main survey and a second stage survey focused on water resource issues including levels of service and the different options for maintaining the supply-demand balance
- Acceptability research, and
- Independent scrutiny and challenge from our Customer Engagement Forum.

5.1.2.4 Given the scale of our future supply-demand challenges, we also consulted on a number of key issues in our draft WRMP, including:

- **Should we invest to improve levels of service?** Through historic and recent investment to "drought-proof" vulnerable groundwater sources and our direct intakes, customers supplied from these receive a higher level of service than customers who depend on supplies from reservoirs. Approximately 680,000 customers are directly affected by this issue at the moment. We think that these customers should have the same levels of service as everyone else but delivering this involves building a large raw water transfer from the Trent into our Ruthamford supply system that is estimated to cost £425m. If this investment is made, almost none of our customers would be at risk from rota-cuts or stand-pipes during extended periods of drought
- **By how much more should we reduce leakage?** Leakage is a critical issue for customers. We currently out-perform our leakage target, which is set by Ofwat and the EA at the sustainable economic level of leakage (SELL), and are considering how much lower we should go. Controlling leakage is expensive and short term (2020) options to reduce leakage to 94% and 73% of our current SELL will cost between £16m and £43m per year respectively. Over the long-term (2040), reducing leakage to 44% of our current SELL will cost £25m per year. Since we are already below our SELL, these investments would all be more expensive than developing alternative supply-side options
- **Should we promote metering and water efficiency across the whole of our region?** Typically in water resource investment planning, metering and water efficiency are only promoted in areas which are in deficit. However, a key Government target is reducing levels of consumption and so we are considering the value of extending the programme across the whole of our supply area
- **What is the best approach to achieving sustainable levels of abstraction?** We are committed to restoring sustainable levels of abstraction in our region. However, the EA has identified a large number of sites where we may have to relocate our source works. Given the costs that are involved, we need a high level of certainty about the volume of additional supplies that are required. For schemes where certainty is an issue, we are committed to a combination of investigation, planning and environmental risk mitigation in AMP6, followed by the delivery of assets in AMP7.

5.1.2.5 In the section below we summarise our customers view of these issues and their willingness to pay to avoid the related risks. We then use this information to complete a cost-benefit analysis for each of the related schemes/proposals. We have structured this discussion on the basis of:

- Enhancements to levels of service in the Ruthamford supply system
- A programme of extended demand management schemes, including leakage, metering and water efficiency, and
- The deferral of a limited number of sustainability reduction schemes from AMP6 to AMP7

5.1.2.6 Related to the proposals for an extended demand management programme, we also include details of a cost-benefit analysis for compulsory metering.

5.2 Enhanced levels of service

5.2.1 Background

5.2.1.1 The Trent-Ruthamford transfer scheme is designed to enhance levels of service for customers in our Ruthamford supply system. These are exposed to a three dry winter related risk of non-essential use bans, rota-cuts and standpipes that most of the rest of our customers are not.

5.2.1.2 Since privatisation, there have been a number of droughts in our region. In response to each of these, we have invested to secure supplies. These schemes have been directed at vulnerable groundwater and direct abstraction systems. Once we have delivered our 2010-12 drought schemes, none of our customers who are supplied from these will be vulnerable to drought related restrictions on supply.

5.2.1.3 By contrast, customers supplied from reservoirs will still be exposed to a risk of severe restrictions. This will vary as a proportion of the supply which is derived from reservoirs and our biggest vulnerability is in the Ruthamford supply system. In this, 680,000 customers depend almost entirely on reservoirs for their water supply.

5.2.2 Investment need

5.2.2.1 The 2010-12 drought exposed critical vulnerabilities in the Ruthamford system with respect to the effect of three dry winters.

5.2.2.2 Following the second dry winter, a temporary use ban was implemented and arrangements made for a non-essential use ban. Contingency planning showed that a third dry winter would have resulted in a shortfall in supplies and the need for rota-cuts and standpipes. Fortunately, the drought ended and these measures were not required. If used, the consequences would have included:

1. Households and businesses being “off” water for several hours each day. This would have caused severe disruption to essential domestic routines (washing, bathing and toilet flushing), loss of amenities, a risk to public services and severe economic disruption with a significant loss of output
2. Severe strain on our distribution system, leading to a loss of performance and further disruption as essential repairs are made
3. Increased water quality risks from de-pressurisation of the distribution system and the ingress of potentially contaminated surface water and shallow groundwater. This is likely to have led to an increase in boil notices, as well as more frequent unplanned interruptions to supplies as mains were flushed to remove the contaminated water
4. A massive increase in leakage caused by damage to the distribution system from repeated cycles of pressurisation and depressurisation. Experience elsewhere shows that these effects persist well after the system returns to "normal" operation
5. Degradation of the environment as emergency abstractions are used in an attempt to reduce the size of the drought deficit, and
6. If the drought had persisted, massive expenditure on emergency work to bring additional supplies into the region. Options include inter-basin transfers; tankering freshwater into the region from overseas, water re-use and seawater desalination with transfers from the coast to population centres inland.

5.2.2.3 Rota-cuts and standpipes would also have had a massive detrimental impact on the reputation of the water sector.

5.2.3 Customer views and willingness to pay

5.2.3.1 Customer attitudes to levels of service were surveyed for the PR14 Business Plan. Arising from this:

- There is recognition of increasing pressure on water supply systems from growth and changing weather patterns. Customers note that the Anglian region is particularly vulnerable to these effects
- Customers are clear that severe restrictions are unwanted and that they are willing to pay to avoid them
- They do not expect to experience severe restrictions in their lifetime
- They expect us to be planning ahead, taking action now to build resilience and prevent problems storing up for the future, and
- Opinion is divided about future investment in resilience; some customers want investment to continue at the current rate (while keeping bill increases to a minimum) while similar proportions would like to increase levels of investment.

5.2.3.2 From Consumer Council for Water research completed following the 2010-12 drought:

- Customers think that responsibility for managing droughts and conserving water lies mostly with water companies, and
- When asked what companies should be doing to avoid hosepipe bans in the future, the fixing or prevention of leaks featured most prominently, while others mentioned moving water around the country and general investment in infrastructure.

5.2.3.3 Willingness to pay to avoid supply restrictions was also assessed for the PR14 Business Plan. From this:

- Customers are willing to pay £4.813m per year to avoid a 1Ml/d deficit, and
- Overall they would be willing to pay £30 per year each for a defined package of service enhancements. Given 1.904m households, this is equivalent to £57.13m per year.

5.2.4 Investment alternatives

5.2.4.1 Arising from the 2010-12 drought, the following options were considered for maintaining supplies in the Ruthamford system:

- Accelerated delivery of supply-side schemes from our 2010 WRMP. These included the groundwater development and recommissioning a reservoir
- Restricting exports from the Ruthamford system to Lincolnshire. This involved providing an alternative source of supply for customers in Grantham
- Increasing connectivity in the Ruthamford system so that the available resources could be used more effectively
- Enhancing pumping capacity at our intakes on the Rivers Nene and the River Ouse, so that refill opportunities could be maximised, and
- Demand management measures including reducing leakage and increasing metering and water efficiency activities.

5.2.4.2 A number of these schemes are currently being delivered and we are planning further reductions in leakage, more meter installations and more water efficiency activity.

5.2.4.3 Even with these measures, we estimate that a third dry winter in the Ruthamford system would have resulted in a shortfall in supplies of up to 200 Ml/d. The options we have considered for dealing with this include:

- River Trent transfer to Rutland Reservoir (200Ml/d)
- River Trent transfer to Wing WTW and Morcott WTW (200Ml/d)
- River Trent transfer to River Welland and River Nene (200Ml/d)
- Integrated raw water transfer network – the Trent Ruthamford scheme comprising a Trent transfer to the River Nene and River Ouse (200Ml/d)
- River Trent transfer to Pitsford Reservoir by canal (50Ml/d)
- Transfer from Grafham to Pitsford (40Ml/d)
- Trading water with Severn Trent Water
- Trading water with Affinity Water
- Dam raising for Rutland Water (20Ml/d)
- Dam raising for Pitsford Water (14Ml/d)
- Dam raising for Grafham Water (50Ml/d)
- New reservoir near Grafham Water (33Ml/d), and
- New South Lincolnshire Reservoir (113Ml/d).

5.2.4.4 In respect of these:

1. The water trading options are unlikely to be reliable in times of drought and so have been discounted
2. The Grafham-Pitsford option assumes resource availability in the southern part of the Ruthamford supply system during a drought in the northern part. In a drought across the whole of the Ruthamford supply system this option would not increase overall resource availability
3. Similarly, the new Grafham dam and the dam raising options all assume a partial drought in the Ruthamford supply system and the ability to maintain and then transfer resources from the unaffected parts of the system. As such, it is unlikely that these options would provide additional resources during a drought across the whole of the Ruthamford supply system, and
4. The South Lincolnshire Reservoir and canal transfer options have insufficient capacity to restore the whole of the drought deficit.

5.2.4.5 Based on this, feasible options for mitigating drought risk for all Ruthamford customers are restricted to the various Trent transfers. More work is needed to assess the cost-effectiveness of each of these and so at this stage, a raw water transfer option that would support the whole system is preferred. This would cost around £425m of which £4m is needed for detailed design work. For affordability, we propose to complete the design work in AMP6 and deliver the resulting scheme in AMP7. The design work will assess the environmental and bio-security issues associated with such a large inter-basin transfer.

5.2.5 Cost benefit assessment

5.2.5.1 Assuming that each of the 680,000 customers at risk in the Ruthamford supply system is willing to £30 per year to avoid severe restrictions and that the life of the assets we deliver is 80 years, customers value the benefit from investing in the scheme at £447.97m. This sum exceeds the current scheme capex estimate by £23m.

5.2.5.2 If a value based on the Ml/d avoided deficit is used and this is capped to account for diminishing marginal benefit effects at £96.26m per year (equivalent to 20Ml/d), the benefits of the scheme are valued at £794.54m. This is £370m or 1.9 times more than the cost of the scheme. Both sets of calculations assume a discount rate of 4.5%.

5.2.5.3 A high level assessment of the impact on customer bills shows that the scheme will add between 1.5% and 2% to total bills for water and wastewater services. This is equivalent to approximately £6 per year and is much less than the £30 limit derived from our willingness to pay surveys. Other benefits from the scheme include avoidance of the following:

- Damage to the integrity of our Ruthamford distribution system with benefits for leakage reduction, water quality risk, incidences of low pressure and unplanned interruptions to supply
- The risk of needing to deliver high value capital schemes in an emergency situation, and
- Reputational damage from having over 1,000,000 people on rota-cuts and standpipes.

5.2.5.4 The value of these benefits is in addition to the benefits valued by customers.

5.2.6 Impact of the investment on levels of service

5.2.6.1 Until the scheme is delivered (2024-25), our levels of service will remain as they are now. These include:

- Temporary Use Ban: 1 in 10 years (includes hosepipe bans)
- Non-essential Use Ban: 1 in 40 years
- Rota-cuts and Standpipes: 1 in 100 years.

5.2.6.2 Following delivery of the scheme, the risk of widespread non-essential use bans, rota-cuts and standpipes will be removed. We will likely retain a level of service based on a 1 in 10 year temporary use ban, since this gives us the flexibility to deal with environmental and social issues that arise from drought and extended periods of dry weather.

5.2.7 Scheme implementation

5.2.7.1 For this WRMP and the PR14 Business Plan, we have completed a high level assessment of the different drought resilience options for the Ruthamford system. This has shown that the Trent-Ruthamford scheme is both technically feasible and our preferred option.

5.2.7.2 Before the scheme is delivered, however, more detailed work is needed to assess the environmental issues associated with the scheme; to validate the initial feasibility assessment and to confirm affordability. This work will be undertaken in AMP6 in the early "Risk and Value" stages of our capital delivery process.

5.2.7.3 The progression of the scheme depends on a favourable outcome to these preliminary works. At the present time construction is not planned until AMP7 (2020-25).

5.2.7.4 A significant part of the preliminary work will be with the Environment Agency and Natural England to map the environment-related regulatory requirements for the scheme. This includes discussing the most appropriate drought management measure under which the transfer would be used. The legislative measures would include drought permits or drought orders, both detailed under the Water Resources Act 1991 as amended by the

Environment Act 1995 and the Water Act 2003. Our discussions with the Environment Agency will extend to requirements for environment assessments ahead of drought permit or drought order applications as well as baseline monitoring. Our next Drought Plan, scheduled for publication in 2019, will also be extended to include the Trent to Ruthamford option should the scheme prove to be environmentally and technically feasible and affordable.

5.2.7.5 The remaining scope for the AMP6 work includes:

- Validation of the high level need and alternatives assessment, including the development of detailed Capex and Opex estimates for feasible alternative options. This work will involve an appraisal of the infrastructure in the Ruthamford system to ensure that, if required, water delivered to the Welland and Nene parts of the system can be distributed to areas supported by the Great Ouse
- Completion of a Strategic Environmental Assessment (SEA) and Habitats Regulation Assessment (HRA) for the scheme. These are likely to require a significant effort since the proposed scheme involves a large inter-basin transfer and there are concerns in respect of:
    - Invasive species and the related need for adequate bio-security measures
    - The potential for adverse impacts on designated sites. These include on the Trent as well as on the Nene, Welland and Great Ouse and
    - In combination effects, arising from the abstraction of water from the Trent. This includes taking account of downstream abstractions for a number of large power stations
- An assessment of the impact of the scheme on current and future flows in the Trent, Nene, Welland and Great Ouse. This work will include an assessment of the likely effect of the scheme on navigation in the Trent, as well as on other downstream abstractors and an assessment of the possible future effects of climate change
- Completion of field investigations related to the environmental and engineering assessments that are required
- Completion of the detailed design work, and
- The preparation and submission of one or more planning applications.

5.2.7.6 Given the strategic nature of the transfer, the potential for using it as part of our long-term water resource strategy will also be assessed in AMP6. This work will be completed via the Water Resource East Anglia (WREA) project and will focus on whether the transfer can be used to support additional winter storage reservoirs in the region and if delivery of the scheme risks stranding any current or future assets. It should be noted, however, that since the transfer is required for mitigating drought related risk in the short to medium term, this work will focus on the additional value or risk that could arise from integrating its use with our longer term supply-demand strategy.

5.3 Extended demand management programme

5.3.1 Background

5.3.1.1 Our baseline supply-demand modelling shows that under a dry year annual average (DYAA) scenario, the sum of our RZ deficits is 34.5Ml/d at the end of AMP6 and 103.2Ml/d at the end of AMP10. From Section 4, we have a number of feasible options for meeting these deficits, including reducing leakage, increased metering and water efficiency activity, resource development, transfers and trading.

5.3.1.2 From Figure 5.1 and Figure 5.2, however, scenario testing shows that there are circumstances in which our supply-demand deficits could be much larger than we are currently forecasting. In the short-term, these are restricted to capping our deployable output at recent actual levels of abstraction. By 2039-40, higher than expected population growth; worst case climate change and sustainability reductions; capping deployable output at recent actual levels of abstraction and our least cost planning scenarios may all produce deficits which are significantly greater than in our baseline. In the event that some combination of these scenarios is realised, likely outcomes would include:

- A much higher risk of restrictions on supply, including more temporary use bans and non-essential use bans and in extreme circumstances, rota-cuts and standpipes, and
- Greater than expected levels of investment to maintain the supply-demand balance. In extreme circumstances this could include for strategic options such as winter storage reservoirs

5.3.1.3 Under these circumstances, we are proposing to extend our demand management programmes; using the water savings that result to off-set our future supply-demand risk.

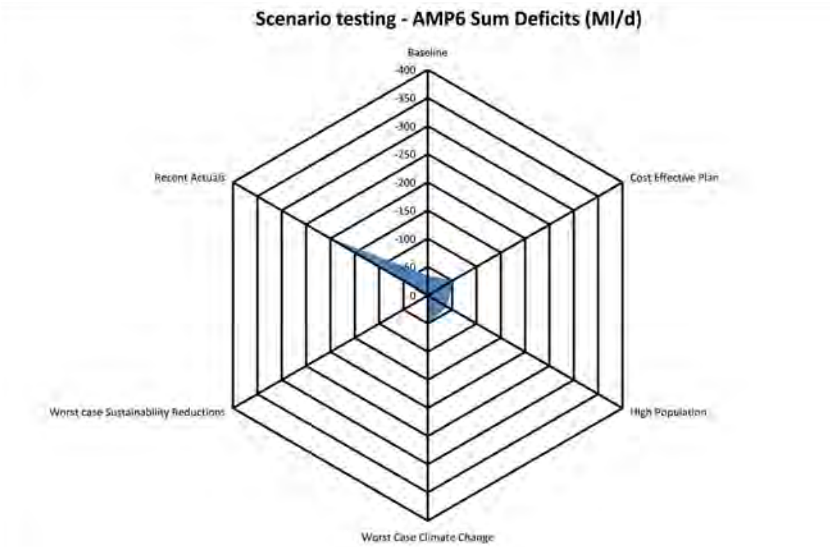


Figure 5.1 Sum of RZ DYAA deficits at end of AMP6 (scenario testing)

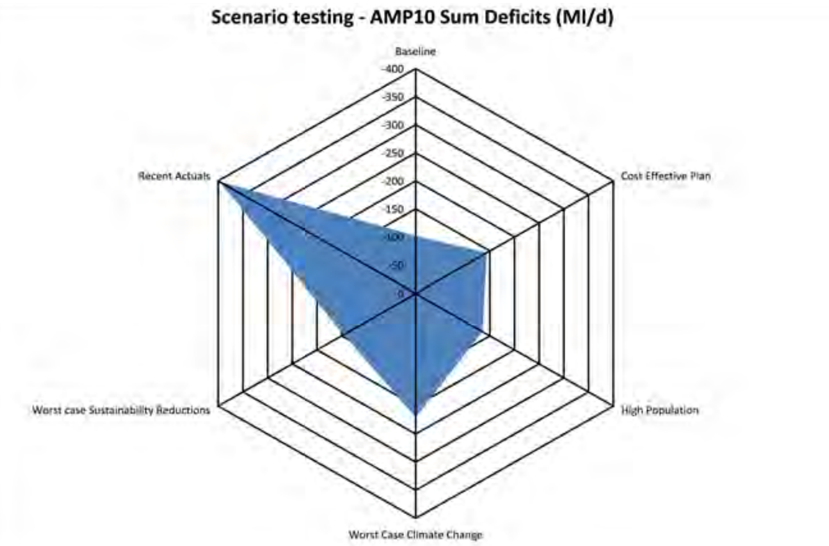


Figure 5.2 Sum of RZ DYAA deficits at the end of AMP10 (scenario testing)

5.3.2 Customer views and willingness to pay

5.3.2.1 Customer attitudes to various supply-demand issues, including the restrictions on supply that would result from widespread supply-demand deficits in our system, have been evaluated for our PR14 Business Plan. Arising from this, our customers:

1. Recognise that there is increasing pressure on supply systems from growth and a changing climate and that the Anglian region is particularly vulnerable to this threat
2. Are clear that severe water restrictions are unwanted and are willing to pay to avoid these. They do not expect to experience rota-cuts and standpipes in their lifetimes.
3. Want us to take preventative action and engage in long-term planning to build resilience. This includes working in partnership with others and investing to deliver extra supplies, and
4. Have divided opinions on the level of investment needed; some customers want to spend the same as we are spending now, while others want us to increase levels of expenditure.

5.3.2.2 In terms of leakage, metering and water efficiency:

- Customers are particularly concerned about leaks, which are seen as wasteful of a precious natural resource, a reason for higher bills and a reason why interruptions to supply are sometimes necessary
- Arising from the above, customers want clear evidence that we are "doing our bit" to tackle leakage
- Most customers regard meters as the fairest way to pay for water, although the issue of compulsory metering divides opinion. There is recognition that some customers have additional needs for water, or may struggle to pay their bills, and
- There is strong support for campaigns to help customers save water including more advice from us; low cost or free water saving devices and greater evidence of payback on bills.

5.3.2.3 From research conducted by the Consumer Council for Water (CCW) following the 2010-12 drought, customers are clear that water companies are responsible for maintaining supplies during droughts. Measures that they expect us to adopt include preventing leakage; providing free water saving devices and advice on how to use less water and investing in transfers and other infrastructure.

5.3.2.4 For PR14 cost-benefit purposes, our customers have also been surveyed to determine their willingness to pay to avoid supply restrictions. This work was based on:

- A "main" willingness to pay survey that was focused on our service measures framework and included an assessment of customer value for changing the frequency of hosepipe bans, and
- A second stage survey, in which the relative value of other forms of restrictions and the value of different options for maintaining the supply-demand balance were assessed.

5.3.2.5 The main survey determined that customers were willing to pay £644k per year for a 1% change in the frequency of hosepipe bans. The second stage survey determined that equivalent values for non-essential use bans and rota-cuts/standpipes were £1.731m and £3.342m respectively.

5.3.2.6 These levels of service based valuations were converted to equivalent values per Ml/d of avoided deficit. Based on the data for hosepipe bans:

- Customers are willing to pay £4.813m per year to avoid a 1Ml/d deficit
- Where leakage options are used to maintain levels of service, this increases to £12.471m per year, and
- For demand management options the equivalent value is £6.404m per year.

5.3.2.7 In respect of an upper limit for willingness to pay, customers have also said that they would only be willing to pay up to £30 per year each for a defined package of service improvements.

5.3.3 Cost benefit analysis

5.3.3.1 Details of the capex requirements and water savings for the extended demand management programme are given in Table 5.1 below:

Programme Element	Details	Water saving (Ml/d)	AMP6 Capex (£m)
Leakage	172Ml/d leakage by 2019-20 (from 211Ml/d SELL target in 2014-15)	39Ml/d	£118.48m
Enhanced metering	85,595 meter installations with switching on demand or by change of occupancy. Estimated saving 50 l/p/d per installation	1.9Ml/d (AMP6) to 4.3Ml/d (AMP10)	£20.73m
Water efficiency audits (Bits and Bobs)	180,000 water efficiency audits with free fitting of water saving devices. Estimated saving 48 l/p/d per audit	8.6Ml/d	£16.26m
Total (AMP10)		51.9Ml/d	£155.47m

Table 5.1 Capex and water savings for extended demand management programme

5.3.3.2 From the scenario testing, and excluding impacts from the recent actual scenario, our supply-demand deficits may be between 5.5Ml/d and 16.8Ml/d greater than forecast by the end of AMP6. By the end of AMP10 the deficits could be between 33Ml/d and 118Ml/d greater.

5.3.3.3 Based on the second stage willingness to pay survey data, customers would be willing to pay at least £72.19m per year to avoid a notional 15Ml/d deficit. If this was delivered through leakage reduction, the willingness to pay would be equivalent to £187.06m per year.

5.3.3.4 However, customers have also said that they are only willing to pay £30 per year extra for a defined package of service improvements. Given 1.904m household customers in 2012-13, this is equivalent to £57.13m per year.

5.3.3.5 Discounted over 25 years at 4.5% and assuming willingness to pay capped at £30 per customer per year, the maximum that customers are willing to pay to avoid deficits is £847m. This is around 5.5 times the Capex needed to deliver the extended demand management programme. Assuming willingness to pay based on the second stage study and a short term supply-demand risk of 15Ml/d gives equivalent willingness to pay values of between £1,070m and £2,774m. These values far exceed the cost of the programme.

5.3.3.6 In addition to the reduced levels of service risk that our customers are willing to pay for, the benefits of the extended demand management programme include:

- A smaller water foot print, with benefits for sustainability that include helping to meet the long-term environmental needs of our region
- Increased resilience to the longer-term effects of population growth and climate change
- Based on water savings of 52Ml/d, a reduction in greenhouse gas emissions equivalent to 23,000 tonnes of CO_2e per year
- The metering part of the extended programme will help us to achieve high rates of meter penetration without the need for compulsory metering. In respect of this, the majority of our customers think that the decision to have a meter should be voluntary
- Meeting our customers need for practical help to reduce levels of water consumption, as well as their desire to see us “doing our bit” to reduce leakage, and
- For measured customers receiving a water efficiency audit and a reduction in their bills. This is particularly important for vulnerable customers.

5.4 Deferred sustainability reduction schemes

5.4.1 Background

5.4.1.1 Where abstraction for public water supply is shown to have a damaging effect on the environment, we are required to reduce deployable output and restore abstraction to sustainable levels. Where this can be achieved through a change in the abstraction licence, this is known as a “sustainability change”; where we need to deliver a scheme, this is known as a “sustainability reduction”.

5.4.1.2 Sustainability changes and reductions may result from the Habitats Directive (HD), the WFD or some other local driver. Details of the changes and reductions that are required are developed in conjunction with the EA and delivered via the National Environment Programme or NEP. For the 2015 WRMP we have referred to Phase III of the NEP. In total, this contains details of 182Ml/d of confirmed, likely and unknown sustainability reductions (see Section 3). Of these, schemes for confirmed sustainability reductions in the Norwich and the Broads and Hunstanton RZs are being delivered in AMP6.

5.4.1.3 For the remaining confirmed sustainability reductions, we have developed feasible options for delivering these that have been modelled as part of the process for developing our WRMP. This shows that the following schemes would be the most cost-effective:

- **Fenland RZ**: a £22m treated water transfer from the Ruthamford North RZ. This is required so that we can reduce abstractions from our intake on the River Nar, and
- **West Suffolk RZ**: a £2.9m scheme to divert recycled water to a new discharge point on the River Lark. If this is successful, we would avoid a reduction in deployable output from one of our sources which is close to the River Lark.

5.4.1.4 In the least-cost model, an option to transfer supplies into the West Suffolk RZ using a main from our East Suffolk RZ is also selected. This main is needed to provide resilience for the West Suffolk supply system and will be delivered in AMP6. To ensure that the main is kept ready for use in an emergency, a relatively small volume of water would have to be pumped into the West Suffolk RZ at all times; in the model this is used to help mitigate the need for the confirmed sustainability reduction.

5.4.1.5 No scheme is included in the WRMP for a large confirmed sustainability change/reduction in the East Lincolnshire RZ. This is because the supply-demand balance is projected to remain in surplus after the proposed change/reduction has been made.

5.4.2 Delivery risks and issues

5.4.2.1 Through the Phase III NEP, we will also be delivering 23km of river restoration works and a number of environmental investigations. The restoration works will target the River Nar in the Fenland RZ and Laceby Beck and Skitter Beck in the East Lincolnshire RZ. These rivers are the focus of the confirmed sustainability reductions in this area.

5.4.2.2 Arising from these restoration works and other factors, the following risks and issues are apparent in respect of the confirmed sustainability reductions for the East Lincolnshire, Fenland and West Suffolk RZ's:

Resource zone	Current scheme	Risk	Issues
West Suffolk	Augmented flow and East Suffolk RZ (resilience transfer)	Demand management, infiltration reduction or a reduction in consented discharges could reduce the volume of dry weather flow available for the scheme	An additional 5.3Ml/d of sustainability reductions may be required in this RZ. A combined solution for 9.8Ml/d may be more cost-effective than separate solutions for 4.5Ml/d and 5.3Ml/d
		Changes in the discharge consent for the water recycling centre could affect the economics of the proposed scheme, making it more expensive than an alternative	Possible stranding of the recirculation scheme following the delivery and use of the resilience transfer main from East Suffolk
		A solution based on the "best value" demand management programme (leakage reduced to 172Ml/d; more metering and water efficiency) and a transfer via the resilience main from East Suffolk may be more sustainable and reliable than the preferred scheme	

Resource zone	Current scheme	Risk	Issues
		Scenario testing shows that the transfer options selected in the Norfolk, Suffolk, Cambridgeshire and Essex areas are all sensitive to assumptions about the possible future effects of climate change, sustainability reductions and WFD no-deterioration requirements. Given significant uncertainty about each of these, there is a risk of asset stranding.	

Table 5.2 Sustainability reduction scheme delivery risks and issues

Resource zone	Current scheme	Risk	Issues
East Lincolnshire	NEP river restoration works	The effectiveness of the river restoration works has yet to be determined and so the total volume of sustainability changes/reductions is not yet fully known	Additional sustainability reductions may be required in this RZ. A combined solution may be more cost-effective than separate solutions for the confirmed sustainability reduction and any subsequent sustainability reductions
			There is a large unknown sustainability reduction in the adjacent Central Lincolnshire RZ. In combination with East Lincolnshire and West Lincolnshire, our total sustainability related needs in Lincolnshire could be over 90Ml/d. To meet this, one or more strategic options are likely to be required. These could include: • Extension to Cadney Reservoir • Extension to Covenham Reservoir • Trent valley aquifer storage and recovery scheme
Fenland	Ruthamford North RZ Transfer and NEP river restoration works	The transfer is too small to accommodate the likely sustainability change/reduction that is also proposed	A combined solution may be more cost-effective than equivalent separate solutions for the confirmed and likely sustainability reductions. This solution could either be an enlarged transfer from Ruthamford North or the development of a local resource (desalination or water reuse)
		Scenario testing shows that the transfer options selected in the Norfolk, Suffolk, Cambridgeshire and Essex areas are all sensitive to assumptions about the possible future effects of climate change, sustainability reductions and WFD no-deterioration requirements. Given significant uncertainty about each of these, there is a high risk of asset stranding	
		Stranding of the transfer following subsequent selection of a local resource option	In the short to medium term, resources from the Ruthamford North RZ could also be used to support areas to the south of the Fenland RZ including the West Suffolk RZ, Newmarket RZ and Ely RZ. This type of strategy would need the Ruthamford North to Fenland RZ to be between 14Ml/d and 24Ml/d bigger than is currently planned; it would also trigger the need for a large new resource option in either the Ruthamford North RZ or the Fenland RZ. Options include:
		The effectiveness of the river restoration works has yet to be determined and so the total volume of sustainability	

Resource zone	Current scheme	Risk	Issues
		changes/reductions required is not yet fully known	• South Lincolnshire Reservoir • Grafham dam raising • Water reuse • Wash desalination • Canal transfer from River Trent • Trade with Severn Trent Water, supported by future development of resources in the Trent

Table 5.3 Sustainability reduction scheme delivery risks and issues

5.4.3 Risk mitigation

5.4.3.1 From Table 5.3:

1. The sustainability changes/reductions in the Fenland RZ, West Suffolk RZ and East Lincolnshire RZ could all be different than the current volumes which have been confirmed
2. Sustainability changes/reductions in adjacent RZ's which are as yet unconfirmed have the potential to affect any assessment of the most cost-effective solution for delivering the required changes/reductions
3. Some of the solutions which are likely to end up being considered are strategic in nature and so will also be considered as part of a plan for mitigating long-term supply-demand risks from climate change and population growth. The costs and benefits of these schemes will be assessed as part of the WREA project; a multi-company, multi-sector planning initiative in East Anglia designed to develop a robust long-term water resources strategy for the region
4. Scenario testing shows that transfers selected in the Norfolk, Suffolk, Essex and Cambridgeshire parts of our system are sensitive to assumptions about the future effects of climate change, sustainability reductions and WFD no-deterioration requirements.

5.4.3.2 Under these circumstances the risk of stranding expensive new assets or having to duplicate them is high. To mitigate this risk the confirmed sustainability reductions for the East Lincolnshire RZ, Fenland RZ and West Suffolk RZ will be deferred to AMP7. This will allow time in AMP6 for:

- Confirming the volume of sustainability changes/reductions that are needed, and
- Planning to align the investment which is required with our longer-term supply-demand needs. This includes other AMP7 sustainability reductions as well as schemes needed for growth and to mitigate the effects of climate change.

5.4.3.3 Much of the work that will be required will be delivered via the AMP6 WREA programme. In this, provision has been allowed for the following:

- Assessments of long-term resource availability and of equivalent hydro-ecological needs

- The development and testing of feasible options for maintaining the supply-demand balance
- Economic modelling and assessment based on emerging techniques such as robust decision making and multi-criteria optimisation, and
- The stakeholder management activities that will be necessary for effective decision-making

5.4.3.4 In monetary terms, delivering AMP7 schemes for the deferred sustainability reductions will avoid at least £25m of risk.

5.4.3.5 The short-term environmental risks that result from this will be mitigated by a combination of the following:

1. For the East Lincolnshire RZ and Fenland RZ, the NEP river restoration works that are planned, and
2. Delivery of the "best value" programme of demand management activities. By 2019-20, these include reducing leakage to 172Ml/d; installing 85,595 household meters with switching on demand or on change of occupancy and by completing 180,000 water efficiency audits with free fitting of water saving devices.

5.4.3.6 The enhanced metering and water efficiency audits save around 50 l/p/d and 48 l/p/d respectively through reductions in consumption and supply-pipe leakage. In the RZs where we are proposing to defer the sustainability reduction schemes, we estimate that the best value programme will off-set the effect of growth in AMP6 and the early part of AMP7. Details are given in Table 5.4 below:

Resource Zone	AMP6 Water Saving				Estimated Impact of AMP6 New Development (Ml/d)
	Enhanced Metering (Ml/d)	Water Efficiency (Ml/d)	Leakage (Ml/d)	Total (Ml/d)	
East Lincolnshire	0.00	1.35	3.9	5.25	2.50
Fenland	0.74	0.37	2.2	3.31	0.85
West Suffolk	0.00	0.28	1.1	1.38	0.65
Total	0.74	2.00	7.2	9.94	4.00

Table 5.4 Mitigation of short-term environmental risk

5.4.3.7 The savings in Table 5.4 exclude savings from meter options and from the Drop 20 water efficiency campaign. At a regional level it is estimated that these will result in additional savings of 3.6Ml/d and 1.3Ml/d respectively (all estimates are annual averages).

5.4.3.8 As well as completing river restoration works and delivering an enhanced package of demand management measures, we will also implement an abstraction incentive mechanism in AMP6. If successful, this will divert abstraction from sensitive habitats during periods of environmental stress, with significant ecological benefits.

5.5 Compulsory metering

5.5.1 Background

5.5.1.1 The Anglian Water region has been designated an area of serious water stress. To minimise the environmental impact of water abstraction and use in such areas, the Secretary of State can use powers under the Water Industry (Prescribed Conditions) Regulations (1999) to direct companies to consider compulsory metering.

5.5.1.2 Our AMP5 metering strategy is based on a combination of meter options, a small number of selective (compulsory) meters and enhanced metering. For enhanced metering, meters are installed at the location of unmeasured, unmetered properties and the customers are then encouraged to switch or are switched on change of occupancy. This is our preferred strategy for AMP6, which will include:

- 76,000 meter options
- 85,595 enhanced metering installations, and
- 1,500 selective (compulsory) meter installations.

5.5.1.3 We currently have 82.4% of household customers with meters fitted at their property and 72.2% who pay their bills on the basis of a volumetric charge. By the end of AMP6 (2019-20) we forecast that 95.1% will have meters fitted and that 88.3% will be paying on the basis of volumetric charges.

5.5.1.4 Almost 100% of our non-household customers currently pay on the basis of volumetric charges.

5.5.2 Compulsory metering cost benefit

5.5.2.1 To assess the costs and benefits of compulsory metering we have used a high-level approach based on a simple model of meter installations and water savings. In this, it is assumed that compulsory metering will deliver the same number of metering installations as our preferred strategy. The following is also assumed:

1. The volume saved on receiving a meter and switching to a volumetric supply is estimated to be around 50 l/household/day. This results from reduced levels of consumption and customer supply pipe leakage savings
2. To account for the proportion of enhanced metering customers that opt not to switch, the difference in savings between our preferred strategy and compulsory metering is assumed to be 65 l/household/day for each metered property. This is a conservative assumption that implies compulsory metering will save around 30% more water than our preferred strategy
3. The unit costs for meter installations have been derived from our PR14 Business Plan and are as follows:

    a. Compulsory: £263.69 per meter
    b. Enhanced: £242.20 per meter
    c. Meter Options: £287.12 per meter
    d. Selective (compulsory): £322.34 per meter

4. To complete both programmes it will be necessary to split around 27,000 shared supply pipes. It is assumed that these will cost £700 each and that for each option, these will be completed in proportion to the number of meter installations, and
5. All meters that are installed are assumed to be smart and the cost of reading these is £3.60 per year.

5.5.2.2 The basic switching models are illustrated in Figure 5.3 below. This shows that without enhanced or compulsory metering we would expect to have around 150,000 unmeasured, unmetered customers in 2040; equivalent to having around 93% of household customers metered. The effect of enhanced and compulsory metering is to reduce this number to around 50,000; equivalent to approximately 97.5% metered. However, compulsory metering achieves this within AMP6 while our preferred strategy achieves this over the 25-year forecast period.

5.5.2.3 Differences in the number of installed meters and the assumed savings are illustrated in Figure 5.4. This shows that the additional savings from compulsory metering peak at 6Ml/d in AMP6 and then decline. This reflects the effect of the progressive increase in numbers of metered customers under the preferred strategy scenario.

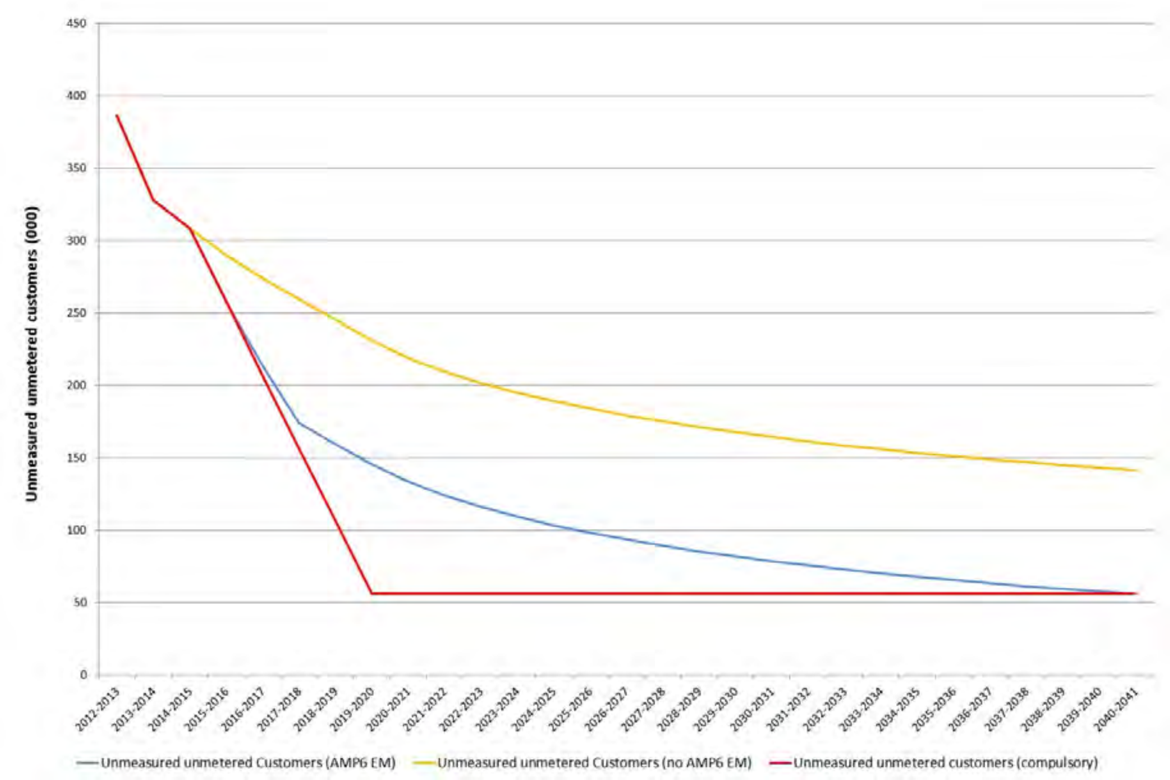


Figure 5.3 Unmeasured unmetered customers

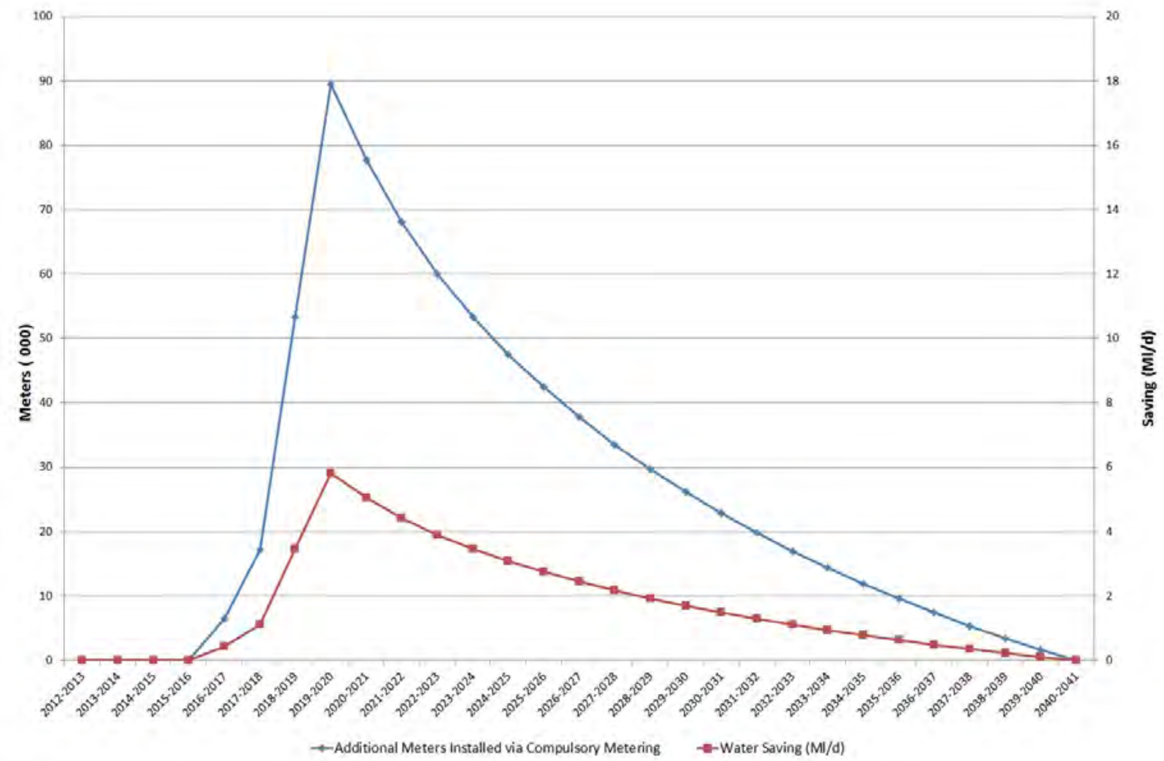


Figure 5.4 Additonal meter installations from compulsary metering and related water savings

5.5.2.4 A summary of the AMP6 Capex requirements is given below:

- Preferred Strategy 162,978 installations for £43.03m, including:
  - Enhanced metering: 85,595 installations for £20.73m
  - Meter options: 75,858 installations for £21.78m
  - Selective metering: 1,525 installations for £0.53m
- Compulsory metering: 252,387 installations for £66.55m.

5.5.2.5 The implied AMP6 unit costs are approximately £264/installation for both the preferred strategy and compulsory metering.

5.5.2.6 To determine the value of the additional meter installations and water savings that would result from compulsory metering, an approach based on discounted cash flows and water savings has been used. In this, we have assumed a 25-year discounting period (to 2040); a discount rate of 4.5% for both costs and water savings and that the capex is funded from available reserves (no annuity costs). The results are given below:

Strategy	CBA element	Net Present Value (NPV) of Costs (£k)	Total NPV (£k)
Preferred	Meter Option meters Capex	£30,149	£69,397
	Enhanced meters Capex	£16,710	
	Selective meters Capex	£400	

Strategy	CBA element	Net Present Value (NPV) of Costs (£k)	Total NPV (£k)
	Shared supply pipes Capex	£13,123	
	Meter Read Opex	£9,016	
Compulsory	Compulsory meters Capex	£51,204	£76,345
	Shared supply pipes Capex	£14,451	
	Meter Read Opex	£10,601	
Cost Difference (Compulsory – Preferred)			£6,948

Table 5.5 Summary of discounted costs

5.5.2.7 Over 25 years, the additional costs associated with compulsory metering are approximately £6.9m.

5.5.2.8 The total additional water savings from compulsory metering are estimated to be 17,948 Ml. When discounted over 25 years, this is equivalent to 10,456Ml or 1.1Ml/d (2Ml/d undiscounted).

5.5.3 Discussion

5.5.3.1 The average incremental cost (AIC) of the compulsory option is estimated to be £664/Ml. Assuming a nominal value for the water saved of £60/Ml, this gives a net AIC of around £600/Ml. In respect of this:

- Compared to the cost of saving water through our preferred metering strategy, saving water by compulsory metering is very expensive
- The additional savings are marginal and since they would distributed across our supply system, they would have no significant benefit in terms of mitigating supply-demand risk, and
- The additional savings are not constant but peak early in the forecast period and then decline. Over 25 years there is no additional benefit from compulsory metering.

5.5.3.2 From customer engagement and feedback on our PR14 Business Plan, customers agree that metering is the fairest way to pay for the services. However, the issue of compulsory metering divides opinion and some customers are strongly against this. Overall, slightly over half the domestic customers surveyed thought that the decision to be on a meter should be voluntary.

6 Summary of the 25-year plan for maintaining the supply-demand balance

Key Points

- Our 25-year plan for maintaining the supply-demand balance is based on a combination of demand management, transfers, trades, a reservoir recommissioning and water reuse. The demand management schemes are cost-beneficial and include the following, which will be delivered in AMP6
  - Reducing leakage from our current 2014-15 SELL of 211Ml/d to 172Ml/d
  - Installing around 160,000 household meters through a combination of enhanced metering, meter optants and a small number of selective (compulsory) meter installations
  - Completing 180,000 water efficiency audits with free installation of water saving devices
- In AMP6 we will also deliver two schemes for meeting our Habitats Directive obligations. This includes the Norwich intake relocation scheme for the River Wensum sustainability reduction
- Over the remainder of the forecast period we have selected cost-effective supply-side schemes to maintain the security of supply. These includes water reuse schemes for the Norwich and the Broads and East Suffolk RZ's, recommissioning a reservoir in the Ruthamford South RZ and a further trade with Affinity Water
- The overall effect of our plan is to maintain distribution input at pre-privatisation levels, despite a 50% increase in new connections, and
- Including allowances for target headroom, the supply-side schemes in our plan will increase annual emissions of greenhouse gases by 62,000 tonnes CO_2e per year. Our AMP6 demand management savings reduces this to 37,000 tonnes CO_2e per year. When combined with our baseline water efficiency savings, this is around 65,000 tonnes CO_2e per year less than would otherwise be expected.

6.1 Overview

6.1.1 Our 25-year plan for maintaining the supply-demand balance combines cost-beneficial demand management schemes, which are included in our baseline forecast, with a series of cost-effective supply-side schemes.

6.1.2 Summary details of the demand management schemes are given below. These will be completed in AMP6 and by 2019-20 will save 53Ml/d:

1. A reduction in leakage from the 2014-15 SELL of 211Ml/d to 172Ml/d. This is equivalent to a water saving of 39Ml/d
2. Installation of 85,595 household meters, with switching on demand or on change of occupancy. In addition to this we expect to fit 75,858 meters through our meter optant

programme and 1,500 selective (compulsory) meters. Overall, our AMP6 water savings from metering will be 5.6Ml/d, and

3. Completion of 180,000 water efficiency audits with free fitting of water saving devices. These will save approximately 8.6Ml/d

6.1.3 Details of the preferred plan supply-side schemes that have been selected are given in Figure 6.1 and Table 6.1 below:

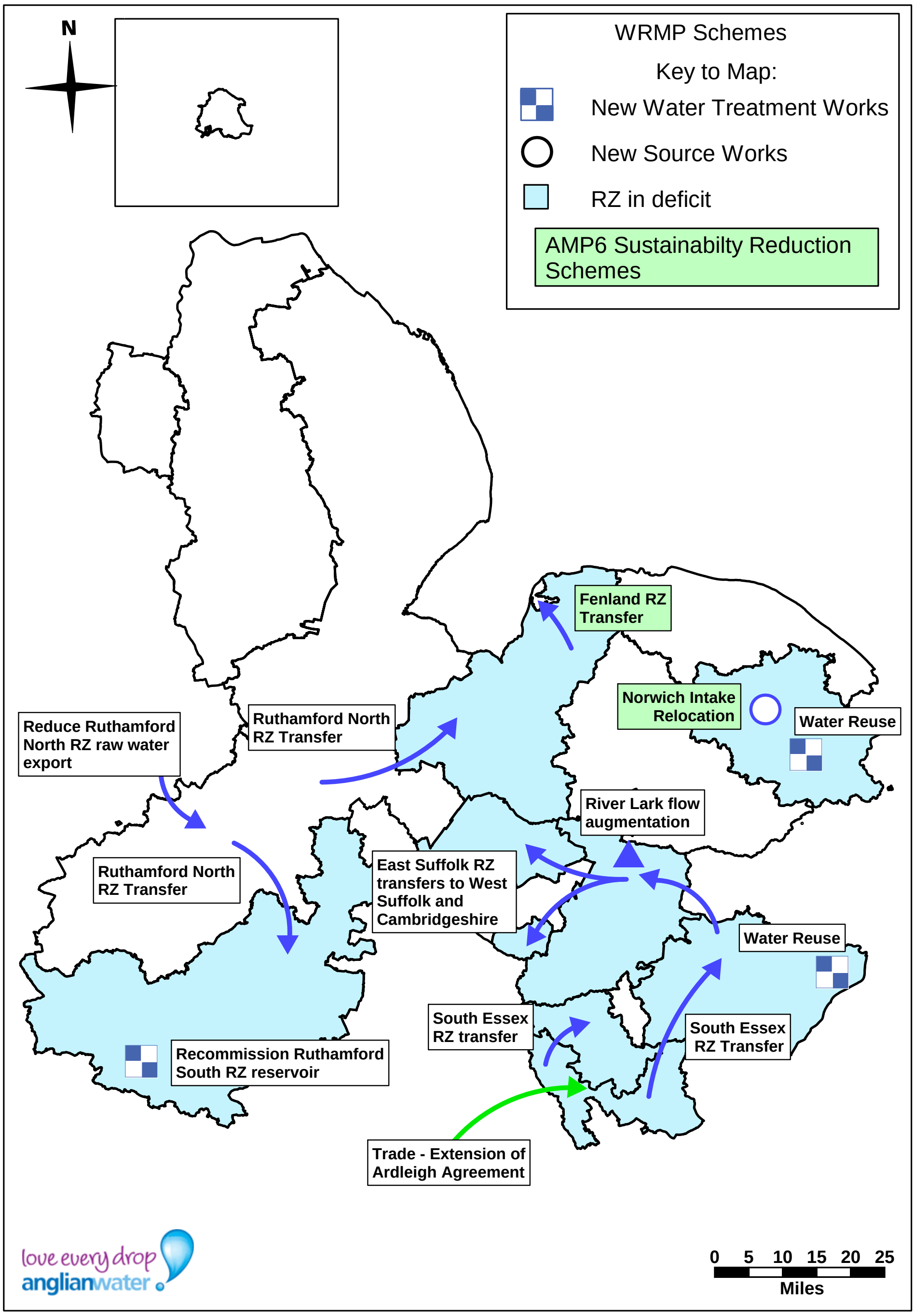


Figure 6.1 Selected Suppy Side Schemes

PART ONE

Summary of the 25-year plan for maintaining the supply-demand balance

Resource Zone	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)
West Lincolnshire	No deficits in forecast period				
East Lincolnshire	No deficits in forecast period				
Central Lincolnshire	No deficits in forecast period				
Ruthamford North					Reduced export to Central Lincolnshire
Ruthamford South			Ruthamford North RZ Transfer		Ruthamford South Reservoir Recommission
Hunstanton	Fenland RZ Transfer				
Fenland		Ruthamford North RZ Transfer			
Norfolk Rural	No deficits in forecast period				
North Norfolk Coast	No deficits in forecast period				
Norwich and the Broads	Norwich Intake Relocation			Norwich Water Reuse	
Ely		Newmarket RZ Transfer			
Newmarket			West Suffolk RZ Transfer		
Cheveley			Newmarket RZ Transfer		
West Suffolk		East Suffolk RZ Resilience Transfer	River Lark Augmentation scheme (see note below)		
Sudbury	No deficits in forecast period				
East Suffolk				South Essex RZ Transfer	Ipswich Water Reuse
Central Essex			South Essex RZ Transfer		
South Essex				Ardleigh Agreement Amendment	
Hartlepool	No deficits in forecast period				

Table 6.1 Preferred plan supply-side schemes

6.1.4 Although the results of the modelling show that it would be most cost-effective to deliver the River Lark augmentation scheme in AMP8, this scheme will be delivered in AMP7 along with the other sustainability reduction schemes that are being deferred from AMP6 to AMP7.

6.1.5 The impact of the plan on projected levels of distribution input is illustrated in Figure 6.2 below. This shows that despite a significant increase in population over the forecast period, distribution input will remain at levels which are similar to those we have now. Our planned reductions in leakage are a significant part of the reason why.

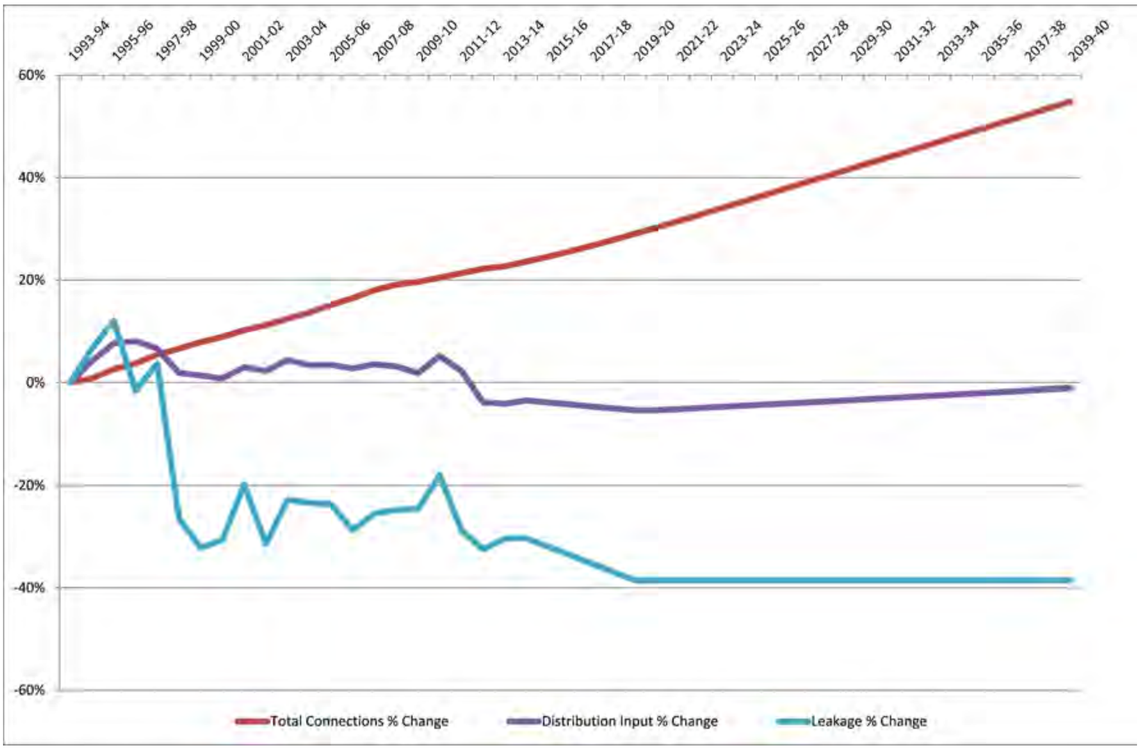


Figure 6.2 Overall effect of the plan on the volume of water going into supply

6.2 Environmental performance of the preferred options

6.2.1 Table 6.2 summarises the results of the SEA, HRA, and WFD assessments for the preferred WRMP options. The assessments have demonstrated that with implementation of mitigation measures the WRMP preferred plan will not have significant negative environmental effects. Anglian Water will commit to completing required mitigation measures, as identified in the environmental assessments, for preferred schemes.

Resource Zone	Scheme	SEA	HRA	WFD
West Suffolk	East Suffolk RZ transfer (WS2)	No significant negative effects predicted following mitigation	No likely significant effect determined at screening	No risks identified
	River Lark Augmentation (WS5)	No significant negative effects predicted	No likely significant effect determined at screening	No risk of deterioration
	Water efficiency	No significant negative effects predicted	Not required	Not required

Resource Zone	Scheme	SEA	HRA	WFD
	Leakage control	No significant negative effects predicted	Not required	Not required
Norwich and the Broads	Norwich intake with pipeline to Costessey pits (NB10)	No significant negative effects predicted following mitigation	No likely significant effect determined at screening	No risk of deterioration
	Norwich water reuse (NB11)	Potential CO_2 effects. No other significant negative effects predicted following mitigation	AA concluded no adverse effects on site integrity	Low risk of deterioration
	Water efficiency	No significant negative effects predicted	Not required	Not required
	Leakage control	No significant negative effects predicted	Not required	Not required
Hunstanton	Fenland RZ transfer (H1)	No significant negative effects predicted	No likely significant effect determined at screening	Low risk of deterioration
	Enhanced metering	No significant negative effects predicted	Not required	Not required
	Water efficiency	No significant negative effects predicted	Not required	Not required
	Leakage control	No significant negative effects predicted	Not required	Not required
Fenland	North Ruthamford RZ transfer (F4)	No significant negative effects predicted following mitigation	No likely significant effect determined at screening	Low risk of deterioration
	Enhanced metering	No significant negative effects predicted	Not required	Not required
	Water efficiency	No significant negative effects predicted	Not required	Not required
	Leakage control	No significant negative effects predicted	Not required	Not required
East Suffolk and Essex	South Essex RZ transfer (ES10)	No significant negative effects predicted following mitigation	No likely significant effect determined at screening	Low risk of deterioration (Colne sources)
	Leakage control	No significant negative effects predicted	Not required	Not required
	Water efficiency	No significant negative effects predicted	Not required	Not required
	Ipswich water reuse (ES3)	Potential CO2 effects. No other significant negative effects predicted following mitigation	No likely significant effect determined at screening following mitigation	No risk of deterioration
South Essex	Extension of Ardleigh agreement (SE4)	No significant negative effects predicted	No likely significant effect determined at screening	Low risk of deterioration
	Leakage	No significant negative effects predicted	Not required	Not required
	Water efficiency	No significant negative effects predicted	Not required	Not required
Newmarket	West Suffolk RZ transfer (NW2)	No significant negative effects predicted following mitigation	No likely significant effect determined at screening	Low risk of deterioration

Resource Zone	Scheme	SEA	HRA	WFD
	Leakage	No significant negative effects predicted	Not required	Not required
	Water efficiency	No significant negative effects predicted	Not required	Not required
Central Essex	South Essex RZ transfer (CE1)	No significant negative effects predicted following mitigation	No likely significant effect determined at screening	Low risk of deterioration (Ardleigh or Colne sources)
	Leakage	No significant negative effects predicted	Not required	Not required
	Water efficiency	No significant negative effects predicted	Not required	Not required
Ely	Newmarket RZ transfer (E2)	No significant negative effects predicted following mitigation	No likely significant effect determined at screening	Low risk of deterioration
	Leakage	No significant negative effects predicted	Not required	Not required
	Water efficiency	No significant negative effects predicted	Not required	Not required
	Enhanced metering	No significant negative effects predicted	Not required	Not required
Cheveley	Newmarket RZ transfer (CVY1)	No significant negative effects predicted following mitigation	No likely significant effect determined at screening	Low risk of deterioration
	Leakage	No significant negative effects predicted	Not required	Not required
	Water efficiency	No significant negative effects predicted	Not required	Not required
Ruthamford North	Saltersford reduction (RHFA15)	No significant negative effects predicted	No likely significant effect determined at screening	No risks identified
	Leakage	No significant negative effects predicted	Not required	Not required
	Water efficiency	No significant negative effects predicted	Not required	Not required
	Enhanced metering	No significant negative effects predicted	Not required	Not required
Ruthamford South	RHF North transfer 1 (RHFA1)	Potential CO2 effects. No other significant negative effects predicted following mitigation	AA concluded no adverse effects on site integrity with mitigation	No risk of deterioration (existing mitigation measures for Rutland Water)
	Foxcote Reservoir (RHFA11)	No significant negative effects predicted	No likely significant effect determined at screening	Potential risk to Foxcote Reservoir. Mitigation identified to be implemented
	Leakage	No significant negative effects predicted	Not required	Not required
	Enhanced metering	No significant negative effects predicted	Not required	Not required

Resource Zone	Scheme	SEA	HRA	WFD
	Water efficiency	No significant negative effects predicted	Not required	Not required

Table 6.2 Summary of SEA, HRA and WFD assessments for preferred options

6.2.2 Options with a low risk of deterioration require further assessment. These will be addressed either through the WREA project or as part of required implementation works.

6.3 AMP6 supply-side schemes

6.3.1 River Wensum

6.3.1.1 We currently hold a licence authorising abstraction from an intake within the River Wensum SAC which is the subject of a significant sustainability reduction of 46Ml/d. We have been investigating the impacts of the abstraction, in collaboration with the EA and Natural England, since 2005. During this period we have carried out a full habitat survey of the river and completed detailed hydrological and environmental impact assessments for the river, the storage pits, the groundwater abstractions and associated land parcels. To date, we have spent over £0.6 million investigating this issue. There is also the ongoing River Wensum Restoration Strategy developed by Natural England to facilitate the physical functioning of the river channel.

6.3.1.2 In 2010, we signed a Statement of Common Understanding with the EA and Natural England, in which it was agreed that we would progressively reduce abstraction and deliver a solution for the River Wensum SAC by 2020, or soon thereafter. It was also agreed that maintaining historical levels of abstraction would satisfy Natural England's concerns for the interim period.

6.3.1.3 We have fulfilled this commitment through re-instatement of a downstream intake point which is located outside of the River Wensum SAC.

6.3.1.4 A range of feasible supply options have been assessed to balance the demands in the Norwich and Broads RZ The preferred solution (NB10) is a transfer scheme from the refurbished downstream intake via a new 8km pipeline to the existing upstream bankside storage. This option would mean that when flows fall below a defined rate at the Costessey Mill gauging station, abstraction would transfer from the upstream to the downstream abstraction point.

6.3.1.5 During AMP5 we have been carrying out further comprehensive investigations to assess subsequent concerns raised by the EA relating to the potential links between the River Wensum SAC, our groundwater abstractions and the bankside storage pits. We have now reached agreement with the EA and Natural England that there is sufficient lag in the system to allow use of the storage pits and the groundwater abstraction to support the preferred option. This solution is now considered by all to be compliant with the Habitats Regulations.

6.3.1.6 We are committed to delivering the preferred option as early as possible in the AMP6 investment period, and will start detailed planning in the final year of AMP5.

6.3.1.7 Application will be made to vary the abstraction licence to support the new transfer, and we accept that this will require the inclusion of new minimum flow conditions to meet Habitats Directive requirements. We have completed a WFD no deterioration assessment for normal operation of this scheme and have concluded no impact. We will continue with the assessment to understand the risk of deterioration downstream during periods of low flow. This will form a part of our drought strategy and will be reported in the Drought Plan.

6.3.1.8 In addition to this preferred solution, we will continue to assess the long-term resource options for Norwich through the WREA project. This will include an assessment of the climate change vulnerability of the Norwich supply system.

6.3.2 North Norfolk Coast

6.3.2.1 As a result of Review of Consents (ROC) appropriate assessment of the North Norfolk Coast SAC, the EA has concluded that the abstraction sources included within our Hunstanton group licence are currently having an unacceptable impact on groundwater flow into the coastal marshes.

6.3.2.2 The EA has modelled a number of different abstraction scenarios within the licence aggregate that will satisfy the environmental outcomes for the site, and each one will require an application to vary our licences. At the beginning of AMP5 we felt that we could accommodate this as a sustainability change through the normal licence variation process. However, as a result of new water quality blending requirements we no longer have the water available to transfer into this zone, and there is a deficit in the planning period.

6.3.2.3 A range of feasible supply options have been assessed to balance demands in the Hunstanton resource zone, including:

- A transfer from the adjacent Fenland RZ
- A water reuse scheme
- A desalination scheme, and
- Groundwater development.

6.3.2.4 The preferred option is the transfer of surplus water from the Fenland RZ. To ensure that we meet the Habitats Directive requirements, we have agreed an interim licence variation with the Environment Agency as part of the licence renewal in 2014. A further licence variation will be required once the final solution has been delivered.

6.3.2.5 The WFD no deterioration assessment has considered the impact of a small increase across various groundwater sources within the Fenland RZ in north-west Norfolk. The assessment concluded no risk of deterioration at two water bodies and a medium risk for the upper reaches of the Heacham Stream. Following recommendation further investigations have been completed. They concluded sufficient headroom exists within existing licence quantities to support 1Ml/d transfer to Hunstanton. The preferred sources for this transfer have also been identified and agreed with the Environment Agency.

6.4 AMP6 demand management schemes

6.4.1 Leakage

6.4.1.1 Our total leakage target by the end of AMP6 is 172Ml/d. This target is practicable, consistent with maintenance of the supply-demand balance and consistent with our customers' expectations.

6.4.1.2 Historically the majority of leakage reduction activity has been finding and fixing visible and hidden leaks. During AMP6 we will achieve the target of 172Ml/d by:

- Maintaining the current high levels of leakage detection and repair resources, and continuing to fix reported leaks within 24 or 48 hours depending on their size
- Replacing 5,000 communication pipes targeted on district metering areas (DMAs) with the highest leakage
- Replacing 40km of mains targeted on the DMAs with the highest leakage
- Continuing the annual inspection and maintenance programme at current levels to maintain meter operability at greater than 90%
- Using the smart revenue metering, planned for installation during AMP6, to enable us to detect more leaks on customers' private supply pipes; consequently, we will need to increase the base level of operational expenditure to manage leakage on customers' private supply pipes
- Pressure management, through a combination of local pressure release valves, which may be targeted on high leakage DMAs, schemes for larger regions and improved pump control, and
- Develop improved systems for monitoring leakage, modelling customer consumption and selecting the right areas for intervention. This work will enable us to achieve lower leakage levels efficiently.

6.4.1.3 Expenditure on leakage in AMP6 will total £118.48m and in the PR14 Business Plan this has been divided into three parts:

- Base expenditure to maintain leakage at the SELL of 211Ml/d
- Supply-demand expenditure to reduce leakage from 211Ml/d to 199Ml/d and the additional cost (over that for 211Ml/d) to maintain it at that level. This leakage reduction was driven by the need to maintain the supply-demand balance in response to the drought
- Enhancement expenditure to reduce leakage from 199Ml/d to 172Ml/d and the additional cost (over that for 199Ml/d) to maintain it at that level. This planned further reduction is driven by customer expectations of lower leakage levels.

6.4.1.4 The leakage management activities that will be completed are summarised below:

Activity	Required to maintain leakage at 211 Ml/d	Required to maintain leakage at 199 Ml/d	Required to achieve and maintain leakage at 172 Ml/d
Leakage control (base)	Yes	Yes	Yes
Consumption models and tools (base)	Yes	Yes	Yes
Pressure management (base)	Yes	Yes	Yes
Operational meters	Yes	Yes	Yes
Leakage control (supply demand)		Yes	Yes
Consumption models and tools (supply demand)		Yes	Yes
Pressure management (supply demand)		Yes	Yes

Activity	Required to maintain leakage at 211 Ml/d	Required to maintain leakage at 199 Ml/d	Required to achieve and maintain leakage at 172 Ml/d
Targeted communication pipe replacement		Yes	Yes
Leakage control (enhancement)			Yes
Pressure management (enhancement)			Yes
Targeted communication pipe replacement			Yes
Targeted mains replacements to reduce leakage			Yes

Table 6.3 AMP6 leakage activity

6.4.2 Water efficiency

6.4.2.1 To deliver the 180,000 water efficiency audits that we plan for AMP6, we estimate that it will cost £16.263m. This is equivalent to approximately £90 per audit.

6.4.2.2 Each audit will take around 40 minutes to complete. The audits use Energy Savings Trust (EST) software and following the audit, the customer will be left with a personalised water saving plan. Other features of the audit include:

- Fitting of shower-save or water efficient shower-head, eco-beta, tap fittings or hose gun
- Where appropriate, providing a water saving CD ROM game, a garden pack, a sink strainer, a washing up bowl and fat traps
- Locating the internal stop tap, and
- Checking for running cisterns and adjusting if required.

6.4.2.3 Overall we expect that the water efficiency audits will save 8.6Ml/d. Although take-up is subject to some uncertainty, we have assumed that the audits will be distributed on the basis of the following:

Resource Zone	Estimated Number of Water Efficiency Audits
Central Essex	1670
Central Lincolnshire	17937
Cheveley	194
East Lincolnshire	28225
Ely	3336
East Suffolk	12727
Fenland	7626
North Norfolk Coast	4145
Norfolk Rural	5317

Resource Zone	Estimated Number of Water Efficiency Audits
Norwich and the Broads	10555
Newmarket	1804
Ruthamford North	35527
Ruthamford South	31829
South Essex	9158
Sudbury	1252
West Lincolnshire	2836
West Suffolk	5811
Total	**180000**

Table 6.4 Estimated number of water efficiency audits per RZ

6.4.3 Metering

6.4.3.1 Details of our preferred strategy given below:

Resource Zone	Unmetered Unmeasured Customers end of AMP5 (“target”)	AMP6 Enhanced Metering Installations	AMP6 Meter Options	AMP6 Selective (compulsory) Installations
Central Essex	4094		1347	22
Central Lincolnshire	36223		11922	169
Cheveley	462		152	2
East Lincolnshire	22558		7405	212
Ely	6308	5667	453	27
East Suffolk	19293		6350	88
Fenland	16932	14873	1312	86
Hunstanton	834	529	123	5
North Norfolk Coast	10855	7717	1948	44
Norfolk Rural	9539	6997	1686	55
Norwich & The Broads	30878	24920	4960	141
Newmarket	3416		1125	13
Ruthamford North	52537	1403	16890	243
Ruthamford South	36581	23490	6514	196
South Essex	11449		3764	76

Resource Zone	Unmetered Unmeasured Customers end of AMP5 (“target”)	AMP6 Enhanced Metering Installations	AMP6 Meter Options	AMP6 Selective (compulsory) Installations
Sudbury	2996		986	14
West Lincolnshire	6672		2193	46
West Suffolk	10271		3380	53
Hartlepool	26194		3348	39
Total	**308092**	**85595**	**75858**	**1531**

Table 6.5 Preferred metering strategy

6.4.3.2 The AMP6 meter installation costs associated with each of these programmes are summarised below:

- Enhanced metering: £20.73m
- Optant metering (meter options): £21.79m
- Selective (compulsory) meters: £0.48m.

6.4.3.3 In each case we are planning the installation of smart meters. In combination with the replacement of dumb meters by smart meters in our reactive and proactive metering exchange programmes, this will result in a large increase in the number of smart meters in our system in AMP6.

6.4.3.4 We estimate that the metering programme will save around 5.6Ml/d in AMP6. In part, this is a function of the rate at which the enhanced metering customers switch to measured supplies. In AMP6, we estimate that the contribution from this segment is 1.9Ml/d; toward the end of the forecast period, this will increase to around 4.3Ml/d. Smart metering has the potential to increase the volume of water which is saved.

6.5 Greenhouse gas emissions

6.5.1 For our drinking water treatment and distribution system, we estimate that our base year (2011-12) emissions of greenhouse gases are equivalent to 180,538 tonnes of carbon dioxide (tCO_2e).

6.5.2 Figure 6.3 below shows the impact of the plan on our future greenhouse gas emissions based on our forecast demand for water over the next 25 years. Our baseline demand is not forecast to increase significantly; the increase towards the end of the planning period is as a result of our target headroom requirements.

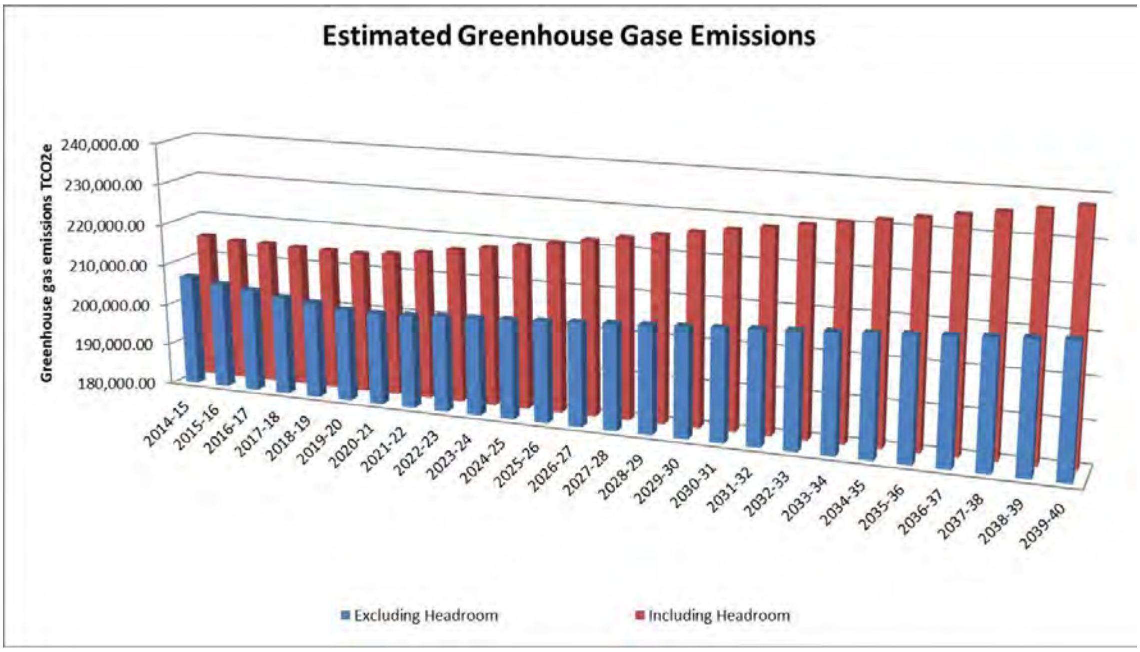


Figure 6.3 Estimated greenhouse gas emissions

6.5.3 As a result of our preferred plan we have a number of schemes planned over the next 25 years. Each scheme will have embodied carbon costs associated with their commissioning as follows:

Scheme	Ref	Embodied carbon (CO_2e) Tonnes	Year
West Suffolk RZ transfer	CE2	1864	2027/28
Newmarket RZ transfer	CVY1	239	2029/30
South Essex RZ transfer	ES10	2089	2033/34
Ipswich Reuse	ES3	10273	2037/37
Newmarket RZ transfer	E2	895	2024/25
North Ruthamford RZ transfer	F4	4989	2024/25
Fenland RZ transfer	H1	353	2019/20
West Suffolk RZ transfer	NWM2	2955	2025/26
Norwich intake to existing bankside storage	NB10	3725	2019/20
Norwich reuse growth scheme	NB11	11918	2030/31
Reduction of Ruthamford North Raw water export	RHFA15	0	2036/37
RHF North RZ transfer	RHFA1	8627	2028/29
Foxcote	RHFA11	3664	2038/39
Amendment to Ardleigh agreement	SE4	0	2034/35

Scheme	Ref	Embodied carbon (CO_2e) Tonnes	Year
East Suffolk RZ transfer	WS2	8132	2024/25
Treated effluent diversion	WS5	2187	2027/28
Total		**61910**	

Table 6.6 Greenhouse gas emissions for each of the selected supply-side options

6.5.4 Our projected increase in demand and target headroom over the forecast period is equivalent to 144Ml/d. Based on emissions of 446 tCO_2e per Ml/d of water into supply in 2012-13, this is equivalent to 62,241 tCO2e per year by 2039-40. Included in this is the effect of 87.5 Ml/d of water savings through baseline water efficiency activity.

6.5.5 However, this plan will also deliver additional water savings through AMP6 leakage reduction, enhanced metering and water efficiency audits. In total, these savings will amount to 56 Ml/d; equivalent to 24,797 tCO_2e per year. Including the effect of these activities gives a net increase in greenhouse gas emissions of 37,443 tCO_2e per year. Combined with the effect of our baseline water efficiency savings, this is around 65,000 tCO_2e per year less than would otherwise be expected.

6.5.6 This assessment excludes any consideration of grid de-carbonisation. Assuming implementation of current policies, the likely possible effect of this will be to reduce greenhouse gas emissions significantly below our current baseline.

6.6 Implementation of the preferred plan

6.6.1 Details of the preliminary work required to deliver the supply-side options in our plan are outlined in Table 6.7 below. This shows that with issues in respect of the Wensum resolved and a small number of sustainability schemes deferred from AMP6 to AMP7, there is sufficient time available to complete all necessary preliminary works to confirm the scope of the preferred options. Where this work shows issues that are unlikely to be cost-effective to resolve, Table 6.7 also shows that there is enough time to evaluate possible alternatives. Much of this work will be completed using the AMP6 WREA project.

Resource Zone	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)
Ruthamford North					Reduced export to Central Lincolnshire
Ruthamford South			Ruthamford North RZ transfer Foxcote mitigation measures	Foxcote mitigation measures	Foxcote Refurbishment
Hunstanton	Fenland RZ transfer				
Fenland	Nene & Welland WFD assessments	Ruthamford North RZ Transfer			

PART ONE
Summary of the 25-year plan for maintaining the supply-demand balance

<table>
<tr><th>Resource Zone</th><th>AMP6 (2015-20)</th><th>AMP7 (2020-25)</th><th>AMP8 (2025-30)</th><th>AMP9 (2030-35)</th><th>AMP10 (2035-40)</th></tr>
<tr><td>Norwich and the Broads</td><td>Norwich intake relocation</td><td colspan="2">Reuse WFD assessment & customer engagement</td><td>Norwich Water Reuse</td><td></td></tr>
<tr><td>Ely</td><td>WFD assessment WSU sources</td><td>Newmarket RZ transfer</td><td></td><td></td><td></td></tr>
<tr><td>Newmarket</td><td></td><td></td><td>West Suffolk RZ transfer</td><td></td><td></td></tr>
<tr><td>Cheveley</td><td colspan="2">WFD assessment WSU sources</td><td>Newmarket RZ transfer</td><td></td><td></td></tr>
<tr><td rowspan="2">West Suffolk</td><td rowspan="2">Lark Augmentation customer engagement</td><td>East Suffolk RZ Resilience transfer</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>River Lark Augmentation Scheme</td></tr>
<tr><td rowspan="2">East Suffolk</td><td rowspan="2"></td><td colspan="2">WFD assessment South Essex sources</td><td>South Essex RZ transfer</td><td rowspan="2">Ipswich Water Reuse</td></tr>
<tr><td></td><td colspan="2">Ipswich reuse mitigation measures & customer engagement</td></tr>
<tr><td>Central Essex</td><td colspan="2">WFD assessment South Essex sources</td><td>South Essex RZ transfer</td><td></td><td></td></tr>
<tr><td>South Essex</td><td></td><td colspan="2">WFD assessment for Colne abstraction</td><td>Ardleigh Agreement Amendment</td><td></td></tr>
</table>

Table 6.7 Preliminary works needed to implement the preferred plan

7 Testing the preferred plan

Key Points

- To determine if we have a robust plan for maintaining the security of supply, we have assessed the climate change vulnerability of our preferred option set and then tested our feasible option set in a number of different scenarios. These included:
    - Removal of the preferred options. This tests whether our plan is flexible enough to adapt to failure to deliver one or more of the preferred options
    - Removal of the cost-beneficial demand management schemes from the baseline supply-demand balance. This reveals the least-cost or most cost-effective plan and helps us to determine the value of delivering additional leakage, metering and water efficiency savings in AMP6
    - Worst case climate change and sustainability reduction scenarios; a high population growth scenario and a scenario in which our deployable output is capped at recent actual levels of abstraction. Each of these scenarios test whether a combination of our preferred options and the other feasible options can mitigate worst case supply-demand risk over the 25 years to 2040 from individual risk scenarios, and
    - A worst case combination of the climate change, sustainability reduction, population growth and recent actual abstraction scenarios
- The results show that our plan is robust in most of the individual scenarios and can easily be adapted to maintain the supply-demand balance. The exception is the recent actual scenario, where additional resources would be needed. The testing also shows that the cost-beneficial AMP6 demand management schemes increase flexibility in the plan and help defer expensive supply-side investments
- Our plan is not robust in the worst case combination of scenarios and fails with a significant remaining, unsatisfied deficit. Since we have many different feasible supply-side options in the plan, this raises issues about the affordability of planning for worst case combination scenarios and the possible future need for strategic assets such as winter storage reservoirs. We are planning to address these issues through our AMP6 Water Resource East Anglia (WREA) project and through the new robust decision making methodologies that this has been piloting, and
- The climate change vulnerability assessment shows that we have a medium to long-term risk from delivery of the Intake Relocation option in the Norwich and the Broads RZ. Options for mitigating this will be evaluated in AMP6 using the WREA project and could include accelerated delivery of the AMP9 water reuse scheme which is planned. This has low climate change vulnerability.

7.1 Overview

7.1.1 To determine if our preferred plan is robust, we have completed the following:

1. Assessed the vulnerability of the plan to the possible future effects of climate change. Where sensitivities are identified, mitigation measures are proposed

2. Removed the selected supply-side options from our preferred plan to see what alternative schemes would be picked and if there are any implementation issues associated with these
3. Assessed the impact of removing our cost-beneficial demand management programme. We have done this to investigate the value of these options in terms of flexibility and our ability to adapt to changing circumstances, and
4. Evaluated the performance of the plan in a number of plausible future scenarios to determine if it can deal with the full range of uncertainty that is associated with growth, sustainability reductions and climate change.

7.1.2 The results of this work are discussed below.

7.2 Climate change vulnerability

7.2.1 A climate change vulnerability assessment has been completed on the plan and is reported in Table 7.1 below. In this, green is for low sensitivity to climate change risk; orange is for limited sensitivity and red is for options that are sensitive to climate change risk.

7.2.2 From Table 7.1, the Norwich Intake Relocation and Foxcote refurbishment options are both sensitive to the possible future effect of climate change. Both options rely on surface water resources and so the sensitivity is a function of future flows and the associated environmental requirements.

7.2.3 For the selected transfer options, there is limited sensitivity to climate change. For each, this reflects climate change vulnerabilities in the donor RZs. The remaining options are based on water reuse and a trade from an existing reservoir and have low sensitivity to climate change.

7.2.4 In the short-term, the risk arising from these sensitivities is low. In the medium to long-term it is much more significant and to ensure that there are no adverse impacts on our supply-demand balance, work will be completed in AMP6 to:

- Further assess the likely impact of climate change on future flows in the rivers in our region
- Assess the potential for a related impact on the hydro-ecology of the rivers
- Determine cost-beneficial options for maintaining security of supply and protecting the environment, and
- From these, select options that can form part of a robust long-term water resource strategy.

7.2.5 This work will be delivered through the WREA project.

7.3 Effect of removing the preferred options ('Plan B')

7.3.1 Table 7.2 shows that if the preferred options are removed from our plan, we are still able to maintain security of supplies. In this respect, our plan is flexible and can be adapted in the event that our preferred options cannot be delivered.

7.3.2 In terms of the alternative schemes that are selected:

- The AMP6 Norwich Intake Relocation scheme would be replaced with a scheme based on seawater desalination and the equivalent transfer scheme for Hunstanton would be based on groundwater development

- Resource development schemes would also replace transfers and a trade in the following RZs:
    - Ruthamford South
    - Fenland
    - East Suffolk
    - West Suffolk, and
    - South Essex
- In Cambridgeshire and West Suffolk, some of the preferred transfers would be replaced with transfers from other RZs. This indicates some sensitivity in the economics of transferring supplies between RZ's in this part of our system, and
- At least two of the alternatives that are selected involve the development of raw water storage. Any plan based on the development of large winter storage reservoirs would also have to consider the costs and benefits of more strategic storage options. These include the South Lincolnshire Reservoir and a new reservoir on the lower Ouse (Feltwell Reservoir).

7.3.3 In the analysis that has been completed, we have made no change to options originally selected for the Ruthamford North, Ely and Newmarket RZs. In the case of the Ruthamford North RZ, this option relies on existing infrastructure. For the Ely and Newmarket RZs, the retained options both rely on an alternative option for the West Suffolk RZ.

7.4 Comparison with the cost effective plan

7.4.1 To determine the value of the cost-beneficial demand management schemes, we have run a version of our economic optimiser in which these options have been stripped from the baseline and modelled. In this version of the model we also assessed the sensitivity of the preferred plan to the social and environmental costs calculated using the Benefits Assessment Guidance (BAG). The results are given in Table 7.3 below and show that without the cost-beneficial demand management schemes:

- We require more investment in supply-side schemes in AMP6. This includes:
    - A transfer for the Ely RZ
    - A transfer for the Newmarket RZ, and
    - A transfer for the Cheveley RZ
- The requirement for an additional resource scheme in the Norwich and the Broads RZ is accelerated from AMP9 to AMP8
- The requirement for a resource scheme in the East Suffolk RZ is accelerated from AMP10 to AMP9
- An additional resource scheme is needed in the South Essex RZ
- A much larger resource scheme is needed in the Ruthamford South RZ, and
- A deficit emerges in the Norfolk Rural RZ.

7.4.2 It is also notable that a large number of leakage reduction schemes are selected. The total yield from these is equivalent to 15Ml/d, suggesting that the SELL at the end of the forecast period reduces to 184Ml/d and that the long-term marginal cost of our cost-beneficial AMP6 leakage reduction programme is significantly lower than £118m.

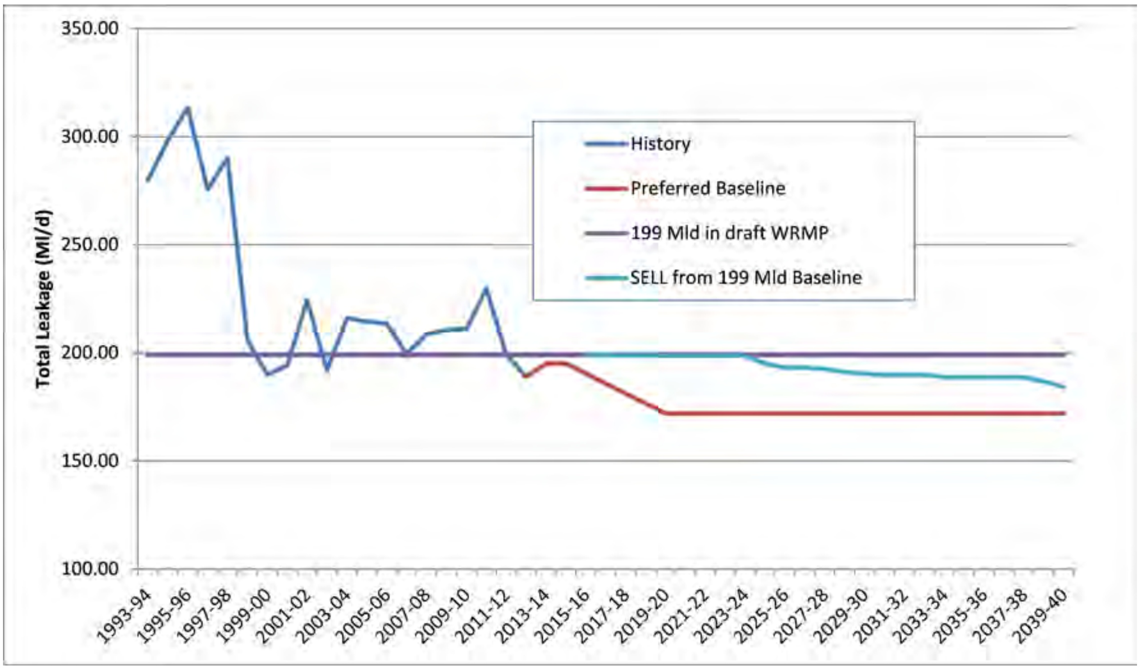


Figure 7.1 Cost-effective level of leakage

7.4.3 In terms of improving the flexibility and adaptability of our plan, the cost beneficial demand management programme:

- Reduces our need for £29m of new transfers in AMP6
- Since these are needed in a part of our system where there is significant uncertainty about our future supply-demand investment needs, it also reduces the risk of asset stranding
- Reduces the volume of additional resources that are needed, conserving these for the benefit of the environment, and
- Through avoiding the need to build and operate the related assets, the programme also reduces emissions of greenhouse gases.

7.4.4 Of these benefits, the most significant in terms of flexibility and adaptability is the deferral of the transfer schemes from AMP6. This allows time for the completion of work on the WREA project, from which we expect to emerge a robust long-term water resource strategy for our region. In this, we would expect the delivery of transfers to be optimised.

Resource Zone	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)
Ruthamford North					Reduced export to Central Lincolnshire
Ruthamford South			Ruthamford North RZ transfer		Foxcote Refurbishment
Hunstanton	Fenland RZ transfer				
Fenland		Ruthamford North RZ transfer			

Resource Zone	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)
Norwich and the Broads	Norwich intake relocation			Norwich Water Reuse	
Ely		Newmarket RZ transfer			
Newmarket			West Suffolk RZ transfer		
Cheveley			Newmarket RZ transfer		
West Suffolk		East Suffolk RZ Resilience transfer	River Lark Augmentation Scheme		
East Suffolk				South Essex RZ transfer	Ipswich Water Reuse
Central Essex			South Essex RZ Transfer		
South Essex				Ardleigh Agreement Amendment	
Key: Red - High vulnerability Amber - Medium vulnerability Green - Low vulnerability					

Table 7.1 Climate change vulnerability assessment (deficit only RZ's)

Resource Zone	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)
Ruthamford North					Reduced Export to Central Lincolnshire (no change)
Ruthamford South			Grafham Dam Raising (Ruthamford North RZ Transfer)		(Ruthamford South Reservoir Recommission)
Hunstanton	Sedgeford Station Borehole (Fenland RZ transfer)				

Resource Zone	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)
Fenland		Wash Desalination (Ruthamford North RZ transfer)			
Norwich and the Broads	Bacton Desalination (Norwich intake relocation)			Norwich Storage (Norwich Water Reuse)	
Ely		Newmarket RZ transfer (No change)			
Newmarket			West Suffolk RZ transfer (No change)		
Cheveley			West Suffolk RZ transfer (Newmarket RZ transfer)		
West Suffolk		Bury Water Reuse (East Suffolk RZ Resilience Transfer)	(River Lark Augmentation Scheme)		Thetford Water Reuse
East Suffolk			(South Essex RZ transfer)	(Ipswich Water Reuse)	Felixstowe Desalination
Central Essex			West Suffolk RZ transfer (South Essex RZ transfer)		
South Essex				(Amendment to Ardleigh Agreement)	Horkesley Borehole

Table 7.2 Plan B (Deficit only RZ's) (preferred options)

Resource Zone	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)
Ruthamford North				Reduced Export of Central Lincolnshire	Leakage Reduction
Ruthamford South		Leakage Reduction	Leakage Reduction		Grafham Dam Raising
Hunstanton	Fenland RZ transfer				Leakage Reduction
Fenland		Ruthamford North RZ transfer			Leakage Reduction
Norfolk Rural					Leakage Reduction
Norwich and the Broads	Norwich intake relocation		Norwich Water Reuse and Leakage Reduction		
Ely	Fenland RZ transfer and Leakage Reduction				
Newmarket	Ely RZ transfer				
Cheveley	Newmarket RZ transfer				
West Suffolk		River Lark Augmentation Scheme	Leakage Reduction	Resilience transfer from East Suffolk RZ and Leakage Reduction	
East Suffolk			South Essex RZ transfer and Leakage Reduction	Ipswich Water Reuse and Leakage Reduction	
Central Essex	Leakage Reduction	South Essex RZ transfer			
South Essex			Leakage Reduction	Amendment to Ardleigh Agreement, Horkesley Borehole and Leakage Reduction	

Table 7.3 Results of cost-effectiveness analysis (Deficit only RZ's)

7.5 Scenario testing

7.5.1 To further assess the robustness of our plan, we tested it against a number of adverse demand and supply-side scenarios. These were based on the following:

- Growth related increases in demand that mirror the effect of high levels of migration to our region

- Worst case sustainability reduction impacts on water available for use. These include all of our NEP Phase III unknown sustainability changes and reductions
- Worst case climate change impacts on water available for use, and
- Capping of our water available for use at recent actual levels of abstraction. This scenario is designed to test the robustness of our plan to the possible impact of WFD no-deterioration requirements.

7.5.2 Finally, the plan was also tested against a worst case combination of the above, from which the best value programme of demand management measures had been removed.

7.5.3 Table 7.4 shows the sum of the RZ level deficits in the baseline forecast for each scenario.

Scenario	End of AMP6		End of AMP10	
	Sum of Deficits (Ml/d)	Increase from Baseline (Ml/d)	Sum of Deficits (Ml/d)	Increase from Baseline (Ml/d)
Baseline	34.5	(-)	102.1	(-)
Cost effective plan	51.3	16.8	143.8	41.7
High population	40.0	5.5	135.0	32.9
Worst case climate change	49.3	14.8	220.0	117.9
Worst case sustainability reductions	0.0	n/a	146.0	43.9
Recent actuals	204.5	170.0	397.0	294.9

Table 7.4 Summary of DYAA scenario deficits

7.5.4 From this and excluding the recent actual scenario:

- In the short-term, our supply-demand deficits may be between 5.5Ml/d and 16.8Ml/d greater than expected, and
- By the end of the forecast period, our deficits may be between 32.9Ml/d and 117.9Ml/d greater than expected.

7.5.5 Overall, the baseline scenario forecasts show that there is relatively little supply-demand risk associated with our plan in the short-term but that this grows to be significant towards the end of the forecast period. The exception is the risk from WFD no-deterioration requirements (recent actual scenario), which is large in the short, medium and long-term.

7.5.6 At RZ level, the scenarios produce the following additional or accelerated deficits:

- In the growth scenario:
    - Central Essex
    - East Lincolnshire

  - Fenland, and
  - Newmarket

- In the worst case sustainability reduction scenario:

  - Central Lincolnshire
  - East Lincolnshire, and
  - West Lincolnshire

- In the worst case climate change scenario:

  - Ruthamford South, and
  - Newmarket

- In the recent actual scenario:

  - West Suffolk
  - Cheveley
  - Central Essex
  - East Suffolk
  - Fenland
  - Ruthamford North
  - Ruthamford South
  - West Lincolnshire
  - Newmarket
  - Sudbury, and
  - Ely.

7.5.7 To test the significance of these additional deficits, we have determined whether the feasible options in our plan are sufficient to maintain the supply-demand balance. The results reported in Figure 7.2 to Figure 7.6 as the remaining, unsatisfied deficit in each RZ. In summary, these figures show that:

- The options in the plan are sufficient to maintain the supply-demand balance in the worst case climate change and population growth scenarios
- We have a small unsatisfied deficit in the West Lincolnshire RZ in the worst case sustainability reduction scenario
- We have more deficits in the recent actual scenario. The majority of these are small but deficits in the Ruthamford North and East Lincolnshire RZ's are moderate, and
- We have widespread deficits in the worst case combination scenario. These are concentrated in the Ruthamford and Lincolnshire RZs.

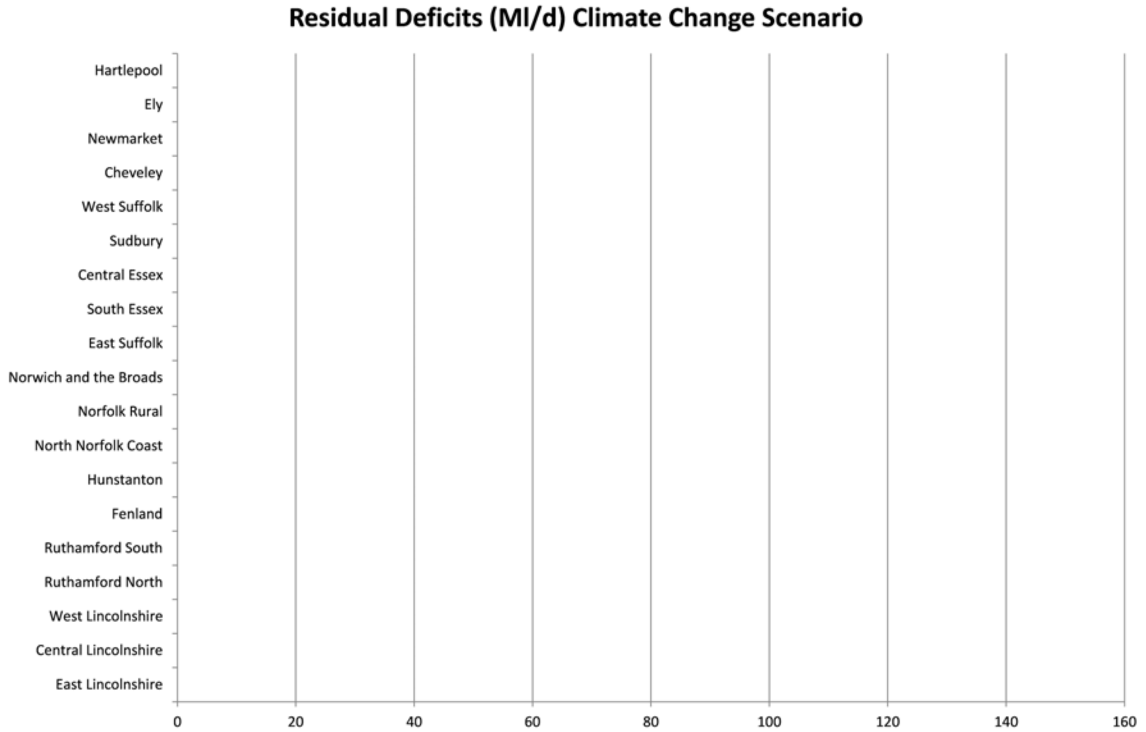


Figure 7.2 Residual deficits in the final planning solution for the worst case climate change scenario

7.5.8 In terms of scheme selection for the worst case climate change scenario (see Figure 7.2):

- Additional resource development schemes are required in the following RZs:
    - South Essex: Colchester water reuse (16Ml/d)
    - Ruthamford North: Canal transfer (13M/d), Rutland Dam Raising (16Ml/d) and Peterborough water reuse (20Ml/d)
    - Ruthamford South: Grafham dam raising (40Ml/d)
    - Hunstanton: Hunstanton RZ groundwater development (1Ml/d)
    - Fenland: King's Lynn desalination (12Ml/d)
- The following scheme selections are altered:
    - Norwich and the Broads: Bacton desalination for Norwich water reuse
    - Hunstanton: Hunstanton RZ groundwater development for Fenland RZ transfer
    - Ely and Newmarket: Fenland transfers for West Suffolk transfers, and
    - Central Essex: West Suffolk RZ transfer for South Essex RZ transfer.

7.5.9 These results confirm that this scenario has a modest impact on scheme selection, with an additional 118Ml/d of capacity required. Notable schemes include Grafham dam raising and Rutland dam raising. The transfers selected for the Norfolk, Cambridgeshire, Suffolk and Essex parts of our supply system also show significant sensitivity to this scenario.

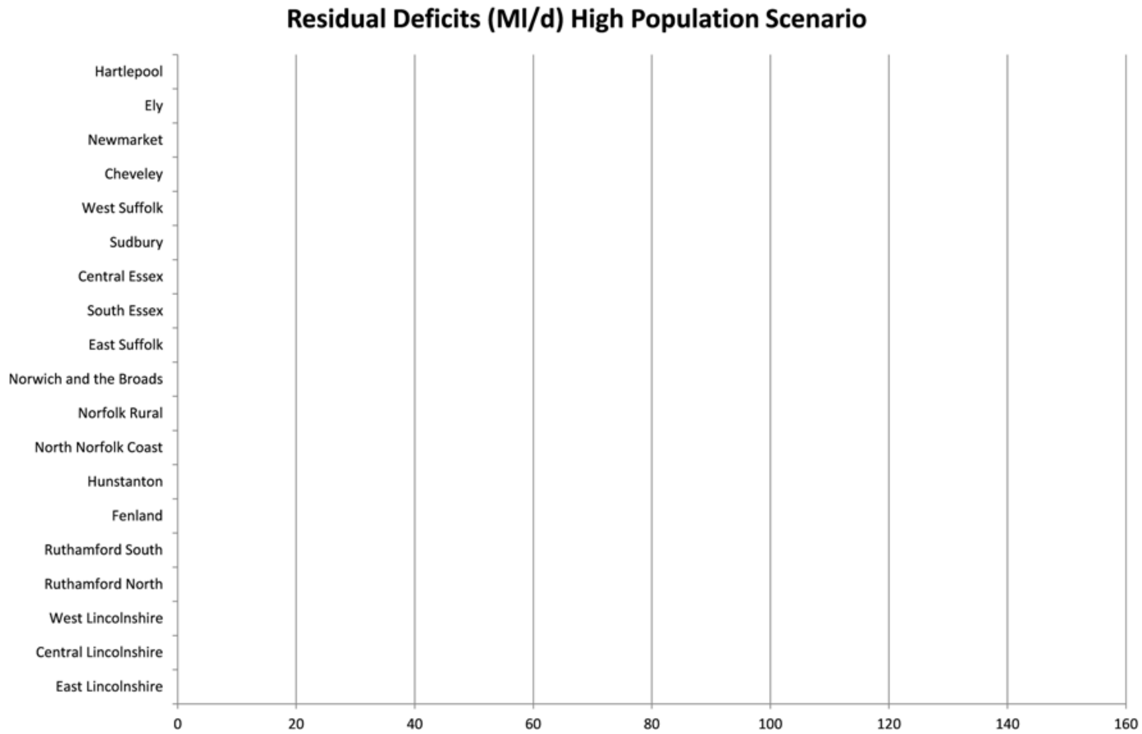


Figure 7.3 Residual deficits in the final planning solution for the high population growth scenario

7.5.10 In terms of scheme selection for the worst case population growth scenario (see Figure 7.3):

- Additional resource development schemes are required in the following RZ's:
  - West Suffolk: Thetford water reuse (2.9Ml/d)
  - South Essex: Ardleigh reservoir extension (2Ml/d) and South Essex groundwater development (1Ml/d)
  - Ruthamford North: Canal transfer (13M/d), and
- The Ruthamford North transfer to Ruthamford South is no longer selected.

7.5.11 These results show that this scenario has limited impact on scheme selection and that the volume of additional yield required is relatively small (18.9Ml/d).

7.5.12 The transfers selected for the Norfolk, Cambridgeshire, Suffolk and Essex parts of our supply system show no sensitivity to this scenario.

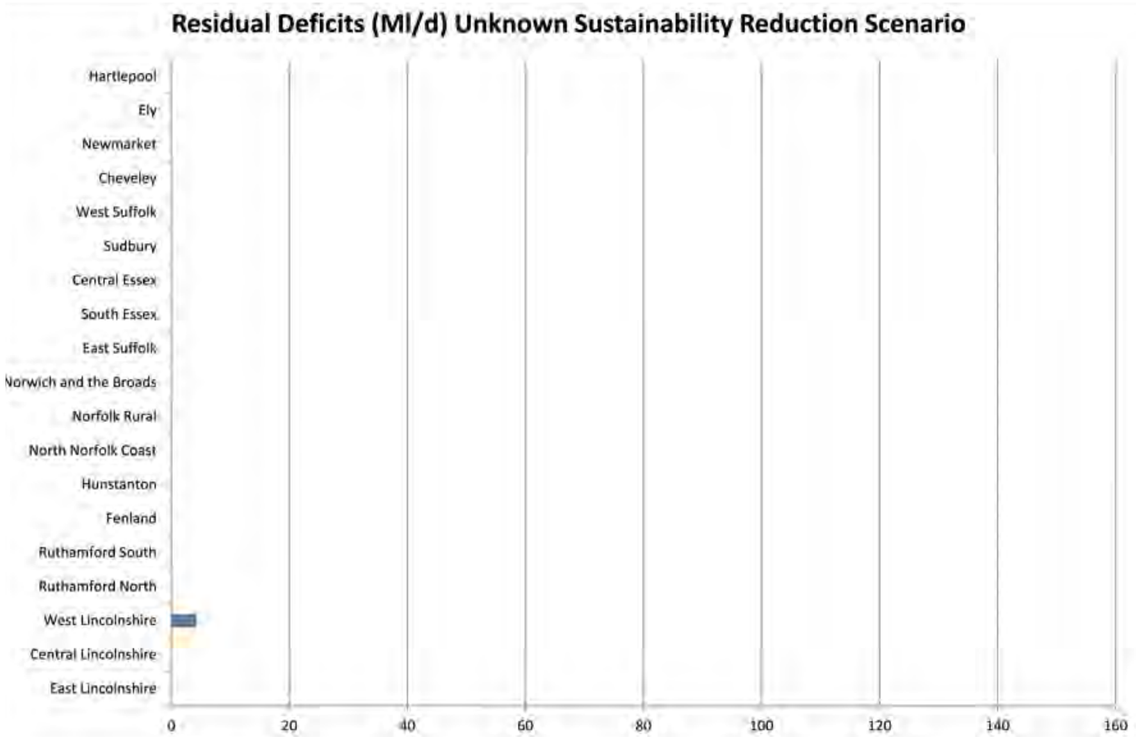


Figure 7.4 Residual deficits in the final planning solution for the worst case sustainability reduction scenario

7.5.13 In terms of scheme selection for the worst case sustainability reduction scenario (see Figure 7.4):

- Additional resource development schemes are required in the following RZs:
    - South Essex: Ardleigh reservoir extension (2Ml/d) and South Essex groundwater development (1Ml/d)
    - Ruthamford North: Canal transfer (13M/d) and Rutland Dam Raising (16Ml/d)
- The following scheme selections are altered:
    - Ely: Fenland RZ transfer for West Suffolk RZ transfers
    - Cheveley: West Suffolk RZ transfer for Newmarket RZ transfer, and
- The Ipswich water reuse scheme is no longer selected (-11Ml/d).

7.5.14 These results show that this scenario has limited impact on scheme selection and that the net volume of additional yield required is relatively small (21Ml/d).

7.5.15 The transfers selected for the Norfolk, Cambridgeshire, Suffolk and Essex parts of our supply system show significant sensitivity to this scenario.

7.5.16 The remaining unsatisfied deficit in the West Lincolnshire RZ is approximately 4Ml/d.

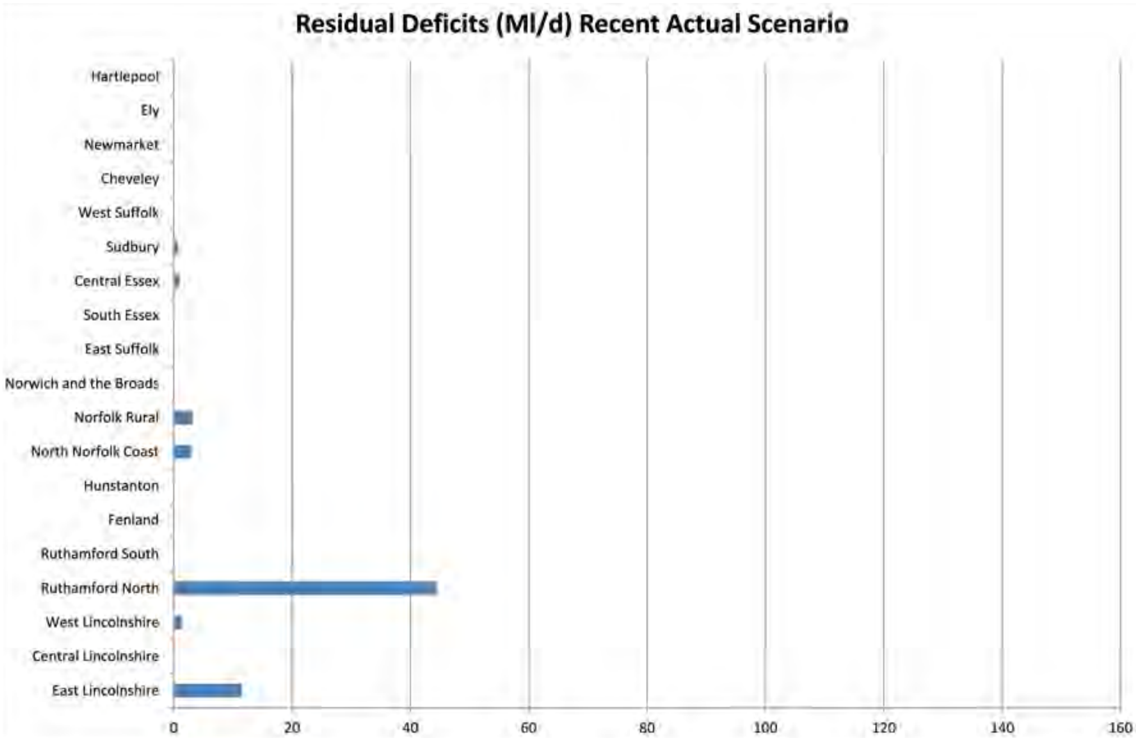


Figure 7.5 Residual deficits in the final planning solution for the recent actual scenario

7.5.17 In terms of scheme selection for the recent actual scenario (see Figure 7.5):

- Additional resource development schemes are required in the following RZs:
    - South Essex: Colchester water reuse (16Ml/d) and South Essex groundwater development (1Ml/d)
    - Ruthamford North: Canal transfer (13M/d), Peterborough water reuse (20Ml/d) and Rutland dam raising (16Ml/d)
    - Ruthamford South: Grafham dam raising (40Ml/d), new Ruthamford South Reservoir (26Ml/d) and Huntingdon water reuse (5Ml/d)
    - Fenland: King's Lynn desalination (12Ml/d) and King's Lynn and Wisbech water reuse (12Ml/d)
    - Norwich and the Broads: Bacton desalination (46Ml/d)
    - East Suffolk: Felixstowe desalination (11Ml/d)

- The following scheme selections are altered:
    - Ely: Fenland transfers for West Suffolk transfers
    - Newmarket: Ely and West Suffolk transfer for West Suffolk transfer, and
    - Hunstanton: Groundwater development for Fenland transfer

7.5.18 This scenario has a large impact on scheme selection, with 218Ml/d of new supplies needed. Even with these, there are 65Ml/d of unsatisfied deficits. Notable schemes include dam raising for Rutland and Grafham; a new reservoir in Ruthamford South; and desalination and water reuse in many RZs. The transfers selected for the Norfolk, Cambridgeshire, Suffolk and Essex parts of our supply system show significant sensitivity to this scenario.

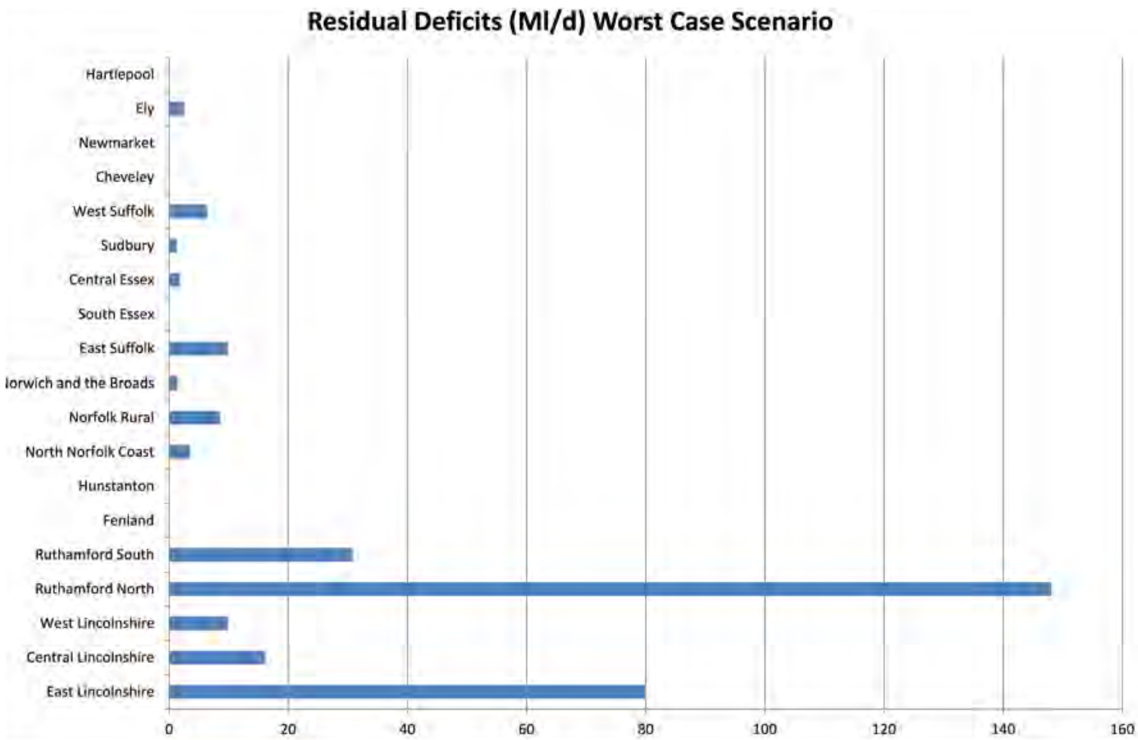


Figure 7.6 Residual deficits in the final planning solution for the worst case combination scenario

7.5.19 In the worst case combination scenario (see Figure 7.6) this scenario most of the available resource development options are selected. Even with these, there are extensive deficits, some of which are significant in size. The total volume of additional resources selected in this scenario was 229Ml/d; the residual, unsatisfied deficit is 320Ml/d.

7.5.20 From Figure 7.2 to Figure 7.6:

- The preferred transfers in the Norfolk, Cambridgeshire, Suffolk and Essex parts of our supply system are very sensitive to the scenario modelled, confirming that there is a significant risk with these schemes of asset stranding
- The worst case climate change scenario has the potential to drive investment in strategic water resource development. This appears not to be the case for the worst case sustainability reduction and high population scenarios
- There is a significant theoretical risk in the recent actual scenario that could drive a large volume of investment in strategic water resource development. Arising from this, key issues for AMP6 include:
    - WFD no-deterioration requirements, and
    - Target headroom allowances and the management of uncertainty and risk, and
- The plan fails in the worst case combination scenario, with very large unsatisfied deficits.

7.5.21 Overall, the plan is:

- Robust in most of the individual scenarios

- Relatively easily modified to maintain the supply-demand balance in the recent actual scenario, but
- Not robust in the worst case combination of scenarios and fails with a significant remaining, unsatisfied deficit. This is of the order of the yield from one or more regional winter storage reservoirs, or the equivalent in terms of desalination, water reuse and aquifer storage and recovery.

7.5.22 Issues arising from the investments needed for the worst case climate change and recent actual scenarios and the failure of the plan in the worst case combination scenario include:

- Which combination of scenarios is it appropriate to plan for if the worst case is judged to overly pessimistic?
- Under such circumstances of deep uncertainty, what is the most cost-beneficial strategy for mitigating supply-demand risk?

7.5.23 These issues are explored in the next section, the WREA project.

8 Water Resources East Anglia (WREA)

Key Points

- Government policy requires robust plans that mitigate long-term supply-demand risk from growth, climate change and sustainability reductions. The development of these is to be based on broader cost-benefit and decision making processes than is currently the case and the plans are to be responsive to the needs of customers and society. This includes supporting growth and protecting the environment
- To meet these enhanced technical and decision-making requirements, we are collaborating with other water companies, the EA, Natural England and others to develop a long-term water resource strategy for the Anglian region. This project (Water Resources East Anglia – WREA) will consider the need for significant and lasting reductions in leakage and consumption as well as the case for increasing supplies. Feasible supply options include water reuse, winter storage reservoirs, aquifer storage and recovery and multi-company or multi-sector trading
- The project will use new, robust planning methodologies. In these, the performance of different groups of options is assessed using different climate change, growth and sustainability reduction scenarios. The assessment criteria are derived from multiple stakeholder needs and the process allows trade-offs between criteria to be easily and quantitatively evaluated. Our objective is for minimum regret plans that are flexible and deliver preferred outcomes
- Outputs from the current WREA pilot have informed the development of this WRMP. In AMP6, the WREA project will be extended and used to develop a robust long-term water resource strategy for our region. Work that will be completed includes assessments of future flows and hydro-ecological need, option development and assessment, scenario development, economic and decision modelling and stakeholder engagement

8.1 Collaborative water resource planning overview

8.1.1 The scenario testing reported in Section 6 shows that our ability to maintain the supply-demand balance in the long-term could be challenged by a combination of growth, climate change and sustainability reductions. In total and excluding risk from capping deployable output at recent actual levels of abstraction, we are at risk of a 567Ml/d adverse impact on our supply-demand balance. While we can manage a significant proportion of this risk through the schemes that are described in Section 6, the delivery of strategic supply-side assets may also be required.

8.1.2 This issue is common to many parts of the industry and in response, the Government expects companies to set ambitious targets for reducing demand and to increase the flexibility and efficiency of our supply systems. This includes enhancing connectivity and increasing the volumes of water that are traded. Government also recognises that investment in new supply-side capacity will eventually be needed.

8.1.3 To develop flexible supply systems, in which potentially large volumes of water can be traded in response to changing patterns of supply and demand, it is necessary for water companies to undertake some form of collaborative water resource planning. If the benefits of these systems are to extend beyond the water industry, other abstractors and water users also need to be involved.

8.1.4 Anglian Water has been quick to realise the need to work with others on water resource related planning issues. Recent projects that we have been i

- A joint planning exercise with Cambridge Water and Essex and Suffolk Water to determine the potential for water trading in the eastern part of our region (Trading Theory for Practice, November 2010)
- A review of the options available for reforming the abstraction regime, making it more flexible and better suited for dealing with the short, medium and long-term needs of all water abstractors (A Right to Water, February 2011)
- A drought crisis scenario workshop. This was hosted by the Institute of Grocery Distributors (IGD) and involved stakeholders from the food and drink sector working with regulators and Anglian Water to develop strategies for mitigating the impact of the 2011-12 drought (IGD, April 2012)
- A thought leadership workshop. This was hosted by us and was designed to share strategic thinking and best practice for the future management of water resources in our region. A key objective was to develop ideas for achieving a long-lasting change in water using behaviours and attitudes (Global Water Challenge, May 2012), and
- The piloting of a market based approach for multi-sector water resource trading. This work was completed in collaboration with the University of Cambridge Programme for Sustainability Leadership and involved testing of an approach to trading resources in the upper Ouse catchment (Research into Water Allocation Through Effective Water Trading, December 2012).

8.1.5 Following on from these, we are currently working on a number of other projects that will help us to develop more flexible water resource management systems. These include:

- The Wissey catchment multi-sector water resource planning pilot. This follows on from the December 2012 water allocation and trading project and will involve working with farmers and other abstractors in the Wissey catchment. The purpose of the pilot is to develop a framework for using the resources in the catchment more effectively. The pilot will look at opportunities for trading and at the infrastructure that is required to support this. It is likely that this will involve assessing the costs and benefits of both demand management measures as well as additional storage and supply-side capacity
- The Suffolk holistic water management pilot project. This project is wider in scope than the Wissey pilot and will examine the opportunities for developing water resource management plans that meet supply-demand, water quality and flood related needs. The project combines stakeholders from a variety of sectors including water companies (both Anglian Water and Essex and Suffolk Water), local authorities, the Environment Agency, internal drainage boards, wildlife groups and local abstractors, and
- The Water Resource East Anglia (WREA) project. This project follows on from the November 2011 Trading Theory for Practice project and is seeking to develop a long-term strategic water resource planning framework for the Anglian region. This includes evaluating options for achieving large reductions in demand, increasing connectivity and trading and developing new sources of supply. Current stakeholders include Anglian Water, Affinity Water, Cambridge Water, Essex and Suffolk Water and

the Environment Agency. In the future it is expected that this group will expand to include other water companies as well as representatives from other sectors.

8.1.6 Of these projects, the WREA is most closely aligned with the current water resource and supply-demand business planning process. Further details are given below:

8.2 WREA project

8.2.1 In combination, the 2010 WRMPs for Anglian Water, Affinity Water, Cambridge Water and Essex and Suffolk Water show that supply demand deficits are widespread in East Anglia from the mid-2030s onwards. The deficits result from imbalances between water availability and growth in demand and assume modest impacts from climate change and sustainability reductions.

8.2.2 Assuming that levels of growth are maintained and that climate change and sustainability reductions become progressively more important, these deficits will increase. In response, companies in the region will have to reduce demand, increase connectivity, trade more and develop new supplies. Since there are no resources available for year-round direct abstraction, the new resource options will be limited to winter storage reservoirs, water reuse schemes, desalination and aquifer storage and recovery. All of these have high capex, opex and carbon requirements.

8.2.3 To help set appropriate long-term targets for demand management and to promote effective planning for new supply-side assets, we have promoted the WREA project.

Robust decision making

8.2.4 The WREA project is evaluating a scenario-based planning approach known as robust decision-making (RDM). The key attributes of RDM include:

- Evaluation of several future strategies (plans) under many plausible sets of future conditions referred to as ‘scenarios’
- The strategies are evaluated using several tangible measures of performance (not just cost) that describe how they would impact customers and stakeholders
- Once a few preferred plans are identified, a ‘vulnerability analysis’ is used to determine which combinations of future conditions cause a proposed system design (the strategy) to fail, and
- Evaluation of this allows decision-makers to assess if a plan is sufficiently robust or whether it needs incremental improvement.

8.2.5 Generally the WREA project approach is focused on:

- evaluating future plans using multiple metrics of system performance and stakeholder satisfaction (multi-criteria method) and,
- seeking robust future plans (that work well under a wide range of plausible futures).

The WREA RDM project

8.2.6 To progress an RDM evaluation, a regional water resource simulation model has been built and used. This WREA model represents all RZs in the East Anglia region; the sources of supply and centres of demand within them and the major new supply schemes being considered. The WREA model was built using a generic simulator called the ‘Interactive river-aquifer simulation 2010’ (IRAS-2010) also used in the ESPRC-funded Adaptation and

Resilience to Climate Change (ARCC-Water) project. Preliminary testing has shown that the WREA model can represent regional water resource and supply systems with sufficient accuracy and detail while still achieving run-times that allow for evaluating many system designs under many future scenarios – a major goal of the WREA project.

8.2.7 A representation of the WREA model domain and regional water system network is given below in Figure 8.1:

Figure 8.1 WREA model domain

8.2.8 The future scenarios that have been modelled include:

- 21 possible climate scenarios for the 2050s, including the historical baseline from 1950-2010 and 20 scenarios obtained from rainfall-run-off modelling of UKCP09 data (medium emission scenario)
- Five demand scenarios equivalent to 90%, 95%, 100%, 105% and 110% of projected demands for the 2050s, and
- Three sustainability reduction scenarios including confirmed, likely and unknown reductions.

8.2.9 Using the different combinations of these, a total of 315 plausible future scenarios were established. In the first instance, these were used to test the performance of our current assets and to indicate which were vulnerable to failure. Then, different long-term strategies for maintaining the supply-demand balance were tested. These included water system plans based on:

- New winter storage reservoirs, including new South Lincolnshire and Norfolk Fens reservoirs
- Seawater desalination, including on the Lincolnshire, Norfolk and Essex Coasts, and
- Water reuse from recycled water centres in Lincolnshire, Norfolk, Suffolk and Essex.

8.2.10 Each strategy was simulated in each scenario and performance tracked with respect to a number of different measures (Table 8.1 below). The metrics used included costs (operating or capital), lowest reservoir level, total summed environmental flow failures, and summed duration of failures for different levels of service. The summed failure duration metrics add either the system-wide total failures or the just the longest (maximum duration) failures.

Performance Metric	Description
Operating costs	Total operating costs for each simulation over 60 years
Supply deficit	Total supply deficit summed over all RZ's
Susceptibility of reservoirs	Minimum volume reached in each reservoir summed over all reservoirs
Total weeks with Hand off flow (HOF) failures	Total number of weeks in which HOF's were reduced in response to low reservoir levels
Maximum duration of HOF failures	The longest consecutive number of weeks that each reservoir spent below the hands off flow (HOF) reduction threshold summed over all reservoirs
Total weeks with level of service 1 (LoS1) failures	Total number of weeks in which reservoirs were below the LoS1 curve summed over all reservoirs
Maximum duration of LoS1 failures	The longest consecutive number of weeks of LoS1 failure summed over all reservoirs. Maximum duration metrics demonstrate system resilience.
Total weeks with levels of service 3 (LoS3) failures	Total number of weeks in which reservoirs were below the LoS3 curve summed over all reservoirs

Performance Metric	Description
Maximum duration of LoS3 failures	The longest consecutive number of weeks of LoS3 failure summed over all reservoirs

Table 8.1 Performance metrics for vulnerability analysis

Preliminary Results

8.2.11 The summary plots below show how the three strategies and current system performed in each of the 315 future scenarios in terms of cumulated longest duration and cumulated total duration of levels of service 1 and levels of service 3 failures.

8.2.12 The x-axis is in % and these ranked performance plots show the percentage of scenarios which did better than a given threshold. For example, from the top left panel, under the current baseline system, 73% of futures had a cumulated regional maximum duration of levels of service failures of less than 50 weeks.

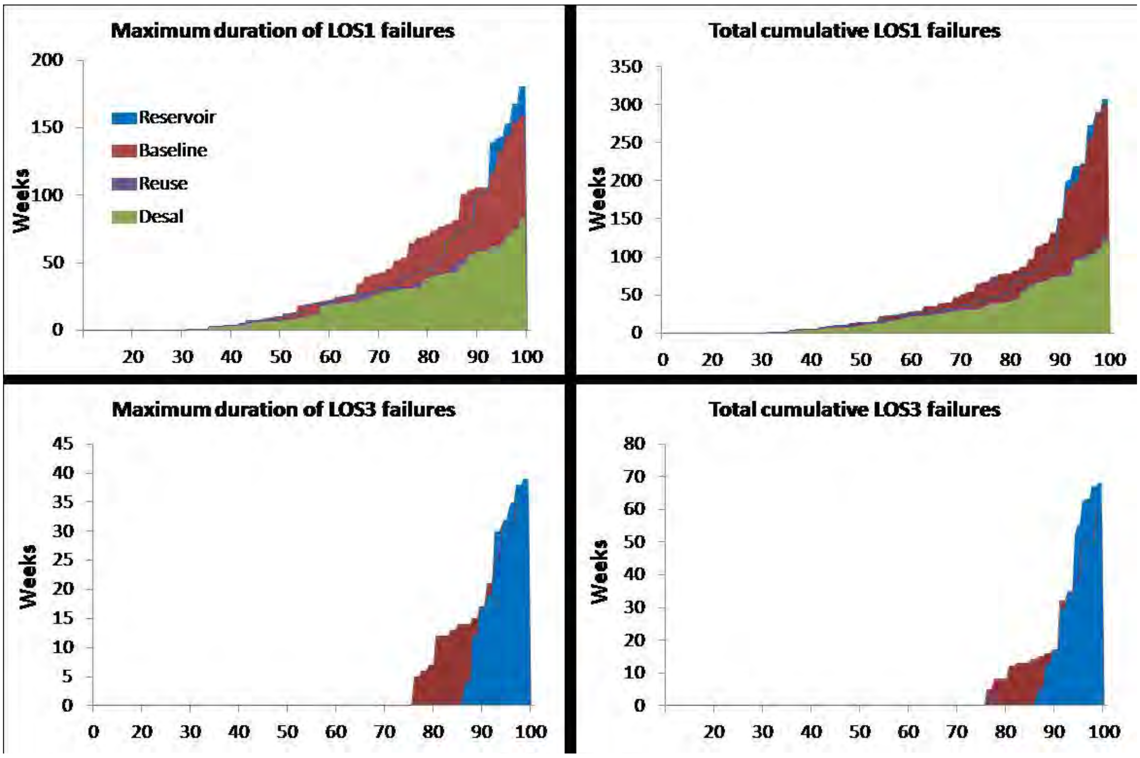


Figure 8.2 Percent of non-exceedance for the LOS1 (top) and LOS3 (bottom panels) duration of the longest failure summed over all reservoirs (left panels) and the total cumulative failure (right panels). The plots compare performance of the baseline, reservoir, reuse and desalination regional strategies

8.2.13 To demonstrate example RDM output, a vulnerability analysis was performed on the winter storage reservoir strategy. This involved finding future conditions in which the strategy performed poorly (in the worst 20%) with respect to the different measures.

8.2.14 The vulnerability analysis identified two scenarios in which the reservoir strategy is vulnerable to system failures. These were:

- Futures where demand is higher than the current projected demand for 2040, and
- Futures where:
    - Unknown sustainability reductions are applied
    - Summers are drier than in the baseline, and
    - Demand is greater than 95% of the projected demand for 2040.

8.2.15 Together these two scenarios account for 96% of all simulated futures in which the reservoir strategy performs poorly. Decision-makers can use the vulnerability analysis to asses if the extent of poor performance in future scenarios is acceptable, or if that strategy needs to be made more robust or dropped altogether.

Discussion and Next Steps

8.2.16 In an RDM analysis, the performance of a preferred strategy, or a few alternative strategies, are considered in detail through a vulnerability analysis and subsequent iterative improvement of the system design. One issue not explicitly considered is how to decide which strategies to test in the first place. Currently the WREA model has 38 optional schemes which leads to many thousands of unique combinations of these options. Traditionally, water companies use a method called EBSD (‘Economics of Balancing Supply and Demand’) to sift through all possible combinations of options and find the least cost one. Since the WREA approach focuses on multiple measures of performance, however, least-cost optimisation alone is not appropriate.

8.2.17 The WREA project is currently testing a multi-criteria search method whereby an automated search algorithm repeatedly uses the WREA model to test different portfolios of options (each portfolio is a unique strategy) searching for those that perform best. The final output of the search is not a single plan (such as a least-cost one), but rather a trade-off curve (e.g. Fig 8.3 left panel) or surface (right panel) that show the best performing strategy for different unique combination of metrics.

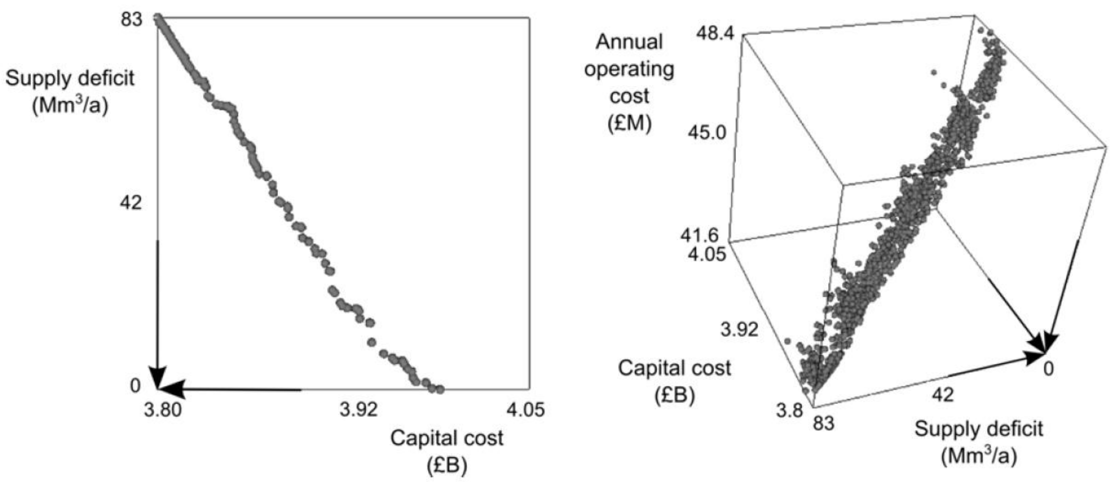


Figure 8.3 Trade-off curve (left panel) and surface (right panel) showing how the best strategies (dots) found by the multi-critiera search fare in terms of capital costs vs. supply deficits vs. annual operating costs. Arrows on axes show the direction of best performance. This plot only evaluates performance under historical hydrological conditions. A ‘robust search’ version of the above (under development) will attempt to search for the best strategies under multiple futures simultaneously

8.2.18 In Figure 8.3 each dot represents a strategy which is the best achievable for that combination of performance measures. This approach will continue to be investigated by the WREA team. Currently it has been used to investigate strategies under the historical climate. In future a robust search will be attempted to find strategies that are most robust according the 9 performance metrics of Table 8.1 over multiple future scenarios simultaneously.

8.3 AMP6 WREA project

8.3.1 The results of the AMP5 WREA project have indicated a number of areas where work is needed in AMP6 to develop a robust long-term water resource strategy for the Anglian region. This includes:

- Resource assessments for each of the major rivers in the Anglian region, as well as for rivers outside the region on which our future supply-demand strategy may depend. This includes the Trent and the Thames and will involve assessing the impact of climate change on flows beyond the 25-years planning horizon normally used for water resource planning
- Equivalent assessments for vulnerable groundwater systems
- Assessments of the future hydro-ecological needs of the major rivers in the Anglian region and adjacent areas. This includes assessing the bio-security needs associated with large inter-basin transfers
- Assessment of the likely significance of extreme weather events, such as drought and floods. This work will look at extending the length of the current hydrological record to determine the likely significance of long-term natural variability in the climate
- Detailed work to determine likely future household and non-household demands. This includes:
    - Long-term population and housing projections
    - Improved household consumption forecasts, and
    - Long-term forecasts for the agricultural, manufacturing and service sectors
- The development of demand management options that will lead to a step change in rates of leakage and consumption
- The development of commercial models to assist the development of water trading
- The development and testing of feasible supply-side options including winter storage reservoirs, aquifer storage and recovery, desalination, water reuse, strategic transfers (regional and national “water grids”), and
- Model development and use, including
    - Further development of the IRAS water resource model
    - The development of an equivalent engineered system model, and
    - The development and use of economic and decision support models.

8.3.2 In addition to these technical works, expenditure is needed for stakeholder management and outreach activities. The purpose of these is to ensure that the results of the technical work are available to non-technical stakeholders and that these have the opportunity to influence both the development of the technical programme and the decisions that result from this.

8.3.3 The AMP6 WREA project will be focused on the strategic challenges of climate change, population growth and growing environmental need. It will also address issues related to intergenerational equity. The purpose of the project will be to develop:

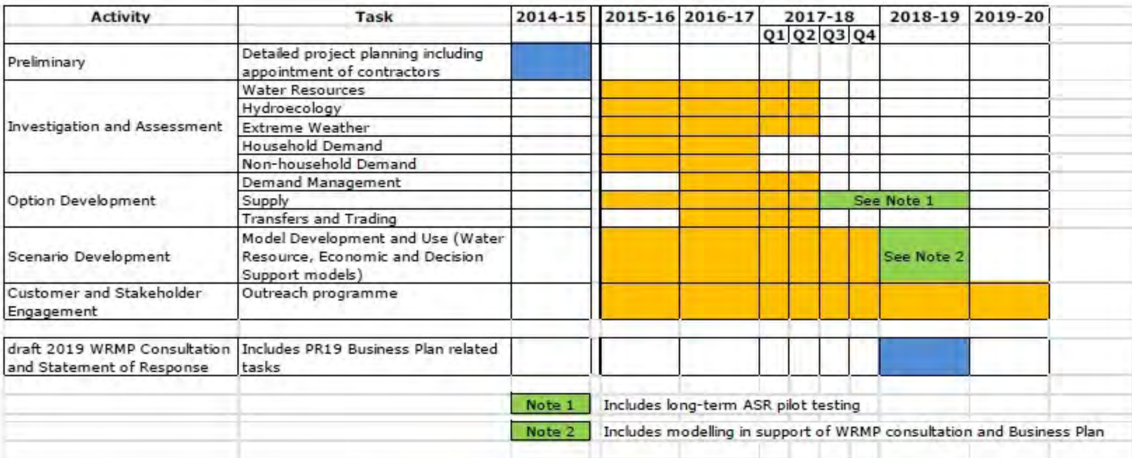
- A common view of long-term supply-demand risk
- A consensus on the most cost-beneficial strategy for mitigating this, and
- An agreed plan for implementing the strategy. This includes
    - Specifying milestones for decision points and asset delivery, and
    - Ensuring alignment with the water company water resource planning and business planning processes.

8.3.4 Customer views on the benefits of the WREA project are clear. They recognise that the Anglian region is vulnerable to the possible future effects of climate change and population growth but do not expect to experience severe restrictions on supplies, and are willing to pay to avoid these. They expect us to be planning ahead, taking action now to build resilience and avoid problems building up for the future.

8.3.5 A high level programme and provisional expenditure profile is given below. These are derived from our Periodic Review 2014(PR14) Business Plan:

Activity	Estimated Cost
Assessment of future water resource availability	£0.87m
Assessment of future hydro-ecological need	£0.65m
Extreme weather assessment	£0.08m
Future household demand assessment	£0.15m
Future non-household demand assessment	£0.10m
Development of strategic demand management options	£0.24m
Development of strategic supply-side options	£1.93m
Development of strategic transfer and trading options	£0.08m
Development and use of economic and decision support models	£0.75m
Customer and stakeholder engagement	£0.15m
Total	£5.00m

Table 8.2 Outline WREA Scope



Activity	Expenditure (£m)					
	2015-16	1016-17	2017-18	2018-19	2019-20	Total
Investigations and assessment	0.75	0.75	0.35			1.85
Option development		1	1	0.25		2.25
Scenario development	0.15	0.15	0.15	0.3		0.75
Customer and Stakeholder Engagement	0.05	0.05	0.02	0.02	0.01	0.15
Total	**0.95**	**1.95**	**1.52**	**0.57**	**0.01**	**5.00**

Figure 8.4 Outline WREA programme and provisional expenditure profile

8.3.6 From the above:

1. Detailed planning for the delivery of the project will be completed in the latter part of the final year of AMP5 (2014-15). This will include specification of the works; selection and appointment of contractors; establishing the project team and governance structures and setting up the out-reach and stakeholder management programmes
2. Most of the investigation, assessment and option development works will be completed by September 2017. The remaining work will comprise completion of long-term pilot testing for an aquifer storage and recovery scheme
3. Work to develop and use the water resource, economic and decision support models will commence in 2015-16. The bulk of this work will be complete by January 2018; residual modelling in support of publication of the draft 2019 WRMP is expected to continue into Q4 of 2017-18 (January to March 2018)
4. An allowance for additional modelling work in 2018-19 has also been made. It is expected that this will be driven by needs arising from feedback on the draft 2019 WRMP and submission of the PR19 Business Plan, and
5. The outreach programme will extend beyond the WRMP and BP processes and into AMP7 (2020-25). This is to provide stakeholders with an on-going link to the project, throughout the delivery of the agreed strategy and any related assets.

8.3.7 Work on the WREA will progress in parallel to work on the draft 2019 WRMP. From this, strategic options recommended by the WREA will be incorporated into the version of the draft plan on which we consult. This draft plan will be prepared in accordance with the requirements of the Water Resource Planning (WRP) guideline.

Trent Ruthamford and NEP schemes

8.3.8 In our PR14 Business Plan, we proposed the following for completion in AMP6 (2015-20):

- £4m for detailed design of a raw water transfer from the River Trent. This is needed to support the reservoirs in our Ruthamford supply system during extended periods of drought. We currently estimate that this scheme will cost around £425m to deliver, and
- £2.75m for option appraisals and mitigation measures in support of the NEP. The option appraisals will be completed for 24 sites; the mitigation measures for 4 sites.

8.3.9 The Trent-Ruthamford scheme includes sums for validating our current assessment of the need for the scheme; completing any required hydrological and water quality studies on the Rivers Trent, Welland, Nene and Ouse and for the completion of any necessary climate change studies. To ensure alignment with the WREA project and consultation on the draft 2019 WRMP, this work will be completed in 2015-16 and 2016-17.

8.3.10 To ensure that outputs from the NEP options appraisals can be aligned with the WREA and the draft 2019 WRMP, we plan to complete this work between 2015 and 2018; approximately 60% will be completed by the end of 2016-17.

8.3.11 For both the Trent-Ruthamford scheme and the NEP option appraisal work, opportunities for synergies and efficiencies will be sought. This includes for both our own supply system, as well as for the supply systems operated by adjacent water companies. The coordination required to achieve this outcome will be managed by the WREA project team.

9 Summary

Key Points

- In the face of pressure from climate change, population growth and reductions in deployable output needed to restore abstraction to sustainable levels, Government policy for the water industry is to promote growth and protect the environment
- To deliver these objectives, we are expected to take a long-term view, reduce consumption, take better account of the value of water, increase connectivity and water trading and take into account the views of customers
- The plan we have developed meets all these objectives. It will restore sustainable abstraction, reduce consumption, increase connectivity and trading and use recycled water to meet future supply needs. The plan includes delivering a Habitats Regulation and WFD no-deterioration compliant solution for the sustainability reduction needed for the River Wensum
- In developing our plan, we assessed many different demand management and supply-side options for maintaining the supply-demand balance. We applied, in full, the process described in the Water Resource Planning guideline, including assessing the climate change vulnerability, completing a SEA and HRA, calculating the social and environmental costs and assessing the impact on greenhouse gas emissions of each option. We have also completed a cost-benefit analysis of compulsory metering
- Our plan combines cost-beneficial demand management measures with a series of cost-effective supply side schemes. In AMP6 we will deliver:

    - 39Ml/d of leakage reductions
    - 4.3Ml/d water savings from enhanced metering
    - 8.6Ml/d water savings from water efficiency audits
    - Schemes for restoring sustainable levels of abstraction to the River Wensum and North Norfolk Chalk, and
    - A detailed design for an AMP7 scheme to enhance levels of service for our Ruthamford customers

- As part of our plan, we are deferring a small number of sustainability reduction schemes from AMP6 to AMP7. We are doing this to avoid stranding expensive new assets; the related short-term environmental risk will be mitigated by a combination of NEP river restoration works and our demand management savings
- For the remainder of the forecast period the supply-demand balance is maintained through a cost-effective mix of transfers, trading, water reuse and a river augmentation scheme
- Testing of our preferred plan shows that it is robust and will maintain the supply-demand balance in most circumstances. The exception is if our deployable output is capped at recent actual levels of abstraction. The plan fails, with a significant unsatisfied deficit, in the worst case combination of scenarios and this raises issues about the affordability of planning for the worst case combination and the most cost-beneficial strategy for mitigating long-term risk, and
- To address these issues, we are promoting the Water Resources East Anglia (WREA) project. Through this collaborative planning initiative, we will work with others to develop a robust long-term water resources strategy for our region.

9.1 Policy context for our 2015 WRMP

9.1.1 Government policy for the water sector is to support growth and protect the environment.

9.1.2 The Government recognise that our ability to achieve these objectives will be challenged by a combination of population growth, climate change and the reductions in deployable output that are needed to restore abstraction to sustainable levels. In response, we are expected to:

- Take a long-term view
- Take more account of the value of water
- Increase connectivity and trading in our supply systems
- Reduce levels of consumption, and
- Reflect the views of our customers.

9.1.3 The plan that we have developed covers the period from 2015 to 2040. It combines a large programme of cost-beneficial demand management measures with a series of cost-effective supply-side schemes. It will restore sustainable levels of abstraction to the River Wensum and the North Norfolk Chalk; reduce consumption; increase connectivity and trading and recycle our water recycling discharges for water supply.

9.1.4 We have consulted widely on these proposals and have reflected the views of our customers in the plan that we have developed.

9.1.5 To meet our longer-term needs, we are promoting the Water Resources East Anglia (WREA) project. This multi company, multi-sector planning initiative will develop a robust long-term water resource strategy for the Anglian region. It will evaluate the need for investment in strategic water resource developments, such as winter storage reservoirs and deliver an affordable, sustainable and reliable system of supply that is resilient to the long-term effects of climate change, population growth and sustainability reductions.

9.2 Baseline supply-demand balance

9.2.1 In AMP6, we forecast deficits in the Norwich and the Broads RZ and Hunstanton RZ, both of which are the result of sustainability reductions.

9.2.2 A combination of growth in demand and target headroom requirements, sustainability reductions and climate change result in additional deficits in the south and east of our system by 2040. The sum total of these under dry year annual average and critical period scenarios is 102Ml/d and 62Ml/d respectively. In both cases, the majority of the deficit is in the Norwich and the Broads RZ and results from the AMP6 sustainability reduction.

9.2.3 This assessment of our future supply-demand risk excludes worst case impacts of climate change and sustainability reductions and assumes that our baseline water efficiency savings will be delivered. Under circumstances in which the worst case combination is realised and there are no baseline water efficiency savings, we are exposed to dry year annual average supply-demand risks equivalent to 567Ml/d. This is composed of the following:

- Growth in demand, target headroom requirements and failure to deliver baseline water efficiency savings: 231Ml/d

- Worst case climate change impacts: 154Ml/d
- Worst case sustainability reduction impacts (including all confirmed, likely and unknown sustainability changes from AMP6): 182Ml/d

9.3 Options

9.3.1 To maintain the supply-demand balance in RZs where deficits are forecast, we have used the option appraisal process specified in the Water Resource Planning guideline. Our process encompassed demand management options, resource developments, water recycling, transfers and trades. As part of this we have:

- Developed an unconstrained list of all possible options for maintaining the supply-demand balance in each RZ
- Screened the unconstrained option list to identify feasible options, and then
- For the feasible options:
    - Determined Capex and Opex requirements
    - Assessed climate change vulnerability
    - Estimated social and environmental costs, and
    - Determined the greenhouse gas emissions that would result from the delivery and operation of each option.

9.3.2 Our appraisal of the option feasibility was combined with work on a Strategic Environmental Assessment and Habitats Regulation Assessment.

9.3.3 In respect of the demand management options, we consulted with our customers and others on whether we should:

1. Reduce leakage from the 2014-15 SELL to some level significantly below this, and
2. Extend our water efficiency and metering activities to areas where deficits were not forecast to occur.

9.3.4 We said that leakage should be reduced and that the water efficiency and metering activity should be extended.

9.3.5 Based on the consultation responses and a willingness to pay survey, our customers agree with us. In response, we have included the following cost-beneficial measures in our plan:

- A reduction in leakage from 211Ml/d to 172Ml/d, with an associated water saving of 39Ml/d
- Installation of 85,000 meters under our enhanced metering programme, with an AMP6 saving of 1.9Ml/d, and
- Completion of 180,000 water efficiency audits, with free fitting of water saving devices. This will save 8.6Ml/d.

9.3.6 In the draft plan, we also consulted on proposals to defer sustainability reduction schemes where there was some uncertainty about the related costs and the benefits. We wanted this to avoid stranding expensive new assets under circumstances in which the assessment of sustainability related needs changed. It has since become apparent that this deferral will only affect a small number of schemes and for these the related environmental risks will be mitigated through a combination of the following:

- National Environment Programme (NEP) river restoration works. In AMP6 we will deliver 23km of restoration works on rivers that are also being targeted for sustainability reductions. Once the benefits of the restoration works have been quantified, we expect the estimated volume of sustainability reductions needed to be confirmed
- Leakage reduction, and
- Metering and water efficiency activity.

9.3.7 We estimate that the water savings from the leakage, metering and water efficiency activities will be sufficient to offset the effects of growth during AMP6 and the early part of AMP7.

9.4 Compulsory metering

9.4.1 Since we operate in an area of severe water stress, we completed a cost-benefit on compulsory metering. This involved a comparison with our preferred metering strategy, which is based on the following:

- Enhanced metering, with switching on request or change of occupancy
- Meter options, where customers opt to switch for a measured supply and don't have a meter already fitted as part of our enhanced metering programme, and
- A small number of selective (compulsory) meter installations.

9.4.2 The results showed that since we are already at high levels of meter penetration, the benefits of compulsory metering are marginal. Over the long-term, these are estimated at around 1Ml/d, which would be distributed across our supply system. Over a 25-year period, the additional cost of delivering this is equivalent to approximately £7m.

9.4.3 Our customer views on compulsory metering are divided, with a significant number believing that the move to measured supplies should be voluntary. Given a combination of this and the adverse cost-benefit assessment, we are not compulsorily metering our remaining unmeasured customers.

9.5 Final planning solution

9.5.1 To maintain the supply-demand balance over the period to 2040, our plan combines a cost-effective series of supply-side schemes with a large programme of cost-beneficial demand management measures. In AMP6, we will deliver the following:

- 39Ml/d leakage reduction
- 8.6Ml/d water saving from water efficiency audits
- 4.3Ml/d water saving from our enhanced metering programme
- An intake relocation scheme to restore sustainable levels of abstraction to the River Wensum, and
- A transfer to restore sustainable levels of abstraction to the North Norfolk Chalk.

9.5.2 Through detailed investigation, we have shown that the intake relocation scheme for the River Wensum is Habitats Regulations and WFD no-deterioration compliant. To enhance the benefits from delivering this scheme, we will be starting detailed design related works in the current AMP.

9.5.3 Over the remainder of the forecast period, we have selected the following schemes for RZs with baseline supply-demand deficits:

- Water reuse for the Norwich and the Broads RZ and the East Suffolk RZ. The scheme for the Norwich and the Broads RZ is needed in the medium to long-term for growth and climate change related needs
- Transfers for the Fenland, Ruthamford South, South Essex, East Suffolk, West Suffolk, Ely and Cheveley RZs
- Refurbishment of an existing intake and reservoir system on the Great Ouse. This is needed to meet long-term growth related needs in the Ruthamford South RZ
- A river augmentation scheme for the West Suffolk RZ, and
- An extension of an existing trade for the East Suffolk RZ.

9.5.4 To support transfers from RZs which are in surplus in our baseline forecast, we also need to reduce the volume of water we export from our Ruthamford North RZ and transfer resources into our Newmarket RZ.

9.5.5 We have assessed all of our preferred options to determine the potential for adverse environmental impacts and either no significant effects are predicted or none following appropriate mitigation works. We have allowed for the planning and delivery of these in our plan.

9.5.6 Despite a large projected increase in population and new connections, the effect of our plan is to maintain distribution input at levels comparable to those at privatisation, while reducing the equivalent volume of leakage by 40%.

9.5.7 Overall, our plan will increase emissions of greenhouse gases by 37,000 tonnes CO2e by 2040. However, thanks to the effects of our baseline water efficiency savings and AMP6 demand management programme, this is around 65,000 tonnes CO2e less than would otherwise be expected.

9.6 Scenario testing

9.6.1 To assess the robustness of our plan, we determined the vulnerability of the preferred option set to climate change and then tested the feasible option set in a number of different scenarios. These included:

- Removal of the preferred options
- Removal of the cost-beneficial demand management measures from the baseline forecast
- Worst case assessments of climate change and sustainability reductions
- High scenario for population growth
- Capping of deployable output at recent actual levels of abstraction, and
- A worst case combination of the above.

9.6.2 The climate change vulnerability assessment shows that most of our preferred options have low sensitivity to the possible future effects of climate change. The exceptions are:

- Norwich Intake Relocation (AMP6), and
- Re-commission Ruthamford South RZ Reservoir (AMP10).

9.6.3 Both of these options rely on surface water resources and so are sensitive to the impact of climate change on river flow. In the short-term, supply-demand risk from these sensitivities is low. In the medium to long-term it is much more significant and to ensure that there are no adverse impacts on our security of supply, work will be completed in AMP6 to develop an appropriate mitigation strategy.

9.6.4 The results of the scenario testing show that our plan is robust in most of the individual scenarios and can easily be adapted to maintain the supply-demand balance. The exception is the recent actual scenario, in which we have a moderate unsatisfied deficit at the end of the forecast period that would require the development of additional resources.

9.6.5 Our plan is not robust, however, in the worst case combination of scenarios and fails with a significant remaining, unsatisfied deficit. Since we have many different feasible options in the plan, this raises issues about:

- Whether planning for the worst case combination is affordable, and
- In circumstances of such deep uncertainty, what the most cost-beneficial strategy for mitigating supply-demand risk would be.

9.6.6 Our AMP6 'Water Resources East Anglia' project is designed to explore these issues and, through this, develop a robust long-term strategy for the Anglian region.

9.7 AMP6 WREA

9.7.1 To address our long-term supply-demand needs, under circumstances in which there is deep uncertainty about the possible future effects of climate change, population growth and the future needs of the environment, we are collaborating with other water companies in the region, other abstractors, the EA, Natural England, local authorities and others stakeholders on the Water Resources East Anglia (WREA) project.

9.7.2 Through the WREA we will develop a robust long-term water resources strategy for the Anglian region. This will account for the costs and benefits of the different strategic options for maintaining the supply-demand balance. Options that will be considered include:

- Significant and lasting reductions in leakage and consumption
- Winter storage reservoirs
- Aquifer storage and recovery
- Water reuse
- Desalination, and
- Strategic transfers and water trading.

9.7.3 To account for the effects of uncertainty, the WREA will use emerging planning methodologies such as Robust Decision Making. This is a scenario based approach to supply-demand planning in which the performance of different options in many different plausible futures is assessed using multiple success criteria. Such techniques allow trade-offs between options to be quantitatively evaluated and for the development of minimum regret plans that are flexible and deliver preferred outcomes.

9.7.4 The WREA will complete detailed planning in AMP6 and, if required, will deliver assets from AMP7 onwards. The work planned for AMP6 includes:

- Future climate assessments of the resources available in the major rivers in the region and vulnerable groundwater systems

- Assessments of the future hydro-ecological needs of our river and wetland systems
- Detailed work to determine likely future household and non-household demands. This includes long-term population and economic projections
- The development and assessment of feasible options for maintaining the supply-demand balance
- Model development and use. This include:
    - Water resource models
    - Equivalent engineered system models
    - Economic and decision support models, and
- Stakeholder engagement and out-reach activities.

9.7.5 The purpose of the WREA will be to develop a common view of long-term supply-demand risk; a consensus on the most cost-beneficial strategy for mitigating this, which includes taking account of for inter-generational equity effects and an agreed plan for implementing the preferred strategy.

PART TWO: RESOURCE ZONE SUMMARIES

Introduction

10 Introduction

10.0.1 In the sections that follow, details from each of the RZ planning tables are summarised. The planning tables are given in the Appendices: each of the summaries below is based on the following template:

Sub-section	Outline of Content
Resource Zone Description	Brief summary of RZ geography, sources of supply and local authority growth estimates. In a summary table these are compared to the rates of growth modelled and recent rates of housing completions.
Baseline Supply-Demand Balance	This section contains details from our RZ level micro-component analysis and a summary of the baseline supply-demand forecast. This includes a probabilistic water balance projection, upon which our target headroom analysis is based.
Feasible Options for Maintaining the Supply-Demand Balance	For RZs with supply-demand deficits, this section details the feasible options. This includes Capex and Opex requirements, scheme details and associated environmental considerations of each scheme.
Preferred Plan	For RZs with supply-demand deficits, this section gives a summary of the results of the EBSD modelling. Details of where we have extended the EBSD option selection, to achieve our wider supply-demand objectives, are also given in this section.
Scenario Testing	This section gives details of the different climate change, sustainability reduction and Levels of Service scenarios that have been modelled and the implications of this for the RZ baseline supply-demand forecast and selected options

Table 10.1 RZ Summary Template

PART TWO: RESOURCE ZONE SUMMARIES

West Lincolnshire

11 West Lincolnshire

Figure 11.1 West Lincolnshire Resource Zone

11.1 Key points

Key Points

- No deficits are forecast in the West Lincolnshire RZ.
- No significant climate change or levels of service sensitivities have been identified.
- No confirmed or likely sustainability reductions are required.
- The worst case sustainability reduction is approximately 7.6Ml/d. A reduction of this magnitude would drive supply-demand investment.
- Local authority policy based growth projections exceed our trend based projections by a significant amount. Our available and target headroom are sufficient to account for the difference and the associated supply-demand risk is minimal.

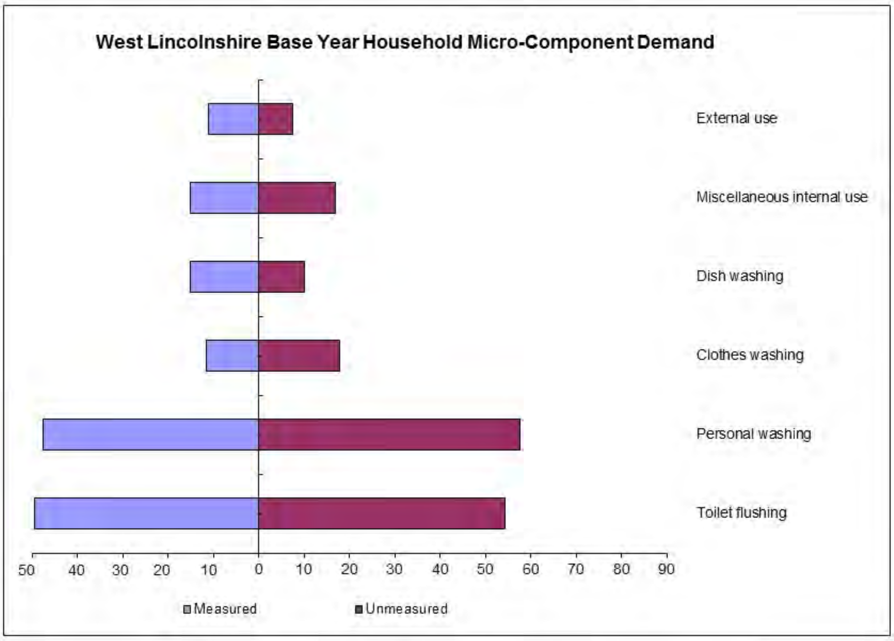
11.2 Resource zone description

11.2.1 The West Lincolnshire RZ lies to the west of the River Trent and is based on the supply systems for Gainsborough and Retford. Customers in the zone receive groundwater abstracted from the Sherwood Sandstone. Water is also exported to the Central Lincolnshire RZ for treatment and distribution to customers in Lincoln.

11.2.2 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 30,000. Of these approximately 53% were billed using measured supplies. The total number of non-household customers was approximately 2,100 and almost all of these are measured.

11.2.3 From Figure 11.2:

- Base year measured and unmeasured PCC are estimated to be more than our regional averages (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 18% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	149	139	134	130
Unmeasured Household	165	141	134	127
Weighted Average	158	139	134	130
Reduction in PCC over forecast (%)	18%			

Figure 11.2 West Lincolnshire average household consumption (litres/person/day)

11.2.4 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using more water for these activities than measured customers. This is consistent with the regional pattern of consumption.

11.2.5 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

11.2.6 Table 11.1 shows measured non-household demands in the base year totalling 4 Ml/d in the West Lincolnshire RZ. These demands are mainly from the agricultural, manufacturing and wholesale sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
4	East Retford	2	Agriculture, manufacturing and wholesale
	Everton	<1	
	Gainsborough	<1	

Table 11.1 West Lincolnshire RZ Patterns of Measured Non-Household Consumption

11.2.7 From Table 11.2, we forecast that up to 300 new properties will be built in the RZ per year. This estimate is based on recent trends in population growth. The equivalent local authority projections assume new properties will be built at a rate of approximately 600 per year. Over the forecast period, the difference between the two estimates is equivalent to approximately 7,500 new properties.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			3,500	3,000	3,000	3,000	3,000
WRMP trend estimate			1,000	1,500	1,500	1,500	1,500
Annual Monitoring Report data		5,500					

Table 11.2 West Lincolnshire Growth Estimates

11.3 Baseline supply-demand balance

11.3.1 From Table 11.3 and Table 11.4, in the last year of AMP6 (2019/20) we forecast that there will be a 4.8Ml/d surplus under DYAA conditions and a 9.3Ml/d surplus under CP conditions. The equivalent target headroom requirements are 0.8Ml/d and 1.0Ml/d respectively. The RZ remains in surplus over the whole of the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	24.00	24.00	24.00	24.00	24.00	24.00
Outage Allowance	0.65	0.73	0.74	0.74	0.74	0.74
Total Water Available for Use	23.34	23.27	23.26	23.25	23.25	23.25
Distribution Input	17.30	17.68	17.80	17.96	18.10	18.23
Target Headroom	0.58	0.80	0.99	1.20	1.45	1.72
Supply Demand Balance	5.47	4.78	4.47	4.10	3.71	3.31

Table 11.3 West Lincolnshire Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	32.70	32.70	32.70	32.70	32.70	32.70
Outage Allowance	0.82	0.89	0.89	0.90	0.89	0.89
Total Water Available for Use	31.88	31.81	31.80	31.80	31.81	31.81
Distribution Input	21.60	21.55	21.57	21.67	21.77	21.87

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Target Headroom	0.72	0.98	1.20	1.44	1.74	2.06
Supply Demand Balance	9.56	9.28	9.04	8.69	8.29	7.87

Table 11.4 West Lincolnshire Baseline Supply-Demand Summary (CP)

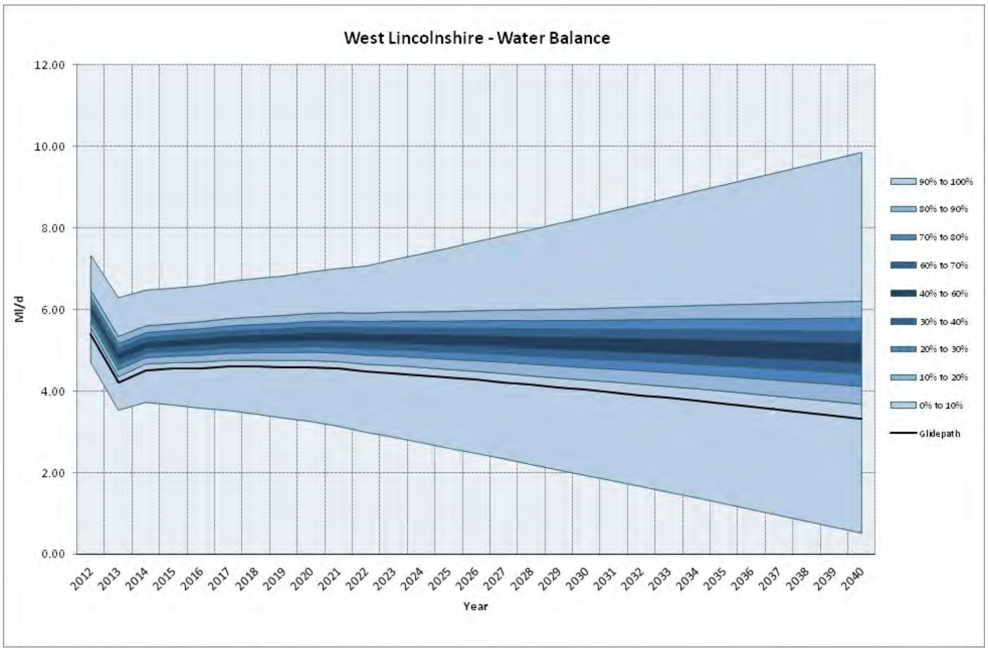


Figure 11.3 West Lincolnshire Probabilistic Water Balance

11.3.2 Figure 11.3 confirms that there is a greater than 95% probability that the RZ water balance will remain in surplus over the 25 year forecast period.

11.3.3 Leakage in the base year is equivalent to 20% of distribution input and remains constant over the remainder of the forecast period

11.3.1 Baseline supply forecast issues

- There have been no significant supply-side adjustments since the 2010 WRMP.
- There is no baseline climate change impact forecast on the available supplies.
- This RZ is not subject to any confirmed or likely sustainability reductions. One unknown sustainability reduction of up 7.6Ml/d has been included in the latest NEP update.
- Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

11.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction and water efficiency. Anticipated savings from these activities in the West Lincolnshire RZ are approximately 1Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

11.4 Scenario testing

11.4.1 Table 11.5 details the impacts of scenario modelling on the supply demand balance for the West Lincolnshire RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	4.78	3.31
Least cost plan	4.69	3.22
High population	3.68	1.31
Worst case climate change	4.78	3.31
Worst case sustainability reductions	4.78	-4.29
Recent actuals	0.12	-1.35
Worst case combination	-0.23	-10.07

Table 11.5 West Lincolnshire Scenario modelling impacts

11.4.2 In summary this shows the following:

- No significant sensitivity to the cost effective plan scenario (maintaining leakage at 199Ml/d)
- 2Ml/d impact on the RZ supply demand balance by the end of the planning period under the increased population scenario
- No impacts resulting from the worst case climate change scenario
- Reductions equivalent to 7.6Ml/d resulting from worst case sustainability reductions scenario
- Impacts of 4.7M/d from restricting deployable outputs to recent actuals by the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts are 5Ml/d by the end of AMP6, reaching 13.4Ml/d by 2039/40.

11.4.3 Options for maintaining the supply-demand balance include:

- Reallocating supplies that are currently exported to the Central Lincolnshire RZ. Any increase in abstractions will be subject to a WFD no deterioration assessment
- Connection of the RZ to the Central Lincolnshire RZ with sharing of the available resources and any new resources that are developed, including an Sherwood Sandstone Groundwater aquifer storage and recovery scheme. This connection could be via Retford

or Gainsborough and would likely be associated with additional connectivity within the West Lincolnshire RZ, and

- Any feasible trading options with Yorkshire Water or Severn Trent Water. It is likely that these would both require new infrastructure.

PART TWO: RESOURCE ZONE SUMMARIES

Central Lincolnshire

12 Central Lincolnshire

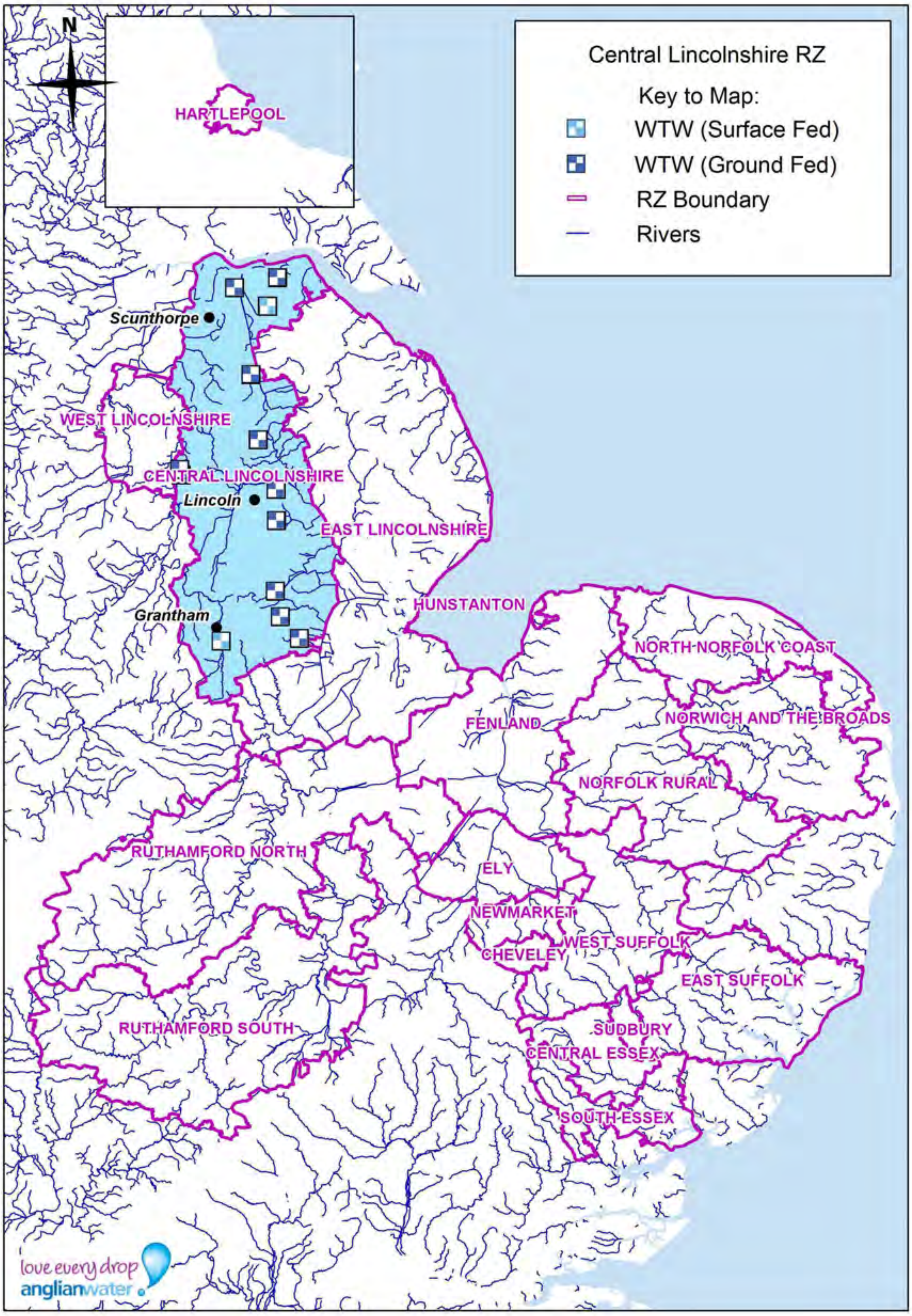


Figure 12.1 Central Lincolnshire Resource Zone

PART TWO: RESOURCE ZONE SUMMARIES
Central Lincolnshire

12.1 Key points

Key Points

- No deficits are forecast in the Central Lincolnshire RZ.
- No significant climate change or levels of service sensitivities have been identified.
- Two WTWs have been targeted for likely sustainability reductions and the deployable output at risk is equivalent to 1.8Ml/d at average.
- A number of sources in this RZ abstract from the Northern Chalk aquifer which is subject to sustainability reduction of up to 25Ml/d; this has been applied to the East Lincolnshire RZ.
- The worst case sustainability reduction risk Central Lincolnshire RZ is equivalent to 4.7Ml/d at peak and 7.5Ml/d at peak.
- Realising the worst case scenario for sustainability reductions would drive local RZ integrity issues and supply-demand investment.
- Local authority policy growth projections exceed our trend based projections by a significant amount; available and target headroom are sufficient to account for the difference and the associated supply-demand risk is minimal.

12.2 Resource zone description

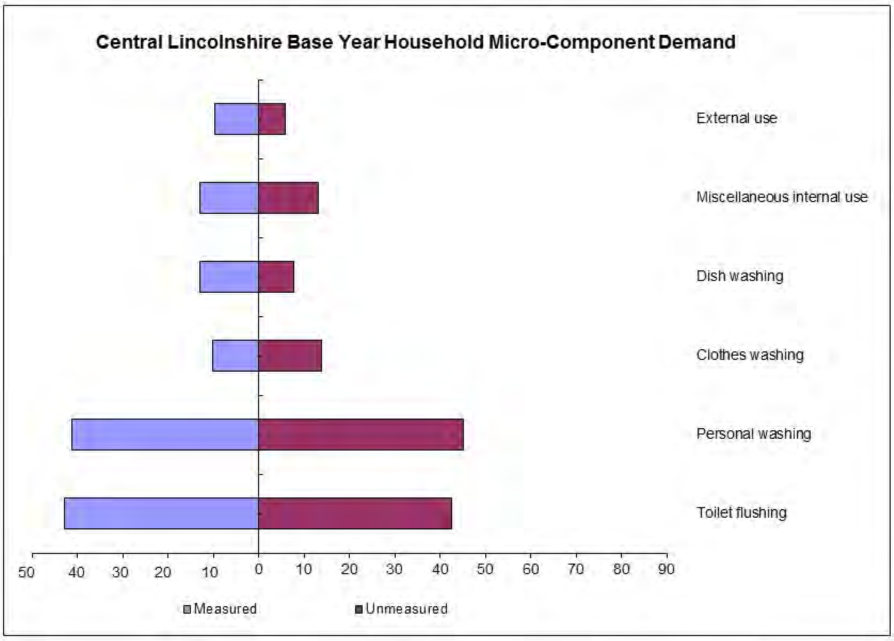
12.2.1 The Central Lincolnshire RZ extends south from the Humber and is based on the supply systems for Scunthorpe, Lincoln, Grantham and Sleaford. Connectivity within the RZ allows for resources to be shared and for the integrity of the RZ to be maintained.

12.2.2 There are a number of sources of supply in the RZ. Groundwater is abstracted from the Sherwood Sandstone and the Lincolnshire Limestone, while surface water is abstracted from the River Ancholme. The abstraction from the River Ancholme is supported by the Environment Agency operated transfer scheme from the River Witham and the River Trent. Further south, the RZ is also supported with raw water supplies from Rutland Water and by abstraction from the River Witham. The new Hall WTW opened in July 2014, which will treat water abstracted directly from the River Trent for supply to customers in Lincoln.

12.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 190,000. Of these 68% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 12,000. Most of these were measured.

12.2.4 From Figure 12.2:

- Base year measured PCC is marginally more and unmeasured PCC is significantly less than to our regional averages (124 l/p/d and 150 l/p/d respectively),and
- Overall, we forecast a 13% reduction in household consumption. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	130	116	115	113
Unmeasured Household	129	117	113	113
Weighted Average	129	116	115	113
Reduction in PCC over forecast (%)	13%			

Figure 12.2 Central Lincolnshire average household consumption (litres/person/day)

12.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using marginally the equivalent amount water for these activities as measured customers. This is not consistent with the regional pattern of consumption.

12.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

12.2.7 Table 11.1 shows measured non-household demands in the base year totalling 40Ml/d in the Central Lincolnshire RZ. These demands are mainly from the manufacturing and wholesale sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
40	Lincoln	15	Wholesale and retail, Manufacturing, light industry, arts and entertainment and public administration
	Scunthorpe South	9	
	Scunthorpe North	6	
	Grantham	5	
	Elsham	<1	

PART TWO: RESOURCE ZONE SUMMARIES
Central Lincolnshire

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
	Welton	<1	
	Branston	<1	
	Waddingham	<1	
	Billingborough	<1	

Table 12.1 Central Lincolnshire RZ Patterns of Measured Non-Household Consumption

12.2.8 From Table 12.2, we forecast new properties equivalent to a long-term average of approximately 2,000 per year. This estimate is based on recent trends in population growth and compares to an equivalent local authority projection of around 4,000 new properties per year. Over 25 years, the difference between the two projections is approximately equal to 50,000 new properties. Recent build rates in the RZ are of the order of 2,500 new properties per year.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			30,000	25,000	20,000	20,000	20,000
WRMP trend estimate			8,500	10,000	10,500	10,500	10,500
Annual Monitoring Report data		13,000					

Table 12.2 Central Lincolnshire Growth Estimates

12.3 Baseline supply-demand balance

12.3.1 From Table 12.3 and Table 12.4, in the last year of AMP6 (2019/20) we forecast that there will be a 32.2Ml/d surplus under DYAA conditions and a 53Ml/d surplus under CP conditions. The equivalent target headroom requirements are 7.8Ml/d and 9.6Ml/d respectively. The RZ remains in surplus over the whole of the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	181.65	181.65	181.65	181.65	181.65	181.65
Outage Allowance	3.77	4.17	4.15	4.16	4.17	4.18
Total Water Available for Use	136.08	156.28	154.51	154.49	154.48	154.47
Distribution Input	120.35	116.25	117.74	119.38	120.92	122.32
Target Headroom	4.01	7.81	10.19	12.73	14.99	17.55
Supply Demand Balance	11.72	32.23	26.58	22.38	18.57	14.60

Table 12.3 Central Lincolnshire Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	239.82	239.82	239.82	239.82	239.82	239.82
Outage Allowance	4.65	5.12	5.07	5.07	5.07	5.07
Total Water Available for Use	185.37	204.89	204.94	204.95	204.95	204.95
Distribution Input	148.34	142.75	144.02	145.52	146.94	148.24
Target Headroom	4.94	9.58	12.46	15.51	18.22	21.27
Supply Demand Balance	32.08	52.55	48.47	43.91	39.79	35.44

Table 12.4 Central Lincolnshire Baseline Supply-Demand Summary (DYCP)

12.3.2 Leakage in the base year is equivalent to 17% of distribution input and remains constant over the remainder of the forecast period.

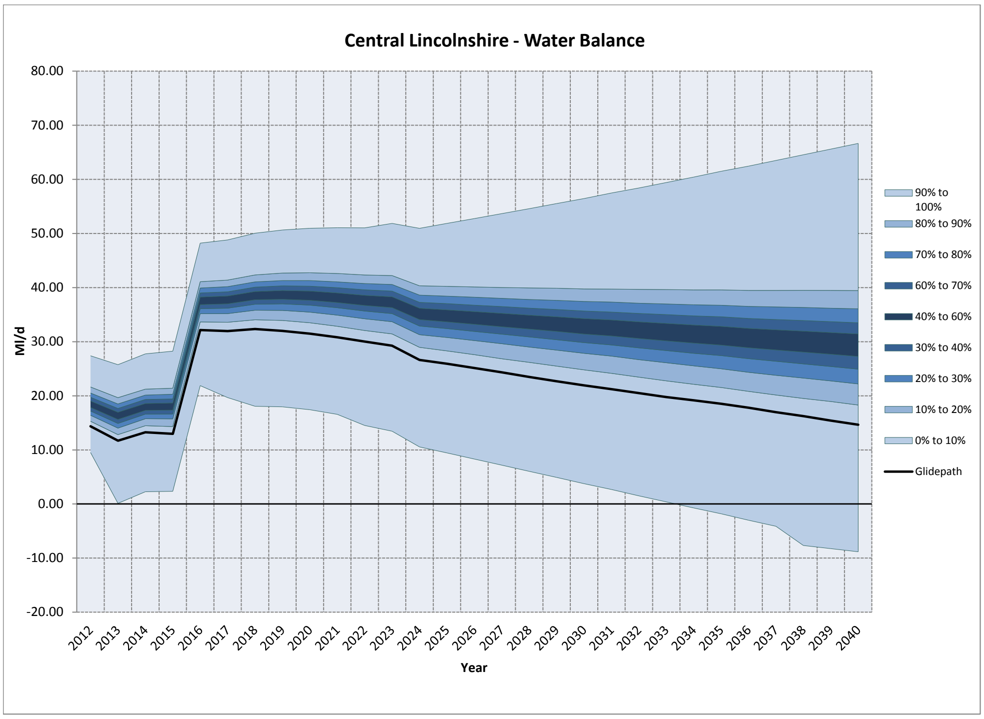


Figure 12.3 Central Lincolnshire Probabilistic Water Balance

12.3.3 From Figure 12.3 there is a greater than 95% probability that the RZ level water balance will remain in surplus over the 25 year forecast period. The step change adjustments in the early part of the forecast period reflect a combination of the DO changes associated with the delivery of Hall WTW and the sustainability reductions.

12.3.1 Baseline supply forecast issues

12.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- Likely sustainability reductions of 1.8Ml/d in total at our Clay Hill and Aswarby sources
- The RZ is at risk from further sustainability reductions on sources that abstract from the Northern Chalk aquifer. These sources are subject to a confirmed sustainability reduction of up to 24.5Ml/d, with modelled impacts to the East Lincolnshire RZ. We are currently working with the Environment Agency to complete further modelling at these sources. During AMP6 we will complete river restoration work at Laceby Beck and Skitter Beck under the NEP water resource programme, and will continue to monitor the effect of support boreholes. Implementation of any required sustainability reduction will be in AMP7, if required
- A WFD no-deterioration risk assessment is likely to be required to support renewal of the Swaton abstraction licence.
- There is no baseline climate change impact forecast on the available supplies in this resource zone
- An increase of 20Ml/d in ADSO and MAXSO for the new Hall WTW on the River Trent. This is modelled as being available from 2015/16
- There has been a reduction to average deployable outputs of 8Ml/d. These result from a comprehensive review of our deployable outputs and the application of a consistent methodology, and
- Winterton WTW is now capable of meeting its daily licence and has increased the resource zone MAXSO by 3Ml/d to meet peak demands. However, outputs from this source continue to be at risk from pesticide pollution events and an AMP6 water quality scheme is planned in respect of this.

12.3.1.2 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

12.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction and water efficiency. Anticipated savings from these activities in the Central Lincolnshire RZ are approximately 5Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.
- There has been a significant reduction in the projected increase in non-household demand. This results from the effects of the recent recession and uncertainty about future development.

12.4 Scenario testing

12.4.1 Table 12.5 details the impacts of scenario modelling on the supply demand balance for the Central Lincolnshire RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	32.23	14.60
Least cost plan	24.82	6.76
High population	24.25	0.08
Worst case climate change	31.63	14.00
Worst case sustainability reductions	31.63	-10.75
Recent actuals	-25.49	-43.11
Worst case combination	-40.07	-89.71

Table 12.5 Central Lincolnshire Scenario Modelling Impacts

12.4.2 In summary this shows the following:

- Significant impact on the RZ supply demand balance of up to 7.2Ml/d by 2039/40 under the least-cost plan scenario
- Significant sensitivity to increasing populations
- No sensitivities to worst case climate change impacts
- Most significant impact from restricting deployable outputs to recent actuals, of up to 29.1Ml/d at the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts increase from 91.7Ml/d at the end of AMP6 up to 103.7Ml/d in 2039/40.

12.4.3 Reductions in the supply-demand balance of this magnitude would drive significant investment. Potential options for maintaining the supply-demand balance include:

- Development of an aquifer storage and recovery scheme (ASR) based on abstraction and treatment of water from the River Trent and injection and storage in the underlying, confined Sherwood Sandstone. To generate the net 20Ml/d of additional DO needed, surface water treatment capacity significantly in excess of 20Ml/d is likely to be required
- Development of a conjunctive use scheme based on the existing Sherwood Sandstone sources and the River Trent. The basic requirement for this would be to allow abstraction from the two sources to be balanced to reduce any adverse environmental impacts
- Development of a reservoir in south Lincolnshire (the South Lincolnshire Reservoir). This would store water abstracted from the River Witham and the River Trent during the winter for treatment and distribution. Originally envisaged as a scheme to support growth in demand in areas to the south and east of our supply system, this could also be used to support areas affected by the sustainability reductions
- Development of the resources of the Rivers Witham and Ancholme. These are currently being assessed. Where sufficient resource exists to support direct abstraction and/or winter storage, the Witham and/or Ancholme could be developed as a source of supply for the affected areas, and
- A water reuse scheme based on discharges into the Trent, Witham or Ancholme, and trading with adjacent water companies or other third parties. Where sufficient resource is available and the development of any associated trading infrastructure is cost-effective, resources from adjacent water companies could be used to supply the affected areas.

PART TWO: RESOURCE ZONE SUMMARIES

East Lincolnshire

13 East Lincolnshire

Figure 13.1 East Lincolnshire Resource Zone

13.1 Key points

Key Points

- No deficits are forecast in the East Lincolnshire RZ.
- Confirmed sustainability reductions are required to restrict abstractions from the Northern Chalk by up to 25Ml/d. River restoration and options appraisal will be completed in AMP6 to develop the preferred solution with the Environment Agency. This will impact on water resource zone integrity for AMP7 water resource planning.
- The worst case unknown sustainability reduction is up to 37Ml/d. A reduction of this magnitude would drive significant supply-demand investment and is the subject of further options appraisal.
- No significant baseline climate change or levels of service sensitivities have been identified.
- In the worst case, climate change may reduce average daily source-works output by 2Ml/d. This would affect abstraction from the Louth Canal.
- Deployable output in the RZ has been reduced to take account of the effect of poor quality groundwater, but includes an allowance for non potable demands.
- Local authority policy based growth projections exceed our trend based projections by a significant amount. Our available and target headroom are sufficient to account for the difference and the associated supply-demand risk is minimal.

13.2 Resource zone description

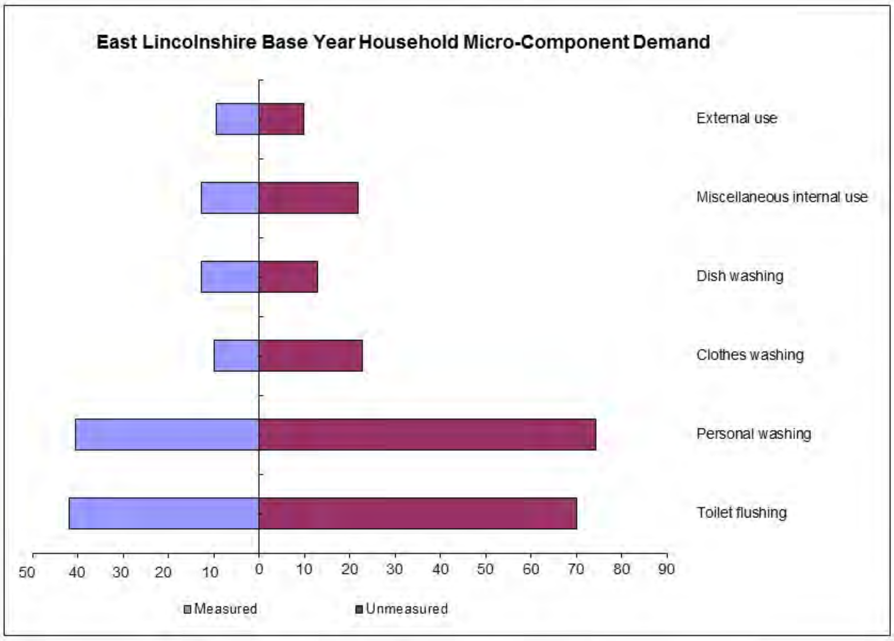
13.2.1 The East Lincolnshire RZ extends from the Humber to the Wash and is based on the supply systems for Grimsby, Louth, Skegness, Boston, Bourne, Spalding and Stamford.

13.2.2 In the northern part of the RZ, supplies are primarily groundwater abstractions from the Chalk and Spilsby Sandstone. There is also surface water abstraction from the Louth Canal into a pumped storage reservoir. Supplies are imported into this part of the RZ from the adjacent Central Lincolnshire RZ. In the southern part of the RZ, supplies are either from Lincolnshire Limestone groundwater sources or are imported from the adjacent Ruthamford North RZ. New mains connect the two parts of the system, allowing resources to be shared and the integrity of the RZ to be maintained.

13.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 240,000. Of these 69% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 15,500. Most of these were measured.

13.2.4 From Figure 13.2:

- Base year measured PCC is marginally more, however unmeasured PCC is estimated to be significantly more than the regional averages (124 l/p/d and 150 l/p/d retrospectively), and
- Overall we forecast a 28% reduction in average PCC. This is mainly driven by the effect of optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	127	114	113	112
Unmeasured Household	212	147	150	152
Weighted Average	157	122	115	113
Reduction in PCC over forecast (%)	28%			

Figure 13.2 East Lincolnshire average household consumption (litres/person/day)

13.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using more water for these activities than measured customers. This is consistent with the regional pattern of consumption.

13.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

13.2.7 Table 13.1 shows measured non-household demands in the base year totalling 45Ml/d in the East Lincolnshire RZ. These demands are mainly from the manufacturing, industry and agriculture sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
45	Grimsby	14	Manufacturing, heavy industry, agriculture, caravan parks and self-catering holiday homes
	Bourne	14	
	Boston	6	
	Skegness	6	
	Louth	2	

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
	Barrow	2	
	Fulstow	1	
	Barnoldby	<1	

Table 13.1 East Lincolnshire RZ Patterns of Measured Non-Household Consumption

13.2.8 From Table 13.2, we forecast new properties equivalent to around 2,500 per year. This estimate is consistent with recent rates of new build but is significantly less than the 5,000 new properties per year forecast by local authorities. Over the forecast period the difference between the two estimates is equivalent to approximately 40,000 new properties.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			20,500	20,500	20,500	20,000	20,000
WRMP trend estimate			10,000	12,000	12,000	12,000	12,000
Annual Monitoring Report data		11,500					

Table 13.2 East Lincolnshire Growth Estimates

13.3 Baseline supply-demand balance

13.3.1 From Table 13.3 and Table 13.4, in the last year of AMP6 (2019/20) we forecast that there will be a DYAA surplus of 61.7Ml/d and a CP surplus of 101.3Ml/d. The equivalent target headroom requirements are 9.8Ml/d and 12.2Ml/d respectively. The RZ remains in surplus over the whole of the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	221.92	221.92	221.92	221.92	221.92	221.92
Outage Allowance	5.64	5.18	5.17	5.20	5.24	5.30
Total Water Available for Use	211.98	217.13	180.04	181.26	181.95	182.75
Distribution Input	158.44	145.65	145.33	146.00	147.31	148.85
Target Headroom	5.21	9.79	12.35	15.40	18.22	21.09
Supply Demand Balance	53.03	61.70	22.37	19.86	16.42	12.82

Table 13.3 East Lincolnshire Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	300.62	300.62	300.62	300.62	300.62	300.62
Outage Allowance	7.13	6.45	6.40	6.41	6.45	6.51
Total Water Available for Use	289.18	294.57	281.72	281.71	281.67	281.61
Distribution Input	200.40	181.14	179.85	180.07	181.31	182.94
Target Headroom	6.59	12.17	15.28	19.00	22.43	25.92
Supply Demand Balance	86.90	101.26	86.58	82.65	77.93	72.76

Table 13.4 East Lincolnshire Baseline Supply-Demand Summary (DYCP)

13.3.2 Leakage in the base year is equivalent to 17% of distribution input and remains constant over the remainder of the forecast period.

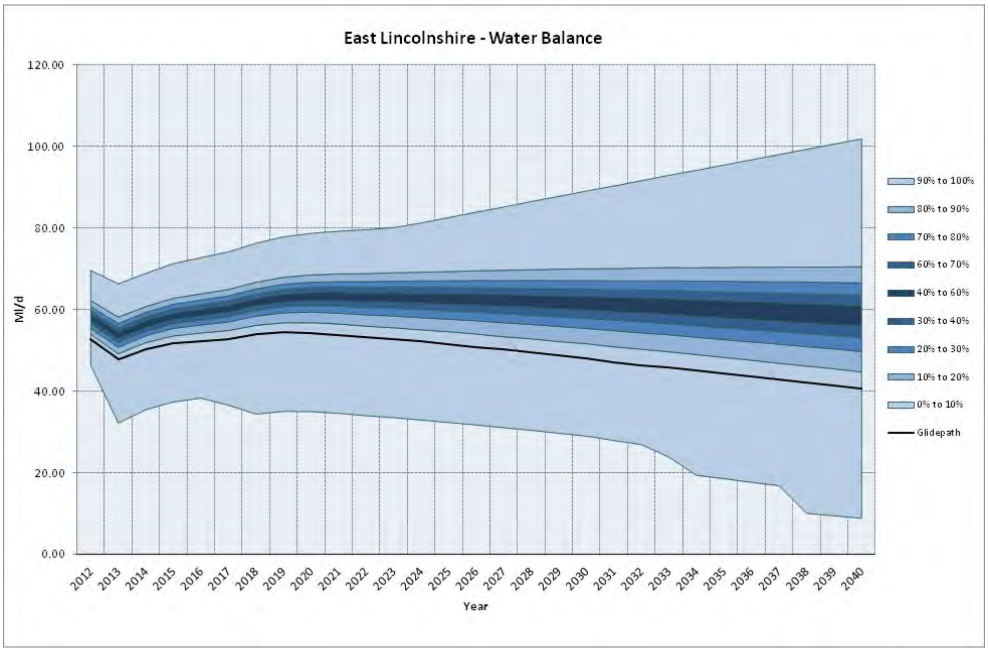


Figure 13.3 East Lincolnshire Probabilistic Water Balance

13.3.3 From Figure 13.3, there is a greater than 95% probability that the RZ level water balance will remain in surplus over the 25 years forecast period.

13.3.1 Baseline supply forecast issues

- Significant reductions were made to the deployable outputs of the Northern Chalk groundwater sources for the draft WRMP14. This reduction met the confirmed sustainability changes on the Northern Chalk group constraining abstractions to 75Ml/d.
- These sources also support industrial demand in this zone and for the revised draft the deployable outputs from these sources have been increased to reflect the current

industrial demand. As a result the deployable outputs have been increased back to 100Ml/d.

- The sustainability change is now being reported in this zone as a confirmed sustainability reduction of 24.5Ml/d and is included in the baseline forecast in 2024/25.
- A sustainability reduction of this magnitude will introduce sub-resource deficits and resource zone integrity issues. Once confirmed it is likely that this resource zone will be disaggregated for AMP7 planning purposes.
- We are currently working with the Environment Agency to complete further modelling of the Northern Chalk. The outcome of this work will allow us to determine which sites will be subject to reduction in AMP7 and agree the preferred solution with the Environment Agency.
- Our AMP6 Water Resources National Environment Programme includes provision for extensive river restoration work, including proposals for the Laceby Beck and Skitter Beck.
- The need for a WFD no-deterioration assessment has been identified to support renewal of the Welton Le Marsh and Candlesby abstraction licences in 2016.
- There is no baseline climate change impact forecast on the available supplies.

13.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction and water efficiency. Anticipated savings from these activities in the East Lincolnshire RZ are approximately 5Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

13.4 Scenario testing

13.4.1 Table 13.5 details the impacts of scenario modelling on the supply demand balance for the East Lincolnshire RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	61.70	12.82
Least cost plan	29.78	5.33
High population	24.91	-9.75
Worst case climate change	36.44	10.78
Worst case sustainability reductions	37.23	-24.28
Recent actuals	-13.24	-37.65
Worst case combination	-34.38	-107.81

Table 13.5 East Lincolnshire Scenario Modelling Impacts

13.4.2 In summary this shows the following:

- A reduction in the supply demand balance of 7.5Ml/d at the end of the planning period under the least-cost plan scenario (leakage maintained at 199Ml/d)

- Significant sensitivities to increasing populations in the short and long term equivalent to 22.6Ml/d in 2039/40
- Worst case climate change impacts equivalent to a 2.0Ml/d increase on zonal deficits in 2039/40
- Most significant impact from restricting deployable outputs to recent actuals, of up to 50.5Ml/d at the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts equivalent to 120.6Ml/d by the end of AMP10.

13.4.3 Reductions of this magnitude would drive significant investments under these circumstances, options for maintaining the supply-demand balance include:

- A transfer from the Central Lincolnshire RZ, which is supported by the Lower Trent Sherwood Sandstone Aquifer Storage and Recovery (ASR)
- Development of a Spilsby Sandstone ASR scheme. This could be based on the abstraction and treatment of chalk groundwater or chalk fed spring water during the winter and injection of this into the underlying Spilsby Sandstone. To generate a net increase in DO of 20Ml/d, significant additional treatment capacity is likely to be required
- Development of the South Lincolnshire Reservoir. This would store water abstracted from the River Witham and the River Trent during the winter for year-round treatment and distribution. Originally envisaged as a scheme to support growth in demand in areas to the south and east of our supply system, this could also be used to support areas affected by the sustainability reductions
- Development of the resources of the River Witham and River Ancholme. These are currently being assessed. Where sufficient resource exists to support direct abstraction and/or winter storage, the Witham and/or Ancholme could be developed as a source of supply for the affected areas
- A water reuse scheme based on discharges into the River Witham or River Ancholme, and
- Trading with adjacent water companies or other third parties. Where sufficient resource is available and the development of any associated trading infrastructure is cost-effective, resources from adjacent water companies could be used to supply the affected area.

PART TWO: RESOURCE ZONE SUMMARIES

Fenland

14 Fenland

Figure 14.1 Fenland Resource Zone

PART TWO: RESOURCE ZONE SUMMARIES
Fenland

14.1 Key points

Key Points

- AMP7 deficits are forecast in the Fenland RZ. These grow to 7Ml/d under dry year annual average conditions. There is no equivalent deficit under critical period conditions.
- No significant baseline climate change or levels of service sensitivities have been identified.
- In the worst case, climate change may reduce average daily source-works output by 8.8Ml/d. This would affect abstraction from the River Wissey and the River Nar.
- Two WTWs have been targeted for confirmed sustainability reductions; a further works is included as a likely reduction. These may reduce average daily source-works output by 19Ml/d and drive the need for investment to maintain the supply-demand balance.
- One further sustainability reduction has the result of an interim reduction in deployable output to this RZ, whilst the preferred solution is delivered in the adjacent Hunstanton RZ.
- Excluding the WFD no-deterioration and worst case climate change risks, the plan for maintaining the supply-demand balance combines a transfer from the adjacent Ruthamford North RZ with water efficiency activity and enhanced metering. In the long term additional leakage control is also required.

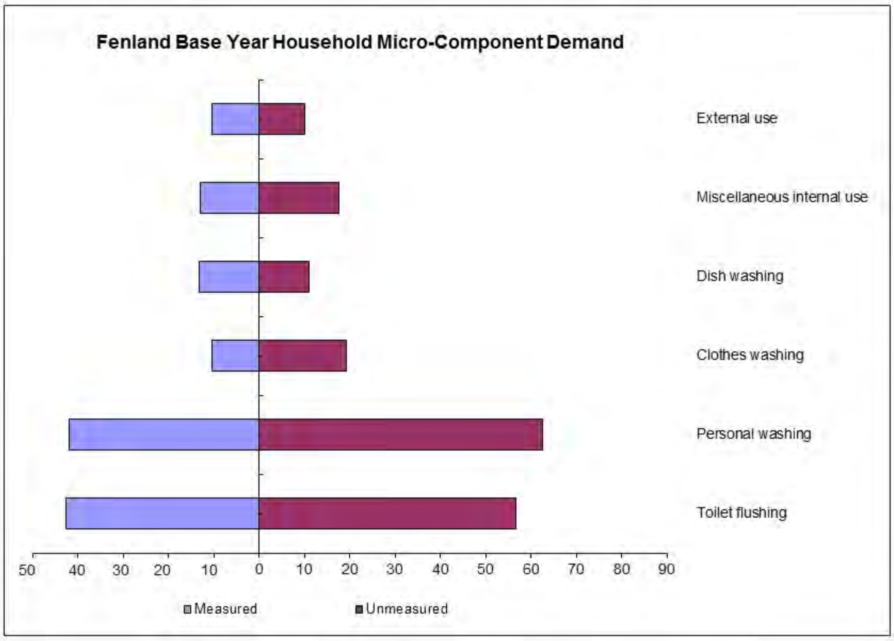
14.2 Resource zone description

14.2.1 The Fenland RZ lies to the south and east of the Wash and is based on the supply systems for Wisbech, Downham Market and King's Lynn. Customers in the RZ are supplied with groundwater pumped from the Chalk and Sandringham Sands aquifers and surface water which is abstracted from the River Nar and River Wissey. Connectivity within the RZ allows for resources to be shared and for the integrity of the RZ to be maintained.

14.2.2 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 80,000. Of these 69% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 5,000. Most of these were measured.

14.2.3 From Figure 14.2:

- Base year measured and unmeasured PCC are more than our regional averages (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 21% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	132	119	118	116
Unmeasured Household	177	151	137	121
Weighted Average	148	122	119	116
Reduction in PCC over forecast (%)	21%			

Figure 14.2 Fenland average household consumption (litres/person/day)

14.2.4 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using more water for these activities than measured customers. This is consistent with the regional pattern of consumption.

14.2.5 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

14.2.6 Table 14.1 shows measured non-household demands in the base year totalling 20Ml/d in the Fenland RZ. These demands are mainly from the agriculture and manufacturing sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
20	Wisbech	12	Agriculture and manufacturing
	Kings Lynn	7	
	Feltwell	1	
	Snettisham	<1	

Table 14.1 Fenland RZ Patterns of Measured Non-Household Consumption

14.2.7 From Table 14.2, we forecast new properties equivalent to around 800 per year. This estimate is consistent with recent rates of new build and with the number of new properties forecast by local authorities.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			4,000	4,000	3,500	3,500	3,500
WRMP trend estimate			3,500	4,000	4,000	4,000	4,000
Annual Monitoring Report data	4,000	4,000					

Table 14.2 Fenland Growth Estimates

14.3 Baseline supply-demand balance

14.3.1 From Table 14.3 and Table 14.4, in the last year of AMP6 we forecast that there will be a DYAA surplus of 16.9Ml/d and a CP surplus of 21.8Ml/d. Equivalent target headroom requirements are 2.8Ml/d and 3.6Ml/d respectively. Owing to the likely sustainability reductions we forecast that in the last year of AMP7 (2024/25) there will be a DYAA deficit which reaches 7.1Ml/d by 2039/40. The RZ remains in surplus under CP conditions to the end of the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	74.47	74.47	74.47	74.47	74.47	74.47
Outage Allowance	1.98	1.92	1.50	1.50	1.50	1.50
Total Water Available for Use	72.49	72.50	53.88	53.85	53.83	53.82
Distribution Input	55.46	52.75	52.90	53.36	53.87	54.38
Target Headroom	1.83	2.80	3.66	4.66	5.57	6.50
Supply Demand Balance	15.20	16.95	-2.68	-4.17	-5.61	-7.06

Table 14.3 Fenland Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	94.96	94.96	94.96	94.96	94.96	94.96
Outage Allowance	2.55	2.45	1.90	1.89	1.89	1.89
Total Water Available for Use	92.40	92.51	80.56	80.57	80.57	80.57
Distribution Input	71.38	67.11	66.99	67.34	67.81	68.29

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Target Headroom	2.35	3.56	4.64	5.88	7.01	8.17
Supply Demand Balance	18.67	21.84	8.94	7.34	5.75	4.11

Table 14.4 Fenland Baseline Supply-Demand Summary (DYCP)

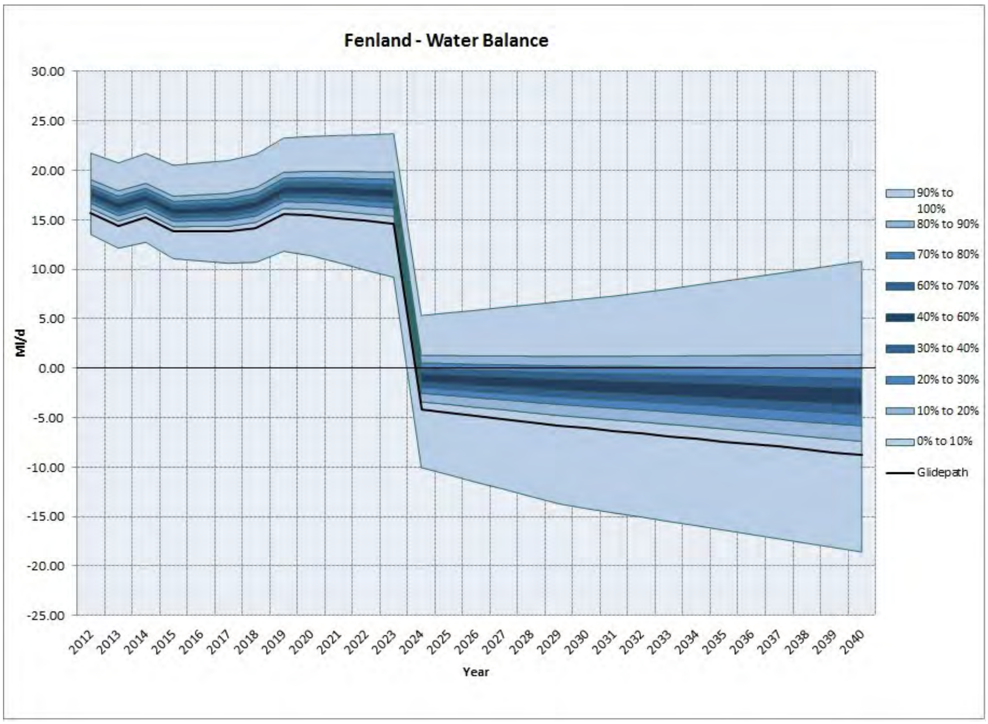


Figure 14.3 Fenland Probabilistic Water Balance

14.3.2 Figure 14.3 confirms that there is a greater than 95% probability that the RZ water balance will be in deficit from the mid-part of the forecast period. The step reduction in the mid-part of the forecast reflects the effect of the proposed sustainability reductions.

14.3.3 Leakage in the base year is equivalent to 16% of distribution input and remains constant over the remainder of the forecast period.

14.3.1 Baseline supply forecast issues

14.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- A confirmed sustainability reduction affecting our source on the River Nar. This is currently estimated to be equivalent to a 9.1Ml/d reduction in ADSO in 2024/25. This reduction will also result in a 12.5Ml/d reduction in critical peak periods.
- A confirmed sustainability reduction affecting one of our Chalk groundwater sources impacting flows in the River Nar and the Old Car Stream. This is currently estimated to be equivalent to a 6.9Ml/d reduction in ADSO in 2024/25.

- Two likely sustainability reductions have been identified to restore flows in Stringside Stream and River Gaywood, totalling 2.96Ml/d.
- A revised estimate of the yield available from the River Nar under dry weather conditions has reduced MAXSO by 1Ml/d and ADSO by 1.9Ml/d.
- The sources identified for these sustainability reductions will also be subject to WFD no-deterioration assessments. An assessment for Hillington licence renewal will be submitted in 2015.
- Operational improvements at Denton Lodge during AMP5 have resulted in availability of the full daily licence and the deployable output has been revised.
- There is forecast to be a marginal baseline climate change impact on available supplies. This approximates 0.15Ml/d and affects abstraction from the River Wissey.

14.3.1.2 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

14.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction, enhanced metering and water efficiency. Anticipated savings from these activities in the Fenland RZ are approximately 3Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

14.4 Feasible options for maintaining the supply-demand balance

14.4.1 The feasible Fenland RZ options that were modelled in our EBSD optimiser are given below in Table 14.5.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Reuse	F1 King's Lynn and Wisbech water reuse	12	16	130,700	2,830
Desalination	F2 King's Lynn desalination	12	15	54,000	3,970
Transfer	F4 RTN RZ transfer (12Ml/d)	12	12	22,100	220
Transfer	F5 RTN RZ transfer (25Ml/d)	25	25	34,200	250

Table 14.5 Fenland Feasible Option Details

14.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon costs. In the EBSD modelling social, environmental and carbon costs have been included.

14.4.1 Scheme descriptions

14.4.1.1 The following schemes have been developed to meet forecast deficits in the Fenland RZ:

- F1 King's Lynn and Wisbech water reuse - Treated effluent from King's Lynn and Wisbech Water Recycling Centres would be diverted to the River Wissey to supplement river flow and allow increased abstraction. The effluent would be treated to an extremely high (near potable) standard before being pumped 50km via a new pipeline to the river upstream of the existing water treatment works intake. From there it would be re-abstracted and treated by a new water treatment works
- F2 King's Lynn desalination - This option provides for the construction of a desalination plant drawing water from the Great Ouse estuary and delivering treated water to a service reservoir through 14km of new main
- F4 Ruthamford North RZ transfer (12Ml/d) - A transfer of 12Ml/d of water from the Ruthamford North RZ to the Wisbech area via 36km of new main, and
- F5 Ruthamford North RZ transfer (25Ml/d) - This option is similar to option F4 but provides for the transfer of 25Ml/d via a larger pipeline following the same route as option F4.

14.4.1.2 Both transfer options (F4, F5) utilise the surplus in Ruthamford North RZ towards the beginning of the forecast. Once this has been exhausted a new resource/s would be required to supply the transfer. The new resource options are described in the Ruthamford North RZ summary. The Options Appraisal Report contains more details about all of these options.

14.4.1.3 The following options are mutually exclusive because only one of the transfer options would be constructed if selected by the model:

- F4 Ruthamford North RZ transfer (12Ml/d), and
- F5 Ruthamford North RZ transfer (25Ml/d).

14.4.2 Environmental considerations

14.4.2.1 The environmental assessments of the feasible options have concluded the following for the Fenland RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options, and
- The climate change vulnerability assessment concludes that both transfer options (F4, F5) are not sensitive to climate change but the donor RZs are vulnerable to climate change. The assessment scored both options as 2 – limited sensitivity. The desalination and reuse options (F1, F2) scored 1 – insensitive.

14.4.2.2 The WFD no-deteriorations assessment concluded:

- F1 King's Lynn and Wisbech water reuse - Further investigation will be required to demonstrate that the diversion of effluent will not have an adverse effect on water quality and flow WFD status for the Wash SPA
- F2 King's Lynn desalination - It cannot be concluded that this option will not lead to the deterioration of the Great Ouse waterbody WFD status. The desalinisation process involves the discharge of brine back to the waterbody. The location within a relatively small tidal estuary means that this presents risks to water quality which cannot be

discounted without significant further investigation. The effects of any abstraction would also have to be assessed, both in terms of the reduction in flow in volumetric terms and the associated changes in tidal functioning and morphological processes

- F4/5 Ruthamford North RZ Transfer - The proposed increase to abstraction has the potential to lead to a deterioration of the River Nene and River Welland waterbody status. The existing licence constraints mean that this risk is low, but further investigation is required. The operation of this scheme is unlikely to adversely affect Rutland Water SPA
- The SEA and HRA concluded that options F1 and F2 could both have a likely significant effect, and would therefore require an Appropriate Assessment if taken forward, and
- No significant negative effects associated with options F4/F5 following mitigation.

Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

14.5 Preferred plan

14.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side		F4 RTN RZ transfer (12Ml/d)			
Distribution side	See below				
Customer side	See below				

Table 14.6 Fenland Supply-Demand Investment Plan

14.5.2 Lowering consumption levels are a priority to offset resource development so leakage reduction, enhanced metering and water efficiency programmes have been included in the baseline. In the Fenland RZ we aim to complete approximately 7,500 water efficiency audits. Our enhanced metering programme will fit over 14,500 meters and as a result of this and background opting rates; we anticipate that approximately 11,000 customers will opt onto metered billing. The baseline supply demand balance also includes 2.1Ml/d leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: supplies in this RZ are obtained in part from direct intakes on the River Nar and River Wissey. Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the ecology of these rivers, and
- An opportunity for customers to reduce bills: metering allows customers to reduce their bills by switching from unmeasured to measured supplies. Extending the current enhanced metering programme into the Fenland RZ allows customers in this zone to share in these benefits. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

14.5.3 In respect of the plan, the following issue is noted:

- The timing of the Ruthamford North transfer depends on when the sustainability reductions are required.

14.6 Scenario testing

14.6.1 Table 14.7 details the impacts of scenario modelling on the supply demand balance for the Fenland RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	16.95	-7.06
Least cost plan	-1.15	-8.95
High population	-0.38	-7.87
Worst case climate change	-2.44	-15.68
Worst case sustainability reductions	0.91	-7.06
Recent actuals	-14.28	-22.25
Worst case combination	-21.03	-33.58

Table 14.7 Fenland Scenario Modelling Impacts

14.6.2 In summary this shows the following:

- Significant impact on the RZ supply demand balance in the short term under the least cost plan scenario
- Sensitivity to increasing populations
- Worst case climate change impacts equivalent to an 8.6Ml/d increase on zonal deficits in 2039/40
- Most significant impact from restricting deployable outputs to recent actuals, of up to 15.4Ml/d at the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts increase from 4.1Ml/d by the end of AMP6 up to 26.8Ml/d in 2039/40.

14.6.3 Table 14.8 below shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	Residual Deficit 2039/40 (Ml/d)
Preferred plan	See note below	F4 Ruthamford North transfer (12Ml/d)				0
Preferred plan - environmental and social costs	See note below	F4 Ruthamford North transfer (12Ml/d)				0
Plan B	See note below	F5 Ruthamford North transfer (25Ml/d)				0
Least cost plan		F5 Ruthamford North transfer (25Ml/d)			Leakage	0
High population	See note below	F4 Ruthamford North transfer (12Ml/d)				0
Worst case climate change	See note below F5 Ruthamford North transfer (25Ml/d)			F2 - Kings Lynn Desalination		0
Worst case sustainability reductions	See note below	F5 Ruthamford North transfer (25Ml/d)				0
Recent actuals	F2 - Kings Lynn Desalination	F1 Kings Lynn and Wisbech Water Reuse	F4 Ruthamford North transfer (12Ml/d)			0
Worst case combination	F2 - Kings Lynn Desalination F1 Kings Lynn and Wisbech Water Reuse Leakage Water efficiency Enhanced metering	F5 Ruthamford North transfer (25Ml/d)				0

Table 14.8 Fenland Scenario Scheme Selection

14.6.4 Although not selected in the EBSD modelling for the least cost plan in AMP6, leakage reduction, metering and water efficiency has been included in the baseline supply demand forecast.

14.6.5 Under all scenarios Fenland RZ has adequate resource however it is reliant on resources being available in Ruthamford North RZ which in the worst case combination and recent actuals scenarios is shown to be in deficit at the end of the forecast. Under these circumstances, strategic options for maintaining the supply-demand balance include:

- Development of the South Lincolnshire Reservoir. This would store water abstracted from the River Trent during the winter for year-round treatment and distribution. Originally envisaged as a scheme to support growth in demand in areas to the south and east of our supply system, this could also be used to support other areas
- Development of a new winter storage reservoir in the Norfolk Fens. This would store water abstracted from the River Ouse during the winter for year-round treatment and distribution. Since the resources of the Ouse are already used to support the Ely Ouse Essex Transfer, careful consideration of the available yield would be required. If support is necessary, it is possible that a raw water transfer from the River Trent could be developed. This would link the Trent, Nene and Ouse, enabling resources to be transferred from the Trent basin to the south and east to support supply-systems in East Anglia
- Associated with the above, the development of trading based infrastructure, either between water companies in East Anglia or between water companies and other third parties. In part, this could be based on schemes which are delivered to improve the resilience of supply-systems in East Anglia, and
- Investment to support the additional storage capacity created by dam raising in Ruthamford North RZ by a transfer of resources from the Trent basin.

PART TWO: RESOURCE ZONE SUMMARIES

Hunstanton

15 Hunstanton

Figure 15.1 Hunstanton Resource Zone

15.1 Key points

Key Points

- AMP6 deficits are forecast in the Hunstanton RZ. These grow to around 1Ml/d under dry year annual average conditions by the end of the forecast period and are the result of a sustainability change.
- Over the forecast period, no significant climate change, sustainability reduction or levels of service sensitivities have been identified.
- Excluding the WFD deterioration risk, the plan for maintaining the supply-demand balance combines a transfer from the adjacent Fenland RZ with metering and water efficiency activity.

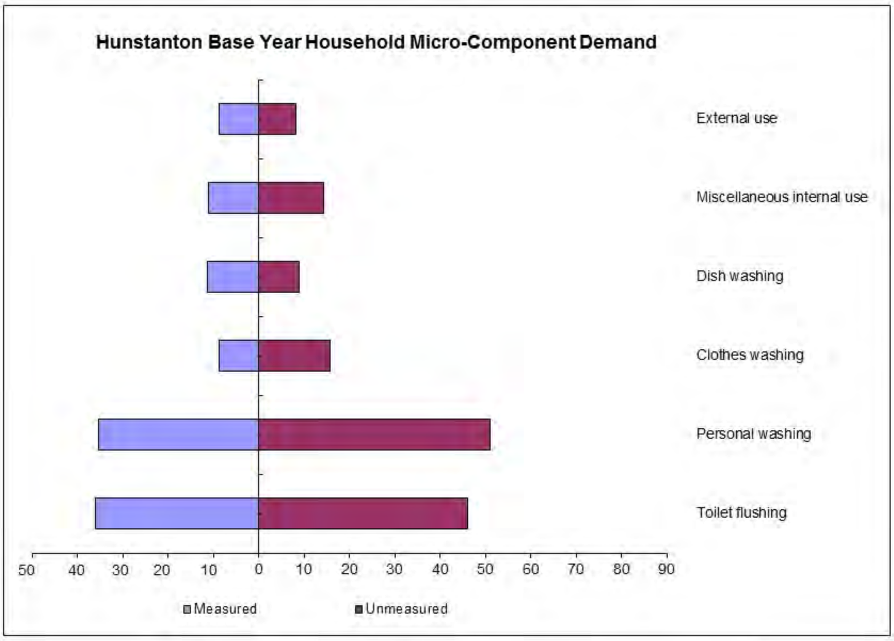
15.2 Resource zone description

15.2.1 The Hunstanton RZ lies to the east of the Wash and is based on the supply systems for Hunstanton town. Customers in the RZ are supplied with groundwater abstracted from the Chalk.

15.2.2 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 4,200. Of these 76% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 300. Most of these were measured.

15.2.3 From Figure 15.2:

- Base year measured and unmeasured PCC are marginally lower than our regional averages (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 12% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	111	107	108	107
Unmeasured Household	145	127	112	105
Weighted Average	121	109	108	107
Reduction in PCC over forecast (%)	12%			

Figure 15.2 Hunstanton average household consumption (litres/person/day)

15.2.4 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using more water for these activities than measured customers. This is consistent with the regional pattern of consumption.

15.2.5 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

15.2.6 Table 15.1 shows measured non-household demands in the base year totalling 1Ml/d in the Hunstanton RZ. These demands are mainly from the food services and tourism sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
1	Hunstanton	1	Food services and tourism

Table 15.1 Hunstanton Measured Non-Household Consumption

15.2.7 From Table 15.2, we forecast new properties equivalent to around 40 per year. This estimate is consistent with recent rates of new build and the number of new properties forecast by local authorities.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			190	180	180	180	180
WRMP trend estimate			160	200	200	200	200
Annual Monitoring Report data	150	200					

Table 15.2 Hunstanton Growth Estimates

15.3 Baseline supply-demand balance

15.3.1 From Table 15.3 and Table 15.4, in the last year of AMP6 (2019/20) we forecast that there will be a DYAA deficit of 0.7Ml/d and a CP surplus of 0.6Ml/d. By 2039/40 the DYAA deficit reaches 0.97Ml/d. The deficit is a function of a sustainability change that was accepted in AMP4. Equivalent target headroom requirements are 0.1Ml/d and 0.13Ml/d DYAA and CP conditions respectively.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	2.77	2.77	2.77	2.77	2.77	2.77
Outage Allowance	0.08	0.08	0.05	0.05	0.05	0.05
Total Water Available for Use	2.68	1.42	1.42	1.42	1.42	1.42
Distribution Input	1.84	2.00	2.03	2.07	2.10	2.13
Target Headroom	0.06	0.10	0.14	0.18	0.22	0.26
Supply Demand Balance	0.78	-0.72	-0.75	-0.82	-0.90	-0.97

Table 15.3 Hunstanton Baseline Supply-Demand Summary (DYAA)

Water Balance Components	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7	End of AMP8	End of AMP9	End of AMP10
Deployable Output	3.46	3.46	3.46	3.46	3.46	3.46
Outage Allowance	0.11	0.11	0.06	0.06	0.06	0.06
Total Water Available for Use	3.35	3.35	3.40	3.40	3.40	3.40
Distribution Input	2.47	2.60	2.62	2.65	2.69	2.73
Target Headroom	0.08	0.13	0.17	0.23	0.28	0.34
Supply Demand Balance	0.80	0.67	0.61	0.52	0.43	0.34

Table 15.4 Hunstanton Baseline Supply-Demand Summary (DYCP)

15.3.2 Leakage in the base year is equivalent to 11% of distribution input.

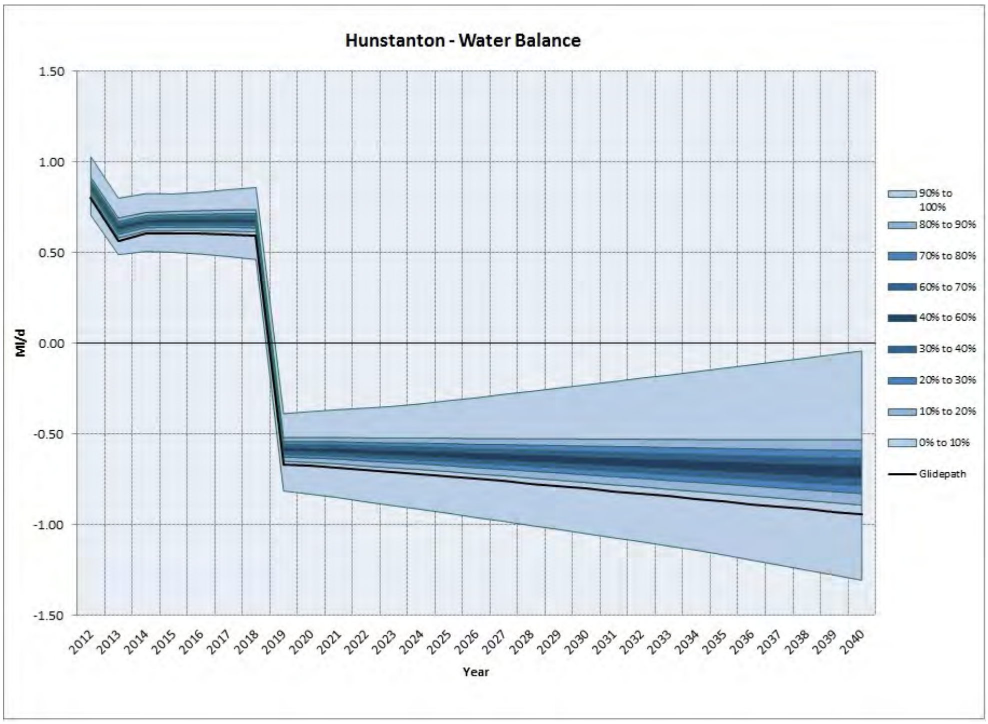


Figure 15.3 Hunstanton Probabilistic Water Balance

15.3.3 Figure 15.3 confirms that there is a 100% probability that the RZ water balance will be in deficit from early in the 25 year forecast period. The step reduction in the early part of the forecast period reflects the effect of a historic sustainability reduction.

15.3.1 Baseline supply forecast issues

- There have been no significant changes to available supplies in the Hunstanton RZ since the 2010 WRMP.
- The RZ is subject to a confirmed sustainability reduction of 1.3Ml/d in 2019/20.
- There is no baseline climate change impact forecast on the available supplies.

15.3.1.1 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

15.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction, enhanced metering and water efficiency. Anticipated savings from these activities in the Hunstanton RZ are approximately 0.1Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

15.4 Feasible options for maintaining the supply-demand balance

15.4.1 The feasible Hunstanton RZ options that were modelled in our EBSD optimiser are given below in Table 15.5.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Transfer	H1 Fenland RZ transfer	1.5	1.5	1,700	20
Water Resuse	H2 Heacham water reuse	1	1.3	15,600	140
Desalination	H3 – Wash desalination	1	1.3	16,600	330
Borehole	H4 Hunstanton RZ groundwater development	1	1.3	3,900	60

Table 15.5 Hunstanton Feasible Option Details

15.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon costs. In the EBSD modelling social, environmental and carbon costs have been included.

15.4.1 Scheme descriptions

15.4.1.1 The following schemes have been developed for Hunstanton RZ:

- H1 Fenland RZ Transfer - A 1.5Ml/d transfer from Fenland RZ, east of King's Lynn, to Hunstanton RZ via a new 6km pipeline and pumping station
- H2 Heacham water reuse - This option provides for treated effluent from Heacham Water Recycling Centre to be discharged to ground to recharge groundwater and permit increased abstraction from existing boreholes. The effluent would be treated to an extremely high (near potable) standard using additional treatment process and pumped 8km before re-abstraction and treatment by a new water treatment works
- H3 Wash desalination - This option provides for a desalination plant situated on the coast near to Hunstanton. Treated water would be transferred 5km into the existing treated water network, and
- H4 Hunstanton RZ groundwater development - This option involves the construction of three new boreholes and utilises two disused licensed boreholes east of Hunstanton. New treatment to remove iron and manganese would be required.

15.4.1.2 The transfer option H1 utilises the surplus in Fenland RZ towards the beginning of the forecast. Once this has been exhausted a new resource/s would be required to supply the transfer. This would either be developed in Fenland RZ or if a transfer is required to support Fenland this would be in the donor RZ supplying Fenland RZ. The new resource options are described in the relevant RZ summaries. The Options Appraisal report contains more details about all of these options.

15.4.2 Environmental considerations

15.4.2.1 The environmental assessments of the feasible options have concluded the following for the Hunstanton RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options, and
- The climate change vulnerability assessment concludes that the transfer option (H1) is not sensitive to climate change but the donor RZs are vulnerable to climate change. The assessment scored this option as 2 – limited sensitivity. The water reuse and

desalination options (H2, H3) scored 1 – insensitive. The groundwater development option (H4) was rated as 2 – limited sensitivity.

15.4.2.2 The WFD no-deteriorations assessment, SEA and HRA concluded:

- H1 Fenland RZ Transfer - The WFD no-deterioration assessment has considered the impact of a small increase across various groundwater sources within the Fenland RZ. The assessment has concluded no risk of deterioration at two waterbodies and a medium risk for the Heacham Stream. The recommendation from the assessment is to review the outcome of the various investigations to determine the optimal balance between sources.
- H2 Heacham water reuse - On the assumption that the water quality will be acceptable this option is considered to be having a benefit in terms of WFD waterbody status. The scheme would require an Appropriate Assessment if taken forward and the SEA identified a mitigation measure to re-route the pipeline.
- H3 Wash desalination - There is a medium risk of WFD no-deterioration associated with this scheme that would require further investigation. An Appropriate Assessment would be required if taken forward.
- H4 Hunstanton RZ groundwater development - Site specific information from the Environment Agency suggests that the upper reaches of the Heacham Stream may be at risk of deterioration as a consequence of the proposed option. Further hydro-ecological investigations are required to look at the sensitivity of the upper reaches to the implementation of this option.

15.4.2.3 Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

15.5 Preferred plan

15.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side	H1 Fenland RZ transfer				
Distribution side	See below				
Customer side	See below				

Table 15.6 Hunstanton Supply-Demand Investment Plan

15.5.2 Lowering consumption levels is a priority to offset resource development, therefore enhanced metering, leakage reduction and water efficiency programmes have been included in the baseline. In the Hunstanton RZ our enhanced metering programme will fit about 500 meters and as a result of this and background opting rates, we anticipate that approximately 350 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

15.5.3 To comply with the Habitats Directive Review of Consents (RoC) April 2014 deadline, an interim arrangement for managing abstraction from the North Norfolk Chalk has been agreed with Natural England and the Environment Agency. This involves a licensing change that reduces abstraction from North Norfolk Chalk sources in parts of the Fenland RZ which are adjacent to the Hunstanton RZ. The areas affected by the reduction in abstraction will be supported by a transfer from Fenland RZ sources which are located further to the south. While these arrangements mitigate short-term environmental risk and enable us to meet the statutory April 2014 deadline, the long-term requirement is for a reduction in the volume of abstraction from the Hunstanton RZ. To deliver this, the permanent transfer from the Fenland RZ is needed.

15.5.4 A WFD no deterioration screening assessment of the Fenland RZ transfer scheme concluded the risk of deterioration ranged from low risk to a potential risk in flow reduction in the upper reaches of the Heacham river. The assessment recommended that the option was balanced against previous and proposed NEP investigations to determine the preferred sources for the transfer.

15.5.5 As a result, a further assessment was completed by Atkins during May 2014 to identify how this scheme will be delivered without risk to the environment and to confirm the sources that will be used to support the transfer.

15.5.6 The assessment considered licence and operational constraints, environmental considerations of increasing abstractions from potential sources and an assessment of historical rates of abstraction to determine the optimal donor sources that could contribute to the Fenland RZ transfer of 1Ml/d.

15.5.7 It concluded that there is sufficient headroom in the daily and annual licences for HILSAN1 and KINGS2 aggregates to allow export of 1 Ml/d from the Fenland RZ to the Hunstanton RZ. The assessment recommended the preferred sources for the transfer by minimising the environmental impacts of abstractions. These have been agreed with the Environment Agency.

15.5.8 Once the Fenland transfer has been delivered, abstraction from the Hunstanton Chalk source will decrease and abstraction from the adjacent Fenland RZ sources will return to more typical levels. Any additional resources needed to support the new transfer will then be pumped into the area from Fenland RZ sources.

15.5.9 To support scheme H1 – Fenland RZ transfer the model selected the following upstream options:

- F4 Ruthamford North RZ transfer to Fenland RZ, and
- RHFA15 Reduce Ruthamford North RZ raw water export.

15.6 Scenario testing

15.6.1 Table 15.7 details the impacts of scenario modelling on the supply demand balance for the Hunstanton RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	-0.69	-0.97
Least cost plan	-0.70	-1.01
High population	-0.73	-1.01
Worst case climate change	-0.69	-0.97
Worst case sustainability reductions	-0.69	-0.97
Recent actuals	-1.60	-1.89
Worst case combination	-1.66	-1.95

Table 15.7 Hunstanton Scenario Modelling Impacts

15.6.2 In summary this shows the following:

- Marginal impacts equivalent to 0.04Ml/d under the least-cost plan scenario and increased population scenarios by 2039/40
- No impacts as a result of worst case climate change impacts or sustainability reductions on zonal deficits in 2039/40
- Most significant impact results from restricting deployable outputs to recent actuals, with up to 0.9Ml/d reduction at the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts increasing to 1Ml/d at the end of AMP6.

15.6.3 Table 15.8 below shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	RZ Residual Deficit 2039/40 (Ml/d)
Preferred plan	H1 Fenland RZ transfer					0
	See note below					
Preferred plan - environmental and social costs	H1 Fenland RZ transfer					0
	See note below					
Plan B	H4 Hunstanton RZ groundwater development					0
	See note below					
Least cost plan	H1 Fenland RZ transfer				Leakage	0
High population	H1 Fenland RZ transfer					0
	See note below					
Worst case climate change	H4 Hunstanton RZ groundwater development					0
	See note below					
Worst case sustainability reductions	H1 Fenland RZ transfer					0
	See note below					
Recent actuals	H2 Heacham Water Reuse					0
	H4 Hunstanton RZ groundwater development					
	See note below					
Worst case combination	Leakage					0
	H2 Heacham Water Reuse					
	H4 Hunstanton RZ groundwater development					

Table 15.8 Hunstanton Scenario Scheme Selection

15.6.4 Although not selected in the EBSD modelling for the least cost plan in AMP6, leakage reduction, metering and water efficiency has been included in the baseline supply demand forecast.

15.6.5 Under all scenarios Hunstanton RZ has adequate resource options. For the scenarios where Hunstanton RZ is reliant on a transfer from Ruthamford North RZ via Fenland RZ adequate resource is available in both upstream RZ in most scenarios. For the worst case combination and recent actual scenarios Ruthamford North RZ is shown in deficit. Under these circumstances, strategic options for maintaining the supply-demand balance include:

- Development of the South Lincolnshire Reservoir. This would store water abstracted from River Witham with support from the River Trent during the winter for year-round treatment and distribution. Originally envisaged as a scheme to support growth in demand in areas to the south and east of our supply system, this could also be used to support other areas
- Development of a new winter storage reservoir in the Norfolk Fens. This would store water abstracted from the River Ouse during the winter for year-round treatment and distribution. Since the resources of the Ouse are already used to support the Ely Ouse Essex Transfer, careful consideration of the available yield would be required. If support is necessary, it is possible that a raw water transfer from the River Trent could be developed. This would link the Trent, Nene and Ouse, enabling resources to be transferred from the Trent basin to the south and east to support supply-systems in East Anglia
- Associated with the above, the development of trading based infrastructure, either between water companies in East Anglia or between water companies and other third parties. In part, this could be based on schemes which are delivered to improve the resilience of supply-systems in East Anglia,and
- Investment to support the additional storage capacity created by dam raising in Ruthamford North RZ by a transfer of resources from the Trent basin.

PART TWO: RESOURCE ZONE SUMMARIES
North Norfolk Coast

16 North Norfolk Coast

Figure 16.1 North Norfolk Coast Resource Zone

PART TWO: RESOURCE ZONE SUMMARIES
North Norfolk Coast

16.1 Key points

Key Points

- No deficits are forecast in the North Norfolk Coast RZ.
- No significant climate change or levels of service sensitivities have been identified.
- One likely sustainability reduction has been included for a maximum quantity of 1.3Ml/d in 2024/25.

16.2 Resource zone description

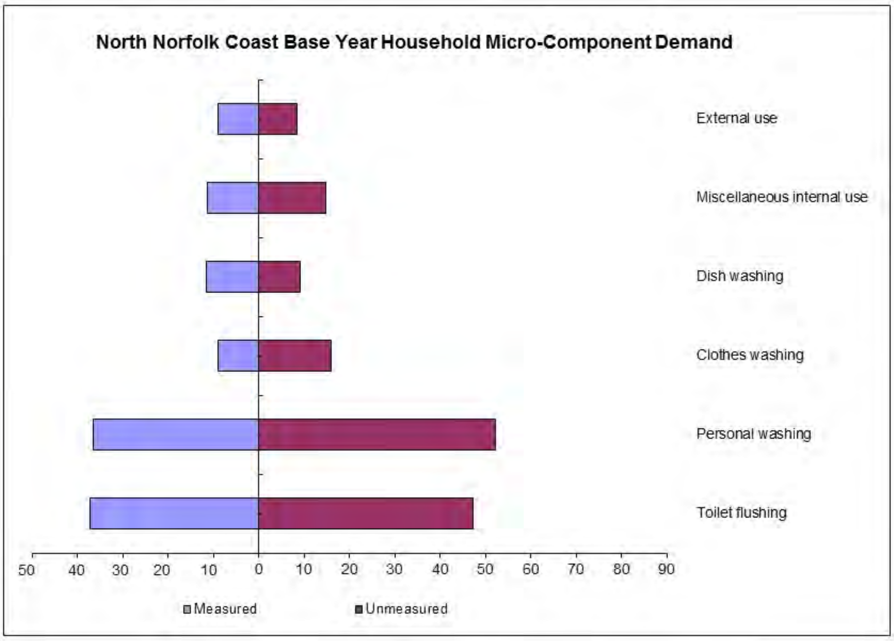
16.2.1 The North Norfolk Coast RZ extends eastwards from the Wash to the Norfolk Broads and is based on the supply systems for Wells, Fakenham, Sheringham, Aylsham, North Walsham and Ludham. Although not well connected, customers in this RZ share similar levels of supply-demand risk, which differ from those in adjacent RZs.

16.2.2 Most of the customers in the North Norfolk Coast RZ are supplied with groundwater pumped from the Chalk. A minority in the extreme East of the RZ also receive some supplies from the adjacent Norwich and the Broads RZ.

16.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 55,000. Of these 75% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 3,500. Most of these were measured.

16.2.4 From Figure 16.2:

- Base year measured and unmeasured PCC are marginally lower than our regional averages (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast an 15% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	115	106	107	106
Unmeasured Household	148	139	122	108
Weighted Average	125	110	107	106
Reduction in PCC over forecast (%)	15%			

Figure 16.2 North Norfolk Coast average household demand (litres/person/day)

16.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using more water for these activities than measured customers. This is consistent with the regional pattern of consumption.

16.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

16.2.7 Table 16.1 shows measured non-household demands in the base year totalling 4Ml/d in the North Norfolk Coast RZ. These are mainly from the wholesale, retail and agricultural sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
4	Sheringham	2	Wholesale and retail (tourism) and agriculture
	Fakenham	1	
	Stalham	<1	
	Aylsham	<1	
	Wells	<1	

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
	Foulsham	<1	

Table 16.1 North Norfolk Coast RZ Patterns of Measured Non-Household Consumption

16.2.8 From Table 16.2, we forecast new development equivalent to around 450 new properties per year. This estimate is consistent with recent rates of new build and the number of new properties forecast by local authorities.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			3,000	2,000	2,000	2,000	2,000
WRMP trend estimate			1,500	2,000	2,000	2,000	2,000
Annual Monitoring Report data	3,000	3,000					

Table 16.2 North Norfolk Coast Growth Estimates

16.3 Baseline supply-demand balance

16.3.1 From Table 16.3 and Table 16.4, in the last year of AMP6 (2019/20) we forecast that there will be a DYAA surplus of 6.2Ml/d and a CP surplus of 13.6Ml/d. Equivalent target headroom requirements are 1.1Ml/d for DYAA conditions and 1.6Ml/d for CP conditions. The RZ remains in surplus over the whole of the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	30.20	30.20	30.20	30.20	30.20	30.20
Outage Allowance	0.78	0.75	0.72	0.73	0.73	0.73
Total Water Available for Use	29.42	29.45	28.14	28.13	28.13	28.13
Distribution Input	23.57	22.14	22.27	22.59	22.93	23.26
Target Headroom	0.78	1.13	1.54	1.98	2.45	2.93
Supply Demand Balance	5.07	6.18	4.33	3.56	2.76	1.94

Table 16.3 North Norfolk Coast Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	46.28	46.28	46.28	46.28	46.28	46.28
Outage Allowance	1.07	1.03	0.98	0.98	0.99	0.99

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Total Water Available for Use	45.20	45.25	43.29	43.29	43.29	43.29
Distribution Input	32.30	30.11	30.13	30.51	30.94	31.36
Target Headroom	1.07	1.54	2.08	2.68	3.30	3.96
Supply Demand Balance	11.83	13.60	11.09	10.11	9.05	7.97

Table 16.4 North Norfolk Coast Baseline Supply-Demand Summary (DYCP)

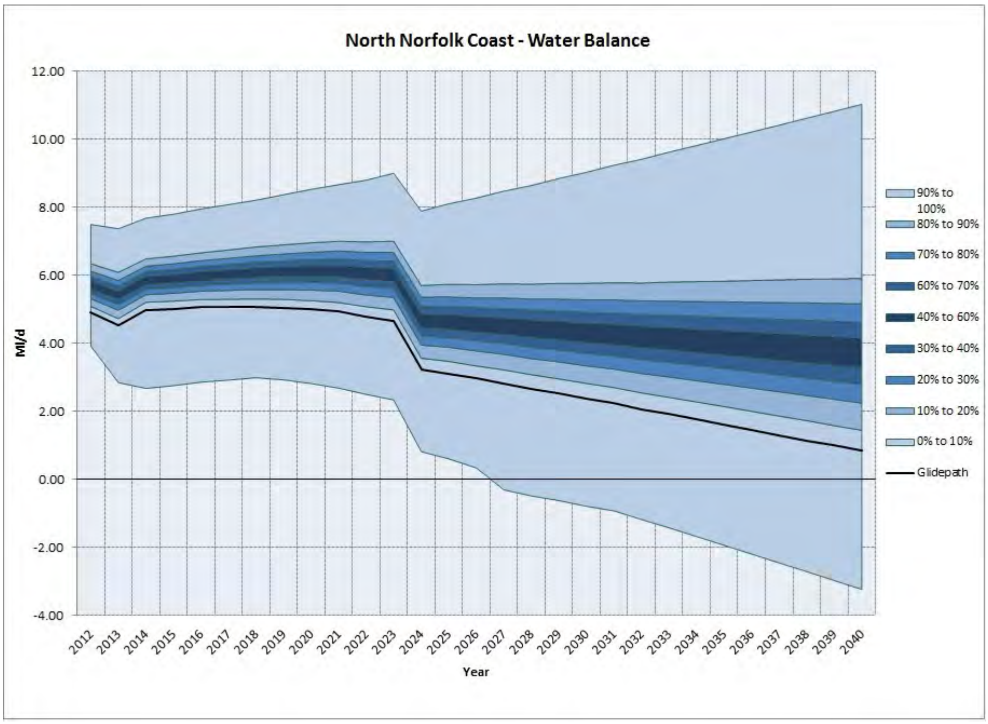


Figure 16.3 North Norfolk Coast Probabilistic Water Balance

Figure 16.3 confirms that there is a 90% probability that the RZ water balance will remain in surplus over the 25 year forecast period.

16.3.1 Baseline supply forecast issues

16.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- One likely sustainability reduction has been included for a 1.3Ml/d in 2024/25. This reduction would affect our Aylsham and Ludham supply systems. No further unknown sustainability reductions have been identified
- There is no baseline climate change impact forecast on the available supplies, and
- Since the 2010 WRMP one treatment works in the RZ has been uprated to meet its daily licence quantity which has increased the available MAXSO by 2.5Ml/d.

16.3.1.2 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

16.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction, enhanced metering and water efficiency. Anticipated savings from these activities in the North Norfolk Coast RZ are approximately 1Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

16.4 Scenario testing

16.4.1 Table 16.5 details the impacts of scenario modelling on the supply demand balance for the North Norfolk Coast RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	6.18	1.94
Least cost plan	4.60	0.32
High population	5.80	1.62
Worst case climate change	6.17	1.94
Worst case sustainability reductions	6.17	1.94
Recent actuals	1.28	-2.96
Worst case combination	-0.69	-4.91

Table 16.5 North Norfolk Coast Scenario Modelling Impacts

16.4.2 In summary this shows the following:

- Impacts equivalent to 1.6Ml/d to the supply demand balance under the cost effective plan scenario up to 2039/40.
- Marginal sensitivity to increasing populations equivalent to 0.32Ml/d
- No significant impacts from the worst case climate change scenario
- Reductions equivalent to 3Ml/d by 2039/40 from the worst case sustainability reductions scenario
- Significant impact from restricting deployable outputs to recent actuals, of up to 6.9Ml/d at the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts increase from 12.2Ml/d at the end of AMP6 up to 6.9Ml/d in 2039/40.

16.4.3 Options for maintaining the supply-demand balance include:

- Promotion of the alternative feasible schemes
- An increase into the RZ from the adjacent Fenland or Norfolk Rural RZs

- Desalination, and
- The development of marginal quality groundwater, where this is available in the Chalk.

16.4.4 In each case, significant reinforcement of infrastructure within the RZ is also likely to be required.

16.4.5 Customer side options would include additional water efficiency, leakage reduction and enhanced metering.

PART TWO: RESOURCE ZONE SUMMARIES
Norwich and the Broads

17 Norwich and the Broads

Figure 17.1 Norwich and the Broads Resource Zone

17.1 Key points

Key Points

- Large AMP6 deficits are forecast in the Norwich and the Broads RZ. These result from a sustainability reduction and at the end of the forecast period are equivalent to 51.9Ml/d under dry year annual average conditions and 57.6Ml/d under critical period conditions.
- Over the forecast period, no significant levels of service or additional sustainability reduction sensitivities have been identified.
- In the worst case, climate change may reduce average daily source-works output by 32Ml/d. This would affect abstraction from the River Wensum. The mean impact is estimated to be equivalent to a 5Ml/d reduction in average daily source-works output.
- Excluding the WFD no-deterioration and worst case climate change risks, the plan for maintaining the supply-demand balance combines source relocation with water efficiency, enhanced metering and additional leakage control. In the long-term, additional supplies will also be required. The capex required for the preferred plan is very sensitive to assumptions about the scope of the sustainability reduction scheme and target headroom requirements at the end of the forecast period.

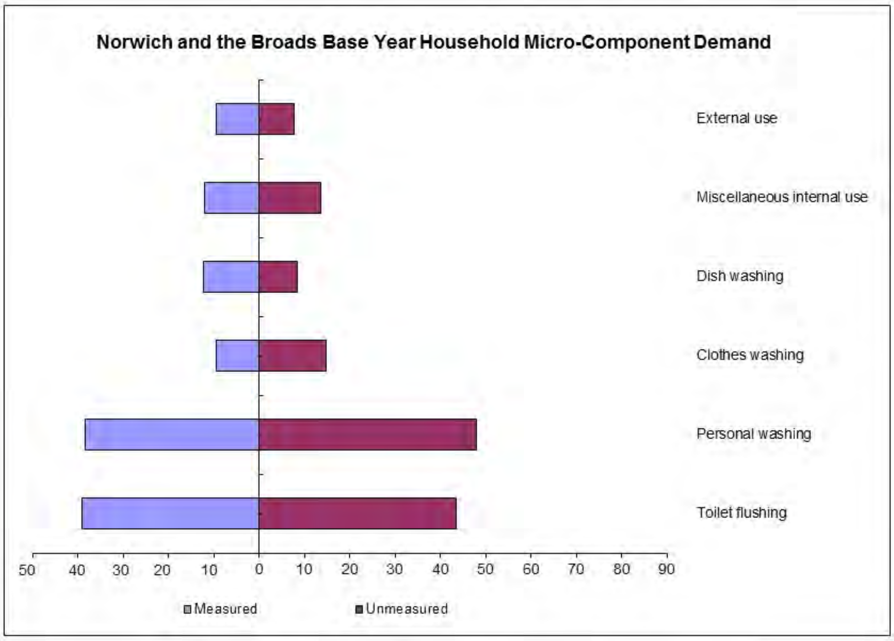
17.2 Resource zone description

17.2.1 The Norwich and the Broads RZ is centred on the City of Norwich and the surrounding area. Customers in the RZ are supplied with groundwater pumped from the Chalk aquifer and surface water which is abstracted from the River Wensum. Connectivity within the RZ allows for resources to be shared and for the integrity of the RZ to be maintained.

17.2.2 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 140,000. Of these 69% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 7,000. Most of these were measured.

17.2.3 From Figure 17.2:

- Base year measured and unmeasured PCC are less than our regional averages (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 14% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	120	110	107	106
Unmeasured Household	136	125	112	102
Weighted Average	126	112	110	109
Reduction in PCC over forecast (%)	14%			

Figure 17.2 Norwich and the Broads average household consumption (litres/person/day)

17.2.4 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using more water for these activities than measured customers. This is consistent with the regional pattern of consumption.

17.2.5 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

17.2.6 Table 17.1 shows measured non-household demands in the base year totalling 16Ml/d in the Norwich and the Broads RZ. These are mainly from the agricultural, wholesale, public administration, human health and manufacturing sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
16	Norwich	9	Agriculture, wholesale, manufacturing, public admin and human health services
	Hethersett	5	
	Poringland	1	
	Brundall	<1	

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
	Lyng	<1	

Table 17.1 Norwich and the Broads RZ Patterns of Measured Non-Household Consumption

17.2.7 From Table 17.2, we forecast new development equivalent to around 1,300 new properties per year. This estimate is consistent with recent rates of new build and marginally less than the number of new properties forecast by local authorities. Given our target headroom allowances, this difference is not significant.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			9,000	9,000	9,000	9,000	9,000
WRMP trend estimate			5,000	6,000	6,500	7,000	7,000
Annual Monitoring Report data	6,500	6,500					

Table 17.2 Norwich and the Broads Growth Estimates

17.3 Baseline supply-demand balance

17.3.1 From Table 17.3 and Table 17.4, in the last year of AMP6 (2019/20) we forecast that there will be a DYAA deficit of 33.8Ml/d and a CP deficit of 40.5Ml/d in the Norwich and the Broads RZ. These result from the Wensum sustainability reduction. Equivalent target headroom requirements are 6.2Ml/d and 7.7Ml/d respectively.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	77.73	77.73	77.73	77.73	77.73	77.73
Outage Allowance	2.03	1.00	0.95	0.91	0.89	0.88
Total Water Available for Use	75.90	34.22	33.05	31.87	31.48	31.11
Distribution Input	63.76	61.81	62.45	63.40	64.44	65.44
Target Headroom	2.57	6.22	10.02	14.00	15.80	17.59
Supply Demand Balance	9.57	-33.81	-39.42	-45.52	-48.76	-51.93

Table 17.3 Norwich and the Broads Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	100.72	100.72	100.72	100.72	100.72	100.72

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Outage Allowance	2.55	1.24	1.18	1.12	1.10	1.08
Total Water Available for Use	98.37	44.10	44.17	44.23	44.25	44.26
Distribution Input	80.09	76.82	77.17	78.06	79.18	80.27
Target Headroom	2.65	7.73	12.38	17.23	19.41	21.58
Supply Demand Balance	15.63	-40.45	-45.39	-51.07	-54.35	-57.58

Table 17.4 Norwich and the Broads Baseline Supply-Demand Summary (DYCP)

17.3.2 Leakage in the base year is equivalent to 12% of distribution input.

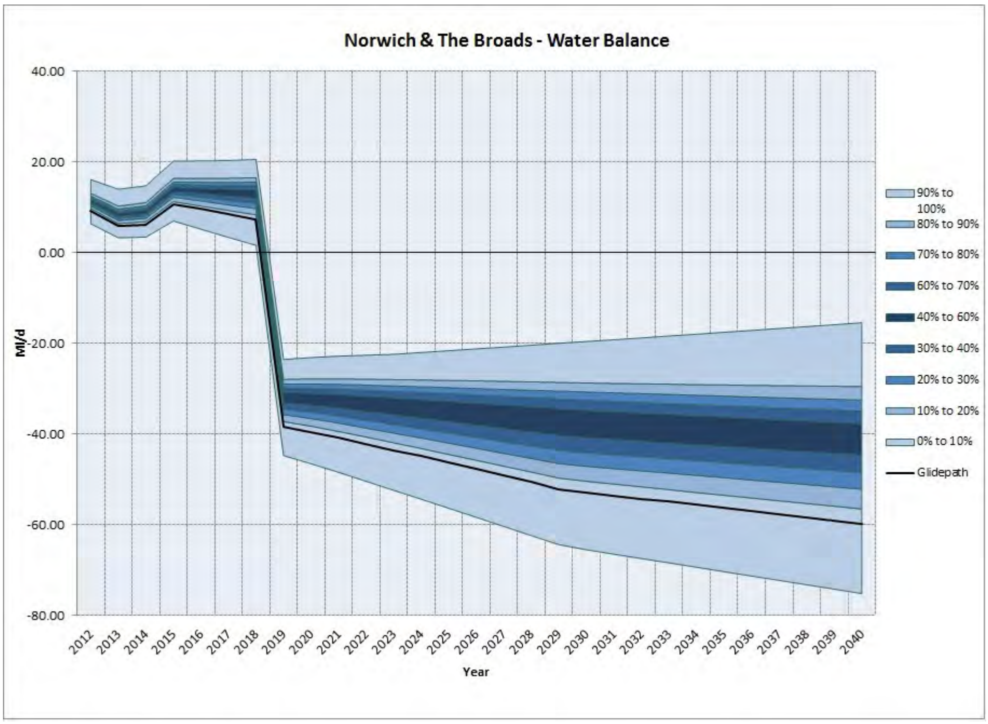


Figure 17.3 Norwich and the Broads Probabilistic Water Balance

17.3.3 Figure 17.3 confirms that there is a 100% probability that the RZ water balance will be in deficit from early in the 25 year forecast period. The step reduction in the early part of the forecast period reflects the effect of the Wensum sustainability reduction.

17.3.1 Baseline supply forecast issues

17.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- A confirmed sustainability reduction affecting one of our intakes on the River Wensum. This is equivalent to a 46.2Ml/d reduction in ADSO and a 58Ml/d reduction in MAXSO

- Reductions in the MAXSO available from two of our Chalk sources, as a consequence of poor quality groundwater and associated process restrictions. The total capacity lost is equivalent to 6.2Ml/d
- Development of an additional groundwater source in the Norwich area will be complete in 2015, resulting in a 5.2Ml/d increase in ADSO and a 7.1Ml/d increase in MAXSO
- One of our other sources in the RZ is also subject to a confirmed sustainability reduction for Coston Fen SSSI. The groundwater source is being relocated as part of a capital maintenance scheme and will need to be connected during AMP6. Subject to finding a suitable location for the new groundwater source, this will meet the requirements of the sustainability reduction and no associated loss of ADSO or MAXSO is reported in the tables
- WFD no-deterioration assessments will be required to support renewal of the Costessey groundwater abstraction licence in 2015. This work will be completed as part of the Drought Plan and will include consideration of the Norwich surface water sources, and
- Climate change is forecast to impact on the available supplies. The mean effect is equivalent to a 5Ml/d reduction in ADSO and would affect abstraction from the River Wensum.

17.3.1.2 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

17.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction, enhanced metering and water efficiency. Anticipated savings from these activities in the Norwich and the Broads RZ are approximately 3Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

17.4 Feasible options for maintaining the supply-demand balance

17.4.1 The feasible Norwich and the Broads RZ options that were modelled in our EBSD optimiser are given below in Table 17.5.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Desalination	NB1 Bacton desalination (46Ml/d)	46	57	150,100	15,500
Storage	NB5 Norwich storage	46	57	67,200	510
Storage	NB10 Norwich intake to existing bankside storage	46	57	21,700	290
Reuse	NB11 Norwich water reuse	11	13	79,300	1,780
Desalination	NB12 Bacton desalination (11Ml/d)	11	13	65,400	3,430

Table 17.5 Norwich and the Broads Feasible Option Details

17.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon costs. In the EBSD modelling social, environmental and carbon costs have been included.

17.4.1 Scheme descriptions

17.4.1.1 The following schemes have been developed for Norwich and the Broads RZ:

- NB1 Bacton desalination (46Ml/d) -This option comprises a desalination plant located on the North Sea coast. Treated water would be pumped some 30km to Norwich through a new pipeline and concentrate discharged back to the North Sea
- NB5 Norwich storage - This option requires construction a new large raw water storage reservoir. The reservoir would be filled from the existing intake at the Norwich water treatment works. The reservoir would be used to manage periods when water cannot be abstracted from the river. 10km of twin pipelines would be required to convey water to the reservoir and from the reservoir to the existing Norwich treatment works
- NB10 Norwich intake to existing bankside storage - This option provides the infrastructure to allow raw water to be abstracted from the existing intake at the Norwich water treatment works and conveyed to the existing bankside storage 8km west of the works. From there it will be pumped back to the Norwich water treatment works via existing infrastructure. The Norwich intake and new pipeline would be used in conjunction with the existing intake further upstream. Operation of the two intakes will be dependent on the river flow conditions at each abstraction location
- NB11 Norwich water reuse - Effluent from Norwich water recycling centre would be treated to near potable standard and discharged into the existing bank side storage. A new pipeline and pumping station would be required to convey the water to the water treatment works which would require additional treatment capacity, and
- NB12 Bacton desalination (11Ml/d) - This option provides for desalination on the North Sea coast and transfer of treated water to Norwich similar to option NB1 but with a smaller capacity.

17.4.1.2 Options NB1, NB5 and NB10 have been sized to match the sustainability reduction imposed on the Wensum. Options NB11 and NB12 have been scoped to satisfy the increase in demand due to growth.

17.4.1.3 The following options are mutually exclusive because they rely on the existing intake at Norwich water treatments works:

- NB5 Norwich storage, and
- NB10 Norwich intake to existing bankside storage.

17.4.1.4 A number of options proposed in the draft WRMP have been discounted; the reason for this is described in the table below.

Opt Ref	Option Name	Reason for discounting scheme
NB2	Norwich water reuse	Scheme NB2 is a sustainability reduction scheme which provided an alternative raw water source to the Wensum. However this option did not provide adequate resource to fully satisfy the sustainability reduction so was discounted. A smaller Norwich water reuse option has been developed (NB11) which includes additional water treatment capacity and therefore provides additional DO.

Opt Ref	Option Name	Reason for discounting scheme
NB3	Cantley desalination	Rejected due to potential significant environmental effects of brine discharge and effects on designated sites.
NB4	Lowestoft water reuse	Discounted as this option did not provide adequate resource to fully satisfy the sustainability reduction and the potential environmental effects on designated sites.
NB6	Norwich intake with pre-treatment	Since the publication of the draft WRMP Anglian Water has been working with the Environment Agency and Natural England to resolve concerns about the preferred option for delivering the Wensum sustainability reduction (NB10). As part of this work all the Norwich and the Boards RZ options have been revisited to ensure that a common approach is taken for all options. The preferred option (NB10) is to reinstate the downstream intake with transfer back to the existing storage pits. Therefore as the risks (water quality, low flow etc) can be managed and are considered acceptable for NB10 then the option to add additional upfront treatment process (NB6) is not required and therefore discounted.
NB7	Norwich intake with lining existing bankside storage	As stated above all Norwich and the Broads RZ options have been revisited. A hydrological assessment of the storage pits concluded that normal operation does not impact the River Wensum SAC. There is no requirement to line the pits for continued use and therefore this option has been discounted.
NB8	Norwich intake with new bankside storage	This option to provide new bankside storage (NB8) was developed as an alternative to utilising the existing storage pits if the risks associated with continued operation of the pits were deemed unacceptable. Normal operation of the pits is acceptable and so this option has been discounted.

Table 17.6 Norwich and the Broads Schemes Discounted

17.4.2 Environmental considerations

17.4.2.1 The environmental assessments of the feasible options have concluded the following for the Norwich and the Broads RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options, and
- The climate change vulnerability assessment concludes that the desalination and water reuse options (NB1, NB11, NB12) are all insensitive to climate change and scored 1. The options utilising the intake at Norwich water treatment works (NB5, NB10) are sensitive in relation to water abstraction, available flow and environmental flow requirements. These options scored 3.

17.4.2.2 The WFD no-deteriorations assessment, SEA and HRA concluded;

- NB1/12 – Bacton desalination - The moderate exposure and meso-tidal conditions mean that it can be reasonably concluded that this option would not lead to a deterioration in the WFD waterbody status. Further assessment is required to increase certainty in this conclusion, particularly for the larger option. The desalinisation process involves the discharge of saline rich water back to the coastal environment. Further investigation will be required to demonstrate that this release of water will not have an adverse effect on the aquatic environment. The HRA concluded a likely significant effect and the need for an Appropriate assessment should the option be taken forward

- NB5 – Norwich Storage - No specific WFD, HRA or SEA issues raised on the assumption that this uses existing intake with compliant licence conditions and that pipeline could be routed to avoid ancient woodlands and local nature reserves
- NB10 – Norwich intake to existing bankside storage - This scheme has been the focus of detailed discussions with the Environment Agency and Natural England and full details are provided in the Minimising the Environmental Impact of Abstractions section. The WFD assessment under normal operation concludes no risk of deterioration and the HRA has concluded no likely significant effect. We will continue to work with the Environment Agency to understand the risk of deterioration downstream during periods of low flow, and
- NB11 – Norwich reuse (growth scheme) - The risk of deterioration of WFD status associated with this scheme is considered to be low on the understanding that there will be no net loss of flow downstream. In addition the effluent will be treated to a higher standard than the prevailing water quality in the river. An Appropriate Assessment has been completed and confirmed that there would be no adverse effects on site integrity. The SEA has concluded potential climate change impacts due to increased CO_2 output, but no other significant negative effects following mitigation.

17.4.2.3 Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

17.5 Preferred plan

17.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side	NB10 Norwich intake to existing bankside storage			NB11 Norwich discharge reuse	
Distribution side	See below				
Customer side	See below				

Table 17.7 Norwich and the Broads Supply-Demand Investment Plan

17.5.2 Lowering consumption levels are a priority to offset resource development so enhanced metering, leakage reduction and water efficiency programmes have been included in the baseline. In the Norwich and the Broads RZ we aim to complete approximately 10,500 water efficiency audits. Our enhanced metering programme will fit almost 25,000 meters and as a result of this and background opting rates, we anticipate that approximately 17,000 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

17.5.3 For the option selected for the River Wensum sustainability reduction, a final pumping test report has been completed and submitted to our environmental regulator. Conclusions from this assessment have been shared with the Environment Agency and consensus reached that this option will result in a solution that is compliant with the Habitats Regulations.

17.5.4 In respect of the plan, the following issues are noted:

- The plan assumes that our existing groundwater sources and storage in the vicinity of the upstream intake remain available for use
- We accept that our existing abstraction licence from the Wensum will be varied and that it will require the inclusion of new minimum flow conditions to meet the Habitats Directive requirements, and
- Selection of the Norwich water reuse scheme is to meet target headroom requirements based on a 95% probability of meeting target levels of headroom. By accepting more supply-demand risk in the latter stages of the forecast period, the need for the scheme can be deferred.

17.6 Scenario testing

17.6.1 Table 17.8 details the impacts of scenario modelling on the supply demand balance for the Norwich and the Broads RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	-33.81	-51.93
Least cost plan	-36.80	-55.17
High population	-38.15	-55.91
Worst case climate change	-44.55	-78.99
Worst case sustainability reductions	-33.81	-51.93
Recent actuals	-54.72	-72.83
Worst case combination	-72.96	-107.27

Table 17.8 Norwich and the Broads Scenario Modelling Impacts

17.6.2 In summary this shows the following:

- 3.2Ml/d impact on the RZ supply demand balance by the end of the planning period under the cost effective plan scenario
- Marginal sensitivity to increasing populations equivalent to 4Ml/d
- Sensitivity to worst case climate change impacts equivalent to 27Ml/d by the end of 2039/40
- No further reductions resulting from worst case combination scenario
- Impacts of 20.9Ml/d from restricting deployable outputs to recent actuals by the end of the planning period

- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts are 39.2Ml/d by the end of AMP6, reaching 55.3Ml/d by 2039/40, and
- Further reductions in leakage and levels of consumption would also likely be required.

17.6.3 Table 17.9 below shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	RZ Residual Deficit 2039/40 (Ml/d)
Preferred plan	NB10 Norwich intake See note below			NB11 Norwich Water Reuse		0
Preferred plan - environmental and social costs	NB10 Norwich intake See note below			NB11 Norwich Water Reuse		0
Plan B	NB1 Bacton Desalination See note below			NB5 Norwich Storage		0
Least cost plan	NB10 Norwich intake		NB11 Norwich Water Reuse Leakage			0
High population	NB10 Norwich intake See note below		NB11 Norwich Water Reuse			0
Worst case climate change	NB10 Norwich intake See note below	NB1 Bacton Desalination				0
Worst case sustainability reductions	NB10 Norwich intake See note below			NB11 Norwich Water Reuse		0
Recent actuals	NB10 Norwich intake NB11 Norwich Water Reuse See note below	NB1 Bacton Desalination				0
Worst case combination	Leakage NB11 Norwich Water Reuse NB10 Norwich intake NB1 Bacton Desalination					1.4

Table 17.9 Norwich and the Broads Scenario Scheme Selection

17.6.4 Although not selected in the EBSD modelling for the least-cost plan in AMP6, leakage reduction, metering and water efficiency has been included in the baseline supply demand forecast.

17.6.5 Under most scenarios the feasible options provide adequate resource to meet demand however under the worst case combination scenario the feasible options are not adequate to fully satisfy the demand. Options for maintaining the supply-demand balance in the worst case combination scenario could include:

- The capacity of the desalination option NB1 was sized to meet deficits in the baseline supply demand forecast. The capacity of this option could be increased to meet the scenario deficit
- Development of the South Lincolnshire Reservoir. This would store water abstracted from the River Witham with support from the River Trent during the winter for year-round treatment and distribution
- Development of a new winter storage reservoir in the Norfolk Fens. This would store water abstracted from the River Ouse during the winter for year-round treatment and distribution. Since the resources of the Ouse are already used to support the Ely Ouse Essex Transfer, careful consideration of the available yield would be required. If support is necessary, it is possible that a raw water transfer from the Trent could be developed. This would link the Trent, Nene and Ouse, enabling resources to be transferred from the Trent basin to the south and east to support supply-systems in East Anglia, and
- Associated with the above, the development of trading based infrastructure, either between water companies in East Anglia or between water companies and other third parties. In part, this could be based on connectivity infrastructure which is delivered to improve the resilience of supply-systems in East Anglia.

PART TWO: RESOURCE ZONE SUMMARIES

Norfolk Rural

18 Norfolk Rural

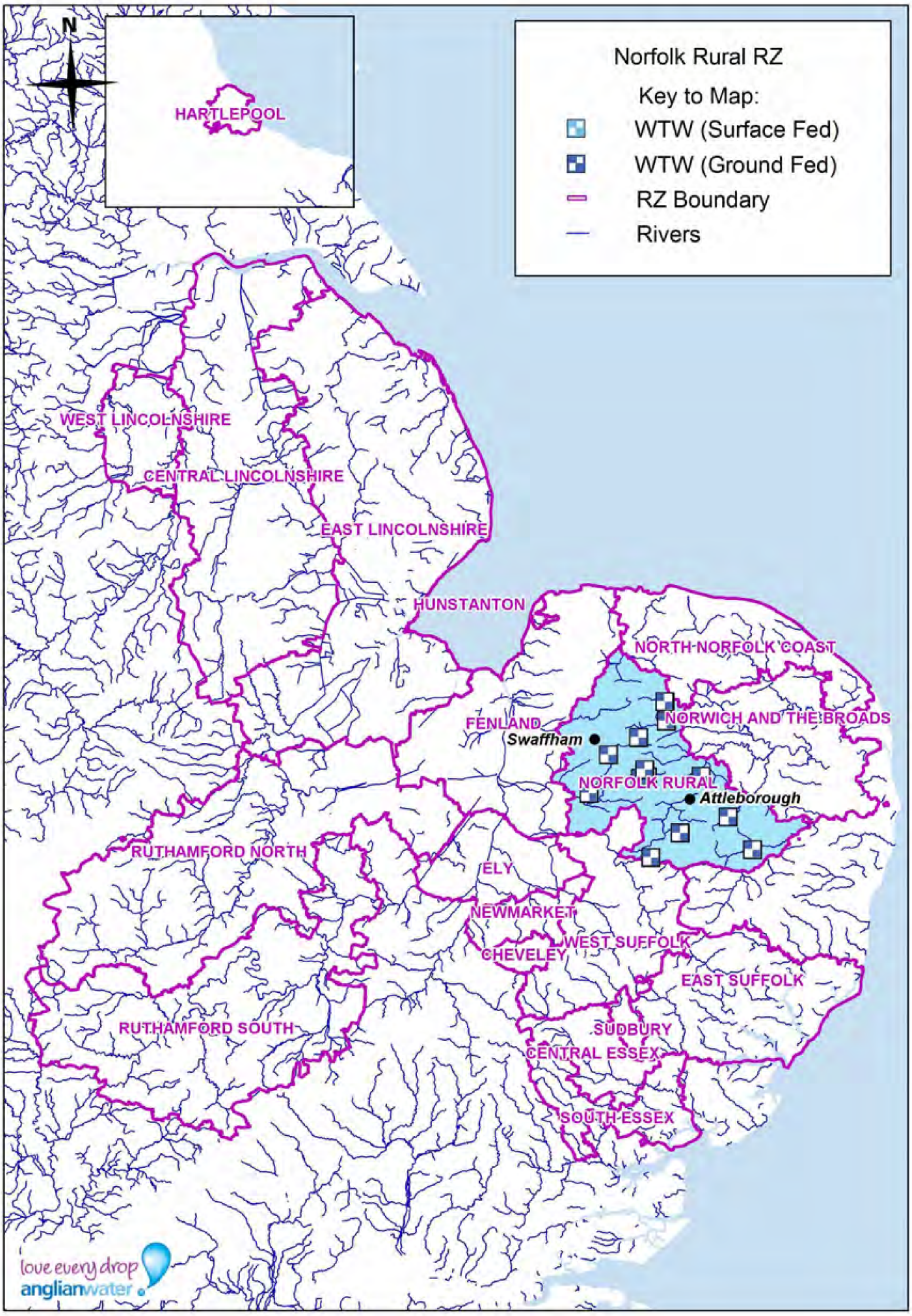


Figure 18.1 Norfolk Rural Resource Zone

PART TWO: RESOURCE ZONE SUMMARIES
Norfolk Rural

18.1 Key points

Key Points

- No deficits are forecast in the Norfolk Rural RZ.
- No significant climate change or levels of service sensitivities have been identified. One WTW has been targeted for a likely sustainability reduction. This may reduce average daily source-works output by 0.2Ml/d.
- The worst case sustainability reduction is approximately 3Ml/d. A reduction of this magnitude is significant and would drive supply-demand investment.

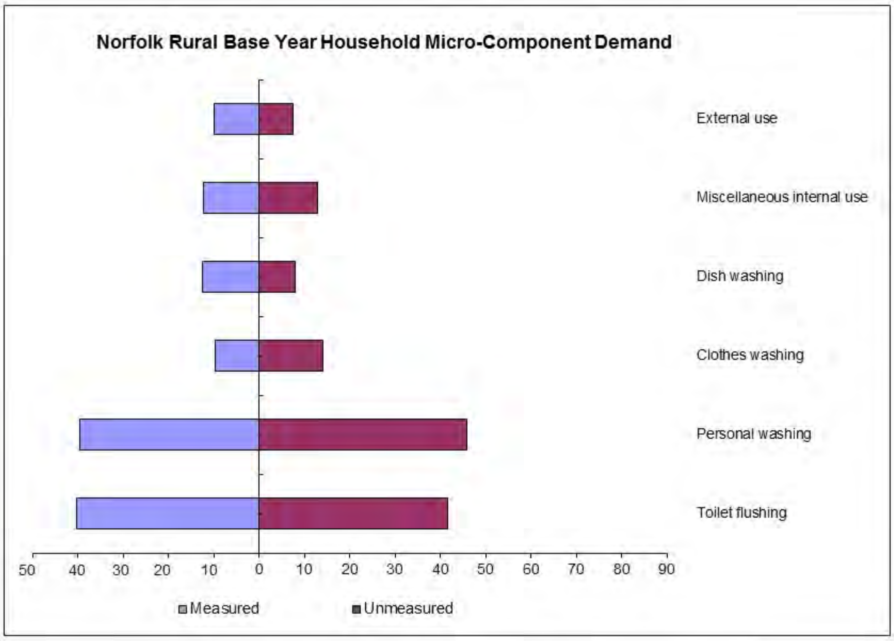
18.2 Resource zone description

18.2.1 The Norfolk Rural RZ lies to the east of Norwich and includes the supply systems for Swaffham, Dereham, Wymondham, Attleborough and Diss. Customers in the RZ are supplied with groundwater that is pumped from the Chalk aquifer. Although not well connected, this means that they share similar supply-demand risks, which are different from those in adjacent supply systems.

18.2.2 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 66,000. Of these 75% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 4,300. Most of these were measured.

18.2.3 From Figure 18.2:

- Base year measured PCC is the same and unmeasured PCC is less than our regional averages (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 12% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	124	113	112	110
Unmeasured Household	130	119	108	105
Weighted Average	126	114	112	110
Reduction in PCC over forecast (%)	12%			

Figure 18.2 Norfolk Rural average Household Consumption (litres/person/day)

18.2.4 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using more water for these activities than measured customers. This is consistent with the regional pattern of consumption.

18.2.5 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

18.2.6 Table 18.1 shows measured non-household demands in the base year totalling 7Ml/d in the Norfolk Rural RZ. These demands are mainly from the wholesale, industry, manufacturing and agricultural sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
7	Harleston	3	Wholesale (tourism) and light agriculture, industry and manufacturing
	Wymondham	2	
	Bradenham	1	
	Dereham	<1	
	Didlington	<1	

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
	East Harling	<1	

Table 18.1 Norfolk Rural RZ Patterns of Measured Non-Household Consumption

18.2.7 From Table 18.2, we forecast new development equivalent to around 750 new properties per year. This estimate is consistent with recent rates of new build and is less than the number of new properties forecast by local authorities. Given our target headroom allowances, this is not significant.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			5,500	5,500	5,500	5,500	5,500
WRMP trend estimate			3,000	3,500	3,500	3,500	3,500
Annual Monitoring Report data	3,700	3,200					

Table 18.2 Norfolk Rural Growth Estimates

18.3 Baseline supply-demand balance

18.3.1 From Table 18.3 and Table 18.4, in the last year of AMP6 (2019/20) we forecast that there will be a DYAA surplus of 8.5Ml/d and a CP surplus of 15.9Ml/d. Equivalent target headroom requirements are 1.6Ml/d for DYAA conditions and 2.1Ml/d for CP conditions. The RZ remains in surplus over the whole of the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	42.55	42.55	42.55	42.55	42.55	42.55
Outage Allowance	1.10	1.07	1.07	1.08	1.08	1.08
Total Water Available for Use	41.25	41.28	41.09	41.09	41.09	41.08
Distribution Input	33.41	31.19	31.79	32.42	33.02	33.59
Target Headroom	1.11	1.59	2.07	2.60	3.23	3.92
Supply Demand Balance	6.72	8.50	7.24	6.07	4.84	3.58

Table 18.3 Norfolk Rural Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	60.53	60.53	60.53	60.53	60.53	60.53
Outage Allowance	1.43	1.41	1.40	1.40	1.40	1.40

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Total Water Available for Use	58.90	58.93	58.93	58.93	58.93	58.93
Distribution Input	43.52	40.90	41.50	42.19	42.85	43.50
Target Headroom	1.45	2.09	2.70	3.38	4.20	5.07
Supply Demand Balance	13.93	15.94	14.73	13.37	11.88	10.37

Table 18.4 Norfolk Rural Baseline Supply-Demand Summary (DYCP)

18.3.2 Leakage in the base year is equivalent to 20% of distribution input.

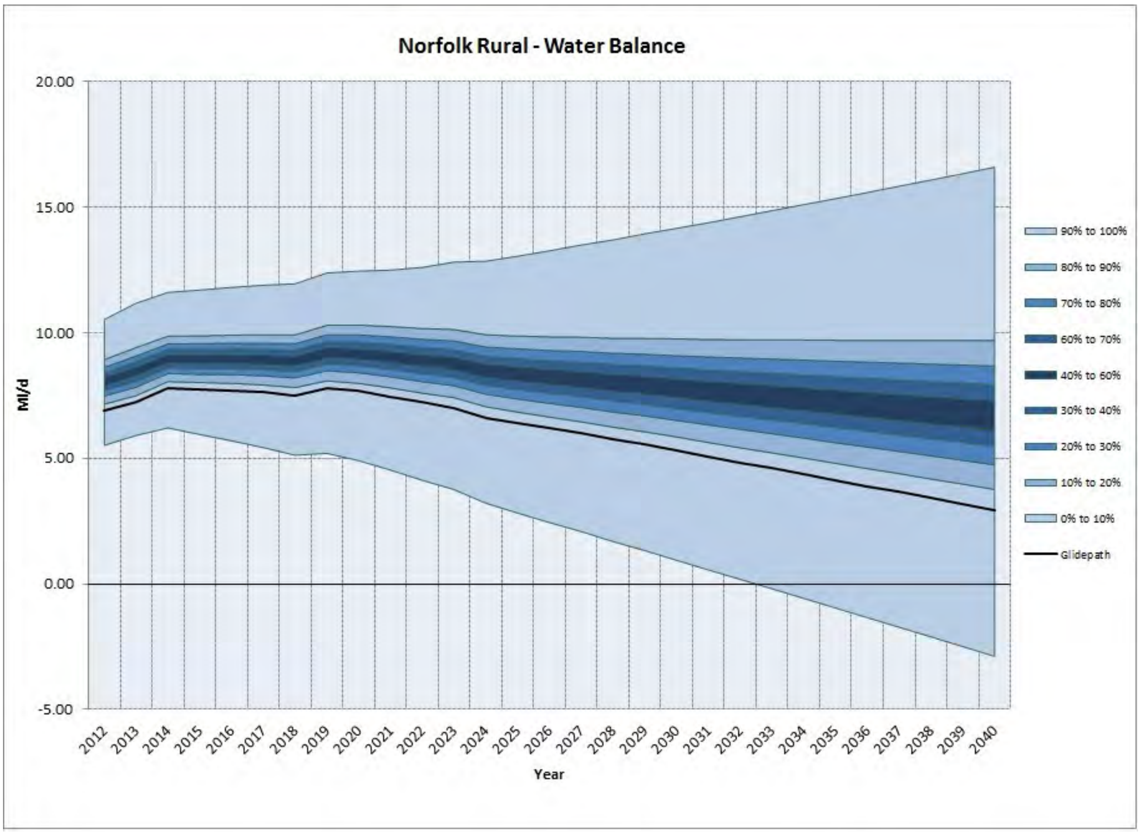


Figure 18.3 Norfolk Rural Probabilistic Water Balance

18.3.3 Figure 18.3 confirms that there is a 95% probability that the RZ water balance will remain in surplus over the 25 year forecast period.

18.3.1 Baseline supply forecast issues

18.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- A likely sustainability reduction to one of our sources in the north of the RZ. This may reduce ADSO by 0.2Ml/d
- Two further unknown sustainability reductions that would decrease the ADSO of the RZ by 2.7Ml/d
- A reduction in ADSO and MAXSO of 0.5Ml/d and 4.7Ml/d respectively as a consequence of relocating abstraction from a source affected by a previous sustainability reduction
- The 2010 WRMP scheme included a scheme to increase the deployable output from the Wicklewood groundwater source. WFD no-deterioration assessment has concluded that the scheme cannot proceed and the outputs have been capped at the baseline rate as reported in 2010. It is understood that the source may now become subject of a confirmed sustainability change in Phase 4 of the NEP and will require options appraisal
- WFD no-deterioration assessment may also be required at Rushall groundwater source, subject to ongong work with the Environment Agency, and
- There is no baseline climate change impact forecast on the available supplies.

18.3.1.2 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

18.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction, enhanced metering and water efficiency. Anticipated savings from these activities in the Norfolk Rural RZ are approximately 2.5Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

18.4 Scenario testing

18.4.1 Table 18.5 details the impacts of scenario modelling on the supply demand balance for the Norfolk Rural RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	8.50	3.58
Least cost plan	4.88	-0.17
High population	6.90	2.20
Worst case climate change	8.48	3.52
Worst case sustainability reductions	8.50	0.84
Recent actuals	1.75	-3.17
Worst case combination	-3.65	-11.22

Table 18.5 Norfolk Rural Scenario Modelling Impacts

18.4.2 In summary this shows the following:

- Impacts equivalent to 3.8Ml/d to the supply demand balance under the least-cost plan scenario up to 2039/40
- Marginal sensitivity to increasing populations equivalent to 1.4Ml/d
- No significant impacts from the worst case climate change scenario
- Reductions equivalent to 2.7Ml/d by 2039/40 from the worst case sustainability reductions scenario
- Significant impact from restricting deployable outputs to recent actuals, of up to 6.8Ml/d at the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts increase from 12.2Ml/d by the end of AMP6 up to 14.8Ml/d in 2039/40.

18.4.3 Options for maintaining the supply-demand balance include:

- A transfer from Norwich and the Broads RZ, supported by one or more of the supply-side options that have been identified for that RZ
- Development of a new winter storage reservoir in the Norfolk Fens. This would store water abstracted from the River Ouse during the winter for year-round treatment and distribution. Since the resources of the Ouse are already used to support the Ely Ouse Essex Transfer, careful consideration of the available yield would be required. If support is necessary, it is possible that a raw water transfer from the River Trent could be developed. This would link the Trent, Nene and Ouse, enabling resources to be transferred from the Trent basin to the south and east, to support supply-systems in East Anglia
- Associated with the above, the development of trading based infrastructure, either between water companies in East Anglia or between water companies and other third parties. In part, this could be based on connectivity infrastructure which is delivered to improve the resilience of supply-systems in East Anglia, and
- In the event that a large asset such as the Norfolk Fens reservoir is developed, significant reductions in leakage and levels of consumption would also likely be required.

PART TWO: RESOURCE ZONE SUMMARIES

East Suffolk

19 East Suffolk

Figure 19.1 East Suffolk Resources Zone

19.1 Key points

Key Points

- AMP10 deficits are forecast in the East Suffolk RZ. These deficits result from growth and at the end of the forecast period grow to 2.3Ml/d under dry year annual average conditions. There is no equivalent deficit under critical conditions.
- No significant baseline climate change or levels of service sensitivities have been identified. In the worst case, climate change may reduce average daily source-works output by 11.5Ml/d. This would affect abstraction from the River Gipping.
- There are no confirmed, likely or unknown sustainability reductions in this RZ.
- Excluding the WFD no-deterioration and worst case climate change risk, the plan for maintaining the supply-demand balance combines a transfer from the South Essex RZ with additional leakage control. In the long-term additional supplies are also needed. The Capex required for the preferred plan is sensitive to assumptions about target headroom requirements at the end of the forecast period.

19.2 Resource zone description

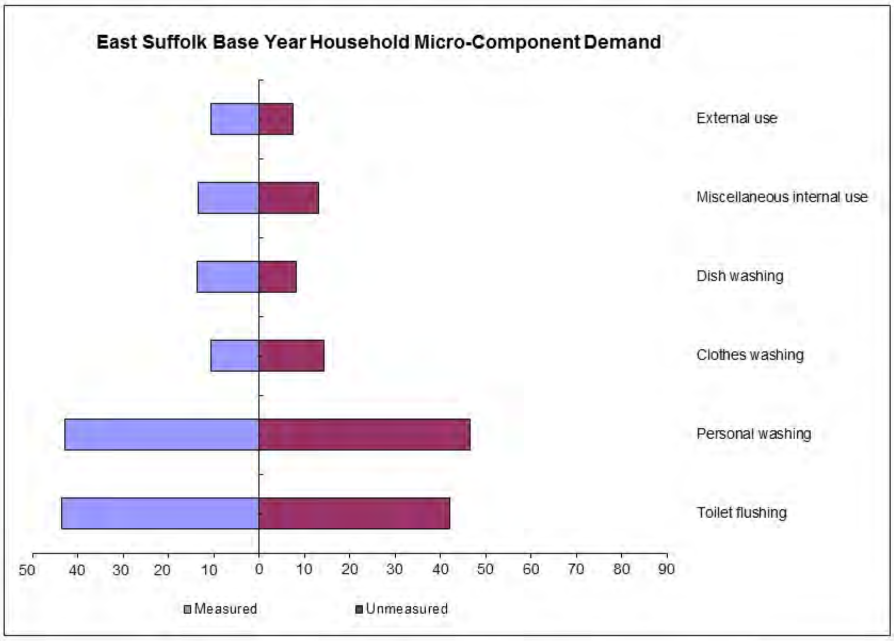
19.2.1 The East Suffolk RZ extends inland from the Stour, Orwell and Deben estuaries and includes the supply systems for Ipswich, Felixstowe, Hadleigh, Stowmarket and Woodbridge.

19.2.2 Supplies in the RZ are obtained from a combination of sources that include groundwater abstracted from the Chalk and surface water which is pumped from the River Gipping into storage. There is a reasonable level of connectivity within the RZ. This allows for resources to be shared and for the integrity of the RZ to be maintained.

19.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 135,000. Of these 79% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 7,000. Most of these were measured.

19.2.4 From Figure 19.2:

- Base year measured PCC is estimated to be marginally more and unmeasured PCC is estimated to be less than our regional averages respectively (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 14% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	134	120	118	116
Unmeasured Household	132	118	110	101
Weighted Average	134	120	117	115
Reduction in PCC over forecast (%)	14%			

Figure 19.2 East Suffolk average household consumption (litres/person/day)

19.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using marginally more water for these activities than measured customers. This is broadly consistent with the regional pattern of consumption.

19.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

19.2.7 Table 19.1 shows measured non-household demands in the base year totalling 15Ml/d in the East Suffolk RZ. These demands are mainly from the agriculture, public administration and manufacturing sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
15	Ipswich	11	Agriculture, public admin and manufacturing
	Woodbridge	3	
	Semer	<1	

Table 19.1 East Suffolk RZ Patterns of Measured Non-Household Consumption

19.2.8 From Table 19.2, we forecast new properties equivalent to around 1,200 per year. This estimate is less than recent rates of new builds but similar to the number of new properties forecast by local authorities.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			7,500	6,500	6,500	6,500	6,500
WRMP trend estimate			5,000	6,500	6,500	7,000	7,000
Annual Monitoring Report data	7,500	12,000					

Table 19.2 East Suffolk Growth Estimates

19.3 Baseline supply-demand balance

19.3.1 From Table 19.3 and Table 19.4, we forecast that by 2039/40 the RZ will be in deficit under DYAA conditions by 5.6Ml/d. The deficit is driven by a combination of growth in household demand and target headroom requirements. There is no equivalent deficit under CP conditions.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	78.95	78.95	78.95	78.95	78.95	78.95
Outage Allowance	2.04	1.96	1.96	1.95	1.95	1.96
Total Water Available for Use	76.91	73.69	73.69	73.70	73.69	73.69
Distribution Input	65.18	62.68	63.61	64.65	65.70	66.71
Target Headroom	2.21	5.18	7.41	9.42	10.96	12.60
Supply Demand Balance	9.52	5.83	2.67	-0.37	-2.97	-5.62

Table 19.3 East Suffolk Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	122.06	122.06	122.06	122.06	122.06	122.06
Outage Allowance	2.50	2.39	2.38	2.36	2.36	2.36
Total Water Available for Use	119.56	116.37	116.39	116.40	116.40	116.40
Distribution Input	79.78	76.36	77.27	78.34	79.46	80.55
Target Headroom	2.70	6.31	9.00	11.41	13.26	15.22

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Supply Demand Balance	37.09	33.70	30.12	26.64	23.68	20.63

Table 19.4 East Suffolk Baseline Supply-Demand Summary (DYCP)

19.3.2 Leakage in the base year is equivalent to 13% of distribution input.

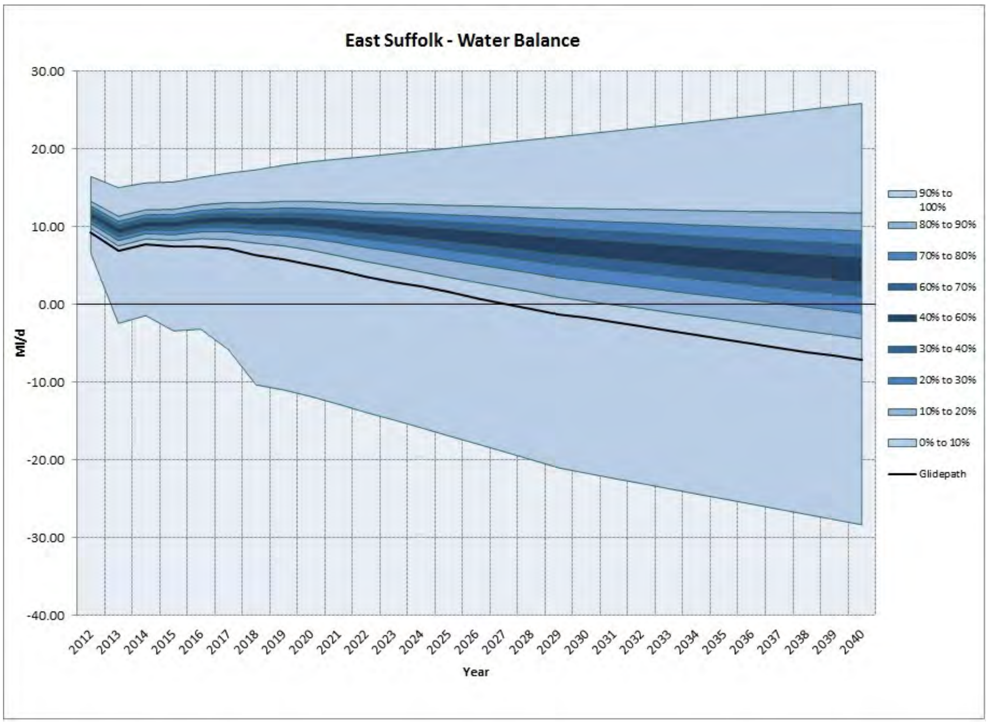


Figure 19.3 East Suffolk Probabilistic Water Balance

19.3.3 Figure 19.3 confirms that there is a greater than 90% probability that the RZ water balance will be in deficit against target levels of service from the middle of the 25 year forecast period.

19.3.1 Baseline supply forecast issues

- There are no sustainability changes or reductions forecast in this RZ.
- There are no baseline climate change impacts forecast on the available supplies.
- There have been no significant changes to deployable outputs since WRMP10.

19.3.1.1 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

19.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction and water efficiency. Anticipated savings from these activities in the East Suffolk RZ are approximately 2Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

19.4 Feasible options for maintaining the supply-demand balance

19.4.1 The feasible East Suffolk RZ options that were modelled in our EBSD optimiser are given below in Table 19.5.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Reuse	ES3 Ipswich water reuse	11	14.2	64,900	1,700
Desalination	ES4 Felixstowe desalination	11	13.3	55,200	3,620
Groundwater	ES6 East Suffolk RZ groundwater development	0.8	1.0	4,500	80
Transfer	ES10 South Essex RZ transfer	6.0	6.0	8,300	80

Table 19.5 East Suffolk Feasible Option Details

19.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon costs. In the EBSD modelling social, environmental and carbon costs have been included.

19.4.1 Scheme descriptions

19.4.1.1 Four options have been developed as follows:

- ES3 Ipswich water reuse -This option proposes for the discharge of treated effluent from Ipswich to the tidal River Gipping to supplement river flows and permit increased abstraction. The effluent would be treated to an extremely high (near potable) standard using reverse osmosis before transfer via a new pipeline. A new pipeline and pumping station would be also be required to convey the water to the water treatment works which would require additional treatment capacity
- ES4 Felixstowe Desalination - This option provides for a desalination plant situated on the coast near the port of Felixstowe. Treated water would be transferred some 17km to an existing service water reservoir in the Ipswich area
- ES6 East Suffolk RZ groundwater development - This option provides for the utilisation of an existing licensed borehole in the Ipswich area. New treatment facilities would be required, and
- ES10 South Essex RZ transfer -This option provides for the transfer of water via a new 22km long pipeline from Colchester in the South Essex RZ to Ipswich.

19.4.1.2 The transfer option ES10 utilises the surplus in South Essex RZ towards the beginning of the forecast. Once this has been exhausted a new resource/s would be required to support the transfer. The new resource options are described in the South Essex RZ summary. The Options Appraisal Report contains more details about all of these options.

19.4.1.3 The following options are mutually exclusive because only one of the transfer options would be constructed if selected by the model:

- ES10 South Essex RZ transfer to East Suffolk RZ
- SE2 East Suffolk WRZ transfer (12Ml/d) to South Essex RZ, and
- SE8 East Suffolk WRZ transfer (2Ml/d) to South Essex RZ.

19.4.2 Environmental considerations

19.4.2.1 The environmental assessments of the feasible options have concluded the following for the East Suffolk RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options
- The climate change vulnerability assessment concludes that the reuse option (ES3) and the desalination option (ES4) are not sensitive to climate change and scored 1 – insensitive. The groundwater development (ES6) and transfer (ES10) scored 2 – limited sensitivity
- The WFD no-deterioration screening has identified a low risk associated with the abstraction sources in the donor RZ's, and
- The SEA and HRA has not identified any significant negative effects following mitigation, with the exception of potential climate change impacts associated with the Ipswich water reuse scheme due to increased CO_2 output.

19.4.2.2 Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

19.5 Preferred plan

19.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side			ES10 South Essex RZ transfer		ES3 Ipswich Water reuse
Distribution side	See below				
Customer side	See below				

Table 19.6 East Suffolk Supply Demand Investment Plan

19.5.2 Lowering consumption levels are a priority to offset resource development and metering and water efficiency programmes have been included in the baseline. In the East Suffolk RZ we aim to complete approximately 12,000 water efficiency audits. We also anticipate that approximately 8,000 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

19.5.3 To support ES10 – South Essex RZ transfer the model selected the following upstream option:

- SE4 Amendment to Ardleigh agreement

19.5.4 Critical assumptions in respect of this option include the following:

- Continuation of the current 70/30 arrangement with Affinity Water to trade the resources of Ardleigh reservoir
- The availability of an option to trade 80/20 with Affinity Water in AMP9, and
- That the DO of the Ardleigh WTW can be maintained at the 36Ml/d currently assumed.

19.5.5 The model has selected transfers out of East Suffolk RZ to support West Suffolk RZ. The downstream options selected are,

- WS2b East Suffolk RZ transfer to West Suffolk RZ.

19.5.6 This transfer into West Suffolk RZ in turn supports the following options:

- NWM2 West Suffolk transfer to Newmaket RZ
- CVY1 Newmarket RZ transfer to Cheveley RZ
- E2 Newmarket RZ transfer to Ely RZ.

19.6 Scenario testing

19.6.1 Table 19.7 details the impacts of scenario modelling on the supply demand balance for the East Suffolk RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	5.83	-5.62
Least cost plan	1.57	-10.07
High population	3.63	-5.94
Worst case climate change	1.34	-17.16
Worst case sustainability reductions	5.83	-5.62
Recent actuals	-4.01	-15.46

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Worst case	-14.72	-31.78

Table 19.7 East Suffolk Scenario Modelling Impacts

19.6.2 In summary this shows the following:

- Impacts equivalent to 4.5Ml/d to the supply demand balance under the least-cost plan scenario up to 2039/40
- Marginal sensitivity to increasing population equivalent to 0.3Ml/d
- Worst case climate change impacts of 11.5Ml/d increase on zonal deficits in 2039/40
- Significant impact from restricting deployable outputs to recent actuals, of up to 10.8Ml/d at the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts increase from 23.9Ml/d at the end of AMP6 up to 26.2Ml/d in 2039/40.

19.6.3 Table 19.8 below shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	RZ Residual Deficit 2039/40 (Ml/d)
Preferred plan	See note below		ES10 South Essex RZ transfer		ES3 Ipswich Water Reuse	0
Preferred plan - environmental and social costs	See note below		ES10 South Essex RZ transfer		ES3 Ipswich Water Reuse	0
Plan B	See note below				ES4 Felixstowe Desalination	0
Least cost plan			ES10 South Essex RZ transfer Leakage	ES3 Ipswich Water Reuse Leakage		0
High population	See note below		ES10 South Essex RZ transfer ES3 Ipswich Water Reuse			0
Worst case climate change	See note below	ES10 South Essex RZ transfer	ES3 Ipswich Water Reuse			0
Worst case sustainability reductions	See note below			ES10 South Essex RZ transfer		0
Recent actuals	ES10 South Essex RZ transfer See note below	ES3 Ipswich Water Reuse			ES4 Felixstowe Desalination	0
Worst case combination	Leakage ES3 Ipswich Water Reuse ES10 South Essex RZ transfer	ES4 Felixstowe Desalination				9.86

Table 19.8 East Suffolk Scenario Scheme Selection

19.6.4 Although not selected in the EBSD modelling for the least cost plan in AMP6, leakage reduction, metering and water efficiency have been included in the baseline supply demand forecast.

19.6.5 Under most scenarios the feasible options provide adequate resource to meet demand however under the worst case scenario the feasible options are not adequate to fully satisfy the demand. Options for maintaining the supply-demand balance in the worst case combination scenario could include:

- The capacity of the desalination option ES4 was sized to meet deficit in the baseline supply demand forecast. The capacity of this option could be increased to meet the scenario deficit
- Development of a new winter storage reservoir in the Norfolk Fens. This would store water abstracted from the River Ouse during the winter for year-round treatment and distribution. Since the resources of the Ouse are already used to support the Ely Ouse Essex Transfer, careful consideration of the available yield would be required. If support is necessary, it is possible that a raw water transfer from the River Trent could be developed. This would link the Trent, Nene and Ouse, enabling resources to be transferred from the Trent basin to the south and east, to support supply-systems in East Anglia, and
- Associated with the above, the development of trading based infrastructure, either between water companies in East Anglia or between water companies and other third parties. In part, this could be based on connectivity which is delivered to improve the resilience of supply-systems in East Anglia.

PART TWO: RESOURCE ZONE SUMMARIES

South Essex

20 South Essex

Figure 20.1 South Essex Resource Zone

20.1 Key points

Key Points

- In the baseline forecast, AMP9 deficits are forecast in the South Essex RZ. These result from growth and at the end of the forecast period are equivalent to 1.02Ml/d under dry year annual average conditions. No deficits are forecast under critical period conditions.
- The baseline forecast assumes continuation of an existing trade with Affinity Water.
- There are no confirmed or likely sustainability requirements.
- No significant sustainability reduction or levels of service sensitivities have been identified. In the worst case, climate change may reduce average daily source-works output by 2.8Ml/d. This would affect abstraction from the River Colne.
- Excluding the WFD no-deterioration and worst case climate change risk, the plan for maintaining the supply-demand balance combines an extension of the Ardleigh trading agreement with additional leakage control and water efficiency savings.

20.2 Resource zone description

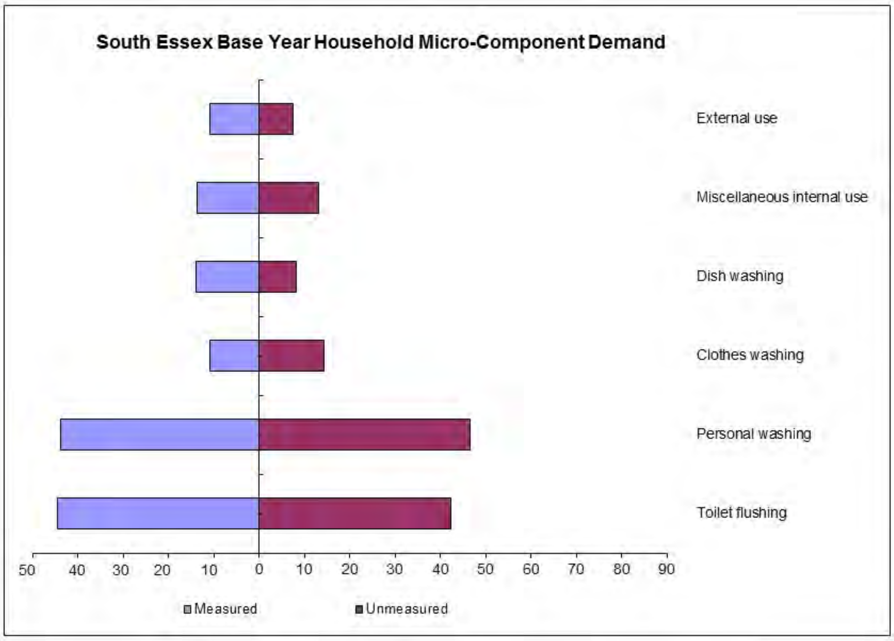
20.2.1 The South Essex RZ extends inland from Colchester and is based on the supply systems for Colchester and Braintree.

20.2.2 Supplies in the RZ are obtained from a combination of sources that include groundwater abstracted from the Chalk and surface water pumped from the River Colne into storage at Ardleigh reservoir. The reservoir held resources are shared with Affinity Water. Connectivity within the RZ allows for resources to be shared and for the integrity of the RZ to be maintained.

20.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 95,000. Of these 76% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 4,500. Most of these were measured.

20.2.4 From Figure 20.2:

- Base year measured PCC is estimated to be marginally more and unmeasured PCC is estimated to be less than our regional averages respectively (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 14% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	138	122	119	117
Unmeasured Household	132	113	104	97
Weighted Average	136	121	119	116
Reduction in PCC over forecast (%)	14%			

Figure 20.2 South Essex average household consumption (litres/person/day)

20.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using marginally less water for these activities than measured customers. This is broadly consistent with the regional pattern of consumption.

20.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

20.2.7 Table 20.1 shows measured non-household demands in the base year totalling 10Ml/d in the South Essex RZ. These demands are mainly from the manufacturing and public administrative sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
10	Colchester	7	Manufacturing and public admin
	Braintree	3	
	Tiptree	<1	

Table 20.1 South Essex RZ Patterns of Measured Non-Household Consumption

20.2.8 From Table 20.2, we forecast new properties equivalent to around 1,400 per year. This is less than the recent rates of new build and more than the number of new properties forecast by local authorities.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			4,500	4,000	3,000	3,000	3,000
WRMP trend estimate			6,000	7,000	7,000	7,000	7,000
Annual Monitoring Report data	10,000	10,500					

Table 20.2 South Essex Growth Estimates

20.3 Baseline supply-demand balance

20.3.1 From Table 20.3 and Table 20.4, at the end of AMP10, the RZ is forecast to be in deficit under DYAA conditions by 1Ml/d. The DYAA deficit is driven by a combination of growth in household demand and target headroom requirements. There is no equivalent CP deficit.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	58.04	58.04	58.04	58.04	58.04	58.04
Outage Allowance	1.61	1.55	1.55	1.56	1.56	1.57
Total Water Available for Use	59.52	59.58	59.57	59.57	59.56	59.56
Distribution Input	49.11	49.35	50.62	51.97	53.24	54.48
Target Headroom	1.64	2.48	3.19	4.14	5.07	6.10
Supply Demand Balance	8.77	7.75	5.76	3.46	1.25	-1.02

Table 20.3 South Essex Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	80.11	80.11	80.11	80.11	80.11	80.11
Outage Allowance	1.95	1.86	1.86	1.87	1.87	1.87
Total Water Available for Use	82.76	82.85	82.84	82.84	82.84	82.83
Distribution Input	59.54	59.32	60.72	62.25	63.73	65.16
Target Headroom	1.99	2.98	3.82	4.96	6.07	7.29

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Supply Demand Balance	21.23	20.55	18.30	15.63	13.04	10.38

Table 20.4 South Essex Baseline Supply-Demand Summary (DYCP)

20.3.2 Leakage in the base year is equivalent to 17% of distribution input.

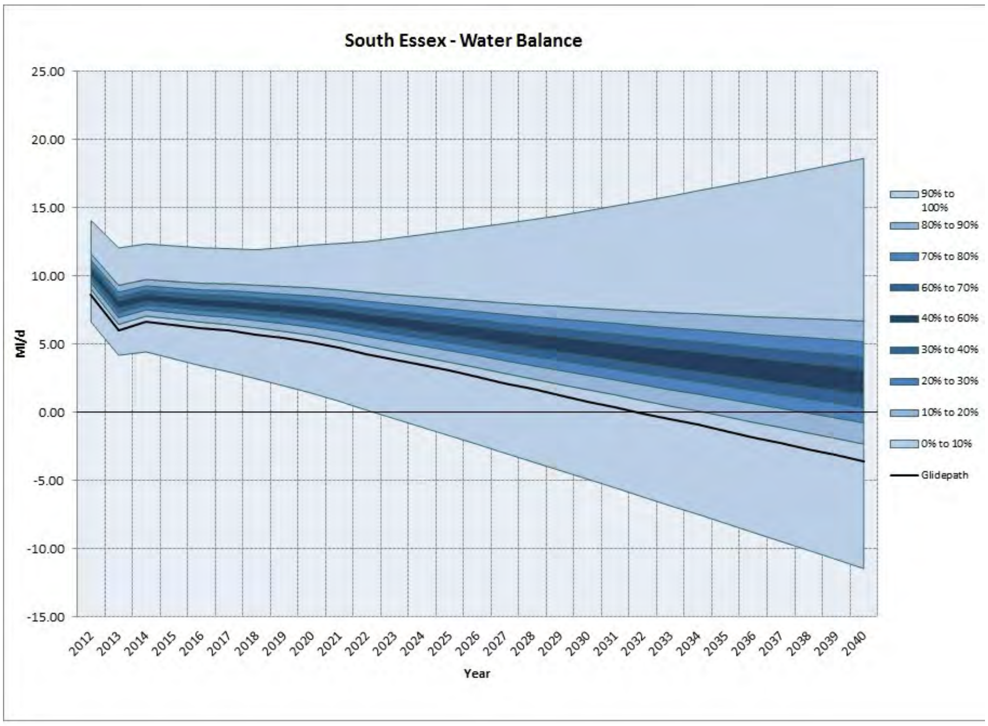


Figure 20.3 South Essex Probabilistic Water Balance

20.3.3 Figure 20.3 confirms that there is a greater than 90% probability that the RZ water balance will be in deficit towards the end of the forecast period.

20.3.1 Baseline supply forecast issues

20.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- Increased resource availability resulting from our agreement for a 70:30 split of Ardleigh WTW deployable output
- No base line climate change impacts forecast on available supplies
- There are no confirmed, likely or unknown sustainability reductions required in this RZ, and
- A WFD no deterioration risk assessment is likely to be required to support renewal of the Aldham abstraction licence.

20.3.1.2 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

20.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction and water efficiency. Anticipated savings from these activities in the South Essex RZ are approximately 1Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

20.4 Feasible options for maintaining the supply-demand balance

20.4.1 The feasible South Essex RZ options that were modelled in our EBSD optimiser are given below in Table 20.5.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£/yr)
Reuse	SE1 Colchester water reuse	16	21	74,400	1,540
Transfer	SE2 East Suffolk RZ transfer (12Ml/d)	12	12	11,300	140
Trade	SE4 Amendment to Ardleigh agreement	2.7	3.6	0	240
Groundwater	SE6 South Essex RZ groundwater development	1	1.4	3,100	60
Reservoir	SE7 Ardleigh reservoir extension	2	3	10,700	190
Transfer	SE8 East Suffolk RZ transfer (2Ml/d)	2	2	6,000	4

Table 20.5 South Essex Feasible Option Details

20.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon cost. In the EBSD modelling all costs, including social, environmental and carbon are modelled.

20.4.1 Scheme descriptions

20.4.1.1 The following feasible options have been developed:

- SE1 Colchester water reuse - Effluent from Colchester Water Recycling Centre would be treated to an extremely high (near potable) standard and discharged to the River Colne to supplement river flows and permit increased abstraction. A new pipeline and pumping station would be required to convey the water to the water treatment works which would require additional treatment capacity
- SE2 East Suffolk RZ transfer (12Ml/d) - This option provides for the transfer of 12Ml/d of water from Ipswich in the East Suffolk RZ to Colchester via a new 22km long pipeline
- SE4 Amendment to Ardleigh agreement - Resources in the Colchester area are shared with Affinity Water. This option would increase the Anglian Water share of the available resource

- SE6 South Essex RZ groundwater development - This option provides for the utilisation of an existing licenced borehole in the Colchester area. New treatment facilities would be required
- SE7 Ardleigh reservoir extension - An extension to an existing reservoir utilising disused mineral abstraction pits to provide additional storage. Additional treatment capacity and transfer pipelines would also be required, and
- SE8 East Suffolk RZ transfer (2Ml/d) - This option is similar to option SE2 above but requires a smaller pipeline.

20.4.1.2 The following options are mutually exclusive because only one of the transfer options would be constructed if selected by the model:

- SE2 East Suffolk RZ transfer (12Ml/d) to South Essex RZ
- SE8 East Suffolk RZ transfer (2Ml/d) to South Essex RZ, and
- ES10 South Essex RZ transfer to East Suffolk RZ.

20.4.1.3 The transfer options SE2 and SE8 utilise the surplus in East Suffolk RZ towards the beginning of the forecast. Once this has been exhausted a new resource/s would be required to supply the transfer. The new resource options are described in the East Suffolk RZ summary. The Options Appraisal Report contains more details about all of these options.

20.4.2 Environmental considerations

20.4.2.1 The environmental assessments of the feasible options have concluded the following for the South Essex RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options
- The climate change vulnerability assessment concludes that both transfer options (SE2, SE8) are not sensitive to climate change but the donor RZs are vulnerable to climate change. The assessment scored both options as 2 – limited sensitivity. The ground water development (SE6) also scored 2 – limited sensitivity. The reuse option (SE1) and amendment to Ardleigh agreement (SE4) scored 1 – insensitive to impacts of climate change. The Ardleigh extension (SE7) scores 3 – sensitive in relation to water abstraction, available flow and environmental flow requirements
- The WFD no-deteriorations assessment, SEA and HRA concluded the following for the South Essex RZ options

    - SE1 Colchester water reuse - The HRA screening has concluded potential for likely significant effect on the Colne Estuary SPA and requirement for an Appropriate Assessment if taken forward. The SEA concluded that pipeline re-routing would be required to avoid local nature reserves and ancient woodland. Further investigation into water quality issues required by no WFD issues expected
    - SE2 East Suffolk RZ transfer (12Ml/d) - No significant negative effects identified in SEA, assuming that pipeline can be re-routed to avoid ancient woodland
    - SE4 Amendment to Ardleigh agreement - The WFD no-deterioration screening has identified a low risk associated with increased abstraction from the River Colne that will require further investigation. No other significant negative effects have been identified in the SEA
    - SE6 South Essex RZ groundwater development - The WFD no-deterioration assessment has identified a low risk of deterioration associated with increased

abstraction from the Chalk that will require further investigation. No other significant negative effects have been identified in the SEA
- SE7 Ardleigh reservoir extension - The WFD no-deterioration screening has identified a low risk associated with increased abstraction from the River Colne that will require further investigation. The HRA screening has concluded potential for likely significant effect on the Colne Estuary SPA and requirement for an Appropriate Assessment if taken forward, and
- SE8 East Suffolk RZ transfer (2Ml/d) - No significant negative effects identified in SEA, assuming that pipeline can be re-routed to avoid ancient woodland

- Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

20.5 Preferred plan

20.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side				SE4 – Amendment to Ardleigh Agreement	
Distribution side	See below				
Customer side	See below				

Table 20.6 South Essex Supply-Demand Investment Plan

20.5.2 Lowering consumption levels is a priority to offset resource development and metering and water efficiency programmes have been included in the baseline. In the South Essex RZ we aim to complete approximately 9,000 water efficiency audits. We also anticipate that approximately 4,000 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

20.5.3 The model has selected transfers out of South Essex RZ to support Central Essex RZ and East Suffolk RZ. The downstream options selected are:

- CE1 – South Essex RZ transfer to Central Essex RZ, and
- ES10 – South Essex RZ transfer to East Suffolk RZ.

20.5.4 In respect of the plan, the following issues are noted:

- The preferred plan assumes:

- Continuation of the current 70/30 arrangement with Affinity Water to trade the resources of Ardleigh reservoir
- The availability of an option to trade 80/20 with Affinity Water in AMP9, and
- That the DO of the Ardleigh WTW can be maintained at the 36Ml/d currently assumed.

20.6 Scenario testing

20.6.1 Table 20.7 details the impacts of scenario modelling on the supply demand balance for the South Essex RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	7.75	-1.02
Least cost plan	6.12	-2.60
High population	3.80	-3.53
Worst case climate change	6.90	-3.60
Worst case sustainability reductions	7.75	-1.02
Recent actuals	2.84	-5.93
Worst case combination	-4.48	-13.44

Table 20.7 :South Essex Scenario Modelling Impacts

20.6.2 In summary this shows the following:

- 1.6Ml/d impact on the RZ supply demand balance by the end of the planning period under the least cost plan scenario
- Significant sensitivity to increasing populations and worst case climate change scenarios equivalent to 2.5Ml/d and 2.6Ml/d respectively
- No further reductions resulting from worst case scenario sustainability reductions scenario
- Impacts of 4.9Ml/d from restricting deployable outputs to recent actuals by the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts are 12.4Ml/d by 2039/40.

20.6.3 The table below shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	RZ Residual Deficit 2039/40 (Ml/d)
Preferred Plan	See note below			SE4 Ardleigh Agreement		0
Preferred plan - environmental and social costs	See note below			SE4 Ardleigh Agreement		0
Plan B	See note below				SE6 South Essex RZ groundwater	0
Least cost plan			Leakage	SE4 Ardleigh Agreement SE6 South Essex RZ groundwater Leakage	Leakage	0
High population	See note below		SE4 Ardleigh Agreement SE6 South Essex RZ groundwater		SE7 Ardleigh reservoir extension	0
Worst case climate change	See note below		SE4 Ardleigh Agreement		SE1 Colchester water resue	0
Worst case sustainability reductions	See note below				SE4 Ardleigh Agreement SE7 Ardleigh reservoir extension SE6 South Essex RZ groundwater	0
Recent actuals	See note below	SE4 Ardleigh Agreement	SE1 Colchester water resue SE6 South Essex RZ groundwater			0
Worst case combination	Leakage SE1 Colchester water resue SE4 Ardleigh Agreement				SE7 Ardleigh reservoir extension	0

Table 20.8 South Essex Scenario Scheme Selection

20.6.4 Although not selected in the EBSD modelling for the least cost plan in AMP6, leakage reduction, metering and water efficiency has been included in the baseline supply demand forecast.

20.6.5 Under all the scenarios there are adequate feasible options to meet demand in South Essex RZ. However some of the scenarios select a transfer out of South Essex RZ to support other RZs. The capacity of these transfers is based on the deficits in the baseline supply demand forecast. If these options were re-sized to meet the deficits created in the worst case scenario then the constraint would be on the new resource options within South Essex RZ. The remaining option not selected in the worst case scenario is SE6 South Essex RZ groundwater development. This could be implemented to reduce deficits in Central Essex RZ and East Suffolk RZ.

20.6.6 Scenario testing shows the following:

- Worst case climate change impacts equivalent to a 2.8Ml/d reduction in ADSO. This would affect our abstraction from the River Colne
- No additional sustainability reduction sensitivities, and
- No impacts under different level of service scenarios.

PART TWO: RESOURCE ZONE SUMMARIES

Central Essex

21 Central Essex

Figure 21.1 Central Essex Resource Zone

PART TWO: RESOURCE ZONE SUMMARIES
Central Essex

21.1 Key points

Key Points

- AMP8 deficits are forecast in the Central Essex RZ. At the end of the forecast period the deficits grow to 0.86Ml/d under dry year annual average conditions. There is no equivalent deficit under critical conditions.
- There are no confirmed or likely sustainability reductions.
- Over the forecast period, no significant climate change, sustainability reduction or levels of service sensitivities have been identified.

21.2 Resource zone description

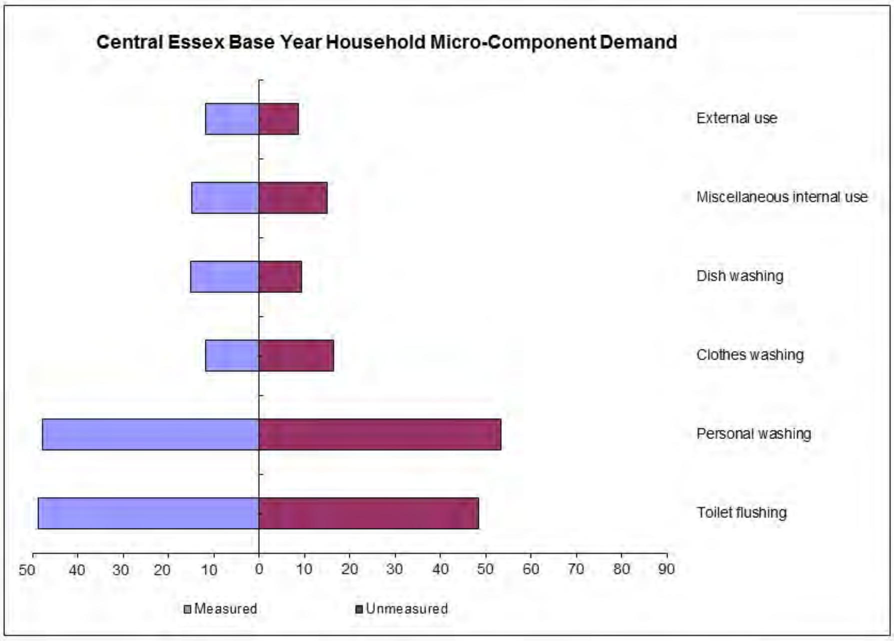
21.2.1 The Central Essex RZ is based on the supply system for Halstead.

21.2.2 The water resource for this RZ is entirely dependent on abstraction from the Chalk aquifer. There is a reasonable level of connectivity within the RZ. This allows for resources to be shared and for the integrity of the RZ to be maintained.

21.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 17,500. Of these 63% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 1,100. Most of these were measured.

21.2.4 From Figure 21.2:

- Base year measured PCC is significantly more and unmeasured PCC is approximately the same as our regional averages (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast an 18% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	150	132	128	124
Unmeasured Household	152	126	116	108
Weighted Average	151	130	127	123
Reduction in PCC over forecast (%)	18%			

Figure 21.2 Central Essex average household consumption (litres/person/day)

21.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using marginally the same amount of water for these activities as measured customers. This is not consistent with the regional pattern of consumption.

21.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

21.2.7 Table 21.1 shows measured industrial demands in the base year totalling 10Ml/d in the Central Essex RZ. These demands are mainly from the manufacturing and public administration sectors.

Average RZ Demand	Planning Zone	Average PZ Demand (Ml/d)	Main RZ sector types
10	Colchester	7	Manufacturing and public admin
	Braintree	3	
	Tiptree	<1	

Table 21.1 Central Essex RZ Patterns of Measured Non-Household Consumption

21.2.8 From Table 21.2, we forecast new properties equivalent to around 200 per year. This estimate is similar to recent rates of new build but significantly more than the number of new properties forecast by local authorities.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			450	450	400	400	400
WRMP trend estimates			950	1,100	1,200	1,200	1,200
Annual monitoring report data	1,300	1,000					

Table 21.2 Central Essex Growth Estimates

21.3 Baseline supply-demand balance

21.3.1 From Table 21.3 and Table 21.4, in the last year of AMP6 (2019/20) we forecast that there will be a DYAA surplus of 0.5Ml/d and a CP surplus of 4.0Ml/d in the RZ. Equivalent target headroom requirements are 0.5Ml/d and 0.6Ml/d respectively. The RZ enters a DYAA deficit by the end of AMP8 (2029/30) and reaches 0.9Ml/d at the end of the forecast period in 2039/40. There are no deficits at peak.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	12.48	12.48	12.48	12.48	12.48	12.48
Outage Allowance	0.34	0.33	0.33	0.33	0.33	0.33
Total Water Available for Use	12.05	12.07	12.07	12.07	12.06	12.06
Distribution Input	11.60	11.10	11.29	11.49	11.69	11.89
Target Headroom	0.38	0.49	0.59	0.72	0.86	1.04
Supply Demand Balance	0.08	0.48	0.19	-0.14	-0.49	-0.86

Table 21.3 Central Essex Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	18.11	18.11	18.11	18.11	18.11	18.11
Outage Allowance	0.40	0.38	0.38	0.39	0.39	0.39
Total Water Available for Use	17.61	17.63	17.63	17.62	17.62	17.62
Distribution Input	13.79	13.09	13.27	13.39	13.71	13.93
Target Headroom	0.45	0.58	0.70	0.84	1.01	1.21

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Supply Demand Balance	3.37	3.96	3.66	3.30	2.90	2.48

Table 21.4 Central Essex Baseline Supply-Demand Summary (DYCP)

21.3.2 Leakage in the base year is equivalent to 29% of distribution input.

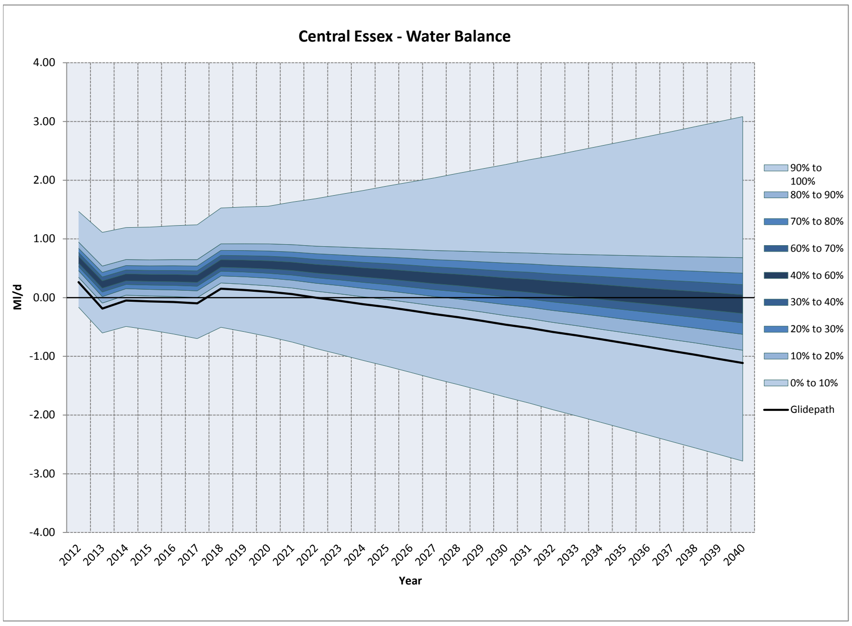


Figure 21.3 Central Essex Probabilistic Water Balance

21.3.3 Figure 21.3 confirms that there is a greater than 95% probability that the RZ water balance will be in deficit over the 25 year forecast period.

21.3.1 Baseline supply forecast issues

- There is no baseline climate change impact forecast on the available supplies.
- No confirmed or likely sustainability reductions have been identified.
- A WFD no-deterioration assessment will be required to support the renewal of the Halstead groundwater licence in 2016.
- There has been no significant change to deployable outputs since WRMP10 or any issues of risk to supplies in this resource zone.

21.3.1.1 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

21.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction and water efficiency. Anticipated savings from these activities in the Central Essex RZ are approximately 0.4Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

21.3.3 Baseline supply forecast issues

21.4 Feasible options for maintaining the supply-demand balance

21.4.1 The feasible Central Essex RZ options modelled in our EBSD optimiser are given in the table below.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Transfer	CE1 South Essex RZ transfer	1.5	1.5	3,700	30
Transfer	CE2 West Suffolk RZ transfer	1.5	1.5	8,500	80

Table 21.5 Central Essex Feasible Option Details

21.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon costs. In the EBSD modelling social, environmental and carbon costs have been included.

21.4.1 Scheme descriptions

21.4.1.1 Two options have been developed for Central Essex RZ. These are:

- CE1 South Essex RZ transfer - This option provides a transfer from South Essex RZ to Central Essex RZ requiring 12km of new pipeline with 2 new pumping stations, and
- CE2 - West Suffolk RZ transfer - A transfer from West Suffolk RZ to Central Essex RZ via a new 34km long pipeline and 3 new pumping stations.

21.4.1.2 Both options are supplied by RZs in deficit by the end of the forecast therefore a new resource will be required in the donor RZs. The new resource options are described in the relevant RZ summaries. The Options Appraisal Report contains more details about all of these options.

21.4.2 Environmental considerations

21.4.2.1 The environmental assessments of the feasible options have concluded the following for the Central Essex RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options

- The climate change vulnerability assessment concludes that both transfer options are not sensitive to climate change but the donor RZs are vulnerable to climate change. The assessment scored both options as 2 – limited sensitivity
- No WFD no-deterioration issues were identified
- No HRA issues were identified, and
- No significant negative effects have been predicted through the SEA.

21.4.2.2 Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

21.5 Preferred plan

21.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side			CE1 – South Essex transfer		
Distribution side	See below				
Customer side	See below				

Table 21.6 Central Essex Supply-Demand Investment Plan

21.5.2 Lowering consumption levels is a priority to offset resource development and enhanced metering, leakage reduction and water efficiency programmes have been included in the baseline. In the Central Essex RZ we aim to complete approximately 1,500 water efficiency audits. We also anticipate that approximately 2,000 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

21.5.3 To support CE1 – South Essex transfer the model selected the following upstream option:

- SE4 Amendment to Ardleigh agreement.

21.5.4 Critical assumptions in respect of this option include the following:

- Continuation of the current 70/30 arrangement with Affinity Water to trade the resources of Ardleigh reservoir
- The availability of an option to trade 80/20 with Affinity Water in AMP9, and
- That the DO of the Ardleigh WTW can be maintained at the 36Ml/d currently assumed.

21.6 Scenario testing

21.6.1 Table 21.7 details the impacts of scenario modelling on the supply demand balance for the Central Essex RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	0.48	-0.86
Least cost plan	-0.44	-1.78
High population	-0.71	-1.70
Worst case climate change	0.23	-1.11
Worst case sustainability reductions	0.48	-1.11
Recent actuals	-1.32	-2.66
Worst case combination	-2.98	-3.95

Table 21.7 Central Essex Scenario Modelling Impacts

21.6.2 In summary this shows the following:

- 0.9Ml/d impact on the RZ supply demand balance by the end of the planning period under the least cost plan scenario
- Sensitivity to increasing populations equivalent to 0.8Ml/d
- 0.25Ml/d impacts arising from worst case climate change and sustainability reductions scenarios
- Impacts of 1.8Ml/d from restricting deployable outputs to recent actuals by the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts are up to 3.1Ml/d by 2039/40.

21.6.3 Table 21.8 below shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	RZ Residual Deficit 2039/40 (Ml/d)
Preferred plan	See note below		CE1 South Essex RZ transfer			0
Preferred plan - environmental and social costs	See note below		CE1 South Essex RZ transfer			0
Plan B	See note below		CE2 West Suffolk RZ transfer			0
Least cost plan	Leakage	CE1 South Essex RZ transfer				0
High population	CE1 South Essex RZ transfer					0
	See note below					
Worst case climate change	See note below		CE2 West Suffolk RZ transfer			0
Worst case sustainability reductions	See note below		CE1 South Essex RZ transfer			0
Recent actuals	CE1 South Essex RZ transfer					0.92
	See note below					
Worst case combination	Leakage					1.79
	Water Efficiency					
	CE1 South Essex RZ transfer					

Table 21.8 Central Essex RZ scenario scheme selection

21.6.4 Although not selected in the EBSD modelling for the least cost plan in AMP6, leakage reduction, metering and water efficiency have been included in the baseline supply demand forecast.

21.6.5 Under most scenarios the feasible options provide adequate resource to meet demand however under the recent actuals and worst case combination scenario there is a residual deficit. This is because the maximum capacity of the transfers has been modelled to meet the deficit in the baseline forecast. If these options were re-sized to meet the deficits created in the worst case scenario then the constraint would be on the new resource options upstream within the donor RZs. For the CE1 South Essex RZ transfer there are new resource options available to transfer under all scenarios which would reduce the deficit. However for CE2 West Suffolk RZ transfer the upstream RZ goes into deficit under the worst case combination scenario.

PART TWO: RESOURCE ZONE SUMMARIES
Cheveley

22 Cheveley

Figure 22.1 Cheveley Resource Zone

22.1 Key points

Key Points

- Confirmation of sustainability reductions in the Cambridgeshire and West Suffolk RZ highlighted local RZ integrity issues. This has resulted in the RZ being disaggregated into five smaller RZs.
- Cheveley is a small discrete zone with only one WTW that supplies the Lower Links Supply system.
- AMP8 deficits are forecast at the end of the planning period with deficits growing to 0.15Ml/d under dry year annual average conditions and 0.18Ml/d under critical conditions.
- No significant baseline climate change or levels of service sensitivities have been identified.
- No sustainability reductions have been identified for this RZ.

22.2 Resource zone description

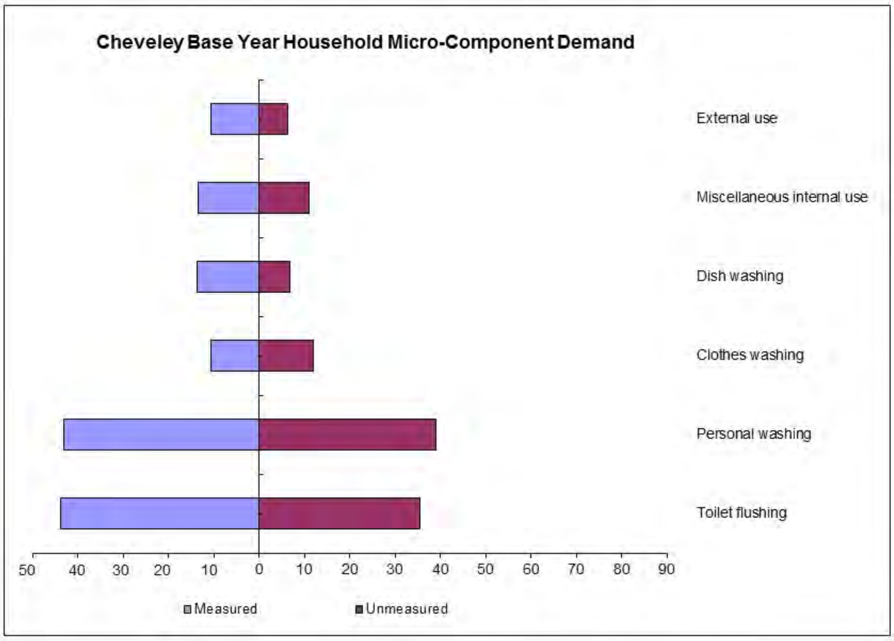
22.2.1 The Cheveley RZ was formerly a part of the Cambridgeshire and West Suffolk RZ. As a result of the sustainability reductions forecast the RZ was disaggregated into five smaller RZ's. The Cheveley RZ is a small discrete RZ, with only one source works that supplies the Lower Links supply system.

22.2.2 The sourceworks in the RZ is supplied by groundwater abstraction from the Chalk. All customers share similar supply-demand risks, which are different from those in adjacent RZs.

22.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 2,000. Of these 63% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 170. Most of these were measured.

22.2.4 From Figure 22.2:

- Base year measured PCC is marginally more and unmeasured PCC is estimated to be significantly less than our regional averages respectively (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 10% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	135	117	114	112
Unmeasured Household	111	98	99	104
Weighted Average	124	112	112	111
Reduction in PCC over forecast (%)	10%			

Figure 22.2 Cheveley average household consumption (litres/person/day)

22.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using less water for these activities than measured customers. This is not consistent with regional pattern of consumption.

22.2.6 Analysis suggests that the projected significant reduction in measured household consumption is from a change in WC use. For unmeasured customers reductions are also projected from a change in personal washing and WC use.

22.2.7 This is one of our smallest resource zones comprising of one planning zone. Table 22.1 shows measured non-household demand in the base year totalling 0.5Ml/d. The demand is mainly from the agriculture sector.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
0.5	Cheveley	0.5	Agriculture

Table 22.1 Cheveley RZ Patterns of Measured Non-Household Consumption

22.2.8 From Table 22.2 we forecast new properties equivalent to around 40 per year. This estimate is similar to both recent rates of new build and the number of new properties forecast by local authorities

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			150	150	250	300	300
WRMP trend estimate			180	200	190	180	180
Annual Monitoring Report data	200	200					

Table 22.2 Cheveley Growth Estimate

22.3 Baseline supply-demand balance

22.3.1 From Table 22.3 and Table 22.4, in the last year of AMP6 (2019/20) we forecast that there will be a DYAA surplus of 0.2Ml/d and a CP surplus of 0.2Ml/d in the RZ. Equivalent target headroom requirements are 0.1Ml/d and 0.2Ml/d respectively. By the end of the planning period the RZ is marginally in deficit in the DYAA and CP scenarios.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	1.96	1.96	1.96	1.96	1.96	1.96
Outage Allowance	0.06	0.06	0.06	0.06	0.06	0.06
Total Water Available for Use	1.90	1.90	1.90	1.90	1.90	1.90
Distribution Input	1.64	1.62	1.66	1.70	1.73	1.77
Target Headroom	0.06	0.13	0.17	0.21	0.25	0.29
Supply Demand Balance	0.20	0.15	0.007	-0.01	-0.08	-0.15

Table 22.3 Cheveley Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	2.45	2.45	2.45	2.45	2.45	2.45
Outage Allowance	0.08	2.42	2.44	2.27	2.27	2.27
Total Water Available for Use	2.37	2.37	2.38	2.38	2.38	2.38
Distribution Input	2.05	2.03	2.08	2.12	2.16	2.20
Target Headroom	0.07	0.17	0.22	0.27	0.31	0.36

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Supply Demand Balance	0.28	0.18	0.09	-0.01	-0.09	-0.18

Table 22.4 Cheveley Baseline Supply-Demand Summary (DYCP)

22.3.2 Leakage in the base year is equivalent to 34% of distribution input and reduces slightly over the remainder of the forecast period. This rate of leakage is significantly higher than elsewhere in our system.

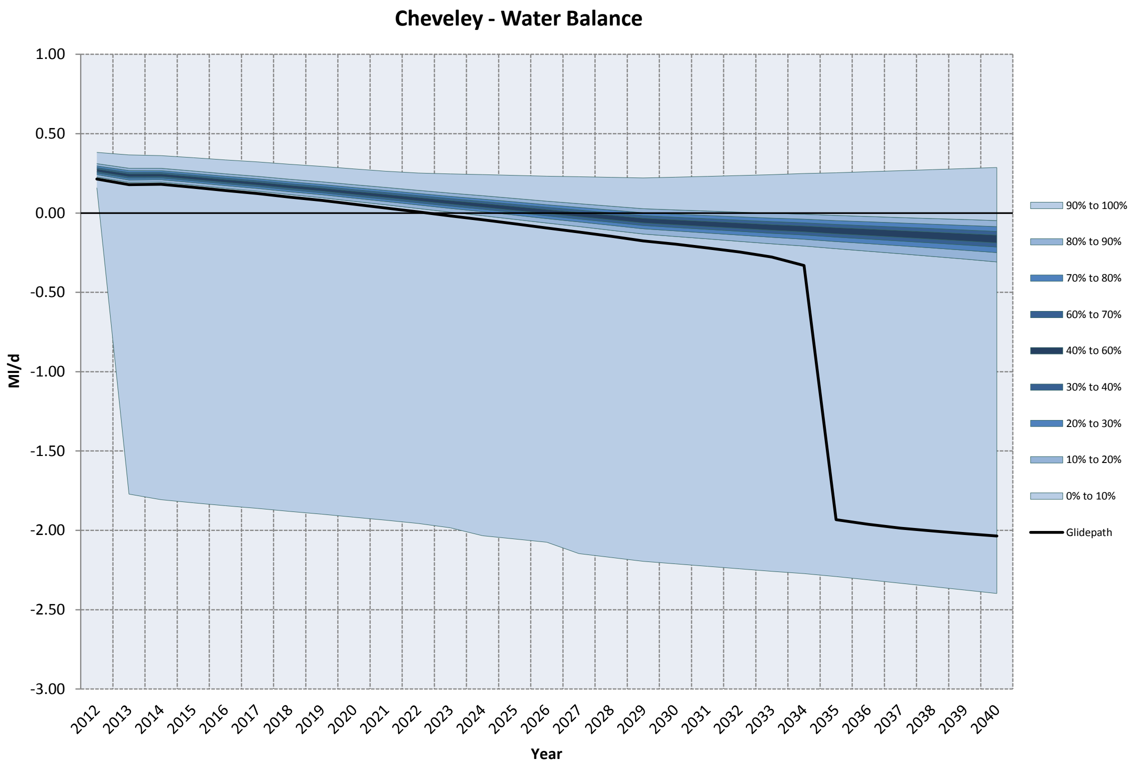


Figure 22.3 Cheveley Probabilistic Water Balance

22.3.3 The probabilistic water balance indicates that there is a significant risk of a deficit in this RZ by the end of the forecast period. This reflects the limited number of sources of supply that there are in this RZ, and the potential vulnerability of these to point sources of contamination. In the economic modelling and the WRP tables, this vulnerability has been treated as a resilience issue and so has been excluded from the analysis. Resulting from this, the risk of a supply-demand related deficit at the end of the forecast period is significantly reduced.

22.3.1 Baseline supply forecast issues

- There have been no significant changes to available supplies from the source in this RZ since the 2010 WRMP.

- There is no baseline confirmed or likely Sustainability Changes forecast for this resource zone, or any climate change impacts forecast on available supplies.
- A WFD assessment for the Lower Links groundwater source may be required, further to ongoing work with the Environment Agency.
- Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

22.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction and water efficiency. Anticipated savings from these activities in the Cheveley RZ are approximately 0.02Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

22.4 Feasible options for maintaining the supply-demand balance

22.4.1 The feasible Cheveley RZ options modelled in our EBSD optimiser are given in Table 22.5 below.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Transfer	CVY1 Newmarket RZ transfer	1	1	1,100	20
Transfer	CVY2 West Suffolk RZ transfer	1	1	3,100	30

Table 22.5 Cheveley Feasible Option Details

22.4.1 Scheme descriptions

22.4.1.1 Two options have been developed for Cheveley RZ. These are:

- CVY1 Newmarket RZ transfer - This option provides a transfer of water from Newmarket RZ to Cheveley RZ via 3km of new pipework and a pumping station, and
- CVY2 West Suffolk RZ transfer - A new pumped transfer from Bury St Edmunds in West Suffolk RZ to Cheveley RZ via 12km of new pipework and a new pumping station.

22.4.1.2 Option CVY1 is supplied by Newmarket RZ which has a marginal surplus by the end of the forecast which is not adequate to fully satisfy the deficit in Cheveley, therefore a new transfer would be required into Newmarket to support this option. The West Suffolk RZ transfer CVY2 would also require a new resource option or transfer into West Suffolk RZ as there is not adequate resource to supply Cheveley RZ. The new resource options that may support the Cheveley RZ options are described in the relevant RZ summaries. The Options Appraisal Report contains more details about all of these options.

22.4.2 Environmental considerations

22.4.2.1 The environmental assessments of the feasible options have concluded the following for the Cheveley RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options
- The climate change vulnerability assessment concludes that both transfer options are not sensitive to climate change but the donor RZs are vulnerable to climate change. The assessment scored both options as 2 – limited sensitivity
- WFD no-deterioration screening has identified a low risk associated with sources in donor RZ's, and
- The SEA has concluded that there will be no significant negative effects following mitigation.

22.4.2.2 Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

22.5 Preferred plan

22.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side			CVY1 Newmarket RZ transfer		
Distribution side	See below				
Customer side	See below				

Table 22.6 Cheveley Selected Supply-Demand Investment Plan

22.5.2 Lowering consumption levels is a priority to offset resource development and metering and water efficiency programmes have been included in the baseline. In the Cheveley RZ we aim to complete approximately 200 water efficiency audits. We also anticipate that approximately 200 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

22.5.3 To support CVY1 Newmarket RZ transfer the model selected the following upstream options:

- NWM2 West Suffolk RZ transfer
- WS5 River Lark flow augmentation
- WS2b East Suffolk RZ transfer (resilience scheme), and
- ES3 Ipswich water reuse.

22.6 Scenario testing

Table 22.7 details the impacts of scenario modelling on the supply demand balance for the Cheveley RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	0.15	-0.15
Least cost plan	0.03	-0.27
High population	0.03	-0.21
Worst case climate change	0.15	-0.15
Worst case sustainability reductions	0.15	-0.15
Recent actuals	-0.26	-0.56
Worst case combination	-0.49	-0.73

Table 22.7 Cheveley Scenario Modelling Impacts

In summary this shows the following:

- 0.12Ml/d impact on the RZ supply demand balance by the end of the planning period under the least-cost plan scenario
- Sensitivity to increasing populations
- No sensitivity to worst case climate change impacts
- Impacts of 0.4M/d from restricting deployable outputs to recent actuals by the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts are up to 0.6Ml/d by 2039/40.

The table below shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	RZ Residual Deficit 2039/40 (Ml/d)
Preferred plan	See note below		CVY1 Newmarket RZ transfer			0
Preferred plan - environmental and social costs	See note below		CVY1 Newmarket RZ transfer			0
Plan B	See note below		CVY2 West Suffolk RZ transfer			0
Least cost plan	CVY1 Newmarket RZ transfer					0
High population	See note below	CVY1 Newmarket RZ transfer				0
Worst case climate change	See note below		CVY1 Newmarket RZ transfer			0
Worst case sustainability reductions	See note below		CVY2 West Suffolk RZ transfer			0
Recent actuals	CVY1 Newmarket RZ transfer See note below					0
Worst case combination	CVY2 West Suffolk RZ transfer Water efficiency					0

Table 22.8 Cheveley Scenario Scheme Selection

22.6.1 Under all scenarios Cheveley RZ has adequate resource options; however the RZ is reliant on transfers from West Suffolk RZ or Ruthamford North RZ (via Fenland, Ely and Newmarket). In the worst case combination scenario the upstream RZs are both in deficit. Under these circumstances, strategic options for maintaining the supply-demand balance include:

- Development of the South Lincolnshire Reservoir. This would store water abstracted from the River Trent during the winter for year-round treatment and distribution
- Development of a new winter storage reservoir in the Norfolk Fens. This would store water abstracted from the River Ouse during the winter for year-round treatment and distribution. Since the resources of the Ouse are already used to support the Ely Ouse Essex Transfer, careful consideration of the available yield would be required. If support is necessary, it is possible that a raw water transfer from the River Trent could be developed. This would link the Trent, Nene and Ouse, enabling resources to be transferred from the Trent basin to the south and east to support supply-systems in East Anglia
- Associated with the above, the development of trading based infrastructure, either between water companies in East Anglia or between water companies and other third parties. In part, this could be based on schemes which are delivered to improve the resilience of supply-systems in East Anglia, and
- Investment to support the additional storage capacity created by dam raising in Ruthamford North RZ by a transfer of resources from the Trent basin.

PART TWO: RESOURCE ZONE SUMMARIES
Ely

23 Ely

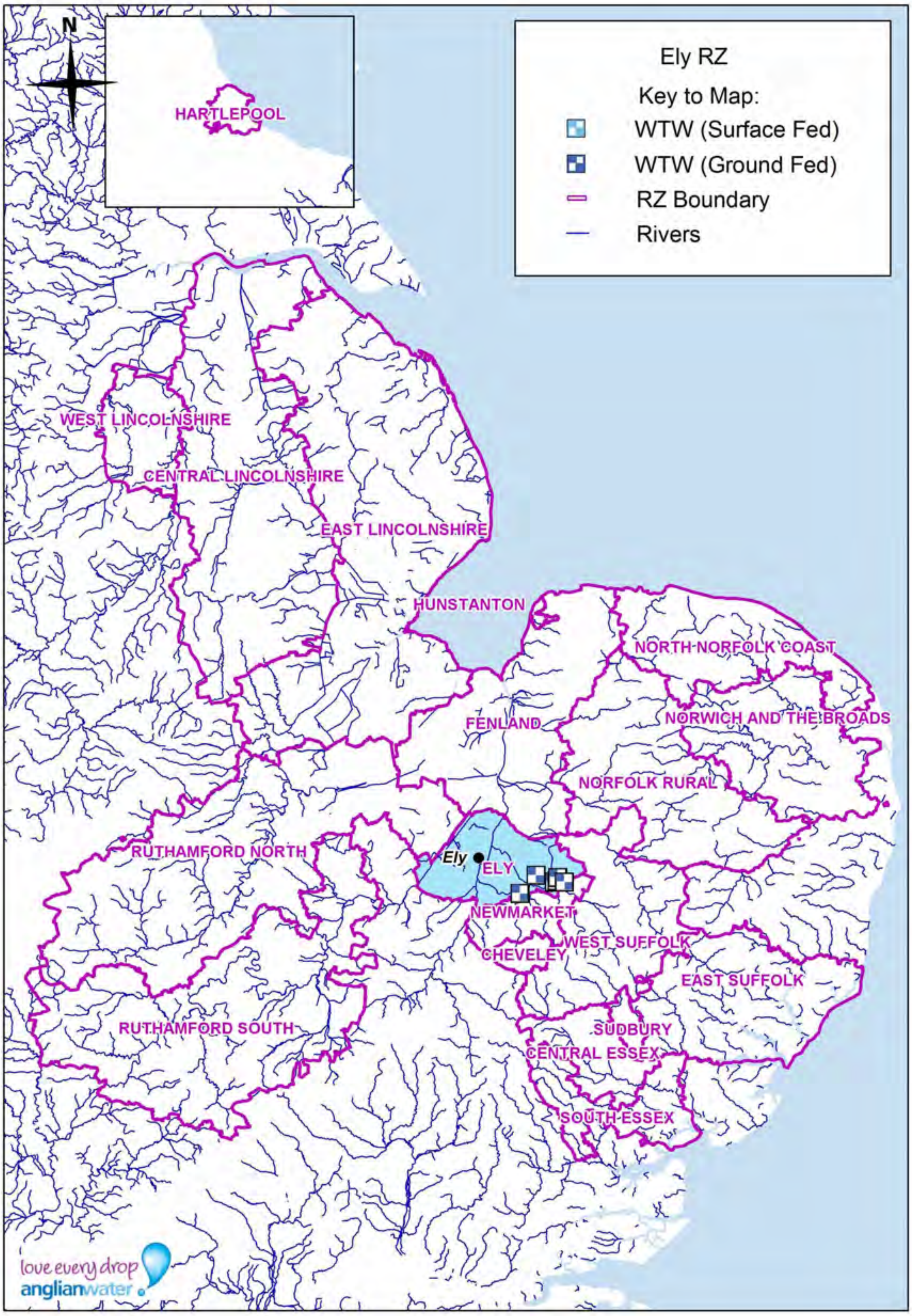


Figure 23.1 Ely Resource Zone

23.1 Key points

Key Points

- Ely is a newly formed RZ, formerly part of the Cambridgeshire and West Suffolk RZ.
- Ely RZ enters into deficit in 2024/25 reaching a deficit at average in 2039/40 of 3.9Ml/d under dry year annual average conditions. There are no equivalent deficits under critical period conditions.
- No significant baseline climate change or levels of service sensitivities have been identified.
- Two WTWs in the RZ are targeted for likely sustainability reductions. These reduce average daily source-works output by 1.5Ml/d.
- The preferred scheme includes a transfer from Fenland/Newmarket RZ.
- In the long-term, this will be supported by increased connectivity and resource development with adjacent zones and East Suffolk and South Essex RZs.
- The worst case sustainability reduction is a further reduction of 4.1Ml/d at average and 7Ml/d at peak.

23.2 Resource zone description

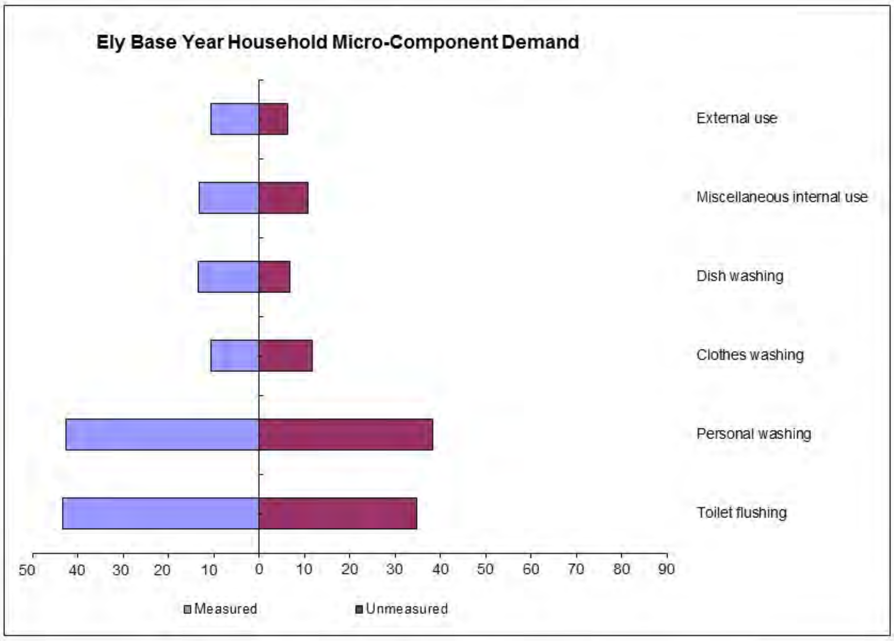
23.2.1 The Ely RZ is located in the centre of East Anglia and is based on the supply systems for Ely.

23.2.2 The water resource for this RZ is entirely dependent on abstraction from the Chalk aquifer. Since the draft WRMP the Cambridgeshire and West Suffolk RZ has been split into five smaller RZs. This has been as a result of the confirmation of sustainability reductions and the relatively poor connectivity in the area. All of the sources in these zones are groundwater abstractions and customers share similar supply-demand risks.

23.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 35,000. Of these 74% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 1,800. Most of these were measured.

23.2.4 From Figure 23.2:

- Base year measured PCC is marginally more and unmeasured PCC is estimated to be significantly less than our regional averages respectively (124 l/p/d and 150 l/p/d), and
- Overall we forecast a 11% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	134	118	115	113
Unmeasured Household	109	98	96	98
Weighted Average	125	115	114	112
Reduction in PCC over forecast (%)	11%			

Figure 23.2 Ely average household consumption (litres/person/day)

23.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using less water for these activities than measured customers. This is not consistent with the regional pattern of consumption.

23.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers reductions are projected from a change in personal washing and WC use.

23.2.7 Table 23.1 shows measured non-household demand in the base year totalling 3Ml/d in the Ely RZ. These demands are mainly from the agriculture and local industry sectors.

Average RZ Demand (Ml/d)	Planning Zone	Average PZ Demand (Ml/d)	Main RZ sector types
3	Ely	3	Agriculture and industry

Table 23.1 Ely RZ Patterns of Measured Non-Household Consumption

23.2.8 From Table 23.2, we forecast new properties equivalent to around 500 per year. This estimate is based on recent trends in population growth and is higher than recent rates of new build and the number of properties forecast by local authorities.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			1,500	1,500	2,500	3,000	3,000
WRMP trend estimate			2,500	2,500	2,500	2,500	2,500
Annual Monitoring Report data	2,500	2,000					

Table 23.2 Ely Growth Estimates

23.3 Baseline supply-demand balance

23.3.1 From Table 23.3 and Table 23.4, in the last year of AMP6 (2019/20) we forecast that there will be a DYAA surplus of 2.3Ml/d and a CP surplus of 7.2Ml/d in the RZ. Equivalent target headroom requirements are 3.2Ml/d and 4.4Ml/d respectively. As a result of a sustainability reduction in 2024/25 the RZ enters deficit at DYAA reaching a deficit of 3.9Ml/d at the end of the forecast. There are no deficits under critical periods.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	24.53	24.53	24.53	24.53	24.53	24.53
Outage Allowance	0.70	0.68	0.69	0.65	0.66	0.66
Total Water Available for Use	23.83	23.85	22.29	22.33	22.33	22.32
Distribution Input	19.10	18.31	18.90	19.46	19.96	20.46
Target Headroom	0.63	3.23	3.76	4.27	4.93	5.75
Supply Demand Balance	4.09	2.30	-0.36	-1.40	-2.56	-3.89

Table 23.3 Ely Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	35.80	35.80	35.80	35.80	35.80	35.80
Outage Allowance	0.88	0.87	0.82	0.83	0.83	0.84
Total Water Available for Use	34.92	34.93	34.98	34.97	34.97	34.96
Distribution Input	24.16	23.37	24.06	24.73	25.33	25.94
Target Headroom	0.80	4.35	4.88	5.53	6.40	7.47
Supply Demand Balance	9.96	7.20	6.04	4.71	3.23	1.55

Table 23.4 Ely Baseline Supply-Demand Summary (DYCP)

23.3.2 Leakage in the base year is equivalent to 27% of distribution input and reduces over the forecast period.

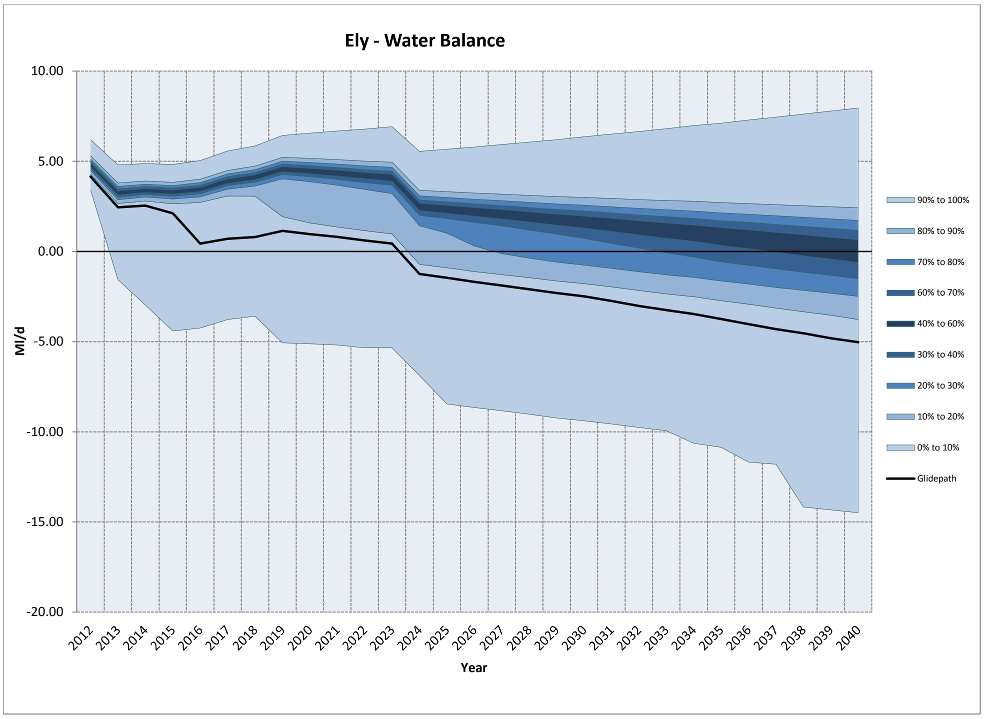


Figure 23.3 Ely Probabilistic Water Balance

23.3.3 Figure 23.3 confirms that there is a 90% risk that the RZ water balance will be in deficit from the middle of the 25 year forecast period. This principally reflects the effect of the AMP7 sustainability reductions, which are responsible for the step reduction in the middle part of the forecast period.

23.3.1 Basline supply forecast issues

23.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- Likely sustainability reductions at two WTWs in the RZ. This will result in a 1.5Ml/d reduction in ADSO
- There is no baseline climate change impact forecast on the available supplies, and
- A need for further WFD no-deterioration assessment has been identified when the Isleham licence is renewed in 2015.

23.3.1.2 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

23.3.2 Baseline Demand Forecast Issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction, enhanced metering and water efficiency. Anticipated savings from these activities in the Ely RZ are approximately 0.6Ml/d by the end of AMP6.
- Climate change impacts - impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

23.4 Feasible options for maintaining the supply-demand balance

23.4.1 Given the risk of deficits in the RZ, feasible options for maintaining the supply balance have been developed. These are summarised in Table 23.5 below.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Transfer	E1 Fenland RZ transfer	15	15	23,400	160
Transfer	E2 Newmarket RZ transfer	5	5	3,900	0

Table 23.5 Ely Feasible Option Details

23.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon costs. In the EBSD modelling social, environmental and carbon costs have been included.

23.4.1 Scheme Descriptions

23.4.1.1 The following feasible options have been developed:

- E1 Fenland RZ Transfer - This option provides for a transfer of water from the Downham Market area in Fenland RZ some 32km to Ely RZ via a new pipeline and pumping station, and
- E2 Newmarket RZ Transfer - This option provides for a transfer of water from Newmarket RZ to Ely RZ via a new 10km pipeline.

23.4.1.2 E1 is supplied by Fenland RZ which is in deficit by the end of the forecast. A new resource or transfer into the donor RZ will be required. E2 is supplied by Newmarket RZ which only has a marginal surplus by the end of the forecast and therefore a new resource or transfer into the donor RZ will be required. The new resource options that may support Ely RZ are described in the relevant RZ summaries. The Options Appraisal Report contains more details about all of these options.

23.4.2 Environmental considerations

23.4.2.1 The environmental assessments of the feasible options have concluded the following for the RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options
- The climate change vulnerability assessment concludes that both transfer options are not sensitive to climate change but the donor RZs are vulnerable to climate change. The assessment scored both options as 2 – limited sensitivity
- WFD no-deterioration screening has identified a low risk associated with sources in donor RZs, and
- The SEA has concluded that there will be no significant negative effects following mitigation.

23.4.2.2 Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

23.5 Preferred plan

23.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side		E2 Newmarket RZ transfer			
Distribution side	See below				
Customer side	See below				

Table 23.6 Ely Supply Demand Investment Plan

23.5.2 Lowering consumption levels is a priority to offset resource development so metering and water efficiency programmes have been included in the baseline. In the Ely RZ we aim to complete approximately 3,000 water efficiency audits. Our enhanced metering programme will fit over 5,500 meters and as a result of this and background opting rates we anticipate that approximately 4,000 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

23.6 Scenario testing

23.6.1 Table 23.7 details the impacts of scenario modelling on the supply demand balance for the Ely RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	2.30	-3.89

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Least cost plan	-0.46	-6.76
High population	0.73	-4.73
Worst case climate change	2.12	-4.04
Worst case sustainability reductions	2.30	-8.14
Recent actuals	-1.28	-7.44
Worst case combination	-5.41	-15.03

Table 23.7 Ely Scenario Modelling Impacts

23.6.2 In summary this shows the following:

- Impacts equivalent to 2.9Ml/d to the supply demand balance under the least-cost plan scenario up to 2039/40
- Marginal sensitivity to increasing populations equivalent to 0.8Ml/d
- No significant sensitivities to worst climate change impacts
- Significant impact from restricting deployable outputs to recent actuals, of up to 3.6Ml/d at the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts increase from 7.7Ml/d by the end of 2019/20 up to 11.1Ml/d in 2039/40.

23.6.3 Table 23.8 below shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10	RZ Residual Deficit 2039/40 (Ml/d)
Preferred plan	See note below	E2 Newmarket RZ transfer				0
Preferred plan - environmental and eocial costs	See note below	E2 Newmarket RZ transfer				0
Plan B	See note below	E1 Fenland Transfer				0
Least cost plan	E1 Fenland transfer					0
	Leakage					
High population	See note below	E2 Newmarket RZ transfer				0
Worst case climate change	See note below	E1 Fenland transfer				0
Worst case sustainability reductions	See note below	E1 Fenland transfer				0
Recent actuals	E1 Fenland transfer					0
	See note below					
Worst case combination	Leakage					2.51
	Water Efficiency					
	Enhanced Metering					
	E1 Fenland transfer					

Table 23.8 Ely Scenario Scheme Selection

23.6.4 Although not selected in the EBSD modelling for the least cost plan in AMP6, leakage reduction, enhanced metering and water efficiency has been included in the baseline supply demand forecast.

23.6.5 Under most scenarios the feasible options provide adequate resource to meet demand however under the worst case combination scenario there is a residual deficit. Options for maintaining the supply-demand balance in the worst case combination scenario include:

- Transfers via Fenland RZ from Ruthamford North RZ, which would be supported by trading or a transfer of resources from the Trent basin
- Development of a new winter storage reservoir in the Norfolk Fens. This would store water abstracted from the Ouse during the winter for year-round treatment and distribution. Since the resources of the Ouse are already used to support the Ely Ouse Essex Transfer, careful consideration of the available yield would be required. If support is necessary, it is possible that a raw water transfer from the River Trent could be developed. This would link the Trent, Nene and Ouse, enabling resources to be transferred from the Trent basin to the south and east, to support supply-systems in East Anglia, and
- Associated with the above, the development of a trading based infrastructure, either between water companies in East Anglia or between water companies and other third parties. In part, this could be based on connectivity which is delivered to improve the resilience of supply-systems in East Anglia.

PART TWO: RESOURCE ZONE SUMMARIES

Newmarket

24 Newmarket

Figure 24.1 Newmarket Resource Zone

24.1 Key points

Key Points

- Confirmation of sustainability reductions in the Cambridgeshire and West Suffolk RZ highlighted local RZ integrity issues. This has resulted in the RZ being disaggregated into five smaller RZs.
- Two WTWs in the newly formed Newmarket RZ are targeted for likely sustainability reductions. These may reduce average daily source-works output by 2.5Ml/d.
- The RZ remains in surplus for the forecast period.
- No significant baseline climate change or levels of service sensitivities have been identified.
- A worst case 2.6Ml/d climate change reduction in average daily source-works output is forecast. This would affect our abstraction from a drought vulnerable portion of the Chalk.
- In the long-term, increased connectivity and resource development in the East Suffolk and South Essex RZs will benefit this RZ.

24.2 Resource zone description

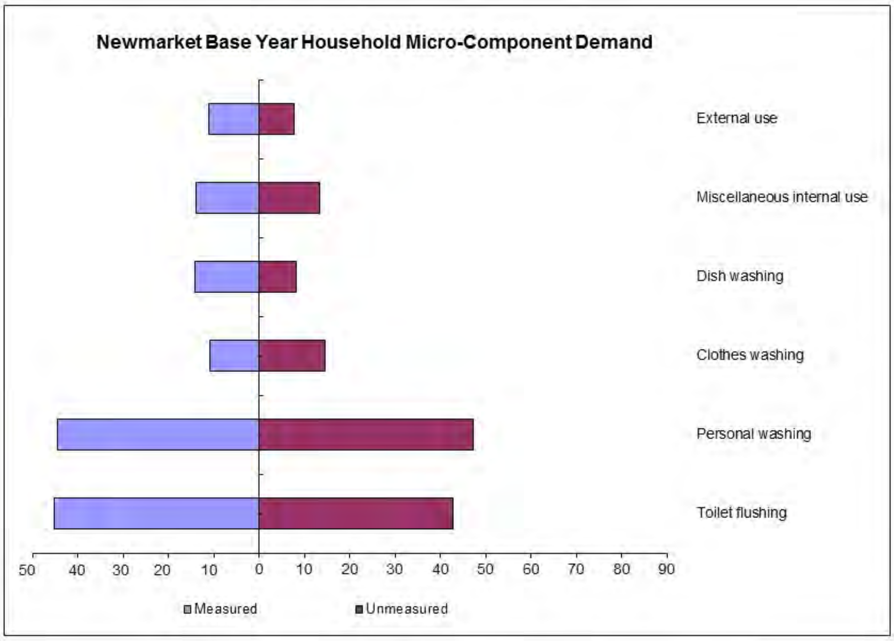
24.2.1 The Newmarket RZ is a newly formed RZ, which is located in the east of the old Cambridgeshire and West Suffolk RZ and is based on the supply systems for Newmarket.

24.2.2 Customers in the RZ are supplied with groundwater pumped from the Chalk aquifer.

24.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 19,000. Of these 72% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 1,000. Most of these were measured.

24.2.4 From Figure 24.2:

- Base year measured and unmeasured PCC are marginally higher and marginally lower than our regional averages (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 15% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	139	122	119	116
Unmeasured Household	134	117	118	126
Weighted Average	138	120	119	116
Reduction in PCC over forecast (%)	15%			

Figure 24.2 Newmarket average household consumption (litres/person/day)

24.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using marginally less water for these activities than measured customers. This is broadly consistent with the regional pattern of consumption.

24.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

24.2.7 Table 24.1 shows non-household demand in the base year totalling 8Ml/d in the Newmarket RZ. These are from the human health services and manufacturing sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
8	Newmarket	2	Human health services and manufacturing
	Bury St Edmunds	4	
	Thetford	2	
	Haverhill	2	
	Ixworth	<1	

Table 24.1 Newmarket RZ Patterns of Non Household Consumption

24.2.8 From Table 24.2, we forecast new development equivalent to around 250 new properties per year. This estimate is higher than the recent rates of new build and the number of new properties forecast by local authorities.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			400	400	700	900	900
WRMP trend estimate			1,000	1,000	1,000	1,000	1,000
Annual Monitoring Report data	650	500					

Table 24.2 Newmarket Growth Estimates

24.3 Baseline supply-demand balance

24.3.1 From Table 24.3 and Table 24.4, in the last year of AMP6 (2019/20) we forecast that there will be a DYAA surplus of 5.1Ml/d and a CP surplus of 8.4Ml/d in the RZ. Equivalent target headroom requirements are 0.8Ml/d and 1.1Ml/d respectively. The RZ is in surplus throughout the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	16.13	16.13	16.13	16.13	16.13	16.13
Outage Allowance	0.43	0.41	0.36	0.36	0.36	0.36
Total Water Available for Use	15.70	15.72	13.30	13.30	13.30	13.30
Distribution Input	10.95	9.78	10.02	10.26	10.48	10.70
Target Headroom	0.36	0.84	1.66	2.12	2.36	2.59
Supply Demand Balance	4.39	5.10	1.62	0.92	0.46	0.01

Table 24.3 Newmarket Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	22.65	22.65	22.65	22.65	22.65	22.65
Outage Allowance	0.55	0.53	0.46	0.46	0.46	0.46
Total Water Available for Use	22.10	22.11	22.18	22.18	22.18	22.18
Distribution Input	13.89	12.63	12.89	13.15	13.40	13.66
Target Headroom	0.46	1.08	2.13	2.72	3.02	3.30

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Supply Demand Balance	7.75	8.41	7.16	6.31	5.76	5.22

Table 24.4 Newmarket Baseline Supply-Demand Summary (DYCP)

24.3.2 Leakage in the base year is equivalent to 27% of distribution input and reduces over the remainder of the forecast period.

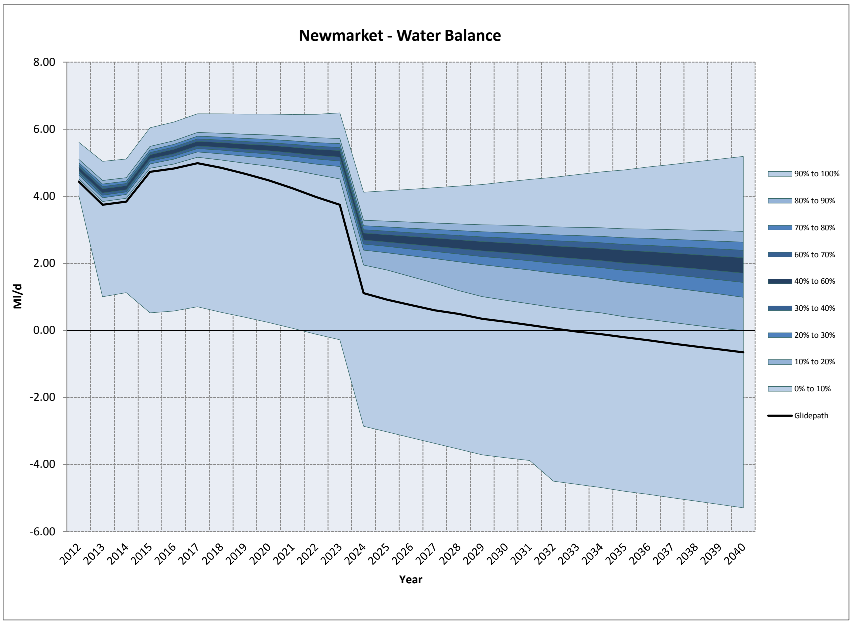


Figure 24.3 Newmarket Probabilistic Water Balance

24.3.3 Figure 24.3 confirms that there is a greater than 90% probability that the RZ water balance will be in deficit from the mid-part of the forecast period. The step reduction in the mid-part of the forecast reflects the effect of the proposed sustainability reductions.

24.3.1 Baseline supply forecast issues

24.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- Three likely sustainability reductions that impact on two WTWs in the RZ. In combination this may result in a 2.47Ml/d reduction in ADSO
- WFD no-deterioration assessments may be required for a number of the Newmarket groundwater sources, subject to ongoing work with the Environment Agency
- Since the 2010 WRMP new sources have been commissioned that have increased ADSO by 3.6Ml/d at average and 4.6Ml/d at peak, and
- There is no baseline climate change impact forecast on the available supplies.

24.3.1.2 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

24.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction and water efficiency. Anticipated savings from these activities in the Newmarket RZ are approximately 0.2Ml/d by the end of AMP6.
- Climate change impacts - Impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

24.4 Feasible options for maintaining the supply-demand balance

24.4.1 Despite there being a surplus in Newmarket RZ, deficits in adjacent RZs mean that it is necessary to consider options to support future transfers or exports. These are summarised in Table 24.5.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Transfer	NWM1 Ely RZ transfer	9	9	4,700	130
Transfer	NWM2 West Suffolk RZ transfer	6	6	11,400	100

Table 24.5 Newmarket Feasible Option Details

24.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon costs. In the EBSD modelling social, environmental and carbon costs have been included.

24.4.1 Scheme descriptions

24.4.1.1 The following feasible options have been developed:

- NWM1 Ely RZ Transfer - This option provides for transfer of water from Ely RZ to Newmarket via 10km of pipeline, and

- NWM2 West Suffolk RZ Transfer - This option provides for transfer of water from Bury St Edmunds in the West Suffolk RZ to Newmarket via 22km of new pipeline.

24.4.1.2 The Newmarket RZ options would form part of a larger transfer scheme supporting either Ely RZ or Cheveley RZ. Both options are supplied by RZs in deficit by the end of the forecast therefore a new resource will be required in the donor RZs. The new resource options are described in the relevant RZ summaries. The Options Appraisal Report contains more details about all of these options.

24.4.2 Environmental considerations

24.4.2.1 The environmental assessments of the feasible options have concluded the following for the Newmarket RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options
- The climate change vulnerability assessment concludes that the transfer option from West Suffolk RZ (NWM2) is not sensitive to climate change but the donor RZ is vulnerable to climate change. The assessment scored this option as 2 – limited sensitivity. The transfer from Ely RZ (NWM1) is scored 1 – insensitive, and
- The WFD no-deteriorations assessment concluded:
  - NWM2 West Suffolk RZ Transfer
  - The WFD no-deterioration screening has identified a low risk associated with the abstraction sources in the donor RZ's, and
  - No other significant negative effects have been identified through the SEA or HRA.

24.4.2.2 Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

24.5 Preferred plan

24.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side			NWM2 West Suffolk RZ transfer		
Distribution side	See below				
Customer side	See below				

Table 24.6 Newmarket Supply-Demand Investment Plan

24.5.2 Lowering consumption levels is a priority to offset resource development and therefore leakage reduction and water efficiency programmes have been included in the baseline. In the Newmarket RZ we aim to complete approximately 1,800 water efficiency audits. We also anticipate that approximately 1,600 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

24.5.3 The model has selected a transfer out of Newmarket RZ to support Cheveley RZ. The downstream option selected is:

- CVY1 Newmaket RZ Transfer

24.5.4 To support the transfer into Newmarket RZ the following upstream options have been selected:

- WS5 River Lark flow augmentation
- WS2b East Suffolk RZ transfer (resilience scheme), and
- ES3 Ipswich water reuse.

24.6 Scenario testing

24.6.1 Table 24.7 details the impacts of scenario modelling on the supply demand balance for the Newmarket RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	5.10	0.01
Least cost plan	3.33	-1.99
High population	4.41	-0.34
Worst case climate change	4.10	-2.55
Worst case sustainability reductions	5.10	0.01
Recent actuals	0.56	-4.52
Worst case combination	-3.00	-9.49

Table 24.7 Newmarket Scenario Modelling Impacts

24.6.2 In summary this shows the following:

- 2Ml/d impact on the RZ supply demand balance by the end of the planning period under the least-cost plan scenario
- Marginal sensitivity to increasing populations equivalent to 0.4Ml/d
- Sensitivity to worst case climate change impacts equivalent to 2.6Ml/d by the end of 2039/40
- No further reductions resulting from worst case scenario
- Impacts of 4.5Ml/d from restricting deployable outputs to recent actuals by the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population and cost effective plan impacts are 8.1Ml/d by the end of AMP6, reaching 9.5Ml/d by 2039/40.

24.6.3 The table below shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	RZ Residual Deficit 2039/40 (Ml/d)
Preferred plan	See note below		NWM2 West Suffolk RZ transfer			0
Preferred plan - environmental and social costs	See note below		NWM2 West Suffolk RZ transfer			0
Plan B	See note below					0
Least cost plan	NWM1 Ely transfer					0
High population	See note below	NWM2 West Suffolk RZ transfer				
Worst case climate change	See note below	NWM1 Ely transfer				0
Worst case sustainability reductions	See note below					0
Recent actuals	NWM1 Ely transfer See note below	NWM2 West Suffolk RZ transfer				0
Worst case combination	NWM1 Ely transfer Leakage	NWM2 West Suffolk RZ transfer				0

Table 24.8 Newmarket Scenario Scheme Selection

24.6.4 Although not selected in the EBSD modelling for the least cost plan, leakage reduction and water efficiency programmes has been included in the baseline supply demand forecast.

24.6.5 The model did not select any options in Newmarket RZ for the Plan B or worst case combination sustainability scenarios. In these scenarios the model has selected local options for the RZs which Newmarket RZ supports in the least cost and preferred plan (i.e. Ely RZ, Cheveley RZ).

24.6.6 Under all scenarios Newmarket RZ has adequate resource options; however the RZ is reliant on transfers from West Suffolk RZ or Ruthamford North RZ (via Fenland and Ely). In the worst case combination scenario the up stream RZs are both in deficit. Under these circumstances, strategic options for maintaining the supply-demand balance include:

- Development of the South Lincolnshire Reservoir. This would store water abstracted from the River Witham with support from the River Trent during the winter for year-round treatment and distribution
- Development of a new winter storage reservoir in the Norfolk Fens. This would store water abstracted from the River Ouse during the winter for year-round treatment and distribution. Since the resources of the Ouse are already used to support the Ely Ouse Essex Transfer, careful consideration of the available yield would be required. If support is necessary, it is possible that a raw water transfer from the River Trent could be developed. This would link the Trent, Nene and Ouse, enabling resources to be transferred from the Trent basin to the south and east to support supply-systems in East Anglia
- Associated with the above, the development of trading based infrastructure, either between water companies in East Anglia or between water companies and other third parties. In part, this could be based on schemes which are delivered to improve the resilience of supply-systems in East Anglia, and
- Investment to support the additional storage capacity created by dam raising in Ruthamford North RZ by a transfer of resources from the Trent basin.

PART TWO: RESOURCE ZONE SUMMARIES

Sudbury

25 Sudbury

Figure 25.1 Sudbury Resource Zone

25.1 Key points

Key Points

- Confirmation of sustainability reductions in the Cambridgeshire and West Suffolk RZ highlighted local RZ integrity issues. This has resulted in the RZ being disaggregated into five smaller RZ's.
- Sudbury is a newly formed RZ which supports the Sudbury supply system.
- There are no confirmed, likely or unknown sustainability reductions in this RZ.
- There are no baseline climate change impacts.
- The RZ is forecast to remain in surplus throughout the planning period at average and peak conditions.

25.2 Resource zone description

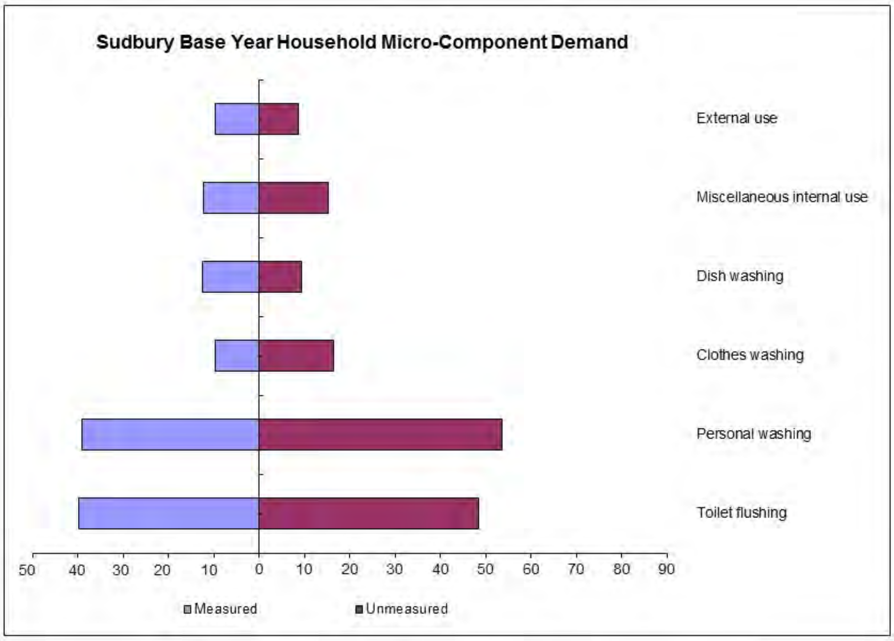
25.2.1 The Sudbury RZ is located in the south of the former Cambridgeshire and West Suffolk RZ. It is a small discrete zone with two WTW's that support demand in the Sudbury supply system.

25.2.2 Both sourceworks are supplied by chalk groundwater sources. All the customers in this RZ share the same level of service.

25.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 13,000. Of these 69% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 900. Most of these were measured.

25.2.4 From Figure 25.2:

- Base year measured and unmeasured PCC are marginally equivalent as our regional averages (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 17% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	123	112	112	110
Unmeasured Household	152	135	129	122
Weighted Average	134	116	113	111
Reduction in PCC over forecast (%)	17%			

Figure 25.2 Sudbury average household consumption (litres/person/day)

25.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using more water for these activities than measured customers. This is consistent with the regional pattern of consumption.

25.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers reductions are projected from a change in personal washing and WC use.

25.2.7 Table 25.1 shows measured non-household demand in the base year totalling 1Ml/d in the Sudbury RZ. This demand mainly comes from the agriculture sector.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
1	Sudbury	1	Agriculture

Table 25.1 Sudbury RZ Patterns of Measured Non-Household Consumption

25.2.8 From Table 25.2, we forecast new properties equivalent to around 100 per year. This estimate is consistent with recent rates of new build but is greater than the number of new properties forecast by local authorities.

PART TWO: RESOURCE ZONE SUMMARIES
Sudbury

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			500	150	150	150	150
WRMP trend estimate			250	400	550	550	550
Annual Monitoring Report data	500	500					

Table 25.2 Sudbury Growth Estimates

25.3 Baseline supply-demand balance

25.3.1 From Table 25.3 and Table 25.4, in the last year of AMP6 we forecast that there will be a DYAA surplus of 2.8Ml/d and a CP surplus of 3.7Ml/d. Equivalent target headroom requirements are 0.6Ml/d and 0.7Ml/d respectively. The RZ remains in surplus under DYAA and CP conditions to the end of the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	10.45	10.45	10.45	10.45	10.45	10.45
Outage Allowance	0.26	0.25	0.23	0.23	0.23	0.23
Total Water Available for Use	10.19	10.20	10.22	10.22	10.23	10.23
Distribution Input	7.18	6.84	6.85	6.90	6.96	7.03
Target Headroom	0.24	0.56	0.72	0.87	1.01	1.15
Supply Demand Balance	2.77	2.80	2.66	2.46	2.25	2.05

Table 25.3 Sudbury Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	13.40	13.40	13.40	13.40	13.40	13.40
Outage Allowance	0.34	0.32	0.29	0.29	0.29	0.28
Total Water Available for Use	13.06	13.08	13.11	13.11	13.11	13.12
Distribution Input	9.19	8.64	8.61	8.64	8.70	8.76
Target Headroom	0.31	0.71	0.90	1.09	1.27	1.43
Supply Demand Balance	3.57	3.73	3.59	3.38	3.15	2.92

Table 25.4 Sudbury Baseline Supply-Demand Summary (DYCP)

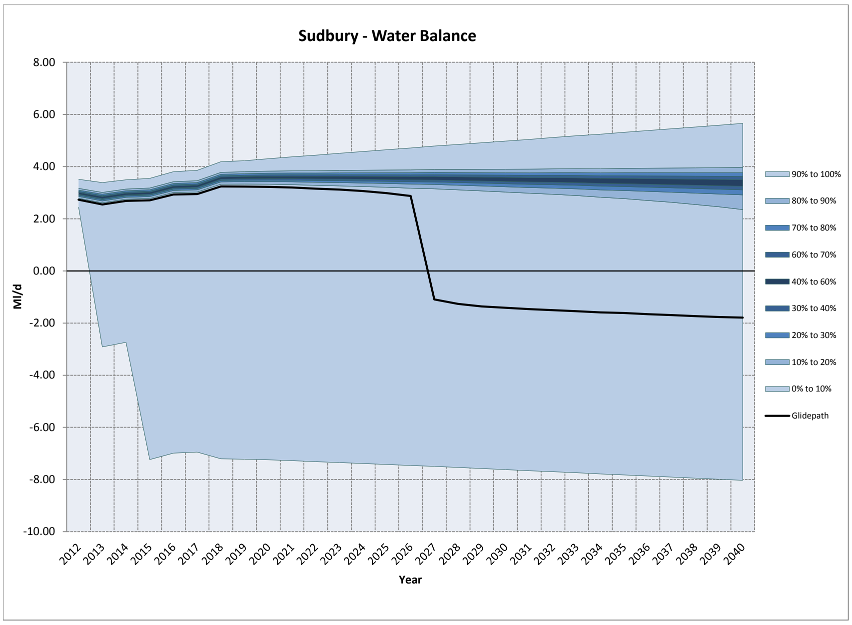


Figure 25.3 Sudbury Probabilistic Water Balance

25.3.2 The probabilistic water balance indicates a small risk of a deficit in this RZ by the end of the forecast period. This reflects the limited number of sources of supply that there are in this RZ, and the potential vulnerability of these to point sources of contamination. In the economic modelling and the WRP tables, this vulnerability has been treated as a resilience issue and so has been excluded from the analysis. Therefore, there is no deficit forecast in this RZ.

25.3.1 Baseline supply forecast issues

- No significant adjustments have been made to the baseline supply forecast since the 2010 WRMP.
- There are no climate change impacts in the baseline, nor any confirmed, likely or unknown sustainability reduction.
- Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

25.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction and water efficiency. Anticipated savings from these activities in the Sudbury RZ are approximately 0.1Ml/d by the end of AMP6.
- Climate change impacts - Impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

25.4 Scenario testing

25.4.1 Table 25.5 details the impacts of scenario modelling on the supply demand balance for the Sudbury RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	2.80	2.05
Least cost plan	2.48	1.73
High population	2.33	1.83
Worst case climate change	2.80	2.05
Worst case sustainability reductions	2.80	2.05
Recent actuals	-0.03	-0.78
Worst case combination	-0.84	-1.32

Table 25.5 Sudbury Scenario Modelling Impacts

25.4.2 In summary this shows the following:

- 0.3Ml/d impact on the RZ supply demand balance by the end of the planning period under the cost effective plan scenario
- Marginal sensitivity to increasing populations equivalent to 0.2Ml/d
- No further reductions resulting from worst case climate change or sustainability reductions scenario
- Impacts of 2.8Ml/d from restricting deployable outputs to recent actuals by the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population and cost effective plan impacts are 3.4Ml/d by 2039/40.

25.4.3 Options for maintaining the supply-demand balance include:

- Transfers from the South Essex RZ, East Suffolk RZ or Fenland RZ supported by one or more of the feasible options for these RZ's (see Sections 12, 17 and 18). These include multiple options for water reuse and desalination and an option in the Fenland RZ for a treated water transfer from the Ruthamford North RZ, which would be supported by an additional water reuse scheme or by trading
- Development of a new winter storage reservoir in the Norfolk Fens. This would store water abstracted from the River Ouse during the winter for year-round treatment and distribution. Since the resources of the Ouse are already used to support the Ely Ouse Essex Transfer, careful consideration of the available yield would be required. If support is necessary, it is possible that a raw water transfer from the River Trent could be developed. This would link the Trent, Nene and Ouse, enabling resources to be transferred from the Trent basin to the south and east, to support supply-systems in East Anglia, and
- Associated with the above, the development of trading based infrastructure, either between water companies in East Anglia or between water companies and other third

parties. In part, this could be based on connectivity which is delivered to improve the resilience of supply-systems in East Anglia.

25.4.4 In the event that a large asset such as the Norfolk Fens reservoir is developed it is likely that, significant reductions in leakage and levels of consumption would also likely be required.

PART TWO: RESOURCE ZONE SUMMARIES

West Suffolk

26 West Suffolk

Figure 26.1 West Suffolk Resource Zone

26.1 Key points

Key Points

- Confirmation of sustainability reductions in the Cambridgeshire and West Suffolk RZ highlighted local RZ integrity issues. This has resulted in the RZ being disaggregated into five smaller RZ's.
- The newly formed West Suffolk RZ supports the Thetford, Haverhill, Ixworth and Bury St Edmunds supply systems.
- Our Bury St Edmunds groundwater sources have been identified for a confirmed and a likely sustainability reduction. Three further WTWs have been identified for likely reductions. These may reduce average daily source works output by 9.8Ml/d in the zone.
- As a result of sustainability reductions this RZ enters deficit in 2024/25 reaching a deficit of 3.15Ml/d in 2039/40 under DYAA conditions.
- The preferred schemes include a river restoration and recirculation project and a transfer into the RZ from the East Suffolk RZ.
- There are no baseline climate change impacts.
- A trade with Cambridge Water Company for 0.25Ml/d at average has been included from 2015. Any further options for trading resources in this RZ are subject to a WFD no deterioration assessment.

26.2 Resource zone description

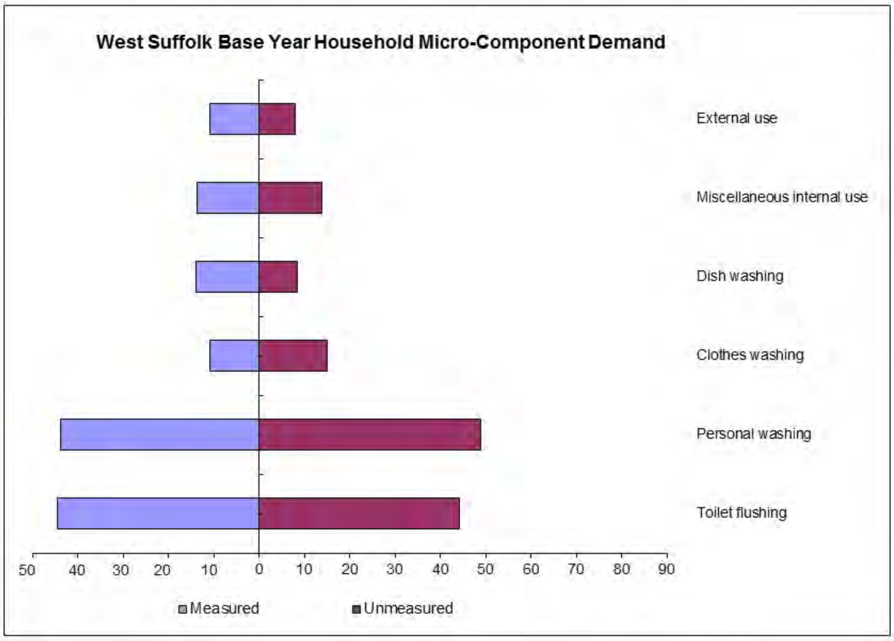
26.2.1 The West Suffolk RZ is located in the centre of East Anglia and is the largest of the five new RZ's formed from the disaggregated Cambridgeshire and West Suffolk RZ. The RZ supports demands in the Thetford, Haverhill, Ixworth and Bury St Edmunds supply systems.

26.2.2 All supplies in the RZ are abstracted from Chalk, therefore all of the customers in this RZ share the same level of service.

26.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 71,000. Of these 79% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 4,500. Most of these were measured.

26.2.4 From Figure 26.2:

- Base year measured and unmeasured PCC is marginally more and marginally less than our regional averages (124 l/p/d and 150 l/p/d respectively), and
- Overall we forecast a 15% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	138	122	120	117
Unmeasured Household	139	127	120	108
Weighted Average	138	123	120	117
Reduction in PCC over forecast (%)	15%			

Figure 26.2 West Suffolk average household consumption (litres/person/day)

26.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using marginally more water for these activities than measured customers. This is broadly consistent with the regional pattern of consumption.

26.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

26.2.7 Table 26.1 shows non-household demand in the base year totalling 8Ml/d in the West Suffolk RZ. These are mainly from the human health services and manufacturing sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
8	Bury St Edmunds	4	Human health services and manufacturing
	Thetford	2	
	Haverhill	2	
	Ixworth	<1	

Table 26.1 West Suffolk RZ Patterns of Non Household Consumption

26.2.8 From Table 26.2, we forecast new properties equivalent to around 600 per year. This estimate is consistent with recent rates of new build but slightly lower than the number of new properties forecast by local authorities.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			4,000	4,000	4,000	4,000	4,000
WRMP trend estimate			2,500	3,000	3,500	3,500	3,500
Annual Monitoring Report data	3,000	3,000					

Table 26.2 West Suffolk Growth Estimates

26.3 Baseline supply-demand balance

26.3.1 From Table 26.3 and Table 26.4, in the last year of AMP6 we forecast that there will be a DYAA surplus of 11.6Ml/d and a CP surplus of 15.4Ml/d. Equivalent target headroom requirements are 3.1Ml/d and 4Ml/d respectively. Owing to the likely sustainability reductions we forecast that in the last year of AMP7 (2024/25) there will be a DYAA deficit which reaches 3.2Ml/d by 2039/40. The RZ remains in surplus under CP conditions to the end of the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	49.85	49.85	49.85	49.85	49.85	49.85
Outage Allowance	1.57	1.55	1.43	1.44	1.44	1.45
Total Water Available for Use	48.28	51.85	42.13	42.12	42.12	42.11
Distribution Input	38.24	37.19	37.54	37.97	38.43	38.89
Target Headroom	1.28	3.06	3.93	4.77	5.59	6.37
Supply Demand Balance	8.76	11.60	0.66	-0.62	-1.91	-3.15

Table 26.3 West Suffolk Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	66.34	66.34	66.34	66.34	66.34	66.34
Outage Allowance	2.05	2.01	1.85	1.85	1.85	1.85
Total Water Available for Use	64.29	67.57	67.73	67.73	67.73	67.73
Distribution Input	49.88	48.23	48.49	48.87	49.32	49.78

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Target Headroom	1.67	3.97	5.08	6.14	7.18	8.15
Supply Demand Balance	12.74	15.44	14.23	12.78	11.28	9.85

Table 26.4 West Suffolk Baseline Supply-Demand Summary (DYCP)

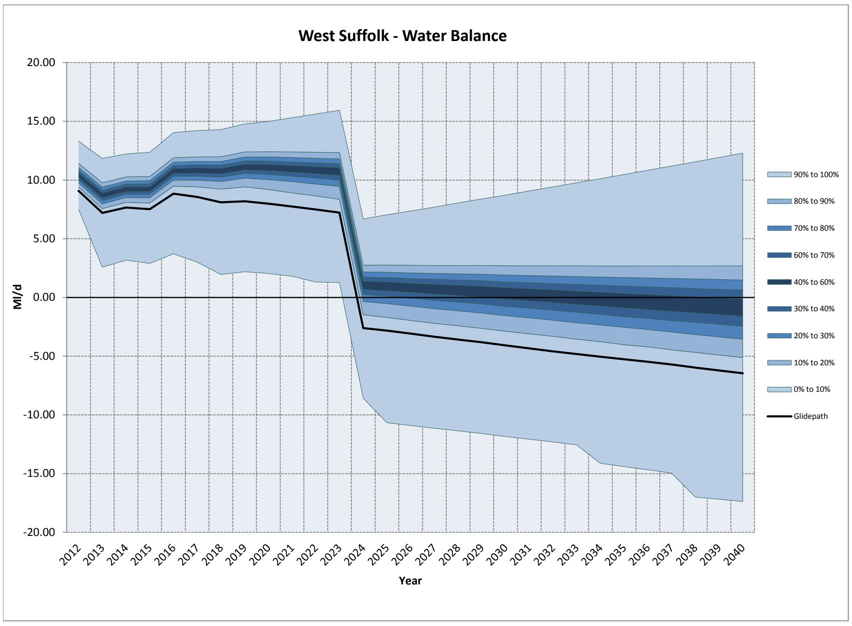


Figure 26.3 West Suffolk Probabilistic Water Balance

26.3.2 Figure 26.3 confirms that there is a greater than 90% probability that the RZ water balance will be in deficit from the mid-part of the forecast period. The step reduction in the mid-part of the forecast reflects the effect of the proposed sustainability reductions.

26.3.3 Leakage in the base year is equivalent to 18% of distribution input and remains constant over the remainder of the forecast period.

26.3.1 Baseline supply forecast issues

26.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- A confirmed sustainability reduction affecting our Bury St Edmunds groundwater sources. This is currently estimated to be equivalent to a 4.5Ml/d reduction in ADSO in 2024/25. The sources are also identified for a likely reduction of 1Ml/d

- Three further likely sustainability reductions have been identified to address flows in the Tuddenham Stream, River Sapiston and Bumpstead Brook, currently estimated to be equivalent to a 4.3Ml/d reduction in ADSO in 2024/25
- A WFD no-deterioration assessment may be required to support renewal of the Bury St Edmunds abstraction licences
- Operational improvements during AMP5 have resulted in the full daily licence being achievable from Denton Lodge
- There are no climate change impacts forecast for the baseline, and
- An AMP6 resilience scheme will provide an additional 3.3Ml/d at average and peak to Bury St Edmunds.

26.3.1.2 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

26.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction and water efficiency. Anticipated savings from these activities in the West Suffolk RZ are approximately 1.5Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

26.4 Feasible options for maintaining the supply-demand balance

26.4.1 The feasible West Suffolk RZ options that were modelled in our EBSD optimiser are given below in Table 26.5.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Transfer	WS1 – Newmarket RZ transfer	8.5	8.5	11,000	70
Transfer	WS2a – East Suffolk RZ transfer (15 Ml/d)	15.0	15.0	28,000	180
Transfer	WS2b – East Suffolk RZ transfer (resilience scheme)	4.7	4.7	0	50
Reuse	WS3 – Bury St Edmunds water reuse	5.0	6.2	33,600	360
Reuse	WS4 – Thetford water reuse	2.9	3.6	21,200	710
Support	WS5 – River Lark flow augmentation	4.5	4.5	3,000	10
Transfer	WS6 – South Essex RZ transfer	15.0	15.0	23,400	140

Table 26.5 West Suffolk Feasible Option Details

26.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon costs. In the EBSD modelling social, environmental and carbon costs have been included.

26.4.1 Scheme descriptions

26.4.1.1 Seven options have been developed for West Suffolk RZ, these are:

- WS1 Newmarket RZ transfer -This option provides for the transfer from Newmarket into Bury St Edmunds via a new 22km long pipeline
- WS2a East Suffolk RZ transfer (15Ml/d) - This option provides for the transfer of water from Ipswich in the East Suffolk WRZ to Bury St Edmunds via a new pipeline 36km long
- WS2b East Suffolk RZ transfer (resilience scheme) - This option assumes that the resilience scheme proposed for delivery in AMP6 can be utilised to supply Bury St Edmunds from West Suffolk RZ. The resilience scheme has a total capacity of 8Ml/d but will be operated at 3.3 Ml/d in standby mode. The standby flow has been accounted for in the baseline supply demand forecast. The costs for Option WS2b are based on the additional operational costs to transfer volumes above 3.3 Ml/d
- WS3 Bury St Edmunds water reuse - Effluent from Bury St Edmunds Water Recycling Centre would be treated to an extremely high (near potable) standard and recharged to the Chalk aquifer to permit increased abstraction from existing wells. The effluent would be treated to an extremely high (near potable) standard using additional treatment processes and pumped 8km before re-abstraction and treatment by a new water treatment works
- WS4 Thetford water reuse - Effluent from Thetford Water Recycling Centre would be treated to an extremely high (near potable) standard and recharged to the Chalk aquifer to permit increased abstraction from existing wells. The effluent would be pumped 3km before re-abstraction and treatment by a new water treatment works
- WS5 River Lark flow augmentation - This option provides for augmentation of flows in the River Lark through Bury St Edmunds by transferring river water abstracted downstream of the Bury St Edmunds Water Recycling Centre and transferring it to the river upstream of the town. This requires a 7km long pipeline and new pumping station, and
- WS6 South Essex RZ transfer - This option provides for the transfer of water from Colchester in the South Essex RZ to Bury St Edmunds via a new 35km pipeline.

26.4.1.2 The transfer options (WS2a, WS2b and WS6) are supplied by RZs in deficit by the end of the forecast therefore a new resource will be required in the donor RZs. WS1 is supplied by Newmarket RZ which only has a marginal surplus by the end of the forecast therefore a new resource or transfer into the donor RZ will be required. The new resource options are described in the relevant RZ summaries. The Options Appraisal Report contains more details about all of these options.

26.4.1.3 The following options are mutually exclusive because they both rely on the discharge from Bury St Edmunds Water Recycling Centre:

- WS3 Bury St Edmunds water reuse, and
- WS5 River Lark flow augmentation.

26.4.1.4 A number of options were proposed in the draft WRMP for the Cambridgeshire and West Suffolk RZ, which has since been split into a number of new RZs. Some options were adapted to suit the new configuration of RZs and some have been discounted, the reason for this is described in the table below.

Scheme Ref	Scheme Name	Reason for discounting scheme
CWS1	Thetford PZ transfer	Following further review of RZ integrity Cambridgeshire and West Suffolk RZ has been split into a number of new RZs for the revised draft WRMP. This option is no longer applicable to the new configuration of RZs.
CWS3	Sudbury PZ transfer	As above, this option is no longer applicable to the new configuration of RZs.
CWS6	Haverhill water reuse	As above, this option is no longer applicable to the new configuration of RZs.
CWS11	Fenland RZ transfer	As above, this option is no longer applicable to the new configuration of RZs.

Table 26.6 West Suffolk Discounted Schemes

26.4.2 Environmental considerations

26.4.2.1 The environmental assessments of the feasible options have concluded the following for the West Suffolk RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options, and
- The climate change vulnerability assessment concludes that the transfer options (WS1, WS2a, WS2b, WS6) are not sensitive to climate change but the donor RZs are vulnerable to climate change. The assessment scored these options as 2 – limited sensitivity. The reuse options (WS3, WS4) scored 1 – insensitive. For the River Lark augmentation scheme (WS5) the assessment assumed the source is secure, so rated it as 1 - insensitive.

26.4.2.2 The WFD no-deteriorations assessment, SEA and HRA concluded:

- WS1 Newmarket RZ transfer - The SEA has not identified any significant negative effects following mitigation measures to re-route the pipeline around an ancient woodland
- WS2a/2b East Suffolk RZ transfer -The SEA has not identified any significant negative effects following mitigation measures unless the pipeline cannot be routed around an ancient woodland
- WS3 Bury St Edmunds water reuse -The WFD assessment concludes a likely positive effect as a result of increased flows, although some further assessment has been recommended. The SEA recommended that the pipeline should be re-routed to avoid SSSI, local nature reserves and ancient landfill sites
- WS4 Thetford water reuse -The WFD assessment has identified a potential concern with deteriorating water quality which would need to be investigated further. The HRA screening concluded potential for likely significant effect on the Breckland SPA and Breckland SAC. An Appropriate Assessment would be required if the scheme is taken forward. The SEA also concluded that further investigation is required into feasibility of re-routing the pipeline

- WS5 River Lark flow augmentation -The WFD assessment concluded a likely positive impact subject to some further investigation regarding water quality. The SEA has not identified any significant negative impacts, and
- WS6 South Essex RZ transfer -The SEA has identified a need for the pipeline to avoid an ancient woodland area and a local nature reserve. There are no other significant negative effects.

26.4.2.3 Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

26.5 Preferred plan

26.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side			WS5 – River Lark flow augmentation		WS2b – East Suffolk RZ transfer
Distribution side	See below				
Customer side	See below				

Table 26.7 West Suffolk Supply Demand Investment Plan

26.5.2 Lowering consumption levels is a priority to offset resource development, and therefore leakage reduction and water efficiency programmes have been included in the baseline. In the West Suffolk RZ we aim to complete approximately 6,000 water efficiency audits. We also anticipate that approximately 4,500 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

26.5.3 To support WS2b – East Suffolk RZ transfer, the model selected the following upstream options:

- ES3 Ipswich water reuse
- ES10 South Essex RZ transfer to East Suffolk RZ, and
- SE4 Amendment to Ardleigh agreement.

26.6 Scenario testing

26.6.1 Table 26.8 details the impacts of scenario modelling on the supply demand balance for the West Suffolk RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	11.6	-3.15
Least cost plan	3.01	-7.35
High population	2.26	-6.61
Worst case climate change	4.85	-5.40
Worst case sustainability reductions	4.85	-5.40
Recent actuals	-3.71	-13.97
Worst case combination	-8.26	-17.17

Table 26.8 West Suffolk Scenario Modelling Impacts

26.6.2 In summary this shows the following:

- 4.2Ml/d impact on the RZ supply demand balance by the end of the planning period under the least cost plan scenario
- Sensitivity to increasing populations equivalent to 3.5Ml/d
- No further reductions resulting from worst case climate change or sustainability reduction scenarios
- Impacts of 10.8M/d from restricting deployable outputs to recent actuals by the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population and cost effective plan impacts are 14Ml/d by 2039/40.

26.6.3 Table 26.9 shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	RZ Residual Deficit 2039/40 (Ml/d)
Preferred plan	See note below		WS5 – River Lark flow augmentation		WS2b – East Suffolk RZ transfer	0
Preferred plan - environmental and social costs	See note below		WS5 – River Lark flow augmentation		WS2b – East Suffolk RZ transfer	0
Plan B	See note below	WS3 – Bury St Edmunds water reuse			WS4 – Thetford water reuse	0
Least cost plan		WS5 – River Lark flow augmentation	Leakage	WS2b – East Suffolk RZ transfer Leakage		0
High population	See note below	WS5 – River Lark flow augmentation WS2b – East Suffolk RZ transfer			WS4 – Thetford water reuse	0
Worst case climate change	See note below	WS5 – River Lark flow augmentation		WS2b – East Suffolk RZ transfer		0
Worst case sustainability reductions	See note below	WS2b – East Suffolk RZ transfer	WS5 – River Lark flow augmentation			0
Recent actuals	See note below	WS3 – Bury St Edmunds water reuse WS2b – East Suffolk RZ transfer	WS4 – Thetford water reuse			0
Worst case combination	WS3 – Bury St Edmunds water reuse WS4 – Thetford water reuse Leakage Water Efficiency	WS2b – East Suffolk RZ transfer Leakage				6.36

Table 26.9 West Suffolk RZ scenario scheme selection

26.6.4 Although not selected in the EBSD modelling for the least cost plan in AMP6, leakage reduction, metering and water efficiency has been included in the baseline supply demand forecast.

26.6.5 Under most scenarios the feasible options provide adequate resource to meet demand however under the worst case combination scenario the feasible options are not adequate to fully satisfy the demand. Options for maintaining the supply-demand balance in the worst case combination scenario could include:

- Development of a new winter storage reservoir in the Norfolk Fens. This would store water abstracted from the River Ouse during the winter for year-round treatment and distribution. Since the resources of the Ouse are already used to support the Ely Ouse Essex Transfer, careful consideration of the available yield would be required. If support is necessary, it is possible that a raw water transfer from the River Trent could be developed. This would link the Trent, Nene and Ouse, enabling resources to be transferred from the Trent basin to the south and east, to support supply-systems in East Anglia, and
- Associated with the above, the development of trading based infrastructure, either between water companies in East Anglia or between water companies and other third parties. In part, this could be based on connectivity which is delivered to improve the resilience of supply-systems in East Anglia.

PART TWO: RESOURCE ZONE SUMMARIES

Ruthamford North

27 Ruthamford North

Figure 27.1 Ruthamford North Resource Zone

27.1 Key points

Key Points

- No baseline deficits are forecast in the Ruthamford North RZ.
- No significant sustainability reduction sensitivities have been identified.
- Deployable output shows some sensitivity to change in levels of service. An increase in the frequency of temporary use bans could increase average daily source-works output by 1.6Ml/d. A no restriction level of service would reduce average daily source-works output by 1.3Ml/d.
- The mean impact of climate change is estimated to be equivalent to a 0.9Ml/d reduction in average daily source-work output. In the worst case, climate change may reduce average daily source-works output by 33Ml/d. This would principally affect abstraction from the River Nene and River Welland.
- There are no confirmed or likely sustainability reduction requirements.

27.2 Resource zone description

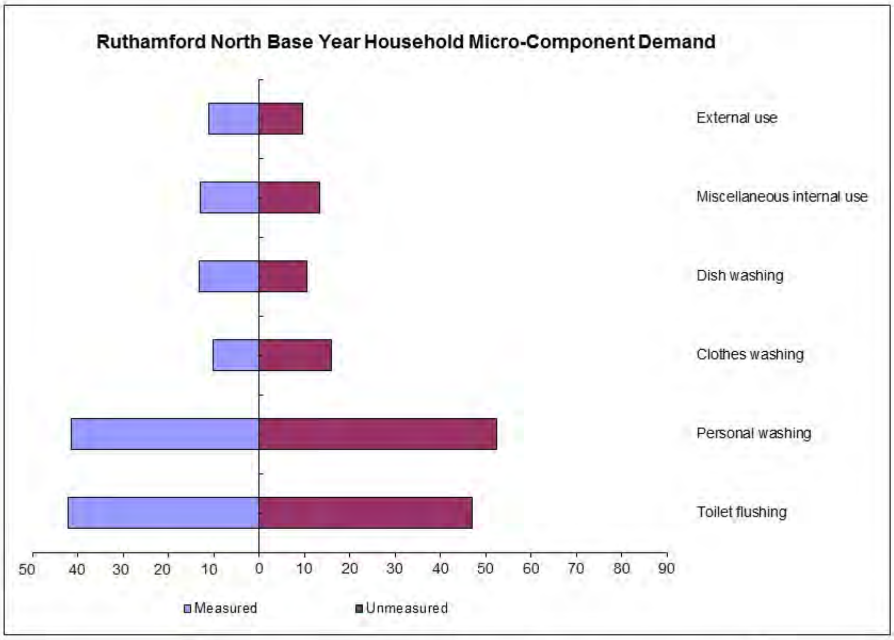
27.2.1 The Ruthamford North RZ is located in the west of our region and is based on the supply systems for March, Peterborough, Corby, Kettering, Wellingborough, Northampton and Daventry.

27.2.2 Supplies in the RZ are derived from the Rivers Welland and Nene. Water abstracted from these is pumped into storage at Rutland Water and is then treated for distribution. Levels of connectivity in the RZ are high. This allows for the effective sharing of resources and for the integrity of the RZ maintained. Treated and raw water supplies are exported from this RZ to the East Lincolnshire and Central Lincolnshire RZs respectively. Significant volumes of treated water are also exported from this RZ to Severn Trent Water.

27.2.3 In 2011/12, the total number of household customers in the RZ was estimated to be approximately 370,000. Of these 76% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 19,000. Most of these were measured.

27.2.4 From Figure 27.2:

- Base year measured and unmeasured PCC are marginally more than our regional averages respectively (124 l/p/d and 150 l/p/d), and
- Overall we forecast a 19% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	131	117	116	114
Unmeasured Household	167	138	128	119
Weighted Average	142	120	117	114
Reduction in PCC over forecast (%)	19%			

Figure 27.2 Ruthamford North average household consumption (litres/person/day)

27.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using more water for these activities than measured customers. This is consistent with the regional pattern of consumption.

27.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

27.2.7 Table 27.1 shows measured non-household demands in the base year totalling 49Ml/d in the Ruthamford North RZ. These are mainly from the manufacturing and wholesale sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
49	Northampton	14	Manufacturing and Wholesale
	Peterborough	12	
	Corby	8	
	Kettering	4	
	Wellingborough	2	

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
	Daventry	2	
	Rushden	2	
	Ravensthorpe	2	
	Woburn	1	
	Oundle	<1	
	March	<1	

Table 27.1 Ruthamford North RZ Patterns of Measured Non Household Consumption

27.2.8 From Table 27.2, we forecast new properties equivalent to around 5,000 per year. This estimate is similar to both recent rates of new build and the number of new properties forecast by local authorities.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			30,500	30,500	25,000	25,000	25,000
WRMP trend estimate			22,500	25,000	25,000	25,000	25,000
Annual Monitoring Report data	23,000	23,000					

Table 27.2 Ruthamford North Growth Estimates

27.3 Baseline supply-demand balance

27.3.1 From Table 27.3 and Table 27.4, in the last year of AMP6 (2019/2), we forecast that there will be a DYAA surplus of 60Ml/d and a CP surplus of 129Ml/d in the RZ. Equivalent target headroom requirements are 13Ml/d and 16Ml/d respectively. The RZ is forecast to be in surplus throughout the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	334.99	334.99	334.99	334.99	334.99	334.99
Outage Allowance	8.07	7.83	7.87	7.90	7.91	7.92
Total Water Available for Use	270.04	268.82	271.49	272.89	274.42	275.68
Distribution Input	218.72	206.13	209.93	214.23	218.20	222.24
Target Headroom	7.27	12.98	17.74	23.38	27.15	31.33
Supply demand balance	49.45	59.75	40.44	30.26	22.44	14.14

Table 27.3 Ruthamford North Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	424.62	424.62	424.62	424.62	424.62	424.62
Outage Allowance	9.86	9.55	9.57	9.57	9.56	9.55
Total Water Available for Use	269.43	278.86	268.11	267.87	267.79	267.71
Distribution Input	267.39	251.43	255.15	259.63	263.76	268.05
Target Headroom	8.89	15.83	21.56	28.34	32.82	37.79
Supply demand balance	111.56	129.17	122.56	112.81	104.66	95.87

Table 27.4 Ruthamford North baseline supply-demand summary (DYCP)

27.3.2 Leakage in the base year is equivalent to 20% of distribution input and reduces over the remainder of the forecast period.

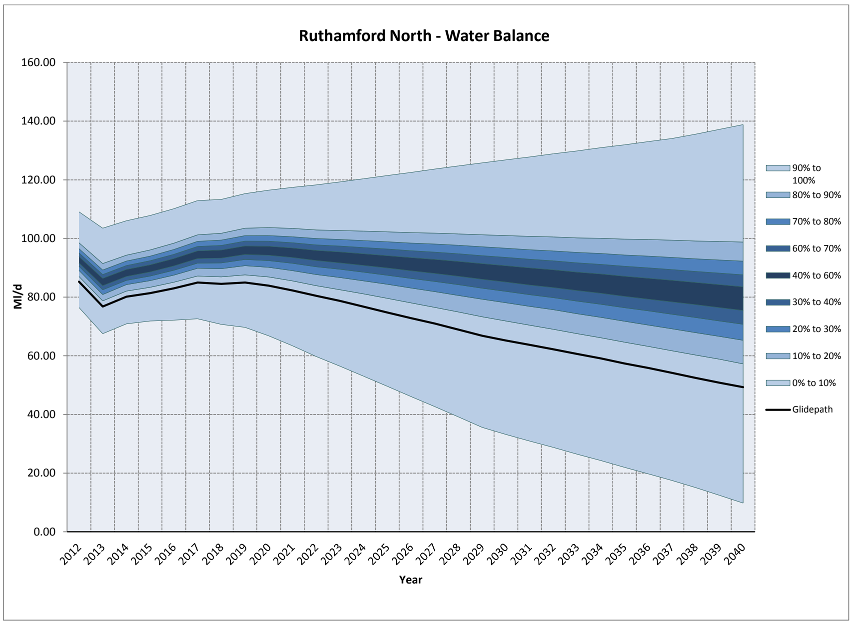


Figure 27.3 Ruthamford North Probabilistic Water Balance

27.3.3 Figure 27.3 confirms that there is a greater than 95% probability that the RZ water balance will be in surplus over in the 25 year forecast period.

27.3.1 Baseline supply forecast issues

27.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- An increase in ADSO of 22Ml/d arising from commissioning of the new Morcott WTW and confirmation of the associated licensing requirements
- As part of the deployable output assessment Pitsford ADSO has been decreased by 6Ml/d inline with the revised assessment methodology
- There is a baseline climate change impact forecast on the available supplies of 0.9Ml/d in 2039/40, and
- WFD no-deterioration assessments may be required for the Birchmoor groundwater source and the Hollowell reservoir, subject to further discussion with the Environment Agency. If required, these will be delivered via the AMP6 NEP water resource programme.

27.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction, enhanced metering and water efficiency. Anticipated savings from these activities in the Ruthamford North RZ are approximately 7Ml/d by the end of AMP6.
- Climate change impacts - Impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

27.3.2.1 Within the Ruthamford North RZ, a significant amount of growth is expected in the Daventry area. The impact of this on the supply-demand balance in the Ruthamford North RZ has been assessed and this shows that the related supply-demand risks are low. Where investment to support individual developments is needed, this will be progressed through the normal process of requisitioning a connection to our supply-system.

27.3.2.2 The need for additional local reinforcements in the Daventry area will be reviewed in AMP6 and if required, more supporting infrastructure may be delivered from AMP7 onwards.

27.4 Feasible options for maintaining the supply-demand balance

27.4.1 Despite there being surpluses in the Ruthamford North RZ, deficits in adjacent RZs mean that it is necessary to consider developing additional resources to support future transfers or exports. These are summarised in Table 27.5.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Reuse	RHFA2 Peterborough water reuse	20	34	103,500	4,400
Dam Raising	RHFA3 Rutland Dam raising	16	20	107,800	400
Dam Raising	RHFA5 Pitsford Dam raising	11	13.8	58,900	430
Canal Transfer	RHFA6 Canal transfer	13	17.7	73,100	1,470
Transfer	RHFA15 Reduce Ruthamford North RZ raw water export	8	8	0	160

Table 27.5 Ruthamford North Feasible Option Details

27.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon costs. In the EBSD modelling social, environmental and carbon costs have been included.

27.4.1 Scheme descriptions

27.4.1.1 The following feasible options have been developed:

- RHFA2 Peterborough water reuse - Effluent from Peterborough Water Recycling Centre would be treated to an extremely high (near potable) standard and transferred via a 22km pipeline. It would be re-abstracted and treated by a new treatment works. Following a detailed appraisal for possible delivery during the 2010-12 drought, this scheme has been sized to account for downstream river needs and so is smaller than previously considered
- RHFA3 Rutland dam raising - The yield from our lower Nene reservoir could be increased by raising the height of the dam. The capacity of the associated water treatment works would also be increased
- RHFA5 Pitsford dam raising -This option provides for increasing the yield from our upper Nene reservoir by increasing capacity by raising the dam. The capacity of the associated water treatment works would also be increased
- RHFA6 Canal transfer -This option provides for transfer of treated effluent from Birmingham to the River Nene via the canal system to allow continued abstraction from the River Nene during low flow periods. A number of pumping stations would be required to overcome level differences on the canal system, as well as water treatment works extension, and
- RHFA15 Reduce Ruthamford North RZ raw water export - The existing raw water transfer to the Central Lincolnshire RZ could be reduced and utilised within Ruthamford North RZ. The reduction in resource in the Central Lincolnshire RZ would be off set by the output from the new Lincoln water treatment works.

27.4.1.2 The following options are mutually exclusive because they are part of the same group licence and it may not be possible to implement all three schemes if selected by the model:

- RHFA3 Rutland dam raising
- RHFA5 Pitsford dam raising, and
- RHFA7 Grafham dam raising.

27.4.2 Environmental considerations

27.4.2.1 The environmental assessments of the feasible options have concluded the following for the RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options, and
- The climate change vulnerability assessment concludes that the canal transfer (RHFA6) and water reuse (RHFA2) options are not sensitive to climate change. The assessment scored both options as 1 – insensitive. The reservoir options (RHFA3, RHFA5) are scored 3 – sensitive in relation to water abstraction, available flow and environmental flow requirements. The reduction in raw water export (RHFA15) is rated 2 -limited sensitivity but the donor RZ is vulnerable to climate change.

27.4.2.2 The WFD no-deteriorations assessment, SEA and HRA concluded:

- RHFA2 Peterborough water reuse -The preliminary environmental investigations have not flagged up any significant issues with flow or quality to the River Nene or the Counter Drain associated with this reuse scheme. The HRA screening identified the potential need for an Appropriate Assessment and requirement to re-route the pipeline
- RHFA3 Rutland dam raising -Further WFD investigation will be required to demonstrate that an increase to abstraction will not affect water quality in the River Nene and River Welland. Further investigation will be required to demonstrate that the increase in water levels at Rutland Water will not affect the biological elements or water quality in the waterbody. The HRA screening has identified the need for an Appropriate Assessment if taken forward due to potential likely significant effect on Rutland Water SPA. The SEA has also identified the need to investigate potential impacts on the Scheduled Monument on site
- RHFA5 Pitsford dam raising -Further WFD investigation will be required to demonstrate that an increase to abstraction will not affect water quality in the River Nene. Further investigation will be required to demonstrate that the increase in water levels at Pitsford reservoir will not affect the biological elements or water quality in the waterbody. The SEA has not highlighted any other concerns
- RHFA6 Canal transfer -The HRA screening and SEA has identified the need to re-route the pipeline to avoid SSSIs and local nature reserves. No other significant negative effects have been identified. A WFD assessment would need to be completed to review any potential impacts at source, and
- RHFA15 Reduce Ruthamford North RZ raw water export -No environmental concerns identified with this option.

27.4.2.3 Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

27.5 Preferred plan

27.5.1 Details of the investment planned to maintain the supply-demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side					RHFA15 Reduce RHF North RZ raw water export
Distribution side	See below				
Customer side	See below				

Table 27.6 Ruthamford North Supply Demand Investment Plan

27.5.2 Lowering consumption levels is a priority to offset resource development, therefore leakage reduction, enhanced metering and water efficiency programmes have been included in the baseline. In the Ruthamford North RZ we aim to complete approximately 35,500 water efficiency audits. Our enhanced metering programme will fit over 1,500 meters and as a result of this, the enhanced metering programme in AMP5, and background opting rates, we anticipate that approximately 29,000 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

27.5.3 Modelling has confirmed that additional resources will need to be developed towards the end of the planning period. The results of the EBSD indicates additional resources could be achieved through the reduction of the raw water transfer that currently goes north to Grantham to support demands in the Central Lincolnshire RZ.

27.5.4 The model has selected transfers out of Ruthamford North RZ to support Ruthamford South RZ and Fenland RZ. The downstream options selected are:

- RHFA1 – Ruthamford North RZ transfer 1 (24Ml/d) transfer to Ruthamford South RZ, and
- F4 – Ruthamford North RZ transfer (12Ml/d) transfer to Fenland RZ.

27.6 Scenario testing

27.6.1 Table 27.7 details the impacts of scenario modelling on the supply demand balance for the Ruthamford North RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	43.45	14.14
Least cost plan	26.25	-3.72
High population	30.36	3.47
Worst case climate change	30.78	-18.38
Worst case sustainability reductions	43.46	14.14
Recent actuals	-61.91	-91.23
Worst case combination	-106.19	-153.01

Table 27.7 Ruthamford North Scenario Modelling Impacts

27.6.2 In summary this shows the following:

- 17.9Ml/d impact on the RZ supply demand balance by the end of the planning period under the least-cost plan scenario
- Sensitivities to increasing populations equivalent to 10.7Ml/d
- Significant sensitivities to worst case climate change impacts equivalent to 32.5Ml/d by the end of 2039/40
- No further reductions resulting from worst case scenario reductions scenario

- Impacts of 20.9M/d from restricting deployable outputs to recent actuals by the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts are 150Ml/d by the end of AMP6, reaching 167Ml/d by 2039/40.

27.6.3 Table 27.8 below shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	RZ Residual Deficit 2039/40 (Ml/d)
Preferred plan	See note below				RHFA15 Reduce RHF North RZ export	0
Preferred plan - environmental and social costs	See note below				RHFA15 Reduce RHF North RZ raw water export	0
Plan B	See note below					0
Least cost plan				RHFA15 Reduce RHF North RZ export	Leakage	0
High population	See note below		RHFA15 Reduce RHF North RZ export		RHFA6 Canal transfer	0
Worst case climate change	See note below		RHFA15 Reduce RHF North RZ export RHFA6 Canal transfer	RHFA3 Rutland dam raising	RHFA2 Peterborough water reuse	0
Worst case sustainability reductions	See note below			RHFA15 Reduce RHF North RZ export	RHFA3 Rutland dam raising	0
Recent actuals	RHFA15 Reduce RHF North RZ export RHFA6 Canal transfer RHFA2 Peterborough water reuse Water efficiency See note below			RHFA3 Rutland dam raising		44.5
Worst case combination	RHFA15 Reduce RHF North RZ export RHFA6 Canal transfer RHFA2 Peterborough water reuse Leakage			RHFA3 Rutland dam raising		148

Table 27.8 Ruthamford North Scenario Scheme Selection

27.6.4 Although not selected in the EBSD modelling for the least cost plan in AMP6, leakage reduction, enhanced metering and water efficiency has been included in the baseline supply demand forecast.

27.6.5 The model did not select any options in Ruthamford North RZ for the Plan B scenario. In this scenario the model has selected local options for the RZs which Ruthamford North RZ supports in the least cost and preferred plan.

27.6.6 The three dam raising options (Rutland, Grafham and Pitsford) have been considered as mutually exclusive in the preferred plan and least cost plan because they are all within the same group licence. However for the scenarios this constraint has been lifted and the model has been allowed to select all options. If a change to the group licence was not feasible this would have the effect of increasing the residual deficit in Ruthamford North RZ up to 16Ml/d in the worst case climate change, 60.5Ml/d in recent actuals scenarios and 164Ml/d for the worst case combination scenario.

27.6.7 Deficits of this magnitude would require further options for maintaining the supply-demand balance. These could include:

- Investment to support the additional storage capacity created by dam raising by a transfer of resources from the Trent basin
- Development of the South Lincolnshire Reservoir. This would store water abstracted from the River Witham with support from the RiverTrent during the winter for year-round treatment and distribution. Originally envisaged as a scheme to support growth in demand in areas to the south and east of our supply system, this could equally be used to support areas in the Ruthamford system affected by sustainability reductions and climate change, and
- Associated with the above, the development of trading based infrastructure, either between water companies or between water companies and other third parties. In part, this could be based on connectivity which is delivered to improve the resilience of supply-systems.

PART TWO: RESOURCE ZONE SUMMARIES

Ruthamford South

28 Ruthamford South

Figure 28.1 Ruthamford South Resource Zone

PART TWO: RESOURCE ZONE SUMMARIES
Ruthamford South

28.1 Key points

Key Points

- The Ruthamford South RZ enters deficits under dry year annual average conditions in 2026/27, reaching 28.5Ml/d in 2039/40. The equivalent critical period deficit is 4.2Ml/d. These result from historic levels of growth and an adjustment to the yield available from Grafham Reservoir. Further significant reductions in the yield available from Grafham Reservoir are also being considered.
- Baseline climate change sensitivities have been identified of 6.8Ml/d by 2039/40. In the worst case, climate change may reduce average daily source-works output by 54Ml/d. This would affect abstraction from the River Ouse.
- Deployable output is sensitive to assumptions about levels of service. An increase in the frequency of temporary use bans could increase average daily source-works output by 20Ml/d. An equivalent reduction would reduce this by 3.4Ml/d. A no restriction level of service would reduce average daily source-works output by 15.7Ml/d. There is limited sensitivity to temporary use bans.
- Deployable outputs in this RZ are subject to potential further reduction as a result of improvements in flow monitoring.
- There is one likely sustainability reduction requirement which will reduce the ADSO by 2.4Ml/d.
- The plan for maintaining the supply-demand balance combines a transfer from the Ruthamford North RZ, the recommissioning of the Foxcote reservoir with additional leakage control and water efficiency.

28.2 Resource zone description

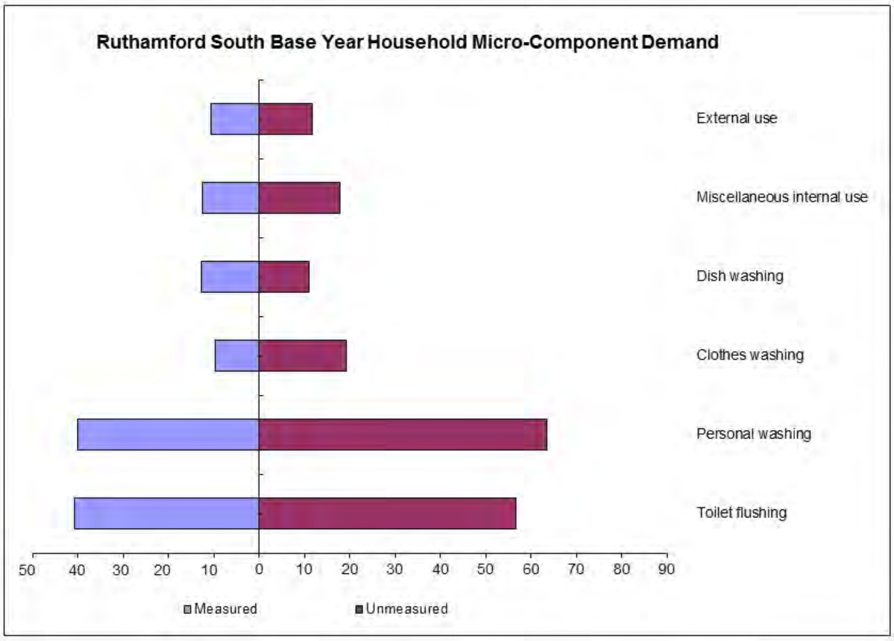
28.2.1 The Ruthamford South RZ is located in the south west of our region and is based on the supply systems for Milton Keynes, Leighton Buzzard, Bedford, Biggleswade, St Neots and Huntingdon.

28.2.2 Customers in the RZ are supplied from a combination of sources including surface water from the River Ouse and groundwater from the Lower Greensand. Water from the Ouse is used both directly and pumped into storage. Connectivity within the RZ allows for resources to be shared and for the integrity of the RZ to be maintained. Treated water is exported from this RZ to Affinity Water under the terms of the Great Ouse Water Act (GOWA).

28.2.3 In 2012/13, the total number of household customers in the RZ was estimated to be approximately 340,000. Of these 76% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 18,000. Most of these were measured.

28.2.4 From Figure 28.2:

- Base year measured and unmeasured PCC are approximately equivalent and more than our regional averages (124 l/p/d and 150 l/p/d) respectively, and
- Overall we forecast a 20% reduction in average PCC. This is driven by optant metering, including baseline water efficiency activities.



	Litres per person per day (PCC)			
	Base Year	2020	2030	2040
Measured Household	126	115	114	112
Unmeasured Household	180	147	137	129
Weighted Average	142	119	116	113
Reduction in PCC over forecast (%)	20%			

Figure 28.2 Ruthamford South average household consumption (litres/person/day)

28.2.5 The majority of household use is for personal washing and toilet flushing, with unmeasured customers using more water for these activities than measured customers. This is consistent with the regional pattern of consumption.

28.2.6 Analysis suggests that the projected reduction in measured household consumption is from a change in WC use. For unmeasured customers significant reductions are projected from a change in personal washing and WC use.

28.2.7 Table 28.1 shows measured non-household demands in the base year totalling 36Ml/d in the Ruthamford South RZ. These are mainly from the public administrative, manufacturing, wholesale and agricultural sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
36	Milton Keynes	10	Public admin, manufacturing, wholesale and agriculture
	Huntingdon	6	
	Bedford	5	
	Buckingham	4	

PART TWO: RESOURCE ZONE SUMMARIES
Ruthamford South

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
	Biggleswade	3	
	Leighton Linslade	2	
	Mursley	2	
	Meppershall	1	
	Clapham	1	
	Newport Pagnell	<1	

Table 28.1 Ruthamford South RZ Patterns of Measured Non Household Consumption

28.2.8 From Table 28.2, we forecast new properties equivalent to around 4,000 per year. This estimate is similar to the number of new properties forecast by local authorities but less than recent rates of new build. These approximate 6,000 new properties per year.

Household Growth Estimates	2001-06	2006-11	2015-20	2020-25	2025-30	2030-35	2035-40
Local Authority policy estimates			25,000	20,000	20,000	20,000	20,000
WRMP trend estimate			18,500	20,000	20,000	21,000	21,000
Annual Monitoring Report data	30,000	31,000					

Table 28.2 Ruthamford South Growth Estimates

28.3 Baseline supply-demand balance

28.3.1 From Table 28.3 and Table 28.4, in the last year of AMP7 (2024/25) we forecast that there will be a DYAA surplus of 7.4Ml/d and a CP surplus of 24.1Ml/d in the RZ. Equivalent target headroom requirements are 17.8Ml/d and 21.1Ml/d respectively. The RZ enters deficits at DYAA in 2026/27, reaching 18Ml/d in 2039/40. The equivalent CP deficit is 4.2Ml/d.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	276.85	276.85	276.85	276.85	276.85	276.85
Outage Allowance	6.91	6.66	6.59	6.56	6.57	6.57
Total Water Available for Use	199.51	189.36	195.96	194.38	193.94	193.33
Distribution Input	178.05	168.25	170.73	173.81	177.07	180.36
Target Headroom	5.95	11.98	17.80	24.12	27.59	31.01

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Supply Demand Balance	15.51	9.12	7.43	-3.55	-10.82	-18.04

Table 28.3 Ruthamford South Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	390.36	390.36	390.36	390.36	390.36	390.36
Outage Allowance	8.55	8.18	8.06	8.01	7.99	7.98
Total Water Available for Use	253.96	257.51	254.78	253.32	252.88	252.43
Distribution Input	220.51	206.74	208.89	212.00	215.44	218.97
Target Headroom	7.37	14.72	21.77	29.42	33.56	37.65
Supply Demand Balance	26.08	36.06	24.11	11.89	3.88	-4.19

Table 28.4 Ruthamford South Baseline Supply-Demand Summary (DYCP)

28.3.2 Leakage in the base year is equivalent to 15% of distribution input and remains constant over the remainder of the forecast period.

28.3.3 The deficit in the Ruthamford South RZ arises from historic levels of growth, recent reductions in ADSO and exposure of the effect of these through work to assess the integrity of the former Ruthamford RZ. This showed that areas in the south of the former RZ could not effectively share resources with areas in the north; this includes additional capacity resulting from the AMP4 resource development scheme at Rutland Water. Subsequent separation of the two areas to reflect the lack of integrity revealed a large surplus in the north and a deficit in the south. This is forecast to grow significantly over the period to 2039-40.

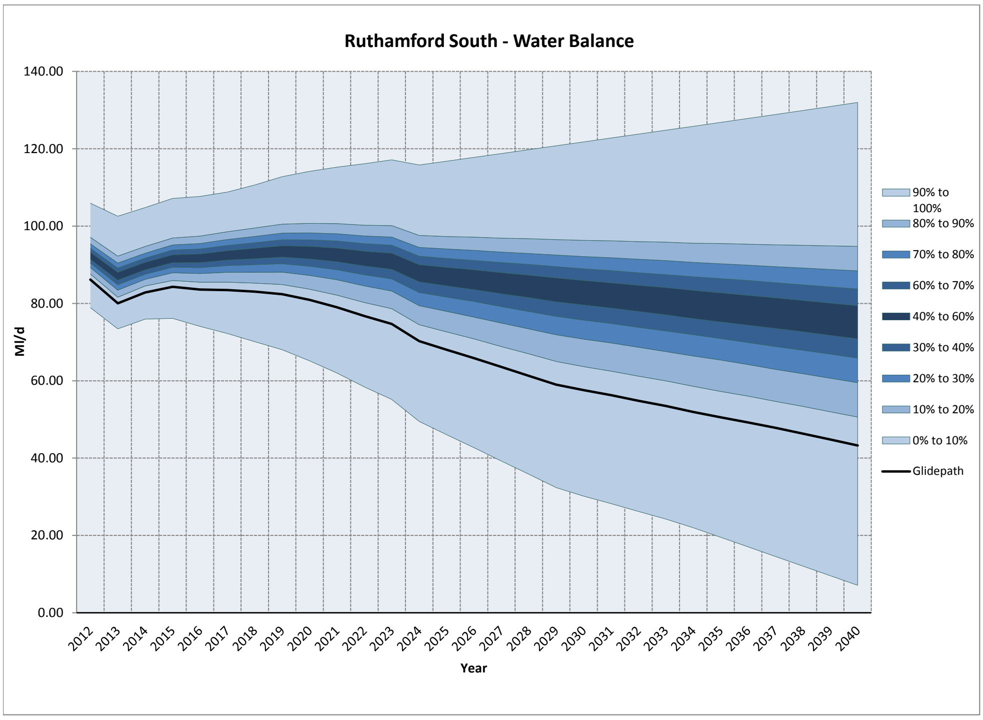


Figure 28.3 Ruthamford South Probabilistic Water Balance

28.3.4 While Figure 28.3 shows that there is a greater than 95% probability that the RZ water balance will be in surplus over in the 25 year forecast period, this excludes effects arising from the export to the Affinity Water. Once this is taken into account, the probabilistic water balance is shows a greater than 90% probability of deficits against target headroom from the start of the forecast period.

28.3.1 Baseline supply forecast issues

28.3.1.1 Significant adjustments to the baseline supply forecast since the 2010 WRMP include:

- A 32Ml/d reduction in ADSO from a reservoir yield update that accounts for the effect of the recent drought
- A 5.3Ml/d increase in ADSO and a 1.7Ml/d increase in MAXSO at surface water source arising from delivery of a capital maintenance scheme and an improved ability at the works to deal with the highly turbid quality of the water which is often found in the River Ouse
- A 1Ml/d increase in ADSO and a 6Ml/d increase in MAXSO for a groundwater source that we expect to be delivered in the current AMP
- The current reduction of deployable outputs at Grafham follows a yield assessment in 2012 which saw a reduction from 262Ml/d to 242Ml/d. However the deployable output of the reservoir source is at risk of a further large reduction from on-going work to update the flow series used in the yield modelling. The current estimates are based on flows derived from three separate measurements. These are due to be replaced by a direct

flow measurement at the reservoir intake. The improved accuracy which results may affect estimates of the reservoir yield and result in a further loss of ADSO. This could result in a total reduction in yield of 50Ml/d from 262Ml/d to 212Ml/d

- A WFD no-deterioration assessment may be required for the Battlesden groundwater source, subject to ongoing work with the Environment Agency, and
- There is a baseline climate change impact forecast on the available supplies of 6.6Ml/d in 2039/40.

28.3.1.2 Investment to maintain the potential yield of boreholes that are vulnerable to deterioration is included in the capital maintenance programme.

28.3.2 Baseline demand forecast issues

- We are planning an extensive programme of demand management during AMP6 including leakage reduction, enhanced metering and water efficiency. Anticipated savings from these activities in the Ruthamford South RZ are approximately 10Ml/d by the end of AMP6.
- Climate change impacts on demand are marginal and equivalent to an increase of around 2% over the whole of the forecast period.

28.3.2.1 Within the Ruthamford South RZ, growth is expected in the Buckingham area. The impact of this on the supply-demand balance in the Ruthamford South RZ has been assessed and this shows that the related supply-demand risks are low. Where investment to support individual developments is needed, this will be progressed through the normal process of requisitioning a connection to our supply-system.

28.4 Feasible options for maintaining the supply-demand balance

28.4.1 The feasible Ruthamford South RZ options that were modelled in our EBSD optimiser are given below in Table 28.5.

Scheme type	Scheme	ADSO maximum capacity (Ml/d)	MAXSO maximum capacity (Ml/d)	Capex (£k)	Opex (£k/yr)
Transfer	RHFA1 RHF North transfer 1 (24Ml/d)	24	24	30,400	320
Dam Raising	RHFA7 Grafham dam raising	40	50	92,900	680
Reservoir	RHFA8 New Ruthamford South RZ reservoir	26	33	274,500	930
Reservoir	RHFA11 Recommission Ruthamford South RZ reservoir	9	12.5	19,800	520
Transfer	RHFA13 Ruthamford North RZ transfer 2 (39Ml/d)	39	39	75,300	640
Reuse	RHFA14 Huntingdon water reuse	5.4	5.4	41,000	670

Table 28.5 Ruthamford South Feasible Option Details

28.4.2 In the table above, estimates for resource-side options exclude social, environmental and carbon costs. In the EBSD modelling social, environmental and carbon costs have been included.

28.4.1 Scheme descriptions

28.4.1.1 The following feasible options have been developed:

- RHFA1 Ruthamford North RZ transfer 1 (24Ml/d) - This option provides for transfer of water from the Ruthamford North RZ to Ruthamford South via 21km long new pipeline
- RHFA7 Grafham dam raising -This option provides for an increase in the capacity of the existing reservoir by raising the dam and an increase in the capacity of the treatment works
- RHFA8 New Ruthamford South RZ Reservoir -This option provides for a new reservoir supplied from the existing river abstraction point for Graham reservoir. New water treatment works capacity would be required along with the associated infrastructure to transfer water between the new assets
- RHFA11 Recommission Ruthamford South RZ Reservoir -Recommissioning of the existing Foxcote reservoir and water treatment works to the south of Ruthamford South RZ
- RHFA13 Ruthamford North RZ transfer 2 (39Ml/d) -This option is similar to option RHFA1 but provides a larger capacity transfer and requires an additional 21km of pipeline to boost supplies to Milton Keynes, and
- RHFA14 Huntingdon water reuse -Effluent from Huntingdon Water Recycling Centre would be treated to an extremely high (near potable) standard and transferred via a 12km pipeline. It would be re-abstracted and treated by a new treatment works.

28.4.1.2 Both transfer options (RHFA1 and RHFA13) are supplied by Ruthamford North RZ which is in surplus. However the capacity of the transfers out of Ruthamford North RZ (to either Ruthamford South RZ or Fenland RZ) will require a new resource/s to be developed in Ruthamford North RZ. The new resource options are described in the Ruthamford North RZ summary. The Options Appraisal Report contains more details about all of these options.

28.4.1.3 The following options are mutually exclusive because only one of the transfer options would be constructed if selected by the model:

- RHFA1 Ruthamford North RZ transfer 1 (24Ml/d), and
- RHFA13 Ruthamford North RZ transfer 2 (39Ml/d).

28.4.1.4 The options below which utilise the existing abstraction at Grafham reservoir are mutually exclusive:

- RHFA7 Grafham dam raising, and
- RHFA8 New Ruthamford South RZ Reservoir.

28.4.1.5 The following options are mutually exclusive because they are part of the same group licence and it may not be possible to implement all three schemes if selected by the model:

- RHFA3 Rutland dam raising
- RHFA5 Pitsford dam raising, and
- RHFA7 Grafham dam raising.

28.4.1.6 A number of options proposed in the draft WRMP have been discounted; the reason for this is described in the table below.

Scheme Ref	Scheme Name	Reason for discounting scheme
RHFP1	RHF North Transfer 3	The original option set for Ruthamford was developed using an early version of the supply demand balance which showed a peak deficit greater than the average deficit. Therefore a set of peak specific options were developed (denoted RHFP1, P2 etc). However the final supply demand balance used for the draft WRMP and the revised draft WRMP shows a smaller peak deficit than at average. Therefore the option set developed for average are adequate to satisfy the peak deficits and the peak
RHFP2	RHF North Transfer 4	See above.
RHFP3	RHF North Transfer 5	See above.
RHFP4	Clapham WTW	See above.
RHFP5	Ruthamford North RZ transfer	See above.

Table 28.6 Ruthamford South Discounted Schemes

28.4.2 Environmental considerations

28.4.2.1 The environmental assessments of the feasible options have concluded the following for the Ruthamford South RZ options:

- No specific issues were identified as part of the BAG assessment other than those common to all options, and
- The climate change vulnerability assessment concludes that both transfer options (RHFA1, RHFA13) are not sensitive to climate change but the donor RZs are vulnerable to climate change. The assessment scored both options as 2 – limited sensitivity. The reservoir options (RHFA7, RHFA8, RHFA11) are scored 3 – sensitive in relation to water abstraction, available flow and environmental flow requirements. The reuse scheme (RHFA14) is rated 1 or 2 (insensitive or limited sensitivity).

28.4.2.2 The WFD no-deteriorations assessment, SEA and HRA concluded:

- RHFA1 Ruthamford North RZ transfer 1 (24Ml/d) -The HRA screening concluded no adverse effect on site integrity for the Upper Nene Valley Gravel Pits SPA with appropriate mitigation. The SEA concluded no significant negative effects apart from potential climate change impacts due to increase CO_2 output. The existing wildlife lagoons were created as mitigation to enable the abstraction licence at Rutland Water to be maximised
- RHFA7 Grafham dam raising -Further WFD investigation will be required to demonstrate that an increase to abstraction will not affect water quality in the River Great Ouse. Further investigation will be required to demonstrate that the increase in water levels at Grafham Water will not affect the biological elements or water quality in the

waterbody. Significant negative effects associated with CO_2 output have been identified, but the SEA has not highlighted any other concerns

- RHFA8 New Ruthamford South RZ reservoir - The SEA and HRA screening has highlighted the need to re-route the pipeline to avoid a SSSI but no other significant issues. The WFD screening identified a low risk of deterioration which would need to be investigated further if the scheme were taken forward
- RHFA11 Recommission Ruthamford South RZ reservoir -A detailed WFD no deterioration assessment has been completed for this option to recommission the Foxcote reservoir. No specific issues were identified for the River Ouse, but there are water quality risks for the reservoir which will require mitigation measures. No other significant negative effects predicted in the SEA
- RHFA13 Ruthamford North RZ transfer 2 (39Ml/d) -In addition to the issues highlighted with RHFA1, the SEA has identified a requirement to re-route the pipeline to avoid a scheduled monument, and
- RHFA14 Huntingdon water reuse -The HRA screening and SEA has concluded that, if taken forward, this option would require an Appropriate Assessment due to a likely significant effect at Portholme SAC. The pipeline would need to be re-routed to avoid a SSSI. It is assumed that relevant discharge consents and treatment would have a benefit in term so of water quality. No WFD deterioration issue shave been identified.

28.4.2.3 Details of the BAG, WFD no-deterioration, SEA and HRA assessments can be found in the Minimising the Environmental Impact of Abstractions section.

28.5 Preferred plan

28.5.1 Details of the investment planned to maintain the supply demand balance are given in the table below. The preferred plan is based on the results of the EBSD modelling, amended to take account of the wider customer and environmental objectives.

Scheme Type	AMP6	AMP7	AMP8	AMP9	AMP10
Resource side			RHFA1 – Ruthamford North RZ transfer (24Ml/d)		RHFA11 Recommission Ruthamford South RZ Reservoir
Distribution side	See below				
Customer side	See below				

Table 28.7 Ruthamford South Supply Demand Investment Plan

28.5.2 Lowering consumption levels is a priority to offset resource development, therefore leakage reduction, enhanced metering and water efficiency programmes have been included in the baseline. In the Ruthamford South RZ we aim to complete approximately 30,000 water efficiency audits. Our enhanced metering programme will fit over 20,000 meters and as a result of this and background opting rates, we anticipate that approximately 30,000 customers will opt onto metered billing. The baseline supply demand balance also includes leakage reduction. Other benefits to reducing demand include:

- Mitigating drought risk: Reducing levels of consumption and increasing awareness of the link between domestic consumption and the environment will help us to mitigate the risk of a drought related impact on the environment, and
- An opportunity for customers to reduce bills by switching from unmeasured to measured supplies. Combining metering with water efficiency reinforces the water saving message and allows them to save even more money.

28.5.3 To support RHFA1 – Ruthamdford North RZ transfer the model selected the following upstream options in Ruthamford North RZ:

- RHFA15 Reduce Ruthamford North RZ raw water export.

28.5.4 In respect of the preferred plan, the following issues are noted:

- The preferred plan is sensitive to the transfer requirements for adjacent RZs, including those in adjacent water company areas. Any change in the supply-demand balance in these areas, for example as a result of clarification about sustainability reductions, is likely to lead to the development of an alternative plan.

28.6 Scenario testing

28.6.1 Table 28.8 details the impacts of scenario modelling on the supply demand balance for the Ruthamford South RZ.

Scenario	Scenario 2019-20	Scenario 2039-40
	AMP6 SD balance (Ml/d)	AMP10 SD balance (Ml/d)
Preferred plan	9.12	-18.04
Least cost plan	-1.38	-28.71
High population	-1.67	-26.93
Worst case climate change	-12.41	-72.71
Worst case sustainability reductions	-30.42	-18.04
Recent actuals	-42.84	-70.00
Worst case combination	-86.26	-144.65

Table 28.8 Ruthamford South Scenario Modelling Impacts

28.6.2 In summary this shows the following:

- 10.7Ml/d impact on the RZ supply demand balance by the end of the planning period under the least-cost plan scenario
- Sensitivity to increasing populations equivalent to 8.9Ml/d
- Significant sensitivity to worst case climate change impacts equivalent to 54.7Ml/d by the end of 2039/40
- No further reductions resulting from worst case scenario reductions scenario

- Impacts of 52Ml/d from restricting deployable outputs to recent actuals by the end of the planning period, and
- Worst case combination scenario which includes all impacts associated with climate change, sustainability reductions, high population, cost effective plan impacts are 95.4Ml/d by the end of AMP6, reaching 126.6Ml/d by 2039/40.

28.6.3 This RZ has also been found to be sensitive to different levels of service scenarios that are equivalent to the following:

- Increase or decrease in the frequency of temporary use bans: limited sensitivity, and
- Increase in the frequency of temporary use bans from 1 in 40 to 1 in 20: a 20.7Ml/d increase in ADSO.

28.6.4 Table 28.9 shows the options selected for each scenario.

Scenario	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	RZ Residual Deficit 2039/40 (Ml/d)
Preferred plan	See note below		RHFA1 Ruthamford North RZ transfer (24Ml/d)		RHFA11 Recommission RHF South RZ Reservoir	0
Preferred plan-environmental and social costs	See note below		RHFA1 Ruthamford North RZ transfer (24Ml/d)		RHFA11 Recommission RHF South RZ Reservoir	0
Plan B	See note below		RHFA7 Grafham dam raising			0
Least cost plan		Leakage	RHFA7 Grafham dam raising Leakage			0
High population	See note below	RHFA1 Ruthamford North RZ transfer (24Ml/d)		RHFA11 Recommission RHF South RZ Reservoir		0
Worst case climate change	See note below RHFA11 Recommission RHF South RZ Reservoir	RHFA1 Ruthamford North RZ transfer (24Ml/d) RHFA7 Grafham dam raising				0
Worst case sustainability reductions	See note below		RHFA1 Ruthamford North RZ transfer (24Ml/d)	RHFA11 Recommission RHF South RZ Reservoir		0
Recent actuals	See note below RHFA11 Recommission RHF South RZ Reservoir RHFA7 Grafham dam raising RHFA14 Huntingdon water reuse Water efficiency			RHFA8 New Ruthamford South RZ Reservoir		0
Worst case combination	Leakage RHFA14 Huntingdon water reuse RHFA7 Grafham dam raising RHFA11 Recommission RHF South RZ Reservoir			RHFA8 New Ruthamford South RZ Reservoir		31

Table 28.9 Ruthamford South Scenario Scheme Selection

28.6.5 The reservoir options (RHA7, RHFA8) have been considered as mutually exclusive in the preferred plan and least cost plan as they utilise the existing licence. For the scenario testing this constraint has been lifted and the model has been allowed to select both options. In the scenarios where both options are selected a new licence would be required for the new reservoir. If this was not feasible this would have the effect of increasing the residual deficit to 26Ml/d in the recent actual scenario and to 56Ml/d in the worst case combination scenario. In both these scenarios there are no available resources to transfer into Ruthamford South RZ from Ruthamford North RZ.

28.6.6 Another constraint is that the three dam raising options (Rutland, Grafham and Pitsford) are all within the same group licence so selection of all three options within the preferred plan and least cost plan has been prevented within the model. However for the scenarios this constraint has been lifted and the model has been allowed to select all options. If a change to the group licence was not feasible this would have the effect of increasing the residual deficit in Ruthamford South RZ up to 40Ml/d in the worst case climate change and recent actual scenarios and 70Ml/d for the worst case combination scenario.

28.6.7 Deficits of this magnitude would require further options for maintaining the supply-demand balance. These could include:

- Investment to support the additional storage capacity created by dam raising or new reservoirs by a transfer of resources from the Trent basin, and
- Development of the South Lincolnshire Reservoir. This would store water abstracted from the Trent during the winter for year-round treatment and distribution. Originally envisaged as a scheme to support growth in demand in areas to the south and east of our supply system, this could equally be used to support areas in the Ruthamford system affected by sustainability reductions and climate change.

PART TWO: RESOURCE ZONE SUMMARIES

Hartlepool

29 Hartlepool

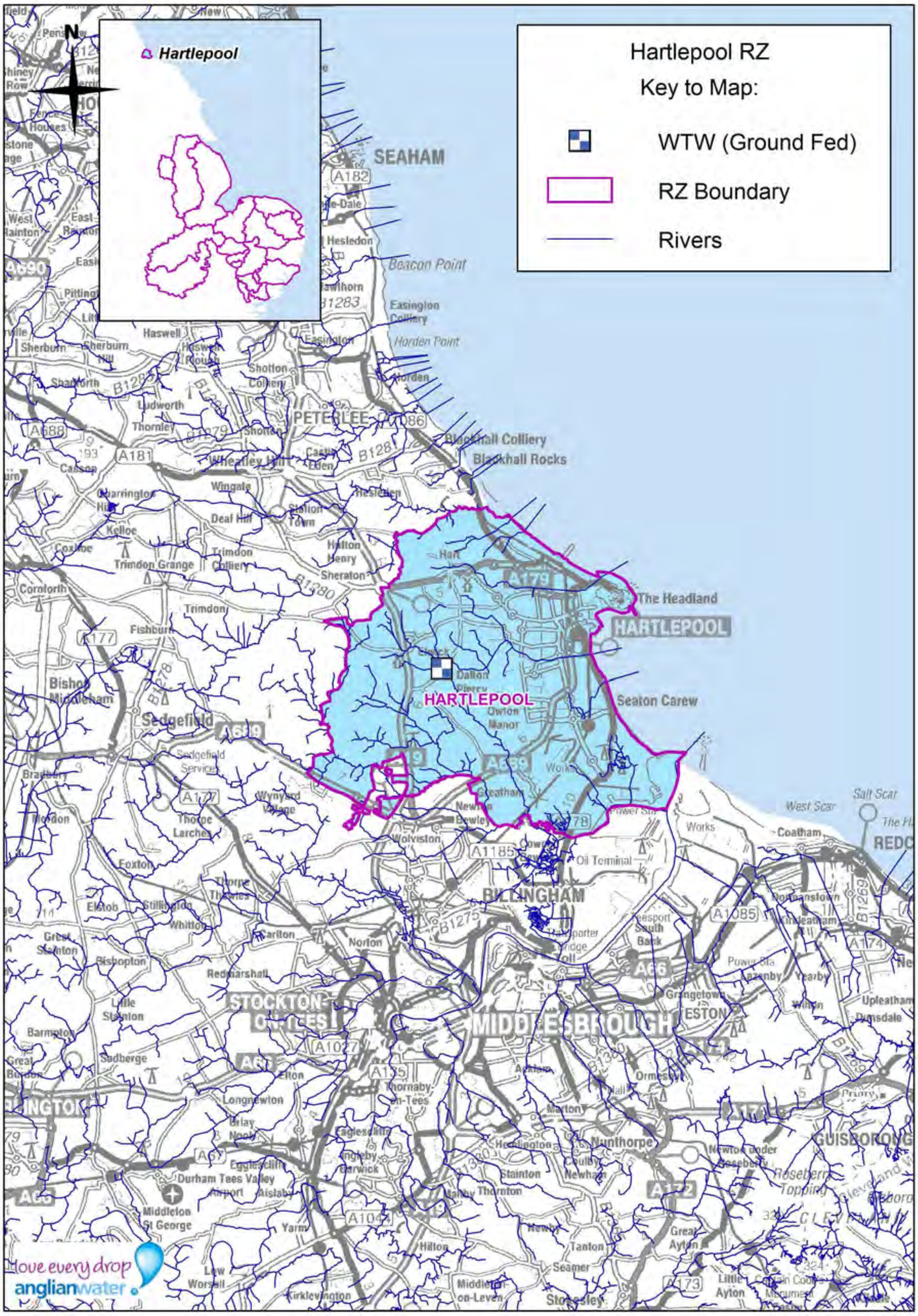


Figure 29.1 Hartlepool Resource Zone

PART TWO: RESOURCE ZONE SUMMARIES
Hartlepool

29.1 Key points

Key Points

- No deficits are forecast in the Hartlepool RZ.
- Over the forecast period, no significant climate change, sustainability reduction or levels of service sensitivities have been identified.
- No significant baseline climate change or levels of service sensitivities have been identified.
- Deployable output in the RZ has been reduced to take account of the effect of poor quality groundwater.

29.2 Resource zone description

29.2.1 The Hartlepool RZ comprises the entire area supplied by Hartlepool Water, in the North East of England, and is geographically separate from the other RZ's in the Anglian region. The water resources are entirely groundwater abstracted from the Magnesian Limestone aquifer. All of the groundwater sources pump to a strategic water storage reservoir where they can be blended to maintain consistent and compliant water quality. This is a well-integrated system.

29.2.2 The two small surface water reservoirs at Crookfoot and Hurworth Burn previously used to provide non-potable industrial supplies. The reservoirs are now unused and have been sold.

29.2.3 In 2012/13, the total number of household customers in the RZ was approximately 40,000. Of these 30% were billed on the basis of measured supplies. The equivalent number of non-household customers was approximately 2,000, of which 75% were measured.

29.2.4 Micro-component demand analysis has not been specifically completed for the Hartlepool RZ. The regional average household consumption models confirm that it is likely that most of the water used by our household customers is for WC use and personal use. A profile of water use is presented on Figure 29.2.

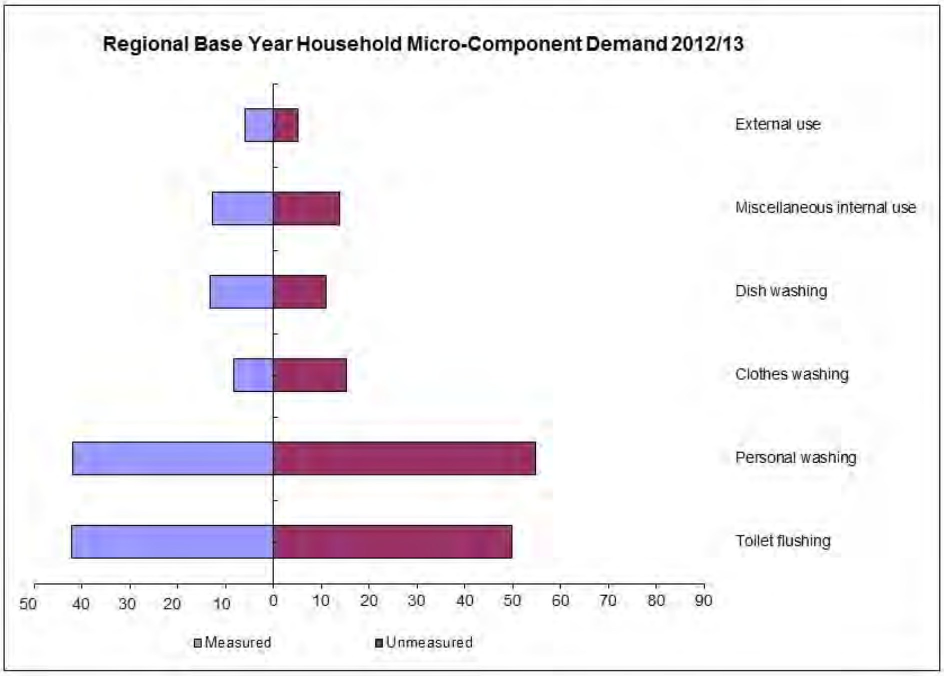


Figure 29.2 Regional average household water consumption (litres/person/day)

Table 29.1 shows measured industrial demand in the base year totalling 8Ml/d in the Hartlepool RZ. These are mainly from the manufacturing and wholesale sectors.

Average RZ Demand (Ml/d)	Planning Zones	Average PZ Demand (Ml/d)	Main RZ sector types
8	Hartlepool	8	Manufacturing, wholesale

Table 29.1 Hartlepool patterns of Domestic Consumption (Litres/person/day)

29.2.5 We forecast new properties equivalent to around 220 per year.

29.3 Baseline supply-demand balance

29.3.1 From Table 29.2 and Table 29.3, in the last year of AMP6 (2019/20) we forecast that there will be a DYAA surplus of 9.5Ml/d and a CP surplus of 11.6Ml/d. The equivalent target headroom requirements are 1.1Ml/d and 1.4Ml/d, respectively. The RZ remains in surplus over the whole of the forecast period.

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	36.84	36.84	36.84	36.84	36.84	36.84
Outage Allowance	0.93	0.94	0.94	0.95	0.95	0.95
Total Water Available for Use	35.91	35.90	35.90	35.89	35.89	35.89

PART TWO: RESOURCE ZONE SUMMARIES
Hartlepool

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Distribution Input	25.01	25.30	25.27	25.29	25.32	25.36
Target Headroom	0.80	1.13	1.42	1.75	2.08	2.43
Supply Demand Balance	10.09	9.47	9.20	8.85	8.49	8.11

Table 29.2 Hartlepool Baseline Supply-Demand Summary (DYAA)

Water Balance Components (Ml/d)	Base Year (2012-13)	End of AMP6 (2019-20)	End of AMP7 (2024-25)	End of AMP8 (2029-30)	End of AMP9 (2034-35)	End of AMP10 (2039-40)
Deployable Output	46.08	46.08	46.08	46.08	46.08	46.08
Outage Allowance	1.17	1.19	1.19	1.18	1.18	1.18
Total Water Available for Use	44.91	44.89	44.89	44.90	44.90	44.90
Distribution Input	31.28	31.83	31.71	31.64	31.58	31.53
Target Headroom	1.01	1.42	1.79	2.19	2.59	3.02
Supply Demand Balance	12.63	11.63	11.39	11.07	10.73	10.36

Table 29.3 Hartlepool Baseline Supply-Demand Summary (DYCP)

29.3.2 Leakage in the base year is equivalent to 16% of distribution input and remains constant over the remainder of the forecast period.

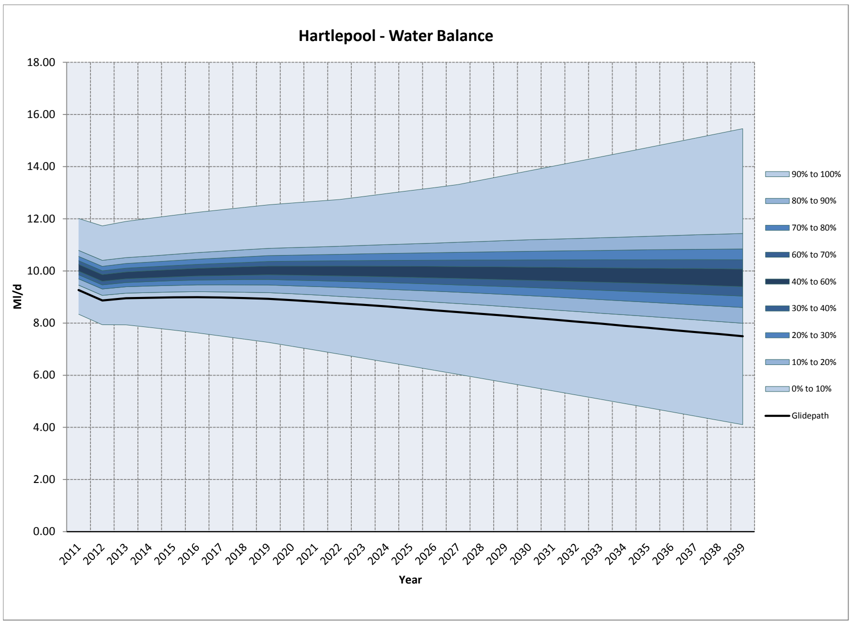


Figure 29.3 Hartlepool Probabilistic Water Balance

29.3.3 From Figure 29.3, there is a greater than 95% probability that the RZ level water balance will remain in surplus over the 25 years forecast period.

29.3.1 Baseline supply forecast issues

- The quality of the groundwater in the Magnesian Limestone has been affected in recent years by the ingress of water from abandoned colliery workings. This water contains elevated concentrations of sulphate and we are working with the Environment Agency and the Coal Authority to assess the risk to public water supplies. To account for the long-term water quality risk we have reduced the deployable output as reported in the 2010 WRMP, with MAXSO reducing from 61.9Ml/d to 46.1Ml/d and ADSO from 50.8Ml/d to 36.8Ml/d.
- There are no confirmed or likely sustainability changes, but the Environment Agency has identified some of the Hartlepool sources for further investigation. Any potential flow impacts on ecology may be masked by poor water quality problems that are unrelated to abstraction. No unknown sustainability reductions have been modelled.
- We are maintaining the Naisberry groundwater source for emergency standby.
- There is no baseline climate change impact forecast on the available supplies.

29.3.2 Baseline demand forecast issues

- Our investment to control leakage means that we do not expect to see levels of leakage increase over the forecast period. The effect of our metering and related water efficiency activity means that there will be an increase in the supply-demand balance, equivalent to 5Ml/d additional supplies.

- We are committed to the ongoing promotion of water efficiency and will continue with our 'business as usual' activities, including bill inserts. Anticipated savings over the forecast period are approximately 1.3Ml/d.
- We continue to maintain the headroom on our abstraction licences to meet potential growth in non-household demand.
- To meet the growth in demand from the development expected at Wynyard, we plan to invest in AMP6 in a new supply main to the site. As well as enabling growth, the £4m scheme will increase the flexibility of our supply system and increase resilience.

29.4 Scenario testing

29.4.1 The baseline supply-demand forecast shows that we have no deficits against target headroom, but there are a number of plausible future scenarios in which it may be necessary to invest to maintain the balance between supplies and demand.

29.4.2 The future availability of high quality supplies from our Magnesian Limestone groundwater sources could be affected by:

- A progressive decrease in quality as a consequence of minewater ingress
- A need to manage levels of abstraction so as to prevent deterioration of the hydroecological conditions in any overlying surface waters. This includes the River Skerne and could arise through application of the WFD, and
- The catastrophic failure of one or more of our groundwater sources.

29.4.3 Competition for non-household supplies is being introduced by Government from 2017 as a way of increasing the efficiency of the water industry and reducing bills for customers. Since there are a number of large industrial customers in our supply area and in adjacent areas of the Northumbrian Water supply system, it is possible that competition will:

- Enable one of our existing large non-household customers to expand
- Result in a new large industrial customer relocating to the Hartlepool area, or
- Result in an increase in the volume of water we supply to industrial customers who are currently outside our supply area.

29.4.4 In any of these circumstances, we will need to increase the volume of water we put into supply.

29.4.5 To meet growth related needs, we maintain licences to abstract significant additional volumes of groundwater from the Magnesian Limestone aquifer. This includes headroom on our existing groundwater sources as well as licences for groundwater sources that we have yet to commission.

Appendices

Appendix 1 - WRP tables

Appendix 1 - WRP tables

The Water Resource Planning (WRP) tables are available on request. Please email the following:

Supply/DemandStrategyTeam@anglianwater.co.uk

Appendix 2 - Improvement plan

Appendix 2 - Improvement plan

Overview

As part of publishing our 2010 WRMP, we were directed by the Secretary of State to make improvements to our supply-demand planning process. This included updating or amending the following:

- The way we forecast population and property growth
- Our approach to assessing the impact of climate change
- The way that we work with the Environment Agency to assess the possible future impact of sustainability reductions
- Our use of consumption monitoring and micro-component analysis
- Our economic modelling, and
- The way that we track the demand effect of our water efficiency and metering campaigns.

Since publication, we have been working to make these improvements. Details have been reported in each Annual Review of our 2010 WRMP and are summarised below.

Population and Property Forecasting

Our population and property forecast for the 2010 WRMP combined the following elements in a top-down disaggregation of growth projections:

- Base year planning zone level water balance data, including estimates of measured and unmeasured population and properties derived from Office of National Statistics (ONS) and billing data respectively. A planning zone (PZ) is a sub-RZ level planning unit previously used for supply-demand investment modelling, and
- ONS based Local and Unitary Authority (LAUA) projections of population and property growth.

The resulting PZ level projections were subsequently amended using data from a study completed by Experian. This used the population and property forecasting methodology recommended in the WRP guideline for the 2010 WRMP. For the WRP planning tables, the PZ level projections were then aggregated to RZ level.

The concern expressed with this approach was that the PZ level forecasts were constrained by the regional forecast and so may not have adequately reflected local growth issues. For our 2015 WRMP, we have amended our process in the following way:

- We have developed our own GIS based approach for mapping ONS population and property projections directly to RZ level. This uses the methodology recommended in the current WRP guideline and forms the basis of the RZ level forecasts that we use
- Our regional population and property growth forecast is now developed from these RZ level projections, and
- Our final RZ level projections are checked for reliability by comparison with the following:
    - The current LAUA growth projections

- Annual Monitoring Reports (AMRs). These are developed from LAUA growth data and confirm recent trends in actual build-rates at LAUA level, and
- A series of population and property growth scenarios that have been developed for us by Edge Analytics. These use the POPgroup suite of forecasting tools, which are used extensively in LAUA planning.

As before, our base year data is derived from the planning zone level water balance data, which we also use for annual leakage and Security of Supply Index (SoSI) reporting. In this, population and property numbers are estimated using a combination of the following:

- ONS 2010 mid-year population estimates
- Billing data, and
- Occupancy rate survey data.

Through these improvements, local growth issues are more accurately reflected in our current draft plan.

Climate Change

Although we assessed the potential impact of climate change on both supply and demand for our 2010 WRMP, concerns were raised over:

- Our use of a methodology for assessing impacts on supply that was different from the one recommended. This resulted in the more extreme possible outcomes being excluded from our assessment
- We took no account of climate change related uncertainties in target headroom, and
- The planning tables we prepared contained no climate change related data.

For our 2015 WRMP we have applied the recommended approach for assessing climate change impacts and we have complied with the requirement in the WRP guideline for developing climate change related target headroom requirements. Our analysis is based on UKCP09 data and all of the outputs from our work are reported in our WRP tables. Our portfolio of climate change related work includes:

- Preliminary RZ level climate change vulnerability assessment
- A joint study with the Environment Agency to pilot a technical approach to assessing climate change impacts on deployable outputs (DO)
- Using this, an assessment of climate change impacts on the DO available from our groundwater and surface water sources. These have been estimated using the “high vulnerability” methodologies specified in the current WRP guideline, and
- An assessment of climate change impacts on demand. These are derived from the recommended methodologies.

In addition, we are in the process of completing longer term climate change projections for use in our WREA project. These are based on the 2050s and are focused on our more vulnerable surface water systems.

To help us model the impact of the different climate change scenarios, we have used a new strategic model of our supply system. This represents sources of supply and centres of demand as well as the strategic network links between the two. We have also used this model to assess RZ integrity, model different level of service and sustainability reduction scenarios and to develop our unconstrained and feasible option sets.

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Appendix 2 - Improvement plan

Our ability to assess and report climate change vulnerabilities is thus greatly enhanced relative to our 2010 WRMP and complies with the requirements of the current WRP guideline.

Sustainability Reductions

Our 2010 WRMP contained only minor sustainability reductions and made no detailed reference to the impact of likely significant future reductions. As a consequence, the potential impact of the Environment Agency's restoring sustainable abstraction (RSA) programme was poorly described.

For the 2015 WRMP, the WRP guideline is much clearer about how the impact of sustainability reductions should be accounted for. The recommended approach is based on scenario testing and the development of strategies for mitigating the associated supply-demand risk. To help us implement this approach we have:

- Worked closely with the Environment Agency to understand what sustainability reductions risks we are exposed to, and
- Developed a strategic model of our system that we have used to test different sustainability reduction scenarios and develop schemes for mitigating the associated risks.

Details of sustainability reductions continue to emerge from the Environment Agency and there is significant uncertainty about the impact of (a) a residual group of possible reductions which are currently referred to as "unknown", and (b) reductions which may be required under WFD no-deterioration requirements. Despite the challenge posed by these, our new approach means we are much better placed to understand supply-demand risk from sustainability reductions than we were during the preparation of the 2010 WRMP.

Demand forecasting and option appraisal

Demand forecasting

For our 2010 WRMP we completed a regional micro-component forecast for our measured and unmeasured customers. In the WRP tables, this was applied to each of our RZs and no commentary was offered on the way that our customers were using water or how this might change in the future. We were criticised for this omission.

Since the 2010 WRMP we have undertaken a complete review of our approach to micro-component forecasting. This has involved recruiting additional resources and completing the following:

- A review of our existing domestic consumption monitoring programmes to identify if these can be used to support our micro-component analysis. This included the collation and review of data from our long-standing G100 micro-component survey and a review of our existing micro-component model. The purpose of this work was to determine if the data we are collecting is:
    - Reliable, accurate and representative of our current customer base, and
    - Suitable for our future micro-component needs.

- Arising from the above, our new survey of domestic consumption (SODCON) and AMP5 water efficiency campaigns are now supported by a full micro-component questionnaire.

In the future, these will be used to develop robust ownership, frequency and volume (OFV) data at RZ level. This will eventually replace the G100 data we currently use in our micro-component analysis

- A review of the micro-component data available from industry, the Market Transformation Programme (MTP) and other sources, and
- Preliminary analysis of 5 minute data from our new SODCON to determine the feasibility of using this to improving the OFV routines in our existing micro-component model.

Using our existing micro-component model and base year water balance data, we have completed a RZ level base year micro-component analysis for both measured and unmeasured customers. This has been validated using micro-component data collected from other sources. We have also prepared equivalent RZ level micro-component forecasts. Through the completion of these works we now have a much better idea of:

1. How our customers are using water and how this varies across the region
2. How these patterns of consumption are likely to change over time
3. What opportunities are available for reducing consumption in line with Government policy, and
4. What additional work is needed to further develop our approach to micro-component analysis and micro-component forecasting.

Relative to our 2010 WRMP, this represents a significant improvement in our demand forecasting capabilities.

Option appraisal

For the 2010 WRMP we used our existing forecasting and economic appraisal model FORWARD to forecast deficits and select the least-cost options for maintaining the supply-demand balance.

Using FORWARD, a robust combination of supply-side and demand management schemes were promoted in our 2010 WRMP. Despite this, concerns were raised in respect of:

- The inability of FORWARD to report average incremental cost (AIC) or average incremental and social cost (AISC) data for options that were not selected, and
- Our ability to validate the model output and to convert this accurately and reliably into the data required in the WRP tables.

In response and for the 2015 WRMP, FORWARD has been replaced with the following:

1. A strategic MISER model of our supply system: this has been used to assess RZ integrity, model different supply-demand scenarios, help develop unconstrained options for maintaining the supply-demand balance and validate the output from the EBSD optimiser
2. A new EBSD optimiser: this has been developed by University College London (UCL) to meet the following requirements:

    - Enable application of the “Economics of Balancing Supply” least-cost optimisation process
    - Meet the WRP guideline specification for optimisation which is based on 80-year discounted costs, scheme utilisation and an average weighted demand, and

3. Models which support a robust decision making (RDM) approach to long-term water resource planning. We are developing these collaboratively with other water companies in the region and the Environment Agency (see WREA project, Section 9).

This combination of new models improves the transparency of our option development and appraisal process and is a significant improvement on the FORWARD based approach we used for the 2010 WRMP.

Consumption Monitoring

Prior to the 2010 WRMP we discontinued use of our historic SODCON. We did this because it was expensive to maintain and because we had developed a model capable of predicting per capita consumption (PCC) and micro-component use from customer and weather data (our PCC MC model).

While not criticised for this directly, we have since found that the PCC MC model is not adequate for all of our needs. As a result, we have decided to invest in a new SODCON. This is based on a sample of a 1000 measured and 1000 unmeasured household customers from whom we will collect consumption data at 15 minute intervals. From a sub-sample of 400 of these, the data will be collected at 5 minute intervals.

We have now completed recruitment of the survey population and are collecting data from them. In combination with the micro-component aligned questionnaires described above, we are using the SODCON data to:

- Validate our sub-RZ level water balance data, including our estimates of leakage, measured household PCC, unmeasured household PCC, peaking factors and dry year uplift
- Determine the feasibility of developing new micro-component models, and
- Update our existing PCC MC model.

Since we had no large-scale consumption monitor prior to the 2010 WRMP, the current SODCON programme and our commitment to future improvement of our PCC MC model is a significant improvement.

AMP5 Demand management projects

In our 2010 WRMP Improvement Plan, we gave a commitment to track implementation of our AMP5 (2010-15) demand management projects and to estimate the water savings that result from them. In response, we now operate two demand management databases:

- A water efficiency database for tracking delivery of our AMP5 sustainable economic level of water efficiency (SELWE) campaign. This logs water efficiency audits and the installation of water efficiency devices, from which water savings are estimated, and
- An enhanced metering database. This records the installation date for meters installed as part of our AMP5 enhanced metering programme, as wells as a series of subsequent meter reads. For customers who do not opt to switch immediately, these are used to estimate the volume of water saved on switching.

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Appendix 3 - Technical approach

Appendix 3 - Technical approach

Key Points

- In all key respects, our technical approach complies with the requirements of the WRP guideline and associated technical documents.
- The schemes selected for our 25 year plan have been chosen using the approach given in the Economics of Balancing Supply and Demand (EBSD). This includes scheme optimisation based on average weighted demand, utilisation forecasts and an 80 year discount period.
- The plan selected using the EBSD approach has been assessed to determine sensitivity to different climate change, sustainability and levels of service scenarios.
- For our longer term strategy, we are developing an approach based on robust decision making or RDM. RDM differs from the EBSD approach in that it selects schemes and investment portfolios that perform well over a wide variety of scenarios rather than optimally in a few. This allows for a more detailed assessment of risk and is better suited for planning where the long-term uncertainty is significant and the schemes which may be required are expensive.

Resource Zone Integrity

For the 2015 WRP guideline, the Environment Agency confirmed its definition of a water resource zone and published a methodology for assessing integrity (“A proposed approach to ensuring water company water resource zones are integrated”, Environment Agency, 2011).

In response, we reviewed the integrity of our 2010 WRMP RZs. This work was completed in accordance with the new methodology and included the following:

- Stage 1: Assess the integrity of existing RZs using criteria based on scale, connectivity, sources and transfers
- Stage 2: Where appropriate, identify new RZs or modifications to existing RZ boundaries, and
- Stage 3: Complete workshops with stakeholders to test the new RZ boundaries.

Stage 1 was completed using the recommended decision tree approach. Where appropriate, the work was supported by use of our new strategic MISER model. This allowed for the effect of sub-RZ level supply-demand balances and connectivity to be assessed. In summary, recommendations from the project included:

Existing RZs that should be split:

- Ruthamford
- East Suffolk and Essex,and
- Fenland.

Existing RZs that should be aggregated

- Lincolnshire and South Humberside (west), and
- Lincolnshire Coastal, Lincolnshire Fens and South Humberside (east).

Existing RZs that should stay the same:

- Hartlepool
- North Norfolk Coast, Norwich and the Broads, Norfolk Rural, and
- Cambridgeshire and West Suffolk.

We have adopted these recommendations in full and so the number of RZs we report has increased from 12 to 15. Details of the work are given in the Atkins report "Review of Water Resource Zone Integrity" Final Report, February, 2013. The changes are illustrated in the figures below:

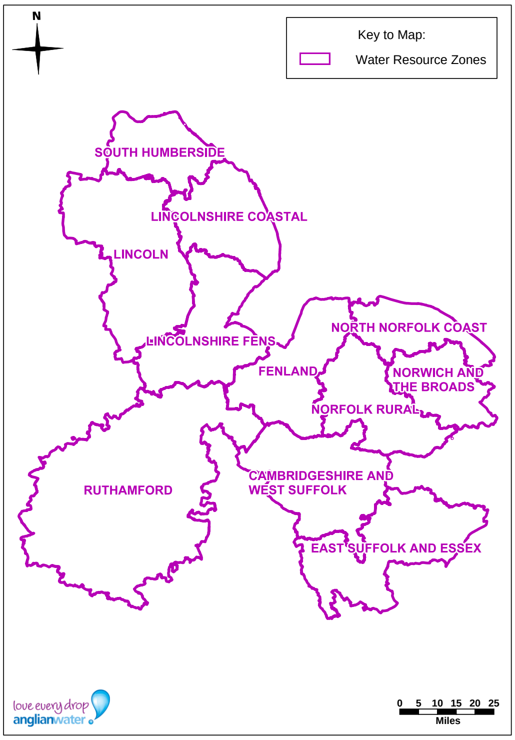

Figure .1 WRMP 2010 RZ boundaries

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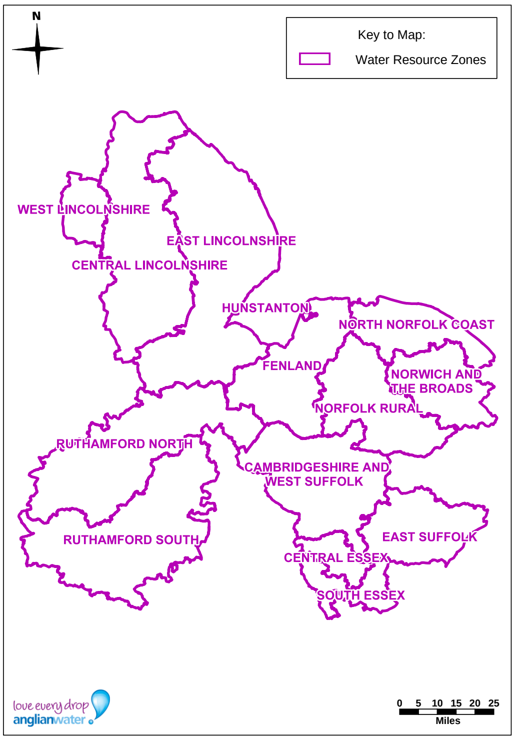

Figure .2 Draft WRMP 2014 RZ Boundaries

Further assessment for the revised draft WRMP led to the Cambridgeshire and West Suffolk RZ being split into the following RZs:

- Ely
- Newmarket
- Cheveley
- West Suffolk, and
- Sudbury.

The revised changes are illustrated in the below figure:

Figure .3 2015 WRMP RZ boundaries

Demand Forecasts

For our 2015 WRMP, we have updated our approach to demand forecasting. The key improvements include:

- The calculation routines are now contained in a series of spreadsheets and so are accessible for review and comment. This is a significant improvement on the previous approach, where the routines were encoded in our supply-demand forecasting model FORWARD and so could not be viewed directly
- The calculation routines have been designed to feed directly into the WRP tables. Again, this improvement makes reviewing our forecasts easier and our process more transparent
- The property and population forecasting routines that are used are based on the bottom-up projection methodology given in the current WRP guideline. These GIS-based routines replace the top-down disaggregation that was used previously, and
- For selected RZs, the top-down routines for modelling switching from unmeasured to measured supplies have been replaced with a bottom-up approach.

The forecast that we have developed is based on the 2010 mid-year trend projections published by the Office for National Statistics (ONS). In combination with other data, this is processed in a number of areas in our business including:

- Leakage Team - The Leakage Team is responsible for producing the water balance data used in our annual returns to Ofwat and the Environment Agency. These were formerly contained in Tables 10a and 10b of the June Return. The water balance data includes the following, which is used directly in the base year of our RZ level forecasts:

    - Distribution input by measured and unmeasured household and non-household segments
    - Property numbers for all segments
    - Void property numbers for all segments
    - Population for all segments, and
    - Leakage, including distribution losses and estimates of customer supply-pipe leakage

- Income and Tariffs Team - The Income and Tariffs team provide data on regional trends in consumption, new development and selected other parameters. These include:

    - A forecast of the number of new properties in our region in the short term. This is apparent as a "market adjustment" to the ONS based trend projections, and
    - The overall ambitions of the business for reducing levels of domestic consumption. In the RZ level forecasts this is apparent as a reduction in rates of household consumption from baseline levels of water efficiency and metering activity.

The data supplied by each of these teams are assembled in an input database and then used to drive the calculations which produce our RZ level forecasts. These are validated using a combination of the following:

- Data on rates of new development from Annual Monitoring Review (AMR) reports and LAUA policy based projections
- A report on the form of the market adjustment, and
- A report giving a variety of RZ level scenarios for population and property growth.

Dry Year Annual Average and Critical Period Forecasts

To determine our dry year annual average (DYAA) and critical period (CP) demands, we used the approach we used for our 2010 WRMP. This is based on an analysis of historic trends in climate and demand data using our PCC-MC model. This is a regression based model, developed using data from our original SODCON and G100 consumption monitors. For our DYAA and CP analysis, it is used to produce estimates of measured and unmeasured PCC and MC use from customer and weather related data.

To derive the dry year uplift (DYU) and peaking factors (PF), the following elements of the "Peak Water Demand Forecasting Methodology" (UKWIR, 2006 Ref: 06/WR/01/7) are used:

- Normalisation: the process of obtaining a long-term or representative average demand, and
- Re-basing: the process of estimating what a reference peak demand would be if it occurred in the base year, with the base year customer profile.

Our DYU is calculated at company level using rebased mean annual PCCs from the PCC MC model. From these, a reference dry year is identified along with a number of other dry years. The dry years are then excluded from the record and a long-term average PCC estimated. Two measurements result from this:

1. "Pure" dry year uplift: the difference between the long-term average PCC and the reference dry year PCC, and
2. Base year dry year uplift: the difference between the base year average PCC and the reference dry year PCC.

In our analysis, the reference dry year is 1995. Other dry years that are excluded from the Pure DYU analysis include 1996, 2003 and 2006.

Since the Base year DYU is calculated from household demand data, applying it to a demand forecast including non-household consumption and leakage would over-estimate the dry year effect. For this reason, it is assumed that non-household consumption and leakage are unaffected by dry years and that DYU can be applied as a proportion of that calculated for household customers. For planning purposes this is assumed to be 50% - representing the approximate split between household demand and a combination of non-household demand and leakage. From this, a DYU of 1% on household demand is applied as a DYU of 0.5% on total demand.

Our PFs are calculated at RZ level using re-based PCCs from the PCC-MC model and distribution input (DI) data. The CP is 3-day average peak demand, corresponding to observed peak demands and operational constraints. Steps in the calculation process include:

- Estimates of measured and unmeasured household PCC are used to determine the “peak year” and equivalent company level dry year peaking factors for each of these segments
- These are combined with RZ and company level DI data to estimate RZ level peaking factors for each segment
- These separate household peaking factors are then multiplied by equivalent consumption data from the peak year June Return to estimate actual volumes of peak demand for each segment in each RZ, and
- This is subtracted from the total peak demand in the RZ in the peak year and the residual assigned to peak measured non-household demand. From this a measured non-household peaking factor is calculated.

The separate household and non-household peaking factors are then applied to DYAA demands to produce equivalent CP demands. The peak year selected for the analysis is 2006.

Weighted Average Demand and Utilisation Forecast

We have used both weighted average demand and a utilisation demand in our EBSD optimiser. These have been derived from analysis of the dry year uplifts reported in our June Returns. Table 3.1 comprises of the following:

Year	Dry Year Uplift	Dry year designation
2003/04	1.0000	Dry
2004/05	1.0125	
2005/06	1.0000	Dry
2006/07	1.0000	Dry
2007/08	1.0100	
2008/09	1.0149	

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Year	Dry Year Uplift	Dry year designation
2009/10	1.0200	
2010/11	1.0133	
2011/12	1.0096	
2012/13	1.0200	

Table .1 June return dry year uplift factors

From this, a weighted average demand equivalent to 99.11% of the DYAA demand is estimated. This value has been used in the EBSD optimiser.

The same data is used in our utilisation forecast. In this there is no adjustment for normal or dry year water available for use (WAFU), as our WAFU estimates are based solely on performance in dry years.

Micro-component Analysis (MCA)

Our micro-component analysis has been completed in two parts:

- Analysis of the base year measured and unmeasured PCCs that are reported in our
- 2011-12 Annual Yearbook, and
- Development of our micro-component forecast.

In completing this work we have made extensive use of our PCC-MC model. Summary details of the two processes are given below:

Base Year Micro-component Analysis

Our base year micro-component analysis is consistent with the intermediate tier of good practice specified in the recent UKWIR report ("Customer Behaviour and Water Use- A good practice manual and roadmap for household consumption forecasting" UKWIR,v2012 Ref: 12/CU/02/11). The analysis reconciles RZ level PCC to concession level PCC MC outputs. We have three concession areas in our region, Ruthamford, Lincolnshire and the eastern counties and the MCC PC data for these helps us to explain regional patterns in water use. Steps in the analysis include:

- Base year concession level micro-component demands are calculated using the PCC-MC model. The model produces daily total PCC and associated micro-component consumption which is adjusted to take account of meter under registration (MUR), and
- RZ level measured and unmeasured PCC from the base year are then reconciled with the equivalent concession level micro-component demands, producing a RZ level micro-component analysis for both measured and unmeasured customers.

Outputs include use by the following sub-categories:

- Hand basin use Toilet flushing Shower use Bath use
- Kitchen sink use
- Dishwasher use

- Washing machine use, and
- Outdoor use.

In the WRP tables these are grouped into the following and given by RZ:

- Outdoor use
- Toilets
- Personal use
- Clothes washing
- Dishwashing, and
- General use.

Forecast

Our micro-component forecast is consistent with the UKWIR CU02 low tier of good practice. This reflects the use of non-company data in the supporting analysis.

The forecast is based on changes thought likely to occur over two periods: from 2010 to 2030, reflecting the short to medium term and 2030 to 2040, reflecting the long-term. Data from a variety of sources was used to inform the assessments, including from the MTP, ONS, Waterwise, UKWIR and other water company WRMPs. Steps in the process included:

- The percentage change per micro-component for the period 2010-30 was applied to the base year micro-component data and then adjusted to align with the concession level PCC
- A similar process was completed for the 2030-40 data, and
- The resulting concession level 2010-40 micro-component forecasts were reconciled to equivalent RZ level PCC data.

The forecast was then assessed to determine if the model changes in consumption were plausible and consistent with those forecast using projected changes in consumption from baseline water efficiency and metering activities.

Deployable Output and Levels of Service

For the 2015 WRMP we have systematically reviewed the average daily source works output (ADSO) and the maximum daily source works output (MAXSO) for each of our water treatment works (WTWs). In this, we have taken account of the following:

- Implementation of any new resource schemes
- Work undertaken at WTWs that may have affected ADSOs and MAXSOs, and
- The performance of our system and associated resources during the recent drought.

In accordance with recent guidance from UKWIR ("Water Resource Planning Tools 2012: Summary Report" UKWIR, 2012, Ref: 12/WR/27/6), Deployable Output Report), the review was based on the following:

- A DO assessment framework. For us, this included:
    - An initial desk-top study Source to WTW profiling WTW trials
    - Validation of the resulting DO assessments through consultation with Regional Supply Managers, Supply Managers, Water Resource Team and Asset Planning Teams

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- Evaluation of the following constraints:
    - Licences
    - Hydrological and hydrogeological yield
    - Pumping capacity and infrastructure, including outage requirements
    - Water quality
    - Ecological needs including hands-off flows (HOFs), sustainability changes and terms in conditional licences, and
    - Historic demands and outputs from sources, and

- A DO assessment confidence level. For the majority of our WTWs this is high. For a limited number of WTWs, however, issues arising from capital maintenance and the quality of the data used to estimate yields are significant and so these have been graded as medium level of confidence. None of our reported DOs warrant a low level of confidence.

The potential yield available from our groundwater sources is assessed using the established UKWIR methodology ("A Methodology for the Determination of Outputs of Groundwater Sources" UKWIR, 1995 Ref: 95/WR/01/2). The yields available from our surface water systems were assessed in accordance with the new UKWIR WR27 methodology ("Water Resource Planning Tools 2012: Summary Report" UKWIR, 2012, Ref: 12/WR/27/6). This included:

- Recalibration of rainfall-run-off models
- Updated operational details
- Improvements in rainfall data series
- Extension of the available hydrological record to include the 2011/12 drought, and
- The inclusion of seasonal demand factors in direct intake analysis. Levels of service (LoS).

To maintain supplies during extended periods of dry weather, we may periodically act to restrict demand. The frequency with which these are applied is referred to as our "levels of service" (LoS). These include the following:

- Hosepipe bans on average once in every 10 years
- Temporary use bans on average once in every 40 years, and
- Rota cuts and standpipes on average once in every 100 years.

In recent guidance from the Environment Agency, it is recommended that the use of rota-cuts and standpipes is no longer considered. While, for technical reasons, this has limited impact on the supplies we have available in our system, much more significant effects would arise if our customers told us that they wanted to see the remaining restrictions reduced or removed.

Our LoS are used to calculate the yield available from our reservoir sources. For these, hydrological sequences, demand forecasts and levels of service demand restrictions are modelled to determine the yield that can be sustained from the reservoir during critical dry weather or drought periods. The critical period varies for each reservoir; the yield is that which can be sustained without the level in the reservoir falling to some pre-determined minimum level. Since the purpose of the LoS restrictions is to conserve water supplies during extended periods of dry weather:

- Lower LoS are typically associated with more frequent restrictions and higher yields, and
- Higher LoS are typically associated with less frequent or no restrictions and low yields.

For our reservoir systems, in which it is possible to conserve water by applying restrictions, we model the following LoS scenarios:

- No restrictions
- Our planned LoS. These currently comprise:
    - Hosepipe bans 1 in 10 years
    - Bans on non-essential use 1 in 40 years, and
    - Rota cuts and standpipes 1 in 100 years
- EA reference LoS. These include:
    - Hosepipe bans 1 in 10 years, and
    - Bans on non-essential use 1 in 40 years.

For our groundwater sources, we are currently evaluating a methodology for assessing the effect of LoS restrictions on stored water volumes and yield. Preliminary results suggest that the effect is marginal and subject to significant uncertainty.

For our direct intakes, yields are currently assessed using the lowest available historic flow and any associated licence constraints. These vary for each intake. Since there is little water stored in a run-of-the-river system, the concept of level of service is not directly applicable.

In practice, any restrictions that are required are typically applied to the whole of our customer base. This allows for simple messaging of the need to conserve water during extended periods of dry weather and so increases the effectiveness of those restrictions which have a direct benefit to our water supply operations. It also allows for the impact of any drought permits or orders to be mitigated.

Climate Change

The impact of climate change on the hydrological yield of our reservoirs and direct supply intakes was calculated following the WRP proposed methodology.

Climate change yield assessments for all of our groundwater sources were carried out using either the Environment Agency's regional models or a simpler lumped parameter groundwater model, depending on aquifer vulnerability and model availability. The potential impact on DO was then assessed.

Climate Change, Level of Service and Sustainability Reduction Scenarios

The baseline scenario in our WRMP comprises the following:

- Mean climate change impacts
- Reference levels of service, and
- Confirmed and all likely sustainability changes.

The WRP guideline requires testing to determine the sensitivity of our preferred plan to these and related assumptions. To complete this, we have used the following approach:

- Assess the possible future impact of climate change, sustainability reduction and changes to our LoS on the yield available from our sources
- Convert the yield impacts to impacts on DO
- Model the DO impacts on our supply-demand balance at sub-RZ level. This work is done in two parts using our strategic MISER model:
    - An assessment of the impact on our baseline supply-demand balance, and
    - An assessment of the impact on our preferred plan.

In completing this work, the following alternative scenarios have been modelled:

1. Climate change impacts:

- Worst case (surface water) and 1st percentile (groundwater)
- 25th percentile (surface water) and 10th percentile (groundwater) Median (surface water) and 50th percentile (groundwater), and
- Mean (surface water) and 50th percentile (groundwater).

2. Sustainability Reductions:

- All likely and confirmed sustainability changes
- All likely and confirmed sustainability changes with residual risk
- Confirmed and likely (1) sustainability changes
- Confirmed and likely (1) sustainability changes with residual risk
- Confirmed and likely (1) and (2a) sustainability changes
- Confirmed and likely (1) and (2a) sustainability changes with residual risk
- Confirmed and all likely with likely unknown sustainability changes
- Confirmed and all likely with likely unknown sustainability changes and residual risk
- Residual risk for all works against 2003-07 average annual abstraction
- Confirmed and likely (1) and (2a) sustainability changes with residual risk against
- 2003-07 average annual abstraction
- Residual risk for all works against 2009-12 average annual abstraction
- Confirmed and likely (1) and (2a) sustainability changes with residual risk against, and
- 2009-12 average annual abstraction.

Residual risk refers to a situation in which growth in demand from a source triggers an increase in abstraction which may trigger WFD no-deterioration requirements.

3. Levels of Service:

- More frequent hosepipe bans
- Less frequent hosepipe bans
- More frequent bans on non-essential use
- Less frequent bans on non-essential use
- More frequent hosepipe and non-essential use bans, and
- Less frequent hosepipe and non-essential use bans.

4. Combination Effects:

- Worst case climate change, all known, likely and unknown sustainability changes and residual risk, and
- Best case climate change, all known and likely sustainability changes and levels of service improvements.

The results of the scenario testing are referenced both in the regional supply-demand summary and the RZ summaries.

Target Headroom and Outage

Our target headroom and outage model has been updated for the 2015 WRMP, so that the full range of uncertainty associated with each of our RZ level forecasts can now be easily explored.

The calculation routines in the new model are the same as those developed for our PR09 supply-demand submission and 2010 WRMP. For these, model development has been guided by the following:

- Uncertainty and Risk in Supply/Demand Forecasting (UKWIR, 2003 Ref: 03/CL/09/1), and
- An Improved Methodology for Assessing Headroom (UKWIR, 2002 Ref: 02/WR/13/2).

The approach we use is based on a probabilistic balance of supply. This concept is introduced in the 2002 UKWIR report and is consistent with the "Intermediate Framework" referred to in the EBSD (NERA, 2002). The uncertainties that are modelled include:

Household Demand

- Overall base year household demand
- Total population Unmeasured PCC growth Measured PCC growth
- Total number of customers who switch from unmeasured to measured supplies
- ("switchers"), and
- Demand effect of switchers.

Non-household Demand

- Overall base year non-household demand
- Overall base year leakage
- Non-household growth uncertainty, and
- Weather related leakage uncertainty.

Supply Forecast

- Climate change, and
- Long-term point source pollution.

Outage Requirements

- Short-term point source pollution (outage), and
- Short term asset failure.

In our supply-demand modelling, the forecast of available supplies is based on the following:

Deployable output

This is the amount of water that can be produced at each of our water treatment works. This is a function of one or more of the following:

- Yield from the source
- Water quality
- Abstraction licences
- Treatment capacity, and
- Downstream constraints.

Outage

This is an allowance which is made for temporary and unplanned periods when a water treatment works is unable to put water into supply. From these:

Water available for use (WAFU) = (deployable output – outage)

For the Draft WRMP we completed a historical assessment of outages at our WTW (Technical Memorandum, November 2012). We also reviewed the available guidance on outage allowances. From "Uncertainty and Risk in Supply Demand Forecasting" (UKWIR, 2003), these may include:

- Water quality events, including:
    - Pollution
    - Turbidity
    - Nitrates
    - Algae
- Power failures, and
- Other forms of system failure.

From the review, annual outages as a % of the average daily source-works output (ADSO) at RZ level have varied between 0% and 12.5%, with an average of 6.6%. In a single instance a 100% outage was reported in the Hunstanton RZ. This was in 2006 and lasted for 6 days. Reasons given for the outages include:

- Unscheduled cleaning or maintenance
- Removal for supply for operational reasons, and
- Plant repairs.

Plant removal for operational reasons is the commonest cause of outage. Unfortunately, few details are recorded which describe the nature of these.

To forecast outage allowances in our supply-demand modelling, we use our probabilistic supply-demand balance model, HOURUS. HOURUS was developed for PR04; used again for PR09 and has been updated for PR14. It calculates outages allowances at RZ level.

In HOURUS, two sources of short-term WTW failure are modelled:

1. **Short term water quality events:** these risks are estimated separately for ground water and surface water sources and take account of the particular vulnerabilities of

each source. The model calculates the expected number of failures per year and then converts this into an equivalent impact on ADSO and MAXSO, and

2. **Short term asset failure:** these risks are assumed to be uniformly distributed and modelled so that they are typically rare events. Again, failures resulting from short term asset failure are converted into an equivalent impact on ADSO and MAXSO.

The outages estimated using HOURUS are typically of the order of 4% to 6% of distribution input.

For the 2015 WRMP our baseline target headroom requirements are derived from the 5th percentile of the probabilistic water balance. This means that at the point when an RZ goes into deficit, there is a 5% probability of target levels of service not being met.

The impact of climate change on deployable output (DO) was first determined by source for the 2030s using 100 sub-samples for surface water sources and 20 sub-samples for groundwater*. These impacts by source were subsequently aggregated into a set of sub-samples by zone, and then a single average DO impact figure was calculated from those resulting sub-samples. This average figure was scaled for individual years using scaling equations 1 and 2 from the WRP, and was then subtracted from DO line of the headroom model. The difference between the mean impact and the impact for each of the 20 or 100 sub-samples was calculated, giving a set of 20 or 100 figures that gave the range of impact (normalised around zero). The set of 20 or 100 figures (with corresponding equal probabilities) was used to create a discrete distribution in the headroom model and then run as a Monte Carlo simulation with the other headroom risks.

Leakage

For our 2015 WRMP, we have developed new models for assessing leakage performance and economics. These are based on the sustainable economic level of leakage (SELL) and are fully integrated with the rest of our supply-demand forecasting and option appraisal process. This integrated approach is identical to that used for our PR09 supply-demand submission and 2010 WRMP.

The new models have been developed from analysis of recent leakage and leakage-reduction performance data. The model outputs include:

- A baseline leakage forecast at RZ level
- A projected cost for maintaining this
- A leakage option cost-curve for each RZ. This specifies the Capex and Opex required to achieve a number of incremental reductions in levels of leakage and includes an assessment of the related uncertainties, and
- The external costs associated with the leakage option cost curve. This includes environmental, social and carbon external costs.

The leakage control options modelled include active leakage control, pressure management and targeted infrastructure renewal. These have been developed on the basis of the following:

- Active leakage control options: from the approach described in the recent “Best Practice for the Derivation of Cost Curves in ELL Analysis” (UKWIR, 2011 Ref: 11/WM/08/46)
- Pressure management options: from a combination of the costs and benefits of schemes already delivered along with modelling of the potential for individual new schemes, and
- Infrastructure renewal options: from targeting the highest leakage areas of those DMAs with the greatest leakage-reduction potential.

Appendices
Appendix 3 - Technical approach

The costs and benefits of the individual options have been packaged at RZ level using a leakage component model. This is based on well-established burst and background leakage estimation (BABE) principles.

Option Appraisal

We have structured our option appraisal process on the unconstrained, feasible and preferred model given in the WRP guideline. In accordance with this, for each of the deficits we have forecast we have:

- Developed a full, unconstrained list of demand management and supply-side options for maintaining the supply-demand balance
- Screened these to determine feasible options, and
- Undertaken an EBSD economic evaluation to determine the least cost option or combination of options for maintaining the supply-demand balance.

The development of our supply-side options has been informed by use of our new strategic MISER model. This was used to:

- Map the distribution of supply-demand risk at sub-RZ level, confirming RZ integrity
- For RZs in deficit, identify and model potential supply-side options including transfers and new resource developments, and
- For RZs in surplus, identify options that could be used to support a future export to an RZ in deficit.

The options selected for each RZ using the EBSD optimiser have been further tested by assessing sensitivity to our climate change, levels of service and sustainability reduction scenarios. Key stages in our process have included:

- June to July 2012: a preliminary assessment of sub-RZ level deficits followed by unconstrained option workshops with Asset Planning, Water Operations and the @One Alliance
- August 2012 to February 2013: completion of a series of planning studies to confirm the feasibility of the unconstrained options. As part of this process the screening criteria in Section 6.5 of the WRP guideline were used to reduce the list of unconstrained options. In this, no options were discounted on grounds of cost
- August 2012 to February 2013: during the period that the planning studies were being undertaken, an iterative process of validating and updating the demand forecast was completed. This resulted in some adjustments to forecast surpluses and deficits and the related need for schemes
- October 2012 to February 2013: during this period, similar iterations between the WRMP and SEA were also completed, enabling schemes with potentially damaging environmental attributes to be identified and then either discounted or modified
- February 2013: completion of the final feasible option set, including the development of Capex, Opex and carbon estimates for each scheme and use of the Benefits Assessment Guidance (BAG) approach to determine sensitivity to social and environmental costs, and
- February 2013: completion of the EBSD economic modelling and sensitivity testing of the preferred options.

To validate the results of our EBSD modelling, we have used the least cost optimisation routines in our new MISER model. Although simpler than our EBSD model, these provide some assurance that the most appropriate options have been selected.

Willingness to Pay

To help us understand what customers think about issues related to water resource planning, we are completing a detailed willingness to pay (WTP) survey. There are two elements to this:

- A qualitative survey, which is designed to gain customer views about topics such as:
  - Attitudes to water and its use
  - Different types of water restriction and their impact
  - Different sources of water
  - Water efficiency and sustainable water use, and
  - Our current mix of water resources

- The main (quantitative) survey. This is based on a series of choice experiments and examines, in more depth than the qualitative survey, customer attitudes to levels of service and the different options that are available for maintaining the supply-demand balance. These include:
  - Additional abstraction from rivers and new reservoirs
  - Desalination Metering Water reuse
  - Leakage reduction, and
  - Bulk transfers from other regions.

Appendix 4 - Trading discussion

Appendix 4 - Trading discussion

Trading and collaborative water resource planning

In respect of trading:

- We previously completed a joint planning exercise with Cambridge Water and Essex and Suffolk Water to identify trading opportunities in our region. The results were published in our "Trading Theory for Practice" report (November, 2011), and
- For the 2015 WRMP, we contacted water companies who have supply systems that border ours, exchanged details of our baseline supply-demand balance and discussed opportunities for trading supplies.

Arising from these, the trades in our plan include:

- Cambridge Water: one trade. This is for an AMP5 supply-demand scheme
- Affinity Water: a trade based on sharing the resources of Ardleigh reservoir. There are two elements to this – an existing trade which increases our take of the deployable output from 50/50 to 70/30 and a future trade which would extend this to 80/20, and
- Severn Trent Water: we are developing an option to trade the resources we currently share from Rutland Water. Confirmation of the requirement for this and the feasibility of delivery will be determined for the final draft version of this plan.

From our work on trading, it is clear that our ability to make trades could be constrained by the sustainability reductions that need to be made. In addition to confirmed and likely reductions, we are at significant risk from unknown reductions and from reductions to comply with WFD no-deterioration requirements. These could affect trades that increase abstraction from previously under-utilised sources.

As well as our work with other water companies, we are also working on other projects that are likely to increase water trading. These include:

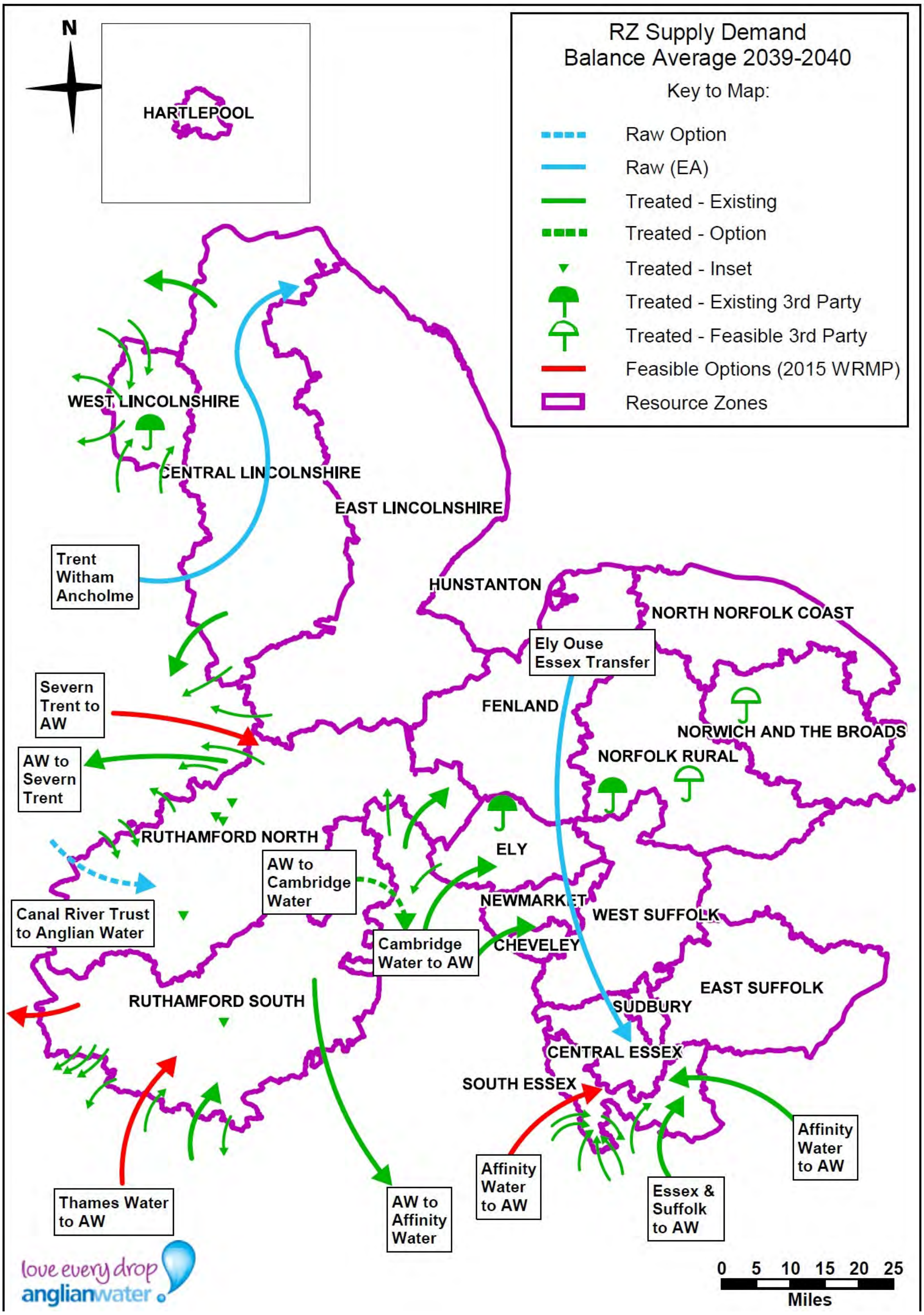
- A pilot trading related project with the Cambridge Programme for Sustainability, and
- Leadership (CPSL). This was based on the catchment of the River Ouse.

A project in the Wissey catchment to determine how to optimise use of the available resources, including how to mitigate drought risk.

Details of all of our current trades and trading options considered as part of this plan are given in Figure 4.1.

Appendices

Appendix 4 - Trading discussion



4.1 Transfers, existing trades and trades considered as part of the plan

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