Dŵr Cymru
Welsh Water

Revised Draft Water Resources Management Plan 2024

June 2023

dwrcymru.com

Contents

Executive Summary (The Executive Summary has been updated in line with amendments made to the Plan between draft and revised draft Plans)

A. Introduction

i. Our Vision

Dŵr Cymru Welsh Water provides an essential public service to over three million people across most of Wales, and adjoining parts of England. We are the sixth largest of the ten regulated water and sewerage companies in England and Wales and are unique in that we are a not-for-profit business with no shareholders. This means we are guided solely by what is in the best long-term interests of our customers and the environment.

We have recently updated our Welsh Water 2050 vision document with a mission statement 'to become a truly world class, resilient and sustainable water service for the benefit of future generations'. The strategy describes our commitment to plan for the long-term, anticipating and responding proactively to the emerging risks and opportunities around our ability to deliver great service to customers and the environment, now or in the foreseeable future.

The service Welsh Water provides is essential to the health of people and the environment, and the normal functioning of everyday life. The Covid-19 pandemic has highlighted what we stand to lose when the services we often take for granted are disrupted by circumstances beyond our control. It is therefore essential that we do all we can to understand the risks to our service, mitigate them, and ensure that they remain at an acceptable level.

We are committed to working closely and collaboratively with the Welsh Government, our regulators, and other stakeholders as 'Team Wales', all in the context of the Wellbeing of Future Generations Act. We have a clear vision in Welsh Water, which is to earn the trust of our customers every day. This will not be achieved by great customer service alone but by also understanding our customers' needs and expectations and building future plans to meet these.

The basis for planning water resources is laid out in specific Welsh Government Guiding Principles and joint regulatory guidance. These documents are built upon and are directly linked to Government and regulatory authority legislation and policy.

The Environment (Wales) Act 2016 and the Well-being of Future Generations (Wales) Act 2015 work together to create modern legislation for managing Wales' natural resources and improving its social, economic, environmental, and cultural well-being. Together with the Planning (Wales) Act 2015, they form part of a wider initiative to create a legislative framework for sustainable development to secure the long-term well-being of Wales.

ii. The Water Supply to our Customers

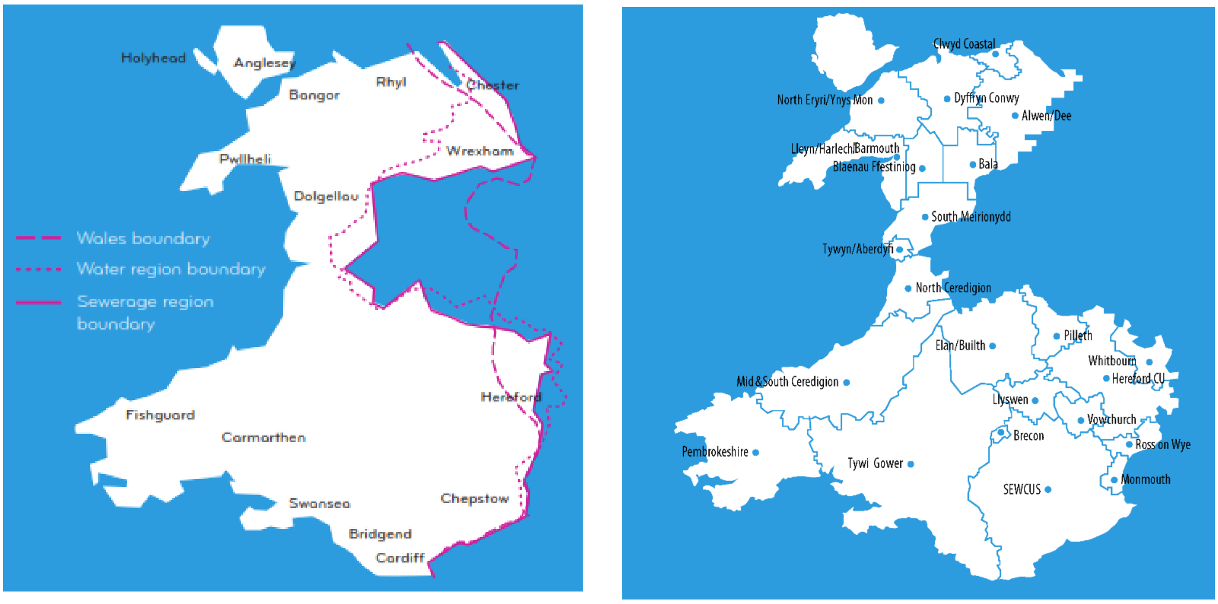
Over the last 25 years, the quantity of water we supply to our customers has reduced from an average of over 1000 million litres per day (Ml/d) to about 850Ml/d today. This is down to reduced leakage and reduced demand from heavy industry and our customers increasing appreciation of the value of their water supply and subsequent reduction in their usage. Around 80% of this demand for water is from the major cities and towns of south Wales around Cardiff, Swansea, Newport, Bridgend, Carmarthen, and the surrounding Valleys.

Wales has a significant amount of rain: we estimate that our infrastructure captures only some 3% of the effective rainfall, leaving some 97% for agriculture and the environment, compared to the southeast of England where up to 50% is used for public water supply. Most of our water is supplied from our impounding reservoirs although we abstract significant volumes from our lowland river sources such as those on the Rivers Wye and Usk in southeast Wales, the Rivers Tywi, Cleddau and Teifi in southwest Wales and the River Dee in north Wales. Groundwater accounts for less than five percent of our supplies at a Company level but at a local level, may be the whole supply.

On the face of it then, we should not have a water resources problem in Wales, however, we need to continually review the future pressures on our water supplies.

We take a progressive approach to Water Resource Planning as successive WRMP timeframes overlap so that each 5-year plan is an update of the last, based upon new drivers such as revised government or regulatory guidance, customer priorities and improved evidence.

We have 23 discrete water supply systems across our operating region which we call Water Resource Zones. These are defined by the extent of the supply network that share the water resources within each zone, whereby the customers in each zone have the same level of service in response to drought conditions. Our water resource planning is based upon these zones. The figures below show our region and our water resource planning zones.



Welsh *Water Resource Zone Boundaries*

i. The Water Resource Management Plan 2019

This Plan is built on our previous WRMP19 in which the key drivers were; the management of significant abstraction licence changes due to the implementation of the Water Framework and Habitats Directives, improvement to water resource resilience, and the mandating of demand management targets.

We set a target to reduce our overall company level of leakage by 15% by 2024-25 and we are on target to achieve this having made a c10.5Ml/d reduction already. Of equal importance was the setting of a longer-term target to reduce the average per capita consumption (PCC) to 110 litres per person per day (l/p/d) by 2050.

Although our average household PCC has risen a result of the Covid-19 pandemic through an increase in home working and schooling and the associated behavioural change, with society moving back to more normal practices we are seeing demand patterns return towards pre-pandemic levels.

We have progressed the schemes to resolve these deficits in all three zones and this year's drought has emphasised the need for the Pembrokeshire scheme, in particular. Due to the dry weather experienced between March and July that left storage in Llys-y-Fran at a low level we installed a temporary pumping scheme at Canaston Bridge, which will be made permanent in 2023 in line with our WRMP19 plan.

iii. Objectives and Principles for the WRMP24

The objective of this Plan is to ensure that Dŵr Cymru Welsh Water will always be able to provide sufficient water supply to meet our customers' demand for water over the next 25 years by making our water supply systems resilient to drought, particularly in light of a changing climate. The plan uses best available evidence to formulate a set of actions through analysing future risks and identifying how we might need to adapt to different future circumstances. We have been guided by our regulators, interested parties and our customers in selecting the most appropriate solutions to the challenges we face.

Based on, and in response to regulatory guidance, the key and principles in developing our WRMP24 are that it will:

- Align with Long Term Delivery Strategies and outcomes
- Make substantive improvement to water demand management performance to support long term environmental policy and supply resilience
- Demonstrate that Welsh Water has enough reliable water resource and treatment capacity to meet future demand over the next 25 years
- Meet revised Government targets with respect to drought resilience and use industry leading tools to assess our ability to meet these
- Account for the latest climate change science using UKCP18 datasets and industry thinking within our assessments
- Actively engage with stakeholders and our customers in considering investment decisions
- Secure enough water for the environment over the long term by taking account of current environmental obligations laid out by our regulators as a minimum requirement and considering wider environmental interests
- Take a 'best value' approach to decision making around solutions to problems
- Robustly test our plans against alternative scenarios and where appropriate take an adaptive planning approach to mitigate future risk
- Consider the options available for trading water with 3rd parties
- Build our Plan into, and maintain consistency with, the 'Water Resources West' Regional Plan

The regulatory guidance provided for this round of planning has some different aspects and approaches with a key request that we set ambitious targets around demand management and more specifically around leakage and support to customers in reducing their water usage. The objectives for this Plan are:

- Leakage – 10% reduction during AMP8, 50% reduction (from 2017/18) by 2050
- Per Capita Consumption – reduced to an average of 110 l/h/d during a dry year
- Business demand – an 8% reduction by 2050 (Normal year demand from a 2019/20 position)
- Drought resilience – achieve 1 in 200 by 2029/30 and 1 in 500 by 2039/40

To achieve our drought resilience targets we assess of our supply capability against the future demand for water. Where there is a deficit in capability, meaning that we have a lower level of resilience than required, then we examine both demand management and new supply options. We judge these not only on cost but their potential wider impact so that a 'best value' investment Plan is developed.

iv. Water Resource Resilience

Water resource resilience is a measure of our ability to meet demand during a specified severity of drought. This is assessed through a comparison of how much water resource we can rely on during a particular drought event compared to the expected demand for water from our customers at this time (known as the 'supply/demand balance').

Our current preferred level of service is to impose significant supply restrictions upon our customers, through an Emergency Drought Order (water rationing via standpipes/rota cuts) no more frequently than once every two hundred years, on average. i.e. the risk of these significant restrictions is no more than 0.5% each year.

The target for implementing Temporary Use Bans (formerly hosepipe bans) is once in twenty years on average and for non-essential use bans it is no more than once every forty years. Within the WRMP24 we set out how we plan to increase our level of drought resilience for significant restrictions to a 1 in 500 year on average standard (0.2% annual probability) within the 25 year planning period.

To understand the 'supply' element of the 'supply/demand balance' we calculate the amount of water we have available during a drought through system simulation using our water resource models. These provide a representation of our supply systems and allow us to understand their capability during drought. If this capability during a severe drought event, i.e. one that is likely to occur no more frequently than once every 500 years on average, is greater than customer demand plus leakage, then we have a Supply/Demand surplus and are resilient at that drought level.

We have gained far greater confidence in our understanding of drought resilience through a step change in the techniques we are now using. These being:

- The development of 60 new catchment models that better represent inflows to our reservoirs and rivers.
- Use of a new systems modelling platform, which provides a better representation of asset operation and demand
- The generation of 20,000 years of weather pattern data using statistical models to allow us to understand the impact and return period of drought events more severe than seen previously.

However, there is uncertainty around many of the factors used to assess both the supply capability within a water resource zone and the demand forecast and so, in addition, we add a factor within the supply/demand balances to account for this, known as 'Headroom'.

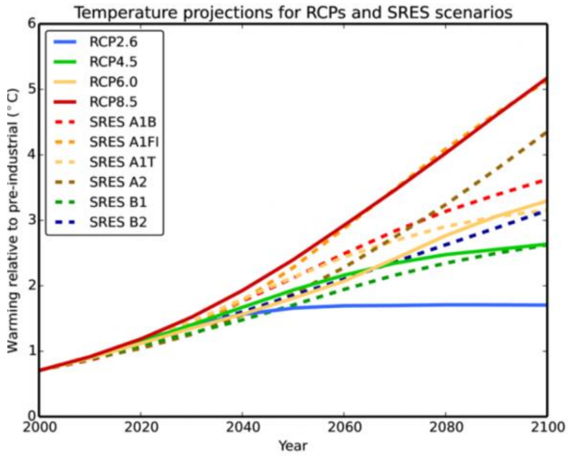
Where there is a supply/demand deficit, all feasible demand management and water supply enhancement options are developed with cost and benefit metrics calculated. A decision-making process is then followed to examine the trade-offs between performance metrics and generate a 'best value' societal and environmental plan.

The preferred programme of solutions is then tested against potential futures to identify any need for an adaptive plan that would lead us to deliver an alternative programme.

v. Supply Assessment - Climate Change

Guidance asks that we use UKCP18 climate impact data but that we should agree our approach to the assessment with Regulators, given the wide choice of climate change data sets related to future emissions and global temperature rise.

We have agreed with NRW to use a 'medium emission' scenario (RCP6.0) within our preferred investment plan, but that we will test our plan against a 'high emission' scenario (RCP8.5) to examine whether we may need to adjust our long-term investment should the future climate follow a path of greater warming and lower rainfall (See the Figure below).



This approach meets Welsh Government's requirements and Ofwat's 'high' common reference scenario. Ofwat also require a 'Low' emission common reference scenario (RCP2.6)

A large number of climate outcomes have been produced for each emission scenario and we use a representative sample of these to understand the possible range of impact on our supply capability. The impact on supply is taken as the central outcome from the sample with uncertainty/variance used in calculating the 'Headroom' allowance.

The climate change impact has increased in all zones from the WRMP19 assessment which was made using UKCP09 data. In WRMP19, climate change was forecast to reduce our supply capability in SEWCUS by 4.3% at 2050. In WRMP24, the equivalent impact at 2050 is 6.3% for a Medium emissions scenario, increasing to 9.2% under a High emissions scenario.

vi. Environmental Factors

Guidance asks that the Plan should "deliver a protected and improved environment and provide benefit to society. You should demonstrate that your plan provides overall positive environmental benefit."

NRW's National Environment Programme (NEP) and the equivalent WINEP in England, identify the investigations and subsequent changes that need to be made to our abstraction licences to meet environmental obligations, including the Habitats and Water Framework Directives. The NEP in AMP6 and AMP7 resulted in significant expenditure to manage the impact of reductions in licence volumes at a number of our river abstractions.

In England, the Environment Agency has defined a policy whereby it seeks to limit abstraction licence quantities to that used over the recent past to meet the 'No Deterioration' requirements of the Water Framework Directive legislation, particularly under a changing climate.

NRW are taking a different approach in Wales, and we have committed to work with them, through research in AMP8, to understand the potential future impact on river flows under climate change and how this may affect ecological needs.

Through the development of our PR24 NEP and WINEP, we have no plans to reduce our abstraction licence volumes during AMP8 period. Studies completed in AMP7 as requested under our WINEP, show that abstraction at Leintwardine, alone, may not significantly impact local river flows below environmental flow targets, however, this may be the case when other upstream abstractions are considered in tandem, particularly under low flow conditions. We will undertake further investigations into the sustainability of our Leintwardine abstraction, considering other upstream influences, so that we can assess the need for licence reductions. We will deliver schemes to resolve the impact of necessary licence reduction during AMP9.

We are mindful however that the future long-term sustainability of our raw water sources is an area of significant uncertainty particularly under a changing climate and so we are by seeking funding for our largest ever programme of water resource environmental investigations during AMP8. This will be a significant piece of work which demonstrates our environmental integrity and will also allow us to link the quantity with quality initiatives on the rivers from which we take water and develop catchment-wide solutions.

vii. The Water Balance and Demand Forecasting

The approach taken to demand forecasting is similar to that used in developing WRMP19. Our base year is 2019/20, as less impacted by the pandemic customer behavioural change. The way in which we account for the water that leaves our Water Treatment Works through to our customers taps, including for any leakage from our distribution system and on our customers premises, is called the 'Water Balance'.

Following our internal end of year audit process for 2021-22 we engaged in a comprehensive review of the water balance including data components, methodologies and reported outcomes for both Leakage and PCC. This process has resulted in the identification and implementation of a number of improvements across data sources and reporting methodologies, and human resources that contribute to our performance outcomes.

The impact of these changes are significant and have led to a greatly improved understanding of true performance and a subsequent need to restate reported performance for prior years in this AMP period.

The changes have resulted in an increase in the estimation of leakage, and reductions in consumption. Whilst this has a small impact on distribution input and PCC at the start of AMP8, this has added to the savings needed to achieve the planned 15% leakage reduction by the end of AMP7 through our leakage recovery programme. The demand forecast for AMP8 starts from this revised position. We have also subsequently updated our demand forecasts within the revised dWRMP24 to account for this.

AMP8 leakage savings will be greater than 18Ml/d while long-term leakage savings have also been adjusted to meet the 50% reduction target by 2050. The average dry year Per Capita Consumption of our customers at the start of AMP8 is 148 l/p/d with the same aspiration for reduction in PCC to 110 l/p/d by 2050.

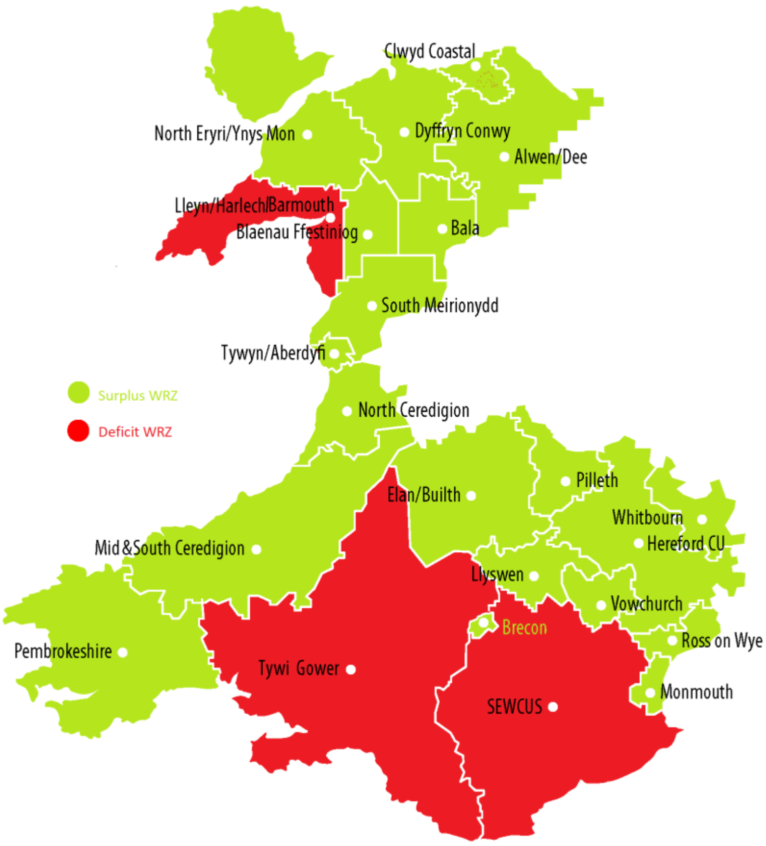
External consultants, Edge Analytics, have developed population and property forecasts following best practice guidance. The data used has been derived from Local Planning Authority projections as published by Welsh Government and apportioned to our water resource zones. New connection estimates have been projected from local development plans combined with GIS data. Occupancy is modelled using past observed trends for different property types at the WRZ level.

Household demand has been generated from a technique called multivariate regression and is built from detailed household water use surveys. The modelling accounts for demographics, house type, property and population forecasts and weather parameters.

Non-household demand forecasts are based upon the models developed for WRMP19 by CACI consultants. Non-households are split into 14 economic-based sectors and the model updated for recently observed demand data at WRZ level, with future projections taking account of econometric and climate change factors. Our strategy to reduce demand is outlined in section C below.

viii. The Supply/Demand position

Our initial Supply/Demand balances have been generated for each of the 23 water resource zones. We undertake these balances over both an annual period to understand the reliability of water resources from a hydrological perspective and during a peak demand week to understand our ability to treat and deliver enough water to our customers during the summer months. Three zones (see Figure below) are not resilient to our preferred 1 in 200, moving to 1 in 500, year level of drought resilience under a medium emission climate change scenario within the 25-year period to 2050. The Tywi Gower zone (deficit up to of 28Ml/d), the South-East Wales Conjunctive Use System (SEWCUS) zone (deficit up to 44Ml/d) and the Lleyn Harlech–Barmouth zone (deficit up to 0.5Ml/d). The SEWCUS and Tywi Gower zones are the most populous with the four zones in deficit having just over 70% of our total population served. The deficit in the Lleyn Harlech-Barmouth zone is small and past 2040 to meet the higher level of resilience target.



ix. Defining a Best Value Investment Programme

Guidance expects solution decisions to be based not solely on cost but taking account of wider range of social and environmental factors. Our approach is to align the Plan to our long-term delivery strategy with a key feature being the demand management policy which has been directed by Government, regulators, and customer expectations. This includes performance commitments on leakage and PCC as well as resilience to drought. To meet these targets and expectations we have set over-riding policies in AMP8 and 9 to reduce customer side leakage and water use.

We have initially taken a least cost approach to the delivery of our demand management strategy and examined the sensitivity of this programme of works. For example, we appraised five alternative metring delivery programmes. We have used the Strategic Environmental Assessment (SEA) of the Plan to understand if any options or alternatives have a significant negative impact on 17 wide ranging factors that cannot be mitigated. The thinking is, that where an option cannot be re-designed or re-worked to avoid the impact then we would remove it from the Plan and implement a less impactful, though potentially more costly, option. However, there is little differentiation in the SEA between demand management options and with these in place, our Plan to resolve zonal deficits is straight forward.

In line with guidance, we have taken an adaptive planning approach whereby, our preferred Plan does not only consider what we think is the 'most likely' future, regarding planning assumptions. We have also looked at a wide range of 'alternative future' scenarios to understand whether we are able to meet objectives under less likely but plausible potential futures and what our response will be if different future scenarios materialise.

Our policy led demand management programme is a key element of our preferred plan within all zones and acts to improve water resource resilience over time. This provides a 'no regrets' solution to reduce customer-side leakage and will help our customers to reduce usage.

Where this policy does not secure resilient water supplies, we have looked at additional 'Best Value' options to ensure that each of our zones is resilient. To support our approach, we have used a number of decision tools to help in our investment decision making.

x. Customer and Stakeholder Engagement

Given our unique business model and the requirement of guidance, we have taken a collaborative approach to plan development through active engagement with regulators, stakeholders and customers.

To ensure acceptance of the WRMP24, we have held regular monthly progress meetings with NRW and EA to review and agree processes and planning assumptions. We have undertaken dedicated formal pre-consultation meetings with OFWAT, The Consumer Council for Water (CCW), NRW, EA and ran a full pre-consultation exercise contacting over 300 stakeholders including National and Regional environmental interest groups and all local authorities. Environmental engagement has also been completed through presentations to the DCWW Independent Environmental Advisory Panel.

Customer Engagement has included qualitative and quantitative preference survey work as well as in depth questioning of an online community over 4 weeks, to better understand customer rationale. We also held a series of online roadshows with the Water Resource West member companies and more recently consulted on our draft WRMP. This was a 14 week consultation including a dedicated stakeholder engagement event. We received over 200 comments and representations from 13 organisations on our draftWRMP24 which we have considered and accounted for with in this revised draft and in our Statement of Response. We have also written to each organisation regarding their individual comments.

B. Learning from the Drought of 2022

i. The drought event of 2022

Between March and August 2022, Wales received just 56.7% of its expected rainfall, the third driest six-month period since records began in 1865. In August, Wales received just 38% of its average monthly rainfall with heatwaves in both July and August leading to very high demand for water especially in the tourist areas of west Wales.

The outcome of this has been very low reservoir storages across most of south Wales and parts of northeast Wales, culminating in the first restrictions being placed on our customers since 1989, whereby on the 19th August a Temporary Ban on Water Use (formerly known as a 'Hosepipe Ban') came into effect in our Pembrokeshire WRZ.

Experience gained through this drought period has substantiated the asset investment decisions made in our WRMP19 and current scheme delivery and supports with good evidence the need for the asset investments presented in this plan. The following sections describe the key schemes.

xi. The Pembrokeshire zone

We were aware of the supply risk in Pembrokeshire with investment in two schemes identified in the WRMP19. The upgraded link main between Preseli water treatment works from the Llys-y-Fran reservoir was completed earlier this year and has been vital in securing supplies to the local area. In addition, we accelerated the delivery of our planned Canaston Bridge scheme, through installation of a temporary solution. This has significantly reduced the rate of drawdown of the Llys-y-Fran reservoir but with the severity of this year's drought demand management measures were required aligned to our level of service promises. With both schemes fully operational we are confident that the zone is resilient to a 1 in 200 year drought event without the need for emergency drought orders.

xii. The Tywi Gower zone

Although customer restrictions were put in place, we have been closely monitoring the areas of the Tywi Gower zone supported by the Crai and Ystradfellte reservoirs where levels fell to low levels at a time when we had abundant supplies in the much larger Brianne reservoir. However, the assessment in this plan shows that the areas supplied by these reservoirs will need water resource reinforcement to maintain supplies in the most extreme droughts. These schemes are now planned for delivery early in the AMP8 period. In the meantime, we will continue to take operational actions where possible to manage the risk and low level of resilience.

xiii. The South East Wales (SEWCUS) zone

We have similar concerns around low levels in the 'high level' reservoirs in the SEWCUS zone. Our experience from the summer of 2022 and improved modelling has confirmed the pinch points in these areas of the system. This provides strong evidence for needing the schemes presented within this plan which will enable us to better balance the available water resource across the zone.

C. Our Proposed Plan

To meet customer and stakeholder aspirations, the WRMP24 sets challenging targets for future demand management in line with the expectations of our regulators, stakeholders and customers. We plan to effectively target our investment to support our customers in managing their demand for water and to reduce leakage across all our water resource zones in accost effective manner. This will provide benefit to the environment, water supply resilience and opportunity to meet future growth. Where, necessary, we also propose to invest in strategic network schemes that will maximise the use of available water resources so that every water resource zone is resilient to severe drought in line with proposed targets. This will again not only add resilience to drought but also against asset outages and against an uncertain future climate.

i. Demand Management

Demand reduction options are driven by industry policy, customer and stakeholder expectations and build upon the work to date in managing demand through leakage reduction and water efficiency. Customer engagement has shown support for reducing leakage, seeing this as a 'social contract' between us and our customers, whereby customers will respond to the requirement to reduce demand if we play our part through reducing leakage.

The water companies in England have set themselves a goal of tripling the pace of leakage reduction in the period 2020-2030, to match the same level of improvement achieved over the past thirty years (1990- 2020). This is set within a longer-term ambition to halve leakage from 2020 levels by 2050.

We have used current costs and benefits data to assess our leakage reduction options and it is clear that a step change in approach is required to cost effectively meet increasingly challenging targets with our conventional 'find and fix' costs increasing as we attempt to trace ever smaller leaks.

Our proposed leakage strategy is closely aligned to metering policy whereby 'Smart' metering will not only support our customers in reducing their demand for water but will also enable us to target customer supply pipe leakage which is becoming an increasingly large proportion of total leakage. We proposed to make 10% leakage saving in AMP8, of which a significant proportion will be saved on our customers' pipes. The leakage reduction will follow a profile from 191Ml/d in 2025 down to 104 Ml/d by 2050 to meets our long-term delivery strategy outcomes.

We are also continuing with our detailed investigations into 'background leakage' supported by the Ofwat Innovation Fund project which Welsh Water are leading. Background leakage is defined as a summation of all leaks which are too small to find using techniques currently available. Estimations of background leakage vary across the industry, with current understanding suggesting that it could represent over two thirds of total leakage by 2050. It is important that we understand the true level and of background leakage so that innovative technologies and data science can be employed in future strategies.

ii. Metering

Our metering policy is to deliver a large-scale programme of customer metering from AMP8 onwards. Our approach to customer metering in WRMP19 and AMP7 is largely reactive, responding to customers' demand to switch to a meter (meter optants), installing in newly built properties, and replacing faulty/damaged meters (reactive replacements). Metering is promoted as an option to reduce bills for low occupancy low-income households. Approximately 47% of our customer base is metered (March 2021) compared to an industry average of 63%.

Our meters are mostly manually read, as are the meters that will be installed over the course of AMP7. Based on the plans that were submitted at PR19, by the end of AMP7 we will have the second lowest level of meter penetration in the sector.

However, the advance of smart metering in other sectors, and the control it gives consumers over usage, is driving customer expectation of this functionality for their water service. It is unlikely that customers in 2050 will consider our current approach to be acceptable and therefore change is required.

From 2025 we propose to move to a strategy of installing 'Smart' meters on unmeasured properties by geographical area. In the first instance these will be unbilled meters and will remain so until there is a change of occupier; this approach is known as 'progressive metering'. We have used a bespoke investment model to examine the cost benefit ratios for a number of delivery options for both Automatic Meter Reading (AMR) type meters and Advanced Metering Infrastructure (AMI) meters. Based on evidence, AMR solutions are currently most cost effective, but this is largely dependent on the cost of data network infrastructure used in integrating AMI type meters.

We are investigating the implementation of AMI ready meters and the pathway between AMR and AMI in AMP8 through discussions with meter manufacturers. Investigations into use of Long-Range Wide Area Networks and IoT technology are ongoing along with procurement of meters. We have asked for manufacturers views on potential pathways between AMR and AMI and we will be refining our strategy over the coming 2 years prior to meter delivery.

Through our strategy we will increase the level of metering to 79% by the end of AMP8 and 96% by 2050 (no water company has yet to achieve 100%) and the demand forecasts include savings achieved from both better data and communication with customers and the identification of leakage on customer's properties. The metering strategy is forecast to reduce overall demand by 37.23 Ml/d by the end of AMP8 and 96 .01 Ml/d by 2050.

iii. Water Efficiency

Achievement of the 110 l/p/d PCC target using only physical water efficiency interventions such as water saving devices, home audits, leaky loos and greywater recycling/rainwater harvesting would be prohibitively expensive, which is why the delivery of our 'Smart' metering programme is critical to achieving this target.

Our long-term targets are only met with support from Government mandatory water labelling along with a range of efficiency interventions such as water saving devices, home audits, leaky loos fixes and encouragement of behaviour change. It is recognised that an understanding of behavioural change is key to the achievement of long-term target. It may take some time to develop a detailed, comprehensive behaviour change campaign and strategy and there are some fundamental questions around how this is best delivered through water companies, governments or third parties. We are planning to undertake behavioural studies in AMP8.

A number of organisations including regulators would like to see increased our support and commitment to non-household customers in improving water efficiency to reduce waste. A number of opportunities exist, taking on some of the lessons learnt from our existing Cartref strategy, but adapting it to support small and medium-sized businesses We have developed a programme of measures that will support the reduction of business demand by 8% (of normal year demand) by 2050.

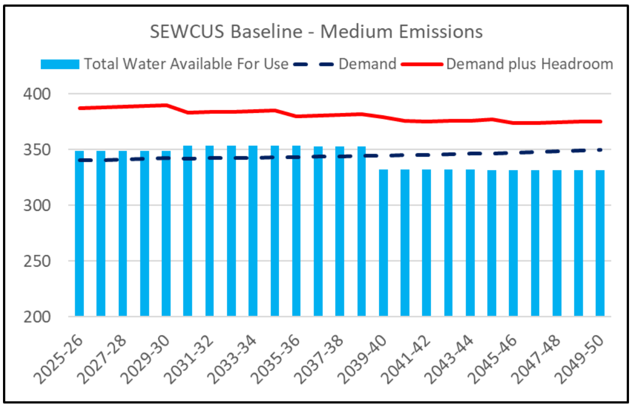
iv. SEWCUS

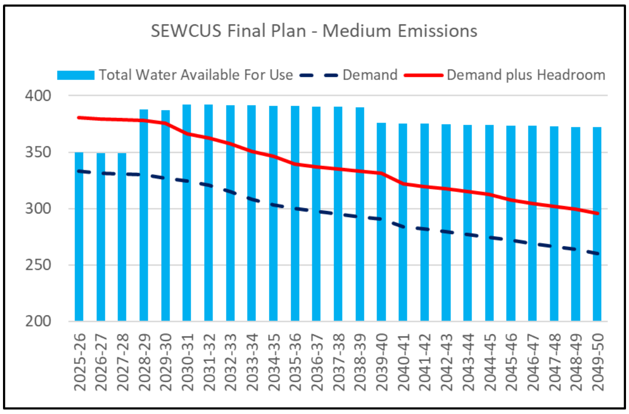
Our WRMP19 showed the SEWCUS system to be resilient under worst historic drought conditions, such as those experienced in 1976 and 1984, and likely to be resilient to a 1 in 200-year drought. However, using more accurate catchment and system models with greater granularity has identified variations in resilience across the zone, particularly when stressed by extreme drought. Under these conditions the 'high-level' reservoirs will have lower relative storage than Llandegfedd (the key 'low-level' reservoir). The existing network connectivity is the limiting factor in our ability to better balance water resource between the two systems.

Evidence during the 2022 drought supports the model findings with the links between our 'low' and 'high level' systems were at their maximum capacity during the majority of the event. These models demonstrate that during a severe drought, it will be the lack of storage in our Taff Fawr and Taff Fechan reservoirs that would cause failures to meet customer demands. This restriction is exacerbated by climate change and the supply capability, when set against our forecast baseline demand for water and an allowance for uncertainty, shows that we will not meet resilience targets. The range of options considered include:

- Additional demand management
- Network enhancement to optimise and balance water resources
- Making use of existing disused sources or under-used abstraction licences
- Raising reservoir levels

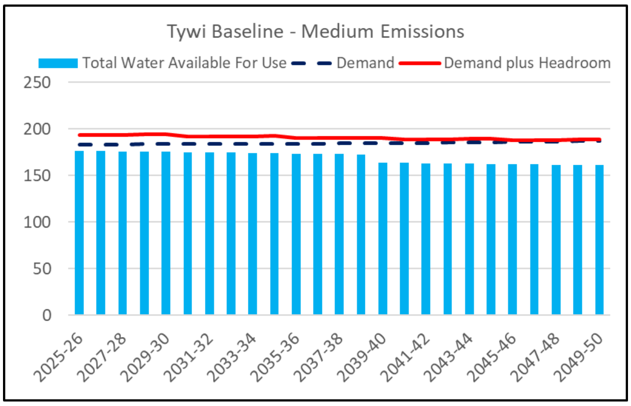
Based on both cost and the benefits provided by the schemes the preferred solution The solutions are schemes to increase the capacity of the network and allow us to reduce the flow down the Llwynon trunk mains, with low water quality risk. The figure below shows how these schemes, alongside demand management benefits secure a high level of drought resilience across the zone. The overall benefit to WAFU of the network enhancement schemes is 39Ml/d at a capital cost of c£20.3m which provides good value. Modelling indicates high utilisation of the schemes even in less severe dry years. The schemes also provide additional resilience to the high-level system works outages which will be needed in delivering the Cwm Taff scheme.

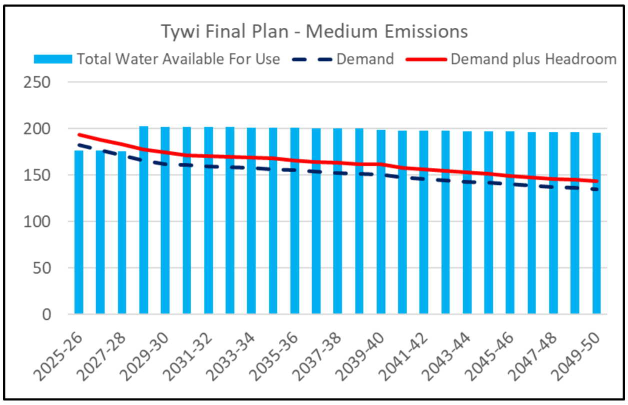




v. Tywi Gower

The position in the Tywi Gower zone is similar to that of SEWCUS with the WRMP19 indicating the system to be resilient but improved evidence has identified network connectivity limitations under extreme drought and climate change conditions.





The baseline supply/demand deficit is around 28Ml/d Ml/d by 2050 due to localised water resource deficits. There is sufficient total water resource across the system with Brianne reservoir underutilised currently, however, neither Crai nor Ystradfellte reservoirs are sufficiently resilient to drought. Our preferred set of solutions is to reduce demand in line with our demand management strategy to reduce leakage and PCC and to reinforce the areas supplied by both Crai and Ystradfellte through increased connectivity to the Felindre system. Demand management alone is not sufficient to overcome the resource deficit in these localised areas.

From the set of available options, network investment is the best value option that provides long-term resilience across the zone, as shown in the figure above right. The plan for Tywi Gower not only meets the current day target of meeting resilience to 1:200 year droughts but generates increased capability to meet at least a 1:500 drought resilience by 2030 through demand management activity. As with all zones, this mitigates risk around future climate change impact pathway, customer usage behaviour, and environmental needs.

vi. Lleyn Harlech–Barmouth

Without any investment, the Lleyn Harlech – Barmouth zone is resilient to Droughts with a return period between 1:200 and 1:500 years and does not meet the higher resilience target by 2039/40. The deficit is small growing from around 0.2 to 0.5Ml/d by the end of the Planning period. The demand management strategy is more than sufficient to overcome this deficit, but the risk may increase under different future scenarios.

vii. Testing the zonal Plans

Our Plan is based on long term forecasts of supply and demand needs and meets our objectives under the 'most likely' future environmental and social circumstances that we might encounter. The long-term impact of leakage and customer usage policies generates an increased water resource surplus which over time provides greater resilience, enhanced benefit to the environment and can mitigate against future uncertainty.

There are some key assumptions within our Plan that could change into the future which may require additional investment to address. Our regulators have asked that we explore the impacts of this through stress testing of our plans to a range of plausible future scenarios, including Ofwat's PR24 Common Reference Scenarios.

The outputs from this testing have informed the makeup of our ‘core’ pathway of investment that would be required under all possible future scenarios. We have also identified alternative pathways due to potential significant deviations from our ‘most likely’ pathway.

Against our most likely pathway, we have tested five alternative pathways:

1) High environmental destination – assumptions as per ‘most likely’ but with DO reduced by 5% from 2030 and 10% from 2040
2) Low demand savings - assumptions as per ‘most likely’ but with our assumed savings in customer usage reduced by 50%
3) High environment + climate change– assumptions as per ‘most likely’ but with DO reduced by 5% from 2030 and 10% from 2040, high emissions scenario RCP8.5
4) Low climate change– assumptions as per ‘most likely’ but using the low emissions scenario RCP2.6
5) Compound High– assumptions as per ‘most likely’ but with DO reduced by 5% from 2030 and 10% from 2040, high emissions scenario RCP8.5, assumed savings in customer usage reduced by 50%

From the above, it’s clear that scenarios 3 and 5 will have the largest impact upon our supply demand position.

We have appraised all our WRZs against the above alternative scenarios, both individually and in combination, to understand what, if any, additional schemes are required over and above that set out in our ‘most likely’ investment pathway. To ensure our ‘Core’ pathway contains all the required ‘no regrets’ investment we have also tested our Plan against ‘Low’ scenario criteria, notably incorporating the impact to our supply capability of lower-than-expected climate change.

Our testing has identified that of our 23 zones, there are 5 (SEWCUS, Tywi Gower, Clwyd Coastal, Lleyn-Barmouth, Pembrokeshire), where additional future investment may be required to maintain our drought resilience under the most extreme alternative futures explored.

Our analysis for the five zones demonstrates that no large, long lead time schemes are needed as part of an adaptive Plan and there are available options to meet the most extreme future scenarios, if these occur. These scenarios demonstrate that we are able to meet objectives under less likely but plausible potential futures and where this is not the case, we are able to adapt our Plan to resolve any shortfalls against these and the implications. Our preferred plan including adaptive pathways, therefore, provides a robust, cost-effective investment programme for the future.

D. Board Assurance

WRMP Guidance requires an assurance statement from our Board to Ofwat and NRW/EA confirming that:

- We have met our obligations in developing our plan
- Our plan reflects the Water Resources West (WRW) regional plan, which has been developed in accordance with the national framework and relevant guidance and policy, or provides a clear justification for any differences
- That our plan is a best value plan for managing and developing your water resources so that we are able to continue to meet our obligations to supply water and protect the environment, based on sound and robust evidence including costs.

Jacobs consultants have acted as our independent auditors, to undertake assurance of our draft WRMP24 to determine if any elements of our approach are likely to be materially inconsistent with WRMP technical guidelines and Welsh Government's guiding principles. Jacobs have also considered how Ofwat's strategic priorities for PR24 are reflected in the WRMP.

The Jacobs assurance letter to the Welsh Water Board is included as Appendix 3 and confirms that:

- We have met our obligations in developing our plan
- Our plan reflects the Water Resources West (WRW) regional plan, which has been developed in accordance with the national framework and relevant guidance and policy, or provides a clear justification for any differences
- Our plan was developed according to the Water Resources Planning Guideline (WRPG) guidance for developing a best value plan for managing and developing your water resources, and is based on sound and robust evidence including relating to costs
- Our plan adequately reflects the Welsh Government's guiding principles and Ofwat's key themes for the 2024 price review and that the processes incorporated appropriate levels of quality assurance
- Our documentation is consistent with the processes reviewed
- Data tables are competently sourced and processed.

Main Report

1. An Introduction to our Water Resources Plan

1.1. Dŵr Cymru Welsh Water

Dŵr Cymru Welsh Water (Welsh Water) is part of the Glas Cymru Group. We are a not-for-profit company without shareholders, and therefore we retain all financial surpluses for the benefit of our customers. We are responsible for the provision of statutory water and wastewater services to around 1.3 million households and businesses across much of Wales, Herefordshire and parts of Deeside (

Figure 1), making us the sixth largest of the eleven regulated water and wastewater companies in England and Wales, in terms of the population we serve.

Our company purpose is to provide high-quality water and environmental services to enhance the wellbeing of our customers and the communities we serve, both now and for generations to come. Our purpose is central to everything we do and guides all our decision making. At the core of our purpose is our vision to earn the trust of our customers every day.

For the management of water resources, our operational area is divided into 23 discrete water supply systems which we call Water Resource Zones (WRZ). These are defined by the extent of the supply network that share the water resources within each zone, whereby, the customers in each WRZ have the same level of service in response to drought conditions. Our water resource planning is based upon these zones (Figure 1).

Figure 1 - Our Operating Area

Figure 2 - Water Resource Zones for WRMP24

1.1.1. Water 2050 - our long-term vision

Our Welsh Water 2050 document has as a mission statement '*to become a truly world class, resilient and sustainable water service for the benefit of future generations*'. The strategy described our commitment to plan for the long-term, anticipating and responding proactively to the emerging risks and opportunities around our ability to deliver great service to customers and the environment, now or in the foreseeable future.

Since the publication of the Water 2050 consultation document in 2017, water supply in Wales has been affected by a number of unprecedented events, including flooding, heatwaves, drought, and the Covid-19 pandemic. These events have tested our resilience as a business, while also generating insights that will help us to prepare better for such shocks in the future.

There is also evidence that some of the trends identified in Welsh Water 2050 are unfolding more rapidly than anticipated, suggesting that we need to reconsider and possibly accelerate our response.

The service Welsh Water provides is essential to the health of people and the environment, and indeed to the normal functioning of everyday life. The Covid-19 pandemic highlighted what we stand to lose when the services we often take for granted are disrupted by circumstances beyond our control. It is therefore essential that we do all we can to understand the risks to our service, mitigate them, and ensure that they remain at an acceptable level.

There are significant challenges ahead, as well as opportunities, and we will need to make difficult decisions on where the priorities lie. All the while, we must be conscious of the affordability of services to our customers, particularly in a period of significant financial hardship and uncertainty.

As a non-shareholder company, we are guided solely by what is in the best long-term interests of our customers and the environment. We are committed to working closely and collaboratively with the Welsh Government, our regulators, and other stakeholders as 'Team Wales', all in the context of the Wellbeing of Future Generations Act.

1.2. Why we prepare Water Resource Management Plans

The water that flows from the taps of our customers comes from a variety of water sources. For the majority, this will come from one of our reservoirs that are designed to capture and store rainfall. For others water is taken from a river, well or borehole. The amount of water we can rely upon is not only affected by the weather conditions each year but also the amount of water that we can store and the natural response of rivers and aquifers to rainfall.

Whatever the source of water, we pass this through a water treatment works before distributing the treated water through our network of pipes to houses and businesses. This can be a complex process, particularly where we have many customers and a variety of sources that can feed into a water supply area. There are however significant benefits to having alternative supplies that can be drawn upon if we have problems with the raw water sources, treatment works or our distribution system.

To provide water to our customers all day every day, we need to make sure there is always sufficient water resource to meet the demand for water especially during periods of drought and so planning for future needs is critical.

Like all water companies, every five years we update our Water Resource Management Plan (WRMP) which describes the basis for ensuring sufficient water supplies over the long-term. This incorporates the latest evidence on the future demand for water and water resource reliability, including the potential impact of climate change, through use of the best available science and technology.

These five yearly review periods provide us with an opportunity to assess how well our Plan has performed against current circumstances and to update the evidence on which it is based. When compared against our 2019 Plan, the Covid-19 pandemic saw changed patterns of water use whilst new scientific information from climate change research is available which can give us a better understanding of future weather patterns.

1.2.1. Government and regulatory requirements

The purpose of the WRMP is to ensure that we have sufficient water to meet our customer's needs. To do this robustly, the plan draws on government and regulatory requirements, which affect the planning assumptions to be used. The basis for water resources planning is laid out in specific Welsh Government Guiding Principles and joint regulatory guidance. These documents are built upon and are directly linked to Government and regulatory authority legislation and policy.

The production of a WRMP is a statutory process with the legislative requirements for water companies to prepare and maintain a WRMP set out under sections 37A to 37D of the Water Industry Act 1991, (as amended by the Water Act of 2003 and the Water Act 2014).

Alongside this, other relevant legislation in the development of a WRMP includes the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 and the Conservation of Habitats and Species Regulations 2017.

The technical approaches utilised in the development of this plan are aligned with the joint NRW/EA/Ofwat 'Water Resources Planning Guideline[1]'. This guideline and other supporting guidance documents on areas such as climate change, decision making and drought resilience have been informed by the Water Resources Planning Technical Advisory Group, which we have been an active member of since its inception in late 2018.

As the main provider of water and sewerage services to the people of Wales, we are committed to working closely and collaboratively with the Welsh Government and so our Plan takes account of the following key Welsh legislation and policies.

Well-being of Future Generations (Wales) Act 2015 and the Environment (Wales) Act 2016

The Environment (Wales) Act 2016 and the Well-being of Future Generations (Wales) Act 2015 work together to create modern legislation for managing Wales's natural resources and improving its social, economic, environmental and cultural well-being. Together with the Planning (Wales) Act 2015, they form part of a wider initiative to create a legislative framework for sustainable development to secure the long-term well-being of Wales.

The Environment (Wales) Act establishes the principles of Sustainable Management of Natural Resources (SMNR). SMNR principles are defined in the Act as: "*using natural resources in a way and at a rate that maintains and enhances the resilience of ecosystems and the benefits they provide… and contributing to the achievement of the well-being goals in the Well-being of Future Generations Act*." Linked to these principles, SMNR has four main aims[2]:

1. Stocks of natural resources are safeguarded and enhanced
2. Resilient ecosystems
3. Healthy places for people
4. A regenerative economy

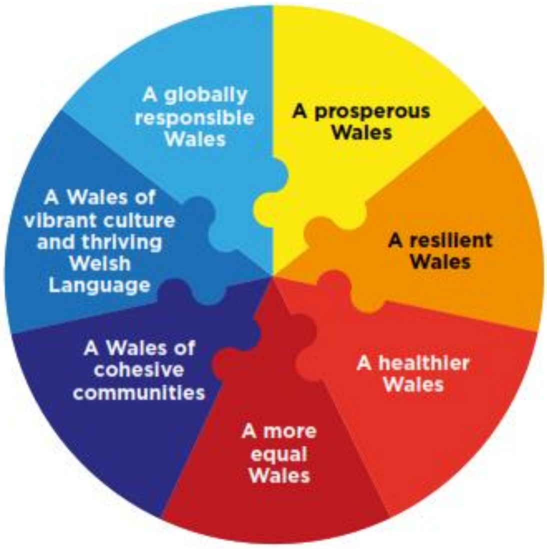


Figure 3 – Well-being Goals (Future Generations Act)

[1] Water resources planning guideline, v12. (Ofwat/EA/NRW, March 2023)

[2] State of Natural Resources Report, Natural Resources Wales, 2020.

The table below links the aims of this legislation to elements of the Plan:

Policy/Legislation	WRMP24 Principles/Guidance
1. Water Industry Act 1991 /Water Act	States the statutory requirement for long term Water Resource Plans
2. Environment (Wales) Act 2016	The requirement for the Sustainable Management of Natural Resources. The WRMP should maintain and enhance Biodiversity, promote the resilience of ecosystems and accounting for carbon.
3. Well-being of Future Generation (Wales) Act 2015	7 Well Being Goals including: • Prosperous Wales – Plan for sufficient supplies to meet demand now and into the future • Resilient Wales – The Plan should demonstrate the resilience of water resources during drought periods • Healthier Wales – The plan should provide sufficient good quality water 5 Ways of Working including: • Collaboration/Involvement – The Plan should be built through effective Customer/Stakeholder Engagement • Long Term – Plan for at least 25 years • Integration – Link to other plans i.e. River Basin Management, Flood plans, Drainage water Management Plans.

Table 1 – Summary of key water resources planning legislation.

The Water Strategy for Wales & Future Wales: The National Plan to 2040

Welsh Government's Water Strategy for Wales sets out a long-term policy direction in relation to water; it aims to ensure a more integrated and sustainable approach to managing water and associated services in Wales and contributes to the implementation of the wider natural resource management policy in Wales.

The 'National Plan 2040' is Welsh Government's national development framework that sets the direction for development in Wales to 2040. It notes that the pressure on water resources is predicted to increase, with the ability to manage our natural resources becoming increasingly important. The National Plan recognises the potential impact of future development patterns and climate change on the supply and availability of water.

Within this Plan we have considered and directly respond to policy direction and the concerns raised.

The Climate Change (Wales) Regulations 2021

Welsh Government have prescribed a net zero target for greenhouse gas emissions by 2050, with interim targets of a 63% reduction by 2030 and an 89% reduction by 2040. In response to this, as a company we have set our own ambitious targets for carbon emissions with the aim to reduce them by 90% by 2030 and achieve carbon neutrality by 2040 including the impact from this Plan. We are targeting 'net zero' on both operational and embedded carbon; Our energy use is already carbon neutral, with the exception of our transportation fleet. Regarding adaptation, this Plan uses and accounts for the latest UKCP18 information both in our hydrological assessments and the impact on demand for water.

Ofwats Public Value Principles

There is a strong link between the Well-being of Future Generation Act 'ways of working' and Ofwat's public value principles. The Plan works within these Principles which are reflected in the WRMP Guidance and Welsh Governments Guiding Principles. These are in summary:

- To create further social and environmental value through our business capability which is measurable, lasting and important to customers and communities.
- This should not come at greater cost to customers without customer support.
- To be open with information and insights on operational performance
- To collaborate with others to optimise solutions and maximise benefits

Strategic Priorities and Objectives Statement

Welsh Ministers may from time to time publish a statement setting out strategic priorities and objectives for Ofwat to follow in carrying out its relevant functions relating to companies wholly or mainly in Wales. In its 2022 Statement, Welsh Government provided direction to Ofwat to be mindful of Welsh policy and legislative differences when comparing water company plans in Wales with those in England but that they should still "*…challenge companies to deliver value for money for customers, communities, and the environment. Ofwat should challenge companies to demonstrate that their plans are acceptable, affordable, and best value, having regard to their existing and future customers."* To this end our WRMP24 will be a 'Best Value' Plan that delivers wider benefit to our customers and the environment.

1.2.2. Linkages to other Plans

As a company we prepare other statutory plans, notably our Drainage and Wastewater Management Plan (DWMP), our company Business Plan, Drinking Water Safety Plans (DWSPs) and our Biodiversity Plan. The focus of a WRMP is to ensure a long term, resilient supply of water during the driest of years and so it performs a specialised function which in many ways makes it a standalone plan. However, there are areas of linkage to these other plans, some of the key ones being:

1) Our commitment to reducing Per Capita Consumption will help support some of the challenges identified in the DWMP through reducing the amount of water returned to our sewers.
2) Water quality impacts are increasingly having an effect upon the volume of water available for supply and so we work closely with our Catchment Team to ensure risks and potential mitigating actions are identified in the DWSPs
3) Our Biodiversity Plan incorporates actions on Invasive Species that have the potential to affect our raw water supplies and so in AMP7 we have undertaken a joint project to identify the main sites of concern and any actions required

Our WRMP is a key element of the company's Business Plan submission, helping to ensure that appropriate asset spend is identified to maintain and enhance our water supply position. Future investment planned in our treatment works, distribution systems and impounding reservoirs that will impact asset capability is incorporated into our water resource models.

1.3. Progression from our WRMP19

We take a progressive approach to Water Resource Planning as successive WRMP timeframes overlap so that each 5-year plan is an update of the last, based upon new drivers such as revised government and/or regulatory guidance, customer priorities and improved evidence.

Although the regulatory guidance provided for this round of planning has some different aspects and approaches, the core process from that put forward for WRMP19 remains the same, which is to assess our long-term water supply capability against the future demand for water.

Where there is a deficit in capability against future demand then both new supply options and demand management are considered, and a plan is developed. The plan is then tested against a range of uncertainties in both assumptions made and the mix of solutions put forward.

1.3.1. Delivery of our WRMP19

The key drivers for the WRMP19 plan were: i) the management of significant abstraction licence changes due to the implementation of the Water Framework and Habitats Directive ii) improvement to water resource resilience and the mandating of demand management targets, specifically leakage reduction in AMP7 of 15%.

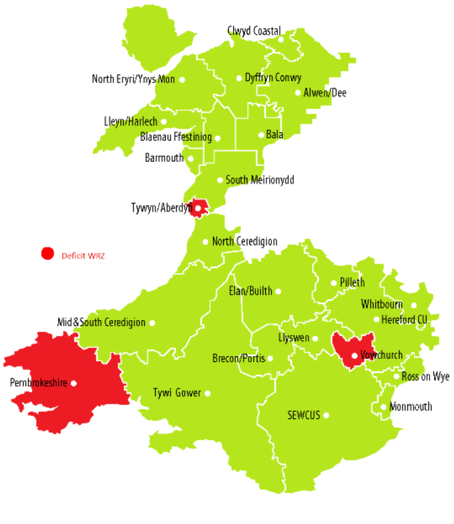
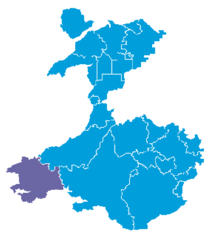


Figure 4 – WRMP19 Deficit Zones

Our supply against demand assessment for the WRMP19 identified three WRZs (Figure 4) that were forecast to have a supply demand deficit over the duration of the planning period, namely: Pembrokeshire, Vowchurch and Tywyn Aberdyfi. A combination of supply side and demand management interventions were put forward to resolve the forecast deficits, an overview of these is given below:

1.3.2. Pembrokeshire WRZ



The supply demand position in Pembrokeshire reduced significantly in 2018 due to abstraction licence changes on the Eastern and Western Cleddau to help protect migratory fish following the outcomes of the Habitats Directive review of consents. The Pembrokeshire WRZ was forecast to be in deficit in both the annual average and critical period scenarios across the whole planning period (See Figure 5).

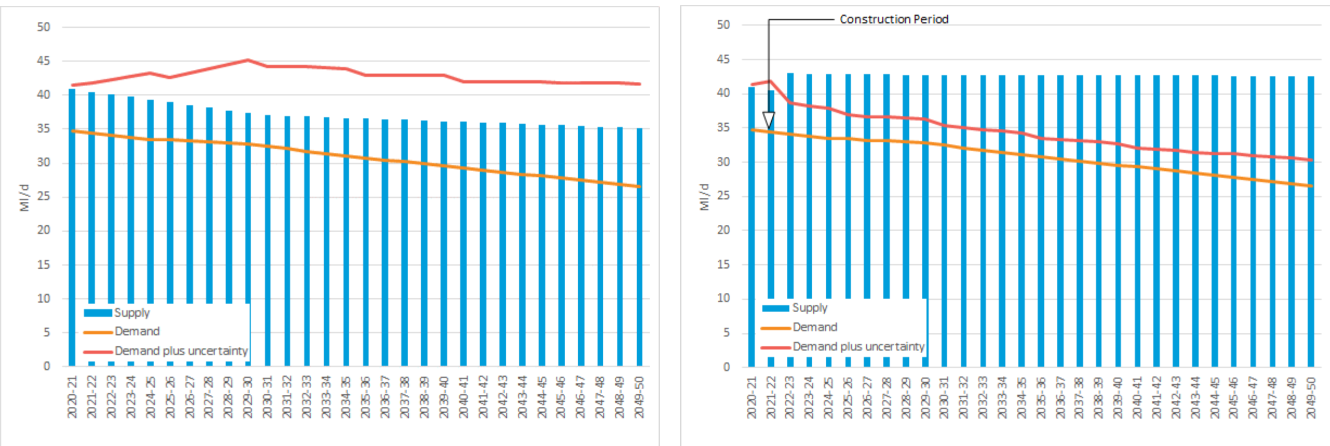


Figure 5 -WRMP19 Supply demand balances for the Pembrokeshire WRZ

The best-value scheme to resolve this shortfall consisted of upgrades to our pumping station at Canaston on the Eastern Cleddau river to improve the efficiency of our operations. This scheme allows us to optimise our regulation releases from Llys y Fran, which is key given that we have less abstraction from the river available to us, which results in a greater requirement to support Canaston from Llys y Fran.

The scheme was not completed for the 2022 summer and so given the pressures from the drought; we have installed a temporary scheme. This will remain in place until the full scheme is delivered, ensuring our proposed level of service is maintained in the interim.

Key enabling elements of the Canaston upgrade to provide the control that will optimise the regulation release against abstraction rate have already been delivered, including operational telemetry to enable flow-control of the low-lift abstraction pumps, installation of upgraded flow metering at Llys y Fran, and we are nearing deployment of newly developed code for scheduling of changes to reservoir release rates. The installation of variable speed drives on the high-lift abstraction pumps at Canaston will be delivered this year. Significant design work has been completed on the electrical, mechanical, ventilation, and control components.

1.3.3. Vowchurch WRZ

Statistical analysis of historic river flow data identified that the aquifer which supports our groundwater source at Vowchurch may not be resilient to extreme drought events, in line with our preferred level of service. Our plan is to deliver a new network connection with the larger Herefordshire zone which has a much more resilient source of water from the River Wye. Hydraulic modelling of the supply network has now been completed and a preferred option selected which will deliver c14km of new trunk main that will connect Aconbury Service Reservoir in the Herford WRZ to Kingston Service Reservoir in the Vowchurch WRZ. Detailed design work is about to commence with construction planned to start later this year and scheme completion due late 2024.

1.3.4. Tywyn Aberdyfi WRZ

The Tywyn Aberdyfi zone is currently supplied from two small stream sources which feed the Penybont water treatment works. Analysis undertaken for our WRMP19 showed there was significant risk that the flow in these streams would be insufficient to meet demand during more extreme drought periods.

The preferred scheme was to deliver a new abstraction from the much larger Afon Dysynni to provide an alternative, and more resilient, supply of water. The updated hydrological inflows that were derived for our WRMP24 indicated that the existing sources may be more resilient under extreme drought conditions than first thought. Since the production of the updated hydrological inflows in 2021, further gauged flow data has been collected on the Afon Fathew that has enabled our GR6J rainfall runoff model to be recalibrated and achieve an improvement in the representation of the hydrological response of the catchment.

The updated calibrations showed that simulated hindcast and stochastic flows would not drop below the key threshold of the 2.6Ml/d Penybont WTW capacity, suggesting catchment resilience to drought under current climate conditions. This was supported by the British Geological Survey fieldwork and analysis undertaken in the summer of 2022 to better understand the contribution of groundwater to baseflows in the Afon Fathew. The number of days when river flow is below the maximum Penybont treatment capacity within these modelled flow sequences is at a substantially lower frequency than the 1 in 500 year (0.2% annual probability) long term target. Based on the outputs of this work we are confident that we do need to develop a new source of supply from the Afon Dysynni. The detailed technical report of the 2022 study is presented as Appendix 23 to this Plan.

1.3.5. Companywide Demand Management

Our WRMP19 set out challenging targets for the 2020-25 period and beyond to reduce the volume of water we supply and support our achievement of reaching a 1-in-200 level of drought resilience. There were three key elements of our demand strategy:

Leakage

We set a target to reduce our overall company level of leakage by 15% (equivalent to 26 Ml/d) by 2024-25 against 2019/20 levels, forming part of our longer-term ambition to achieve a 50% reduction from 2017/18 levels by 2050. We have now re-stated our 'water balance' (see section 4.2) and reported leakage levels have increased to 253 million litres per day (Ml/d). This provides a substantial challenge to reduce leakage levels by 15% over the period from the restated 2019/20 value of 225.8Ml/d by achieving a leakage level of 191Ml/d by April 2025. The revised targeted leakage level for April 2025 delivers on the commitment to deliver a 15% reduction against the 2019/20 level, it does not meet our AMP7 final determination performance commitment which is measured on a 3 year average basis.

To deliver the 15 % reduction there will be a substantial amount of effort required to reduce upstream losses across our trunk main network and leakage across our distribution network. The leakage across the distribution system is within our district metered areas and can be targeted through conventional methods but requires an increase in both detection and repair resources. However, the leakage across our 3,500km of trunk mains requires improved metering, development of targeting methodologies and use of high-risk intrusive detection technology along with complex engineering repairs.

To deliver the leakage recovery plan we have forecast the need for an additional capital investment of £54m and we have now allocated expenditure to projects. We have also engaged several specialist suppliers.

Per Capita Consumption

A longer-term target was set to reduce the average per capita consumption (PCC) of our domestic customers to 110 litres per person per day (l/p/d) by 2050. The restated normal year average household PCC for 2019-20 was 145.8 l/p/d . Since then PCC rose to 160.9 l/p/d in 2020-21 and has fallen back to 148.7 l/p/d in 2022-23.

There has been a clear impact on PCC as a result of the Covid-19 pandemic, following the lockdown measures introduced in 2020/2021 and peoples associated response. An increase in daytime occupancy levels through a large increase in home working and schooling has meant that the consumption of water has shifted from non-household to household for many of our customers. Behavioural change has also been observed due to an increased focus on hand washing and spending more time at home. With society now fully 'open', we are seeing demand patterns return towards pre-pandemic levels but not completely.

Project Cartref

Supporting the achievement of both our leakage and PCC targets is our Project Cartref initiative which aims to help deliver private leak repairs to achieve an AMP7 target reduction of 7.2Ml/d. Our water efficiency strategy for Cartref has been to undertake retrofitting as part of our home visits and promote our 'Get Water Fit' platform to those individuals we see during the home visits. The number of home visits we were able to undertake between 2020 and 2021 was restricted due to Covid-19 which has affected the amount of savings in demand we have been able to make but we anticipate the programme expanding again during 2022-2023.

1.4. The 2022 Drought

Between March and August 2022, Wales received just 56.7% of its expected rainfall, the third driest six-month period since records began in 1865 (based on provisional data). In August alone, Wales received just 38% of its average monthly rainfall. The Met Office has also confirmed that this summer has been the eighth warmest for Wales since 1884.

Figure 9 illustrates some of the key weather that we experienced during this period.

The outcome of this has been very low reservoir storages across most of south Wales and parts of northeast Wales, culminating in the first restrictions being placed on our customers since 1989, whereby on the 19th of August a Temporary Ban on Water Use (formerly known as a 'Hosepipe Ban') came into effect in our Pembrokeshire WRZ.

We have commissioned the Llys y Fran to Preseli water treatment works pumping scheme and this secured the supply to the St Davids area of the zone. In addition, to help arrest the decline of Llys y Fran storage we accelerated the delivery of our planned WRMP19 scheme at Canaston Bridge, through installation of a temporary solution. As planned, this has significantly reduced the 'inefficiency' of the regulation releases from the reservoir and confirms the efficacy of our WRMP19 plan.

With wetter weather arriving in Pembrokeshire early in September, we saw some recovery in reservoir storage, ensuring that no further restrictions were needed. The permanent Canaston pumping station scheme will be delivered during 2023.

The plot below shows Llys y Fran storage for 1995 compared with year-to-date storage for 2022 after accounting for potential freshet releases.

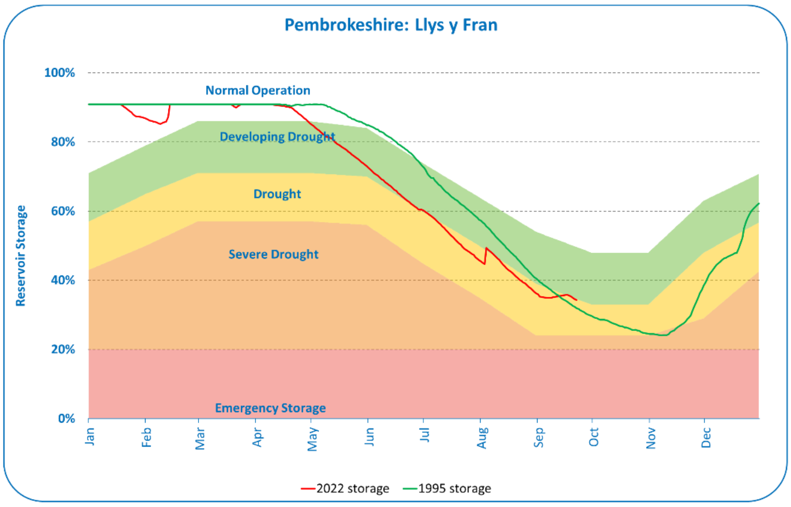


Figure 6 - Llys y Fran storage (2022 vs actual 1995)

Although customer restrictions were not put in place elsewhere, we closely monitored the storage position of the Crai and Ystradfellte (Figure 7) reservoirs in the Tywi Gower zone and the Llwynon and Pontsticill (Figure 8) reservoirs in the SEWCUS zone. Fortunately, good rainfall arrived from late September meaning that further actions beyond those already implemented, were not required.

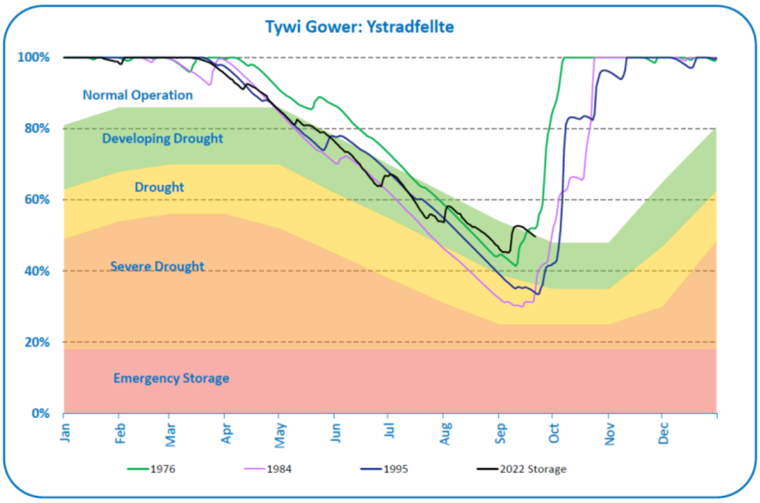


Figure 7 - Ystradfellte storage (2022 vs modelled historic droughts)

Our experiences from the 2022 drought have confirmed the pinch points in these zones that were also identified in our modelling. This provides strong evidence for the need for schemes to support these reservoirs and that our preferred programme of investment will better balance the available water resource.

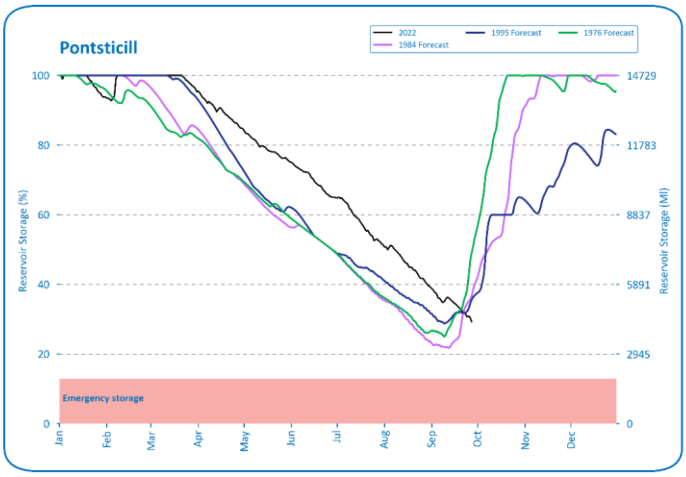


Figure 8 - Pontsticill storage (2022 vs modelled historic droughts)

There were exceptionally high demands across our region over the summer period with heat waves occurring in both July and August. Of particular concern was the Mid and South Ceredigion zone that encompasses the popular tourist areas of Cardigan Bay, where we were unable to meet customer demand from the combined output from our Strata Florida and Llechryd treatment works. For both hot periods we needed to supplement the zone by supplies brought in by road tankers from the Capel Dewi WTW system in the neighbouring Tywi Gower zone.

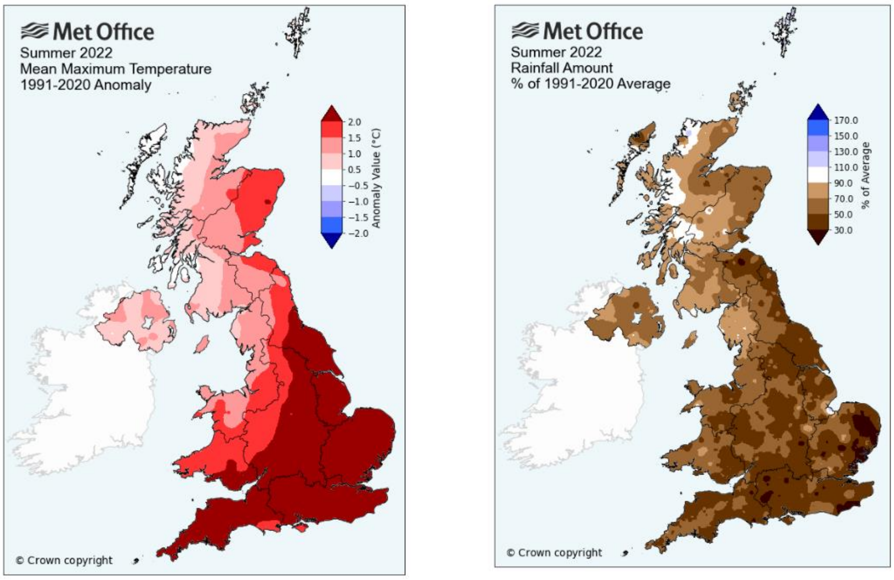


Figure 9 - Key summer 2022 meteorological stats[3]

[3] https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2022/joint-hottest-summer-on-record-for-england#:~:text=For%20England%202022%20was%20the,average%20were%20in%20East%20Anglia.

2. Our approach to WRMP24

2.1. Priorities for the Plan

This Plan describes our ability to meet the future demand for water within our supply area, taking account of the challenges we face from a changing climate, growing population and heightened environmental expectations. We need to respond to revised government/regulatory guidance, customer priorities and improved evidence around these.

The key priorities for this Plan are given in Table 2 below along with any driver for change from the previous WRMP19 Plan:

Priority	Driver for Change
• Alignment with Long Term Delivery Strategies and outcomes	Regulatory guidance
• Make substantive improvement to water demand management performance to support long term environmental policy and supply resilience	Revised policy guidance and customer priority
• Demonstrate that Welsh Water has enough reliable water resource and treatment capacity to meet future demand over the next 25 years	Limited driver change but improved evidence and technology
• Meet revised Government targets with respect to drought resilience and to use industry leading tools to assess our ability to meet these	Revised guidance
• Account for the latest climate change science using UKCP18 datasets and industry thinking within our assessments	Revised guidance and new evidence
• Actively engage with stakeholders and our customers in considering investment decisions	No change
• Secure enough water for the environment over the long term by taking account of current environmental obligations laid out by our regulators and considering wider environmental interests	Revised policy guidance
• Take a 'best value' approach to decision making around solution to problems;	Revised policy guidance
• Robustly test our plans against alternative scenarios and where appropriate take an adaptive planning approach to mitigate future risk	Revised guidance
• Considers the options available for trading water with 3rd parties	Revised guidance
• Build our Plan into, and maintain consistency with, the 'Water Resources West' Regional Plan	Revised guidance

Table 2 – Key priorities for WRMP24

In previous planning rounds, significant asset investment was required to manage the implementation of the Water Framework and Habitats Directives through abstraction licence changes. Demand management and more specifically leakage reduction by at least 15% was also mandated by regulatory expectation.

Although the environment remains a key aspect of our WRMP24, no specific abstraction licence changes have been agreed through the National Environment Programmes that would reduce our current supply capability. We are aware that in the face of a changing climate, the pressure upon the ecology that lives in our rivers will increase and so it is likely that future changes to our operations will be required to maintain their long-term sustainability. To prepare for this challenge we are planning to deliver our largest ever programme of environmental investigations in AMP8 so we can better understand the risks to the environment and how we should respond to this. Compared to our Draft WRMP24, we have undertaken scenario testing looking at assumed levels of reduction in our supply capability from changes made to our abstraction licences to protect the environment. Although very high level in nature, these are intended to provide an indication of the scale of additional investment that could be needed in future planning rounds.

Of the aspects in Table 2, the most meaningful change from WRMP19 relates to the need for improved drought resilience which has required the use of new hydrological evidence and techniques, set within a new 'Long Term Delivery Strategy' framework.

Demand management performance is again a priority for this Plan as it meets the key drivers of increased supply resilience and environmental improvement. This has been mandated to meet both short- and long-term targets.

2.1.1. PR24 Long Term Delivery Strategies

Overview

The long-term delivery strategy (LTDS) forms a key part of our core process for the identification and prioritisation of investment to ensure that the longer-term ambitions of the company can be achieved in an efficient way.

Adaptive planning forms a fundamental element of our LTDS and ensures that viable alternative futures which could impact on achieving the company's ambitions are identified and the consequences managed. Adaptive planning is used to ensure that investment decisions consider the different future environments that assets could be operating in. This allows informed decisions to be made on the timing of investments and design of assets, and avoids the requirement for future re-designs, or assets not being capable of achieving their optimum operating lives. This approach ensures we are undertaking an appropriate whole life cost assessment considering future uncertainty with our understanding of risk based on a range of plausible scenarios to achieve the company's long-term objectives.

Our long-term company ambitions are set out in the 'Water 2050' document. Statutory programmes, such as WRMP related activity, along with other key asset investments combine to define how we will achieve the long-term objectives. We have worked to incorporate LTDS and adaptive planning principles within both the strategic and tactical planning processes.

As such the WRMP24 is built into our overall Investment Delivery Process for PR24. Investment decisions are made based on multiple factors not just lowest cost. Consideration is given to societal and environmental benefits of different interventions.

We have developed a core pathway which outlines the necessary investment to meet the company's long-term strategic objectives under all future operating conditions, or to keep options open, and as such can be considered low or no regrets investment which will be required under all plausible scenarios.

The WRMP is a critical input into delivering the LTDS and the ambition outlined by the company. As such the LTDS and WRMP are aligned.

Customer engagement has helped to shape the company's long-term ambitions and the means of achieving them. The stakeholder engagement undertaken as part of the WRMP has been considered in developing the LTDS and this plan. Section 2.6 of the WRMP identifies stakeholders that have been engaged to date and this aligns with the wider customer engagement plan.

In its guidance document on Long-Term Strategies and Common Reference Scenarios, Ofwat sets out its expectation that companies should start with a Vision and then "*set out what the company will deliver in terms of key performance outcomes for the period*."

The choice of performance outcomes and metrics has been informed by the SPS, the Water Strategy for Wales and other relevant legislation, as well as outputs from the strategic planning frameworks (including NEP, DWMP and WRMP). The outcomes cover the common Ofwat Performance Commitments, plus a set of 'supporting outcomes' which cover other elements of our 2050 ambitions.

The outcomes have been developed through the collaborative process in Wales (i.e. the PR24 Forum) and reflect customer preferences. Table 3 - PR24 Long Term Delivery Outcomes, Measures and Target shows our planned outcomes that are supported by delivery of our WRMP24, these align directly with the key objectives for our WRMP24, namely:

- Leakage – 10% reduction during AMP8, 50% reduction (from 2017/18) by 2050
- Per Capita Consumption – reduced to an average of 110 l/h/d during a dry year
- Business demand – an 8% reduction by 2050 (Normal year demand from a 2019/20 position)
- Drought resilience – achieve 1 in 200 by 2029/30 and 1 in 500 by 2039/40

Outcome	Measure	2050 Target
Leakage Reduction	Leakage (Ml/d)	104
Per Capita Consumption	Consumption per person per day (l/h/d)	110
Drought Resilience	Supply Demand Balance Index (SDBI) based on 1:500 (%)	100
Meters Installed	% of household customers metered	96

Table 3 - PR24 Long Term Delivery Outcomes, Measures and Target

2.2. Defining the Water Resource Problem

There are various methods used in assessing the future water resource risk and deciding on potential solutions in the development of this Plan. These vary from simple methods that make 'high level' approximations, to detailed deterministic or statistical approaches that aim to provide greater insight. A starting point for the Plan is to understand the size and complexity of the planning problem for each zone, termed 'problem characterisation' so that appropriate methods are used.

In zones that have access to plentiful supplies of water resource compared to customer demand, there is little need for investment and so the complexity of analysis can be minimised. Where investment may be needed it is important to quantify the level of water supply risk and so more comprehensive methods should be used.

As with much of the WRMP, the water industry has developed a consistent set of peer reviewed procedures and we have followed the UKWIR 'Problem Characterisation' methodology. The problem characterisation assesses both the complexity and the strategic risk presented by the needs identified in each WRZ. Both are scored as either low, medium or high.

The scores are then combined to create a single 'concern' classification for each zone. Building upon the methodology from WRMP19, additional information was included within the assessment for this plan, namely:

- The WRMP19 supply demand balance position
- The level of drought resilience required
- Updated hydrological inflows and stochastic timeseries
- Impact of climate change – use of updated UKCP18 products and impact of different emissions scenarios
- Operational experiences during recent dry periods

The results of the WRMP24 review are shown in Figure 10. Although very few zones score as either 'Amber' or 'Red', this is largely in part driven by the low complexity scoring in that the concerns identified, and the likely solutions, are well understood. We shared these results with NRW/EA/Ofwat during our enhanced pre-consultation meetings and in their feedback letter, Ofwat commented that *"As your plan develops and the supply demand balance, and its challenges, are better understood, you should consider whether any updates to your problem characterisation are appropriate."*

From discussion with Ofwat we note that this comment was in reference to a relatively low-scoring problem characterisation for zones that we now understand will need investment to maintain and improve drought resilience. We have re-looked at this assessment and we are content that the original findings still hold, due to our clear understanding of the problem and the options to resolve.

Taking our Tywi Gower zone as an example, in Figure 10 it scores as 'Low' under the Problem Characterisation methodology but as set out later in this Plan, it is a forecast deficit zone. Our understanding has been greatly improved as recent dry weather experience in the zone has shown us that our reservoirs will draw down quickly, notably Crai and Ystradfellte. We therefore have a detailed understanding of the issue and are designing options that will target the pinch points in the zone and so under the scoring system the 'problem' will not be complex to resolve. The Tywi Gower zone also provides an import of water to our SEWCUS zone as well as sharing a common resource in Usk reservoir and so the assessment of this zone will align with the methods used for SEWCUS so that an optimal solution across both zones is generated.

The Problem Characterisation has demonstrated that for all our WRZs, traditional decision-making methods remain appropriate, supported where necessary by scenario testing to explore any key uncertainties that could materially influence the Best Value Plan. The assessment has not identified any need to plan beyond a 25-year horizon owing to the relatively 'simple' nature of the current concerns identified. Should bigger challenges present themselves at WRMP29 (e.g., sustainable abstraction reductions) that require more complicated and larger scale solutions then it may become appropriate to plan to a longer timescale. The full Problem Characterisation assessment is available in Appendix 2.

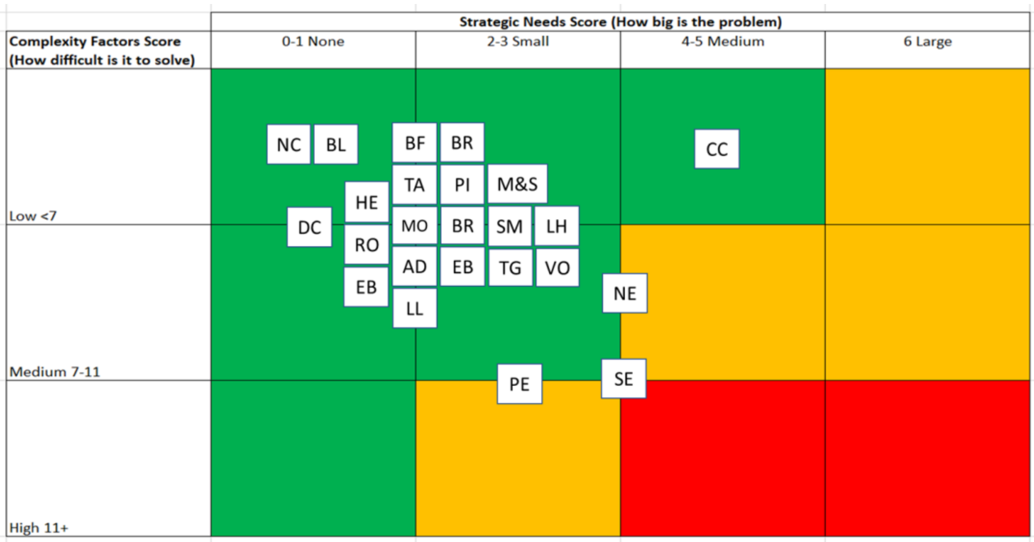


Figure 10– WRMP24 Problem Characterisation

2.2.1. The supply demand balance and level of service

At the core of the WRMP is an assessment of the sufficiency of water resources within each water resource zone which is assessed by comparing supply capability to forecast demand. However, to make allowance for risk, we need to account for uncertainty around many of the factors used to assess the supply capability and future water demand. Planning guidance asks that we add a factor within our zonal supply/demand balances to account for uncertainty. This uncertainty allowance is known formally as 'Target Headroom', more detail of which is provided in Chapter 3.

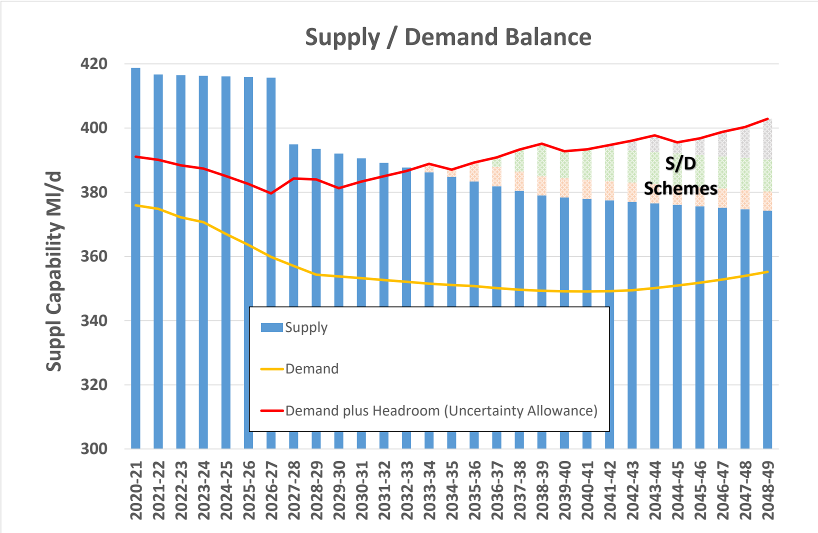


Figure 11- Example supply demand balance graph.

If the deployable output is sufficiently high i.e., greater than demand plus Headroom, then we have a 'surplus' but where it is less than demand plus headroom, we state the zone is in 'deficit'. A zone that is in 'deficit' does not necessarily mean that we would be unable to supply water to our customers but that we would need to use demand restrictions more often than we would like, hence we would provide a poorer level of service (LoS) to our customers. Conversely for a zone in 'surplus' then our customers can expect a better LoS than our company stated minimum and the risk of restrictions upon water use is greatly reduced.

The scale of the surplus/deficit gives an indication of the drought resilience of the zone and so a large percentage deficit relative to our supply capability means there is a risk of more frequent, and more severe, restrictions being needed and so our Plan seeks to address these as quickly as possible.

We estimate our supply and demand forecasts over the planning period to 2050. A number of external factors can impact on these balances. Factors such as climate change or the imposition of tighter environmental standards can significantly affect the amount of supply available and move us from a 'surplus' to a 'deficit' position. Change in customer usage or growth in population over time also needs to be accounted for. The supply demand balance assessment therefore needs to consider a range of futures and make an allowance for the uncertainties associated with these.

Although our WRZs have their own characteristics, it is the level and timing of demand within any zone that defines the water resources planning concern to be addressed. For most of our zones there are two primary planning scenarios that we need to consider, as described below.

2.2.2. Supply Demand Balance Scenarios

Dry Year 'Annual Average'

This scenario assesses our ability to meet the demands that we would expect during an extended dry period when our water resources are most stretched as we have less water coming into our reservoirs and rivers.

Although calculated on a 12-month basis, for many of our zones the 'dry year' is a much shorter period given that rainfall patterns mean our reservoirs will usually always fill through winter and so water resource at these times is not an issue.

The timing between a reservoir coming off spill in spring/summer and returning to spill in autumn/winter governs how resilient our supply availability is. For the majority of our supply systems, an extended dry period of around 6 months is enough to see significant reductions in reservoir levels such that we may be forced to introduce customer restrictions. Section 3 sets out the work we have undertaken to understand the risk of encountering an extended drought period and how that is likely to change in the future.

Dry Year 'Critical Period'

This scenario assesses our ability to meet short term peaks in demand which can occur during hot/dry weather periods when our customers' water use is at its highest. This challenges whether we have sufficient treatment and network capacity within a supply area.

We have assessed all our water resource zones under the "Dry Year Annual Average" scenario and have chosen to assess the following zones under the "Dry Year Critical Period" scenario:

- Ross-on-Wye - to assess the impact of peak demand and risks to our bulk import from Severn Trent Water
- Hereford – to assess the impact of peak demands within this zone and neighbouring zones which are reliant on internal transfers from this zone
- Pembrokeshire- to assess the impact of tourism upon peak demands and our ability to meet these
- Mid & South Ceredigion - to assess the impact of tourism upon peak demands and our ability to meet these

The 2022 drought saw extreme temperatures, notably in July and August as shown in Figure 12 below, resulting in record demands for water. This period significantly tested our water supply capability with tankering frequently required to supplement existing zonal supplies and ensure peak customer demand could be met. This additional activity was almost wholly required in the zones stated above and although we experienced significant peaks in demand in our other tourist areas, such as the North Wales coastal resorts, our supply infrastructure had sufficient capacity such that we are confident we do not need to investigate any critical period planning concerns.

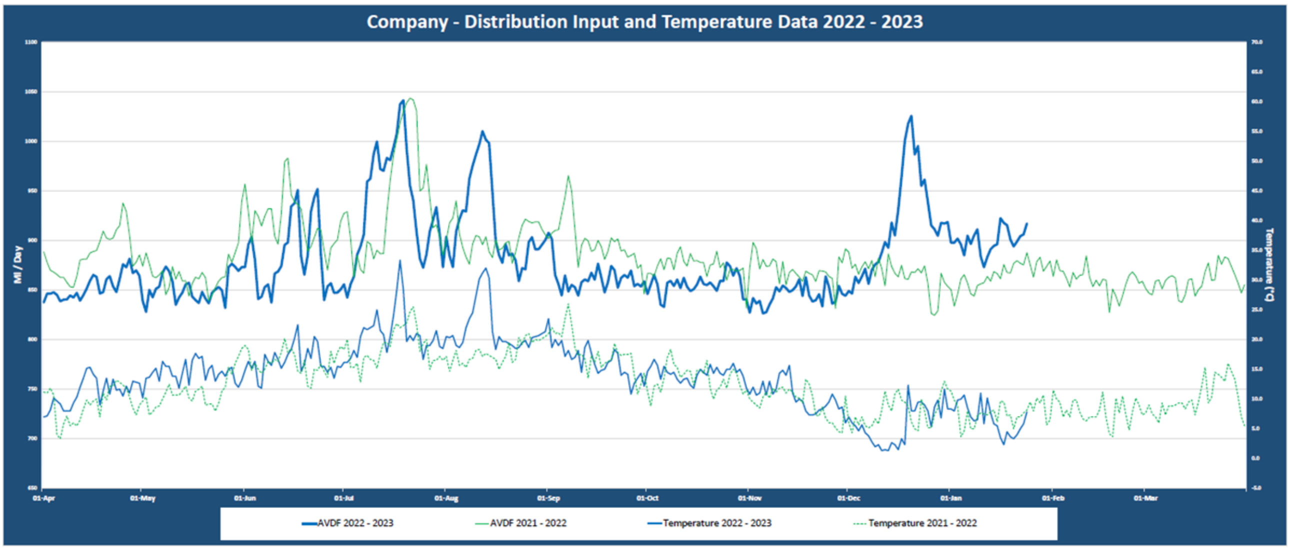


Figure 12 - Companywide demand against daily temperature

2.3. Forecasting Available Supply

Within water resource planning the key measures of our supply capability are termed Deployable Output (DO) and Water Available for Use (WAFU). DO is the reliable output of either an individual water source, or group of sources, accounting for any constraints upon supply such as hydrological inflows, pipework, treatment works capacity and raw water quality.

The amount of water that we can rely on to meet demand within a specific zone also relates to any inefficiencies in our systems such as temporary outages due to equipment failure, or water that is used during the treatment process such as for filter washing. The volume of raw water available to us is affected by the amount of rainfall received and so the effects of climate change are modelled to provide a forecast of how this is likely to change in the future. The term WAFU is therefore used to describe the total amount of water available to meet demand within a specific zone, taking account the effect of the above variables.

2.3.1. Drought and water resource resilience

We assess supply capability in relation to target levels of service. The amount of water we can rely on reduces as higher LoS targets are set. This is detailed further in section 3. As we move into a drought period, we may use measures to reduce demand to ensure that we can continue to supply water even in the most severe droughts. Our LoS measures are:

- Not to have a hosepipe ban (now called a temporary use ban) more than once in every 20 years (1-in-20), on average;
- Not to restrict water for commercial purposes such as car washers, building cleaning, dust suppression (called a non-essential use ban) more than once in every 40 years (1-in-40) on average.
- Not to use emergency drought orders to impose extreme supply side measures (standpipes/rota cuts) more than once in every 200 years (1-in-200) on average. However, moving forward we aim to increase this to a 1-in-500 year LoS.

In previous plans, we have said that we would ‘never’ employ Emergency Drought Orders as these are very disruptive and difficult to manage operationally. In our planning, this meant that we would not use these measures with a repeat of historical drought events. With a growing understanding of climate change, we have been asked to better understand and quantify our level of resilience to drought.

Although severe droughts by their nature are infrequent events (the last time this happened in our supply area was in 1976) their impact can be very high and under a changing climate, could become more frequent. New guidance in England asks that companies move to a position whereby water rationing through use of Emergency Drought Orders would not be imposed more than once in every 500 years on average. This should be in place at the latest by 2040 but preferably sooner. Our preferred Plan will therefore provide our customers with the following minimum levels of service:

Measure	Target Level of Service	Target Date (All WRZS)
Temporary Use Ban	1 in 20 years on average	Available now
Ordinary Drought Order/ Drought Permit	1 in 40 years on average	Available now
Emergency Drought Order	1 in 200 years on average	2030
	1 in 500 years on average	2040

Table 4 – Planned Drought Resilience Levels

In Wales, although government guidance is not prescriptive, we have agreed with NRW that we will meet the AMP7 Ofwat common performance metric of resilience to a 1 in 200 year (i.e. 0.5% annual chance of needing Emergency Drought Orders), if not already reached, as early as possible in AMP8 and match the English target of 1 in 500 by 2040 as a minimum. This Plan sets out how our programme of scheme delivery will move us to this improved level of resilience, linking to both the 'Well Being' Goals and ways of working in Welsh legislation.

We have experienced a number of dry periods over recent years and have used the knowledge gained from these in the development of this Plan, most notably the recent drought in 2022 where we implemented our first 'Hospeipe Ban' since 1989. Other recent dry periods have also provided useful insight; in 2018 we experienced a prolonged, very hot and dry period between April and July with rainfall around half of normal levels across most parts of our supply area, which led to numerous reservoirs drawing down to low levels. We experienced further periods of very hot and dry weather in 2020 that coincided with the first Covid-19 'lockdown' and led to some of the highest levels of demand we've seen, peaking at over 1,050 Ml/d in early June – approximately 20% above normal levels. A similar peak in demand was seen in July 2021 where hot weather coincided with more people holidaying in the UK due to overseas travel restrictions – the 'staycation' effect.

These events provided us with challenging conditions to manage that we had not experienced for some time, and we have used the information gained to improve our assessment of supply capability through updating our water resource behavioural models to better reflect how we are able to operate during a period of dry weather. Our assessments of supply capability (Section 3) provide a more realistic view with known system constraints included so that where required, funding can be sought to alleviate these and enhance our levels of resilience.

The periods of lower reservoir levels provided us with data that we used to help calibrate new hydrological inflow timeseries, generated from our newly built rainfall runoff models.

2.3.2. Climate Change

Understanding the impact of climate change is one of the key considerations for this Plan, something emphasised by both Welsh Government and Natural Resources Wales in their guidance for Welsh companies. Since the Welsh Government declared a climate emergency in April 2019, they are keen to see companies in Wales increase the pace at which they act to both reduce carbon emissions and implement climate adaptation.

In November 2018 the UK Meteorological Office released the UK Climate Projections 2018 (UKCP18). These use cutting-edge climate science to provide updated observations and climate change projections out to 2100 in the UK and globally. This Plan therefore uses these updated outputs, replacing the information from UKCP09 although the general climate trends identified by the Met Office in 2009 have been reconfirmed, in that we should continue to plan for hotter, drier summers and wetter winters with more extreme events within these. The summer of 2022 has provided a stark example of this with both temperature and rainfall records broken across most parts of the United Kingdom including here in Wales.

To ensure that we address these adaptation concerns NRW have issued specific guidance[4] confirming that for those WRZs we classified as having either a 'medium' or 'high' vulnerability to climate change we should assess the zones under both the Representative Concentration Pathway (RCP)6.0 and 8.5 emission scenarios. This data is provided by the outputs of the Met Office UKCP18 project and allows us to perturb our existing meteorological timeseries using various change factors to simulate the impact to our water supply systems under potential future climates. Section 3.5 details our approach to this assessment.

[4] Addendum on UKCP18 scenarios for use in Water Resources Management Plan 2024 (Wales). Natural Resources Wales, May 2021.

2.3.3. Environmental Obligations and Sustainable Abstraction

The National Framework for Water Resources[5] led by the Environment Agency introduced the concept of an 'Environmental Destination' requiring water companies and regional planning groups to be proactive in addressing abstraction pressures by taking a long-term view, particularly in light of the threat posed by a changing climate. The framework in Wales is different with Welsh Government policy providing clear expectations that water companies need to work with regulators to help enhance biodiversity through their water resources activities, whilst continuing to ensure a plentiful supply to customers. The flexible legislative framework allows for the development of a long-term environmental destination that reflects local, regional and national priorities.

As such NRW have not proposed specific abstraction reduction targets for this round of plans but are seeking to achieve a holistic outcome for catchments across the country. In considering this, the greatest challenge is to understand future pressures on the environment with impact from abstraction under a changing climate likely to be one of these.

For this Plan we outline the delivery of wider catchment actions set out in our PR24 business plans related to water catchment management and waste-water discharges. We also plan for increased collaboration with NRW and other stakeholders to gain a better understanding of the costs and benefits of improving environmental flow regimes into the future.

Supplementary guidance from NRW on incorporating environment and society in our decision making (December 2020) states that our WRMP24 "*should therefore follow the principles of Sustainable Management of Natural Resources*" in delivering resilient supplies of water for our customers and the environment. The guidance therefore asks us to take a wider view of water management in seeking multiple benefits from our activities which fully aligns with initiatives that we already have underway such as the Brecon Beacons Mega Catchment collaboration in South Wales and the Dee LIFE project in North Wales, both of which will deliver wider environmental and social benefits.

We are proposing to deliver an AMP8 programme of investigations designed to improve our understanding of how to achieve long term sustainable abstraction to meet the requirements of the Environment (Wales) Act 2016, including the impact of climate change. In catchments from which we affect river flows, assessments should also consider the co-dependency between the needs of both public and non-public water supply sectors to achieve the desired environmental outcome. It is important to recognise that we need a consistent, flexible framework for these investigations that can be applied to specific catchments and regions. Within the PR24 NEP we have agreed with NRW to use the Driver: Biodiversity & Ecosystem Resilience and Driver code W_BIOD_INV1 - Investigations and/or options appraisal for changes to permits or licences, and/or other action that contributes towards Welsh biodiversity duties, requirements, and priorities.

2.4. Forecasting Demand for Water

For each WRZ we compare our supply capability (WAFU) against our forecast of demand for water. There has been little change in the demand forecasting processes since WRMP19 but data sets have been much improved and updated, with the base year for our assessment moving on to 2019/20. Chapter 4 details how our demand data is compiled in line with best practice guidance as outlined in 'Demand Forecasting Methodology' (UKWIR/NRA 1995) and takes account of climate change. 'Dry Year' and 'Critical' Period forecasts of demand have been produced to align with our supply side assessments.

[5] https://www.gov.uk/government/publications/meeting-our-future-water-needs-a-national-framework-for-water-resources

2.4.1. Demand Management

Unlike previous plans, the starting point for our WRMP24 is our over-riding policy driver to reduce demand over time. This is in line with government policy positions to secure both resilient water supplies and enough water for the environment over the long term, to enhance the resilience of ecosystems and support biodiversity.

There is considerable expectation from regulatory guidance, customers, and stakeholders for meaningful demand management to be built into the WRMP24. Customer engagement has shown significant support for reducing leakage, with customers seeing this as a 'social contract' between us, whereby, customers will respond to the requirement to reduce their usage if we play our part in reducing leakage.

Leakage and metering strategies are intrinsically linked with modern metering technology enabling us to identify leakage on our customers' pipes that are linked to our network. Therefore, an increase in the number of customers that have a 'Smart' water meter will decrease the overall leakage position.

'Water Stressed' classification in England enables the compulsory metering of customers and this has enabled a rapid increase in meter penetration for many water companies. However, our customers tell us that they do not want compulsory metering to be part of our plans. We have, therefore, reviewed our metering policy and engaged with our customers and regulators to develop our approach going forward. Our position was set out in the pre-consultation exercise we ran at the start of 2022, with our focus on managing demand through leakage and metering welcomed and supported. This is detailed in section 4.

2.5. Option and solution development

Guidance now requires companies to formally produce a 'Best Value' plan as opposed to the 'least cost' approach taken for WRMP19. Guidance defines a best value plan as "*one that considers factors alongside economic cost and seeks to achieve an outcome that increases the overall benefit to customers, the wider environment and overall society.*"

Where we have assessed that a zone may be in deficit over the planning period, we undertake a thorough assessment of potential options to restore the WRZ into a surplus position. However, given the strength of support and desire for demand management as described above, this element of the plan has been mandated within our preferred set of schemes. Where this is insufficient to restore a positive supply demand balance and deliver the agreed LoS for customers, other options are considered as part of a 'Best Value' Plan.

Like the WRMP19 Plan where leakage targets were mandated through guidance, solutions to reduce leakage and to encourage customer usage in line with our long-term delivery strategy are set within the overall Plan.

Where further schemes are needed, we have examined the cause of the issues and identified a range of solutions to resolve. Chapter 5 describes in more detail the decision-making process for our deficit zones.

Of particular issue for this Plan is the need for increased resilience under a changing climate going forward. Detailed modelling has shown that localised parts of our supply systems are not resilient to extreme droughts even though the system as a whole may have sufficient water resource. This is due to the local nature of some reservoir catchments and the way in which these are linked to meet customer demand. In this case the options to resolve are both limited and relatively straight forward, through increasing network connectivity.

Figure 13 below provides a high-level view of the process we have followed to assess the water resource resilience within each zone and to then decide on the 'Best Value' programme of investment needed to achieve our resilience targets. Chapter 5 provides additional detail around this process.

The overall output is therefore a preferred 'Best Value' Plan with alternative plans that allow for programme adaption during future planning cycles. To ensure the outputs of our Plan are robust we also need to test them against a range of potential alternative future scenarios to reduce the risk that the chosen solutions may become redundant if the assumptions made within our Plan turn out to be incorrect. A key theme in our Plan is to ensure that our systems are resilient.

2.5.1. Environment and Society in decision making and an ecosystems approach

Guidance from NRW and WG is clear that our WRMP24 needs to deliver for both our customers and the environment through adoption of the principles of SMNR. To ensure that our Best Value planning decision making accounts for this, as described in our introduction, we have considered:

- *Environment (Wales) Act 2016, Section 6 biodiversity and resilience of ecosystems duty, and habitats and species of principle importance (Section 7).* Demonstrating that the plan has environmental net gain.
- *Well-being of Future Generations (Wales) Act 2015* – acting in accordance with the sustainable development principle so that the well-being goals are achieved.
- *Natural capital accounting.* - Natural capital factors are included in decision making where needed.
- *Strategic Environmental Assessment (SEA) and Habitats Regulations Assessment (HRA).* - These are undertaken as part of the planning process
- *Water Framework Directive (no deterioration of status).* - This is considered within the SEA and HRA assessments.

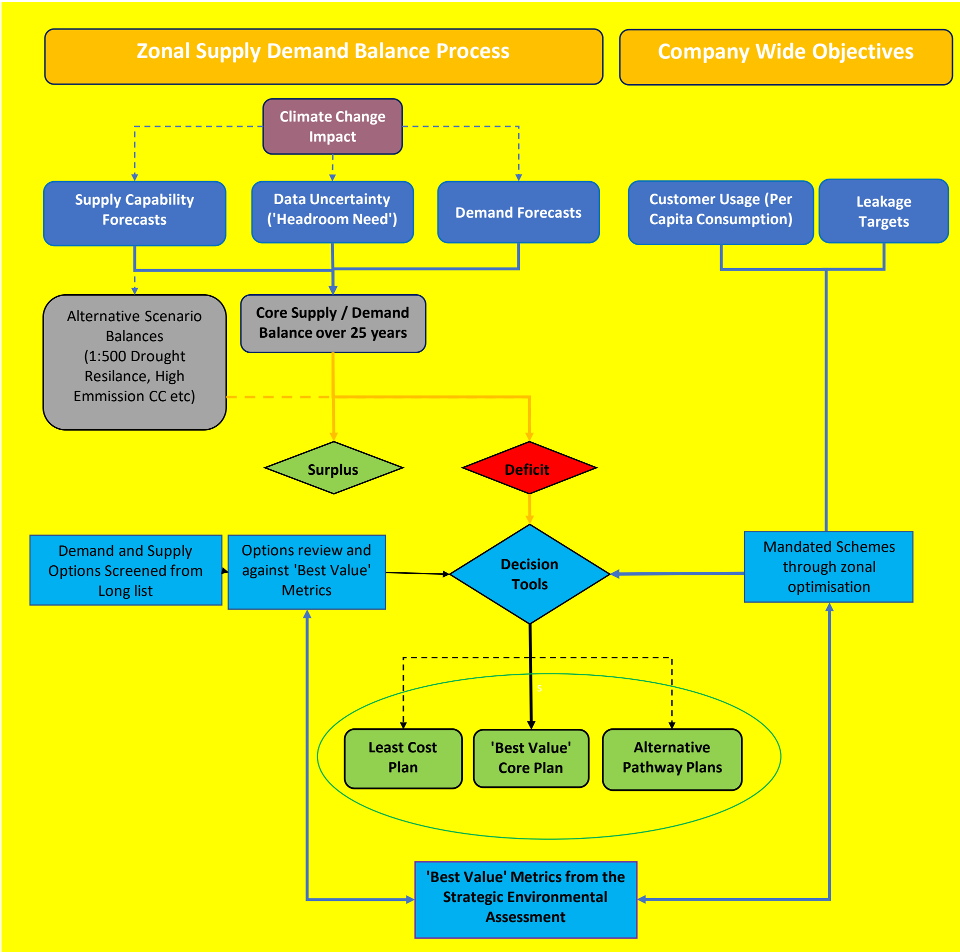


Figure 13 – 'Best Value' Decision Making Process

On the 30th June 2021, the Welsh Parliament declared a nature emergency and called for statutory targets to be set to halt and reverse the decline in biodiversity. The Environment (Wales) Act 2016 already requires that water companies "*maintain and enhance biodiversity in the exercise of their functions, and in so doing promote the resilience of ecosystems.*" Our thinking, decision tool and options filtering process aim to meet the principles of SMNR, namely that our Plan should:

- *Deliver demonstrable benefit for the environment and people* – Preference for schemes that reduce abstraction from the environment such as demand management or make use of existing water resources.
- *Consider the appropriate scale* – Considers options at all scales from local zonal solutions to interzonal transfers.
- *Consider multiple benefits* – Adds environmental and water supply resilience. Maintains or enhances river flows at appropriate times.
- *Use a collaborative approach* – The Plan is developed through active engagement with stakeholders and customers.
- Take account of all relevant evidence – Uses best available evidence such as UKCP18 data and learning from the Drought of 2022. Where evidence is not strong then the Plan seeks to investigate key areas in AMP8 such as the impact of climate change on environmental measures.

2.6. Customer and Stakeholder Engagement

Regular engagement with stakeholders has been a key feature in the development of our draft WRMP24, with early discussions helping to ensure that we reflect the priorities of Government and our regulators. The introduction of the regional water resources planning process has meant that through the Water Resources West group, of which we are a member, we have had regular weekly/monthly engagement with neighbouring water companies (United Utilities, Hafren Dyfrydwy, Severn Trent Water, South Staffs Water) and other key stakeholders such as EA, NRW, Ofwat/RAPID, the Canal & River Trust, the National Farmers Union, Natural England as well as representatives from the power sector.

2.6.1. Pre-consultation

We launched our formal pre-consultation on this Plan on the 7th of Feb 2022, sending an overview of our plan and supporting information to over 300 stakeholders. The consultation ran for 6 weeks, closing on the 21st of March and we received 13 responses including those from NRW, EA and Ofwat. Table 6 provides a high-level summary of the responses received from NRW and Ofwat whilst Table 5 summarises the response from non-Regulators. It was pleasing to see NRW state in their response "*We welcome the engagement with ourselves to date and would be pleased to continue regular engagement on your plan into the future*".

Alongside this we held dedicated pre-consultation meetings with NRW/EA on the 21st of January 2022 and with Ofwat/RAPID (EA/NRW also invited) on the 28th January 2022, providing opportunity for more detailed scrutiny of our proposals for WRMP24. On the 9th of February 2022 we presented our proposals for the draft WRMP24 to a wide range of Welsh stakeholders as part of the WRW dedicated Wales event. We have taken these into account within our Plan.

Organisation	Key feedback summary	Addressed in WRMP
NRW	Strategic priorities – supports our objectives and asks that the plan explores opportunities to enhance ecosystems and improve wellbeing through our decision-making and wider operations	Section 2, 5
NRW	Decision-making and developing your plan. - welcome the commitment to producing a 'Best Value' plan and need to ensure decision making accounts for customer's view and environment.	Section 2, 3, 5, 6
NRW	Managing demand for water – present the evidence behind our demand management strategy and the benefits it will deliver	Section 4, 5, 6
Ofwat	Clearly set out our starting position for WRMP24 and changes since WRMP19.	Section 2, 3, 4, 5
Ofwat	Set ambitious long term demand reductions and provide evidence that our glidepaths towards achieving these are optimal	Section 4, 5, 6
Ofwat	Undertake sensitivity testing and adaptive planning where needed, ensuring that a wide range of supply and demand options are available	Section 5, 6

Table 5 – Summary of pre-consultation feedback from NRW and Ofwat

Organisation	Key feedback summary	Addressed in WRMP
Senedd Cymru - Welsh Parliament	Discuss your plans in more detail and the priority areas for future years	Section 2.1
Bishton Community Council	Local sewerage issue	Through our company DWMP
Business Customer	Population growth in Pembrokeshire	Section 4
Carmarthenshire Council	Seeking continued engagement should we propose any options	Through separate response
Bristol Water	Option development of Great Spring	Through separate response
Afonydd Cymru	Ensure any chosen options do not impact upon SAC rivers. For any strategic options they would expect to see environmental destinations from these schemes that are over and above existing water company obligations	Appendix 16 – HRA

Organisation	Key feedback summary	Addressed in WRMP
Caerphilly Council	We look forward to engaging in further work to capitalise on the opportunities to help both the Local Authority and the Water board to meet the challenges ahead	Through separate response
WRW	To continue the joint working and inform WRW should DCWW put forward any strategic transfer options	WRW is referenced throughout the Plan
RSPB	Ask that we work in partnership to tackle the nature and climate emergency, particularly looking for way to help improve biodiversity which will also have wider benefits	Section 2
CCWater	Keen to see a clear and accessible non-technical summary of the plan. Continue to look for new ways of customer engagement and meaningful stakeholder engagement	Section 1

Table 6– Summary of Pre-consultation feedback

2.6.2. Draft Plan Consultation

We ran a full public consultation on our draft Plan for 14 weeks from the 16th November 2022 through to the 22nd February 2023, receiving 14 responses in total. The main report, together with the planning tables, SEA/HRA reports, and a bilingual non-technical summary were published on our website. During the consultation process we:

- Contacted over 300 organisations
- Contacted all relevant Members of the Senedd and UK Parliament
- Publicised the Plan via our Welsh Water social media
- Presented the Plan to Welsh Water's Independent Environment Advisory Panel (IEAP)
- Ran a dedicated stakeholder engagement event (online) on the 24th of January 2023. Twenty organisations were represented at the event which provided them with an opportunity to discuss in more detail our draft WRMP24 ahead of providing any formal consultation feedback.

A summary of the themes on which comments were received are shown in Table 7 below.

Stakeholder	Major feedback themes
NRW	Preferred plans for Clwyd Coastal and Mid and South Ceredigion, Deliverability of demand reductions, Enhanced ecosystem resilience
OFWAT	Company-level supply demand balance, Clwyd Coastal, Drought resilience, Water balance, Optioneering, Adaptive pathways, Tables
Natural England	Conservation objectives and monitoring specifications within Habitats Regulations Assessment, In-combination effects in Strategic Environmental Assessment,
Afonydd Cymru	Leakage and Per Capita Consumption, Non-household and Critical Period demands, Preferred plan, Natural Capital Approach
CRT	Demands and Preferred plan in the Usk catchment
Cadw	Impact of options on cultural heritage
Waterwise	Demand reductions, Metering strategy, Water efficiency, Preferred plan
CCW	Communication of the plan, Demand management, Leakage, Metering, Per capital Consumption, Bill impact
Flintshire County Council	Demand forecasting, Links to wastewater and water quality
Pembrokeshire Coast National Park Authority	Supply, Communications, 2022 Drought
WRW	Collaboration with regional planning
NFU	Government policy
Arqiva	Metering strategy, Advanced Metering Infrastructure
Environmental Public Health (NHS)	Vulnerable customers, Environmental hazards

Table 7 – Summary of responses

2.7. Board Assurance

WRMP Guidance requires us to provide an assurance statement from our Board to Ofwat and NRW/EA confirming that:

- We have met our obligations in developing our plan
- Our plan is a best value plan that meets our requirements to supply water and protect the environment

- Our plan is based on sound and robust evidence including costings
- Our plan reflects any relevant regional plan

Our Governance structure for sign off of the WRMP submission is as follows:

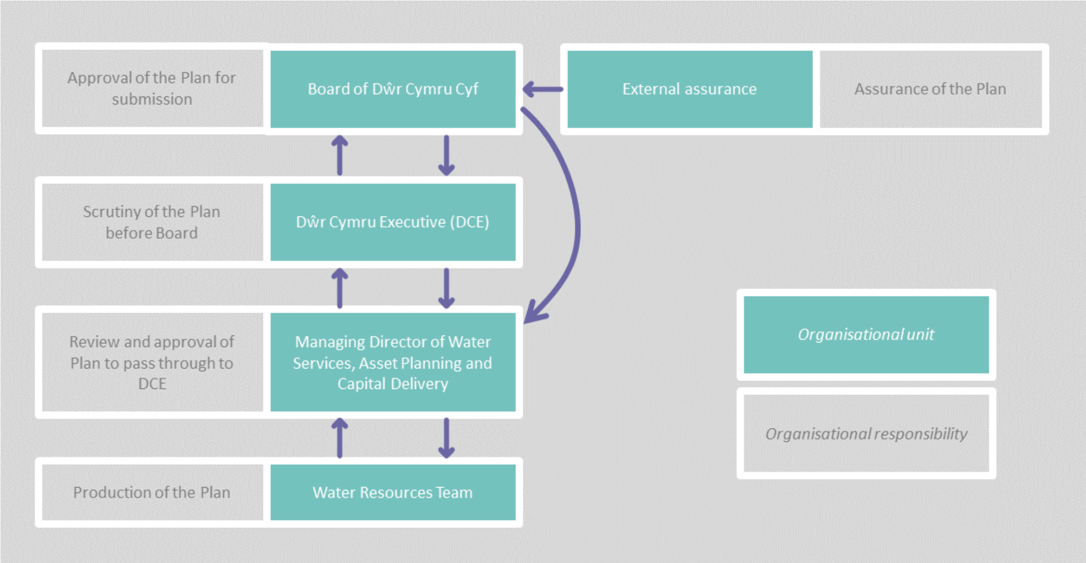


Figure 14 – Internal process for WRMP approval

We have commissioned Jacobs, as our independent Company Auditors, to undertake assurance of our draft WRMP24 to determine if any elements of our approach are likely to be materially inconsistent with WRMP technical guidelines and Welsh Government's guiding principles. Jacobs also considered how Ofwat's strategic priorities for PR24 are reflected in the WRMP.

The Jacobs assurance was asked to focus on five areas in particular:

- Supply Methodologies
- Demand forecasting process
- Option development
- Decision Making
- Environmental aspects and requirement

The Jacobs assurance letter to the Welsh Water Board is included as Appendix 3 to this Plan and confirms that:

- DCWW and partners have demonstrated a good understanding of the WRPG and associated documents;
- the processes that DCWW and partners described are consistent with the WRPG, with any deviations explained and justified;
- the plan adequately reflects the Welsh Government's guiding principles and Ofwat's key themes for the 2024 price review; and
- DCWW processes incorporate appropriate levels of quality assurance.

To allow our Board to sign off submission of the Revised Draft WRMP24, we have again utilised Jacobs to provide assurance on the Plan, focussing on few key areas, notably the incorporation of the revised water balance into our demand forecast and demand management strategy, and how we have amended our Plan in response to the consultation responses received. The updated assurance letter from Jacobs to our Board is included as part of Appendix 3.

2.7.1. Regional Water Resource Planning

The UK Government, through the Environment Agency and Ofwat, set up a National Framework for Water Resources in England in 2020 to explore the long-term needs of all sectors that depend on a secure supply of water. The water industry was tasked to set up 5 regional water resource groups and to consider the availability and use of water resources across sectors and between regions to provide a best value solution to water resource resilience for both water companies and the environment across England.

There is no equivalent regional group within Wales, but DCWW are a core member of the Water Resources West (WRW) planning group due to border interests and shared water resources. Only those zones that border other water companies have been included within the regional plan with the information provided within our Draft and Revised Draft WRMP24 consistent with that provided within the non-statutory WRW regional plan.

The Regulators Alliance for Progressing Infrastructure Development (RAPID) made up of Ofwat, Environment Agency and Drinking Water Inspectorate has also established to help accelerate and manage the funding of potential strategic water resource schemes and water transfers. However, a decision was made by DCWW early in 2021 not to promote trading water with neighbouring companies until we understand the full benefits of doing so.

We are however working closely with the Canal and Rivers Trust in Wales to support the canal system in response to their need for reduced abstraction from the environment. Further details of this are provided in Section 6.

3. Water Supply

3.1. Introduction

Wales has an essentially maritime climate, characterised by weather that is often cloudy, wet and windy but mild. However, the shape of the coastline and the central spine of high ground from Snowdonia southwards to the Brecon Beacons introduces localised differences. Whilst some upland areas can experience harsh weather, the coasts enjoy more favourable conditions and areas in east Wales are more sheltered and hence like neighbouring English counties.[6]

Rainfall in Wales varies widely, with the highest average annual totals being recorded in the central upland spine from Snowdonia to the Brecon Beacons. Snowdonia is the wettest area with average annual totals exceeding 3000 mm, comparable to those in the English Lake District or the western Highlands of Scotland. In contrast, places along the coast and, particularly, close to the border with England, are drier, receiving less than 1000 mm a year[7].

Throughout Wales, the months from October to January are significantly wetter than those between February and September, unlike places in eastern England where July and August are sometimes the wettest months of the year. This seasonal pattern is a reflection of the high frequency of winter Atlantic depressions and the relatively low frequency of summer thunderstorms. For example, at Cardiff, thunder occurs on an average of 11 days a year, compared with 15 to 20 days at many places in England. In west and north-west Wales the frequency drops to around 8 days per year[7].

The diversity of our water supply systems reflects these regional variations, which can range from discrete small-scale local supplies, through to large scale multi-source integrated networks, such as in the South-East Wales area, that is more typical of many other water companies. On average we abstract around 850 million litres a day (Ml/d) for public water supply. This normally increases by around 15 – 20 per cent during the summer. During periods of extreme conditions – long hot summers or sudden thaws following freezing weather – the demands on our supply systems can increase by over 25 per cent, and in some localised areas by more than this.

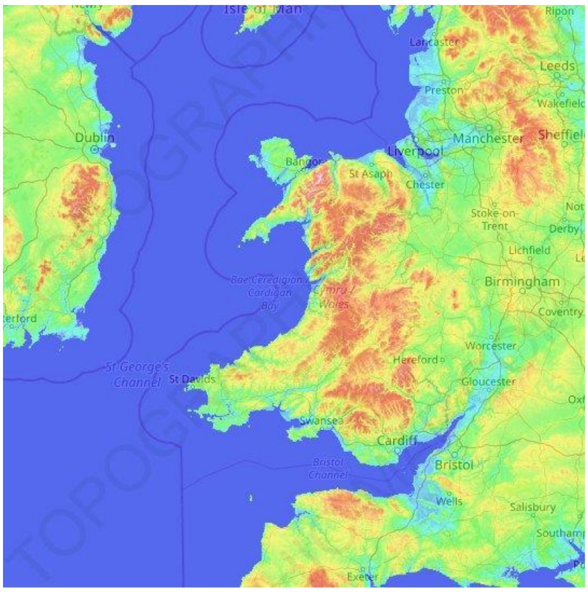


Figure 15 – Topographical map of Wales[7]

—[6] Met Office: Wales Climate, 2016

[7] https://en-gb.topographic-map.com/maps/c4/Wales/ (accessed 08/09/2022)

3.1.1. North Wales

Our North Wales region serves around 520,0000 people living mainly in Chester and Deeside, Anglesey, the Bangor and Caernarfon area and the coastal strip from Llandudno to Prestatyn. We also supply several large non-potable customers in the area, most notably on Deeside and Anglesey.

Some parts of North Wales experience a significant tourism influx during the summer months, which has a direct impact on the quantity of water supplied during that time. As a consequence, the resources and the associated infrastructure supplying these areas need to be able to meet the summer peaks whilst operating at lower levels throughout the remainder of the year.

The rainfall across North Wales varies from upwards of 3,000mm per year on the mountains of Snowdonia to 1,200mm per year around the coastline. However, evaporation throughout the region is also similarly high, reaching over 600mm per year (actual evaporation) across some parts, which offsets the high rainfall to some degree. Our North Wales supply systems vary from small areas supplied entirely from run-of-river abstractions to larger areas supplied from a combination of impounding reservoirs, run-of-river abstractions and groundwater sources.

Figure 16 – Llyn Cwellyn

3.1.2. Southwest Wales

Our Southwest Wales region serves over 960,000 people living mainly in and around Swansea, Bridgend, Llanelli, Carmarthen and the coastal towns and villages from Pembroke to Aberystwyth. We also supply several large non-potable customers in the Pembroke Dock / Milford Haven area and in the Swansea area. Much of Southwest Wales experiences a significant tourism influx during the summer months which has a direct impact on the quantity of water supplied.

The rainfall across Southwest Wales varies from a low of 1,047mm per year at Nevern on the north-west Pembrokeshire coast to a high of 2,220mm per year in the uplands of the Rheidol valley in Ceredigion. Rainfall in the main Tywi catchment averages around 1,600mm per year. Supply areas in the region fall into two categories; the relatively simple systems in the northwest of the area that serves Ceredigion and the complex and highly conjunctive systems in the southern part of the region that serve Pembrokeshire, Carmarthenshire, Swansea and Bridgend.

Figure 17 – Llys y Fran reservoir

3.1.3. Southeast Wales

Our Southeast Wales region serves nearly 1.6 million people living mainly in Cardiff, Newport and the South Wales valleys and parts of Herefordshire. We also supply a number of relatively large non-potable customers throughout the area.

The rainfall across the Southeast of our supply area varies greatly from as little as 700mm per year in the eastern parts around Hereford to some 2200mm in mid-Wales and uplands of the South Wales valleys. The main lowland urban areas such as Cardiff receive around 1200mm per year, slightly under the average for Wales. Supply areas vary from simple, single sources of water to the extremely large, complex and fully conjunctive areas supplied from a combination of impounding reservoirs and river abstractions that have to be managed carefully to ensure sufficient resource is always available.

Figure 18 – Llwynon reservoir

3.2. Supply Capability - Deployable output

We calculate our system capability, or Deployable Output, using behavioural models that simulate the operation and performance of our supply systems under a range of hydrological events. These are linear programming type models in which we describe the basic components of our supply system. For each component such as a reservoir, water treatment works or trunk main we define parameters and put limits on these in line with our actual supply system. For example, we need to specify the size of each reservoir and how much water we are able to take from it given any asset constraints. Within WRMP guidance, Deployable output is defined as the yield of a commissioned source, or group of sources constrained by:

- hydrological yield
- licensed quantities
- environment (represented through licence constraints)
- pumping plant and well and aquifer properties
- raw water mains and aqueducts
- transfer and output restrictions
- treatment
- water quality

Since publication of our Final WRMP19, one of the most significant changes we have made is to upgrade all our water resource models from the WRAPSIM to AQUATOR software platform. This change has provided two key benefits. Firstly, to produce a more detailed and realistic representation of our supply systems and secondly to run larger data sets to support the use of very long time series of generated weather data.

Figure 19 and Figure 20 show how our AQUATOR model of the Mid & South Ceredigion WRZ compares to the previous representation in WRAPIM. The refined model provides a far closer representation of the distribution system (grey lines), and notably the inclusion of greater granularity of demand centres (yellow circles).

We commenced this process in 2018 with the build of our five largest zones (SEWCUS, NEYM, Alwen-Dee, Tywi Gower, Pembrokeshire) in the AQUATOR software. Full details of this migration process, which set a template for how we built the remaining zones in AQAUTOR, is detailed in Appendix 4.

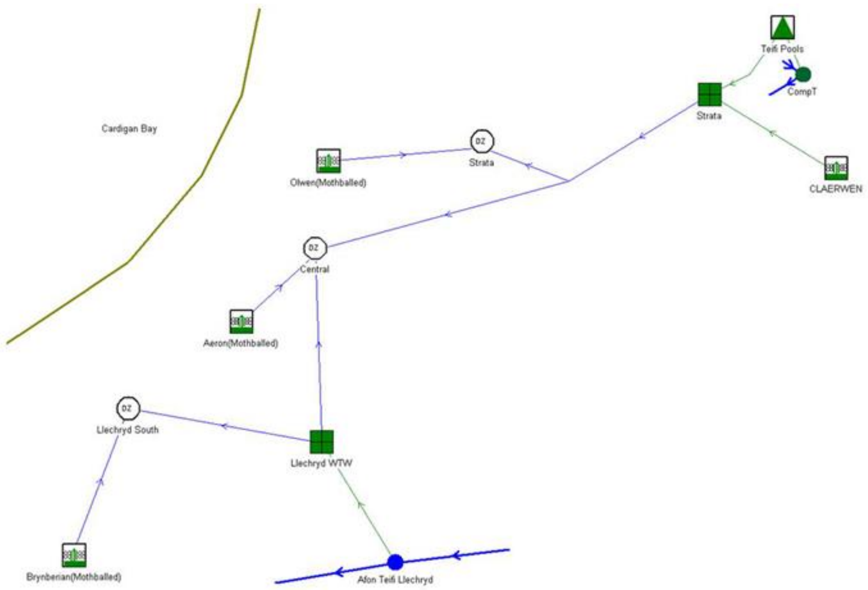


Figure 19 – WRAPSIM schematic of the Mid & South Ceredigion WRZ (WRMP19)

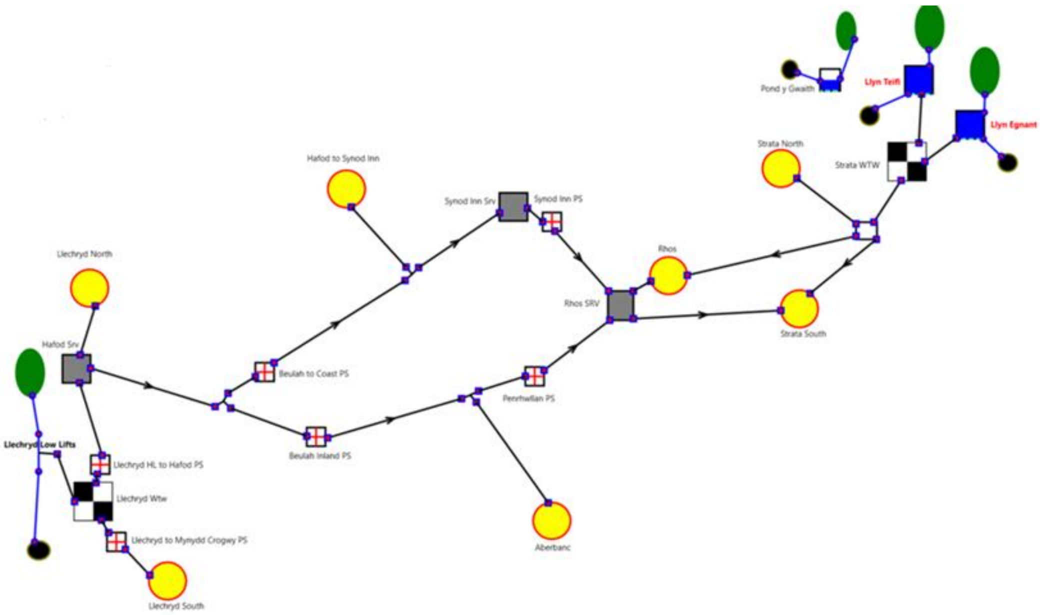


Figure 20 – AQUATOR schematic of the Mid & South Ceredigion WRZ (WRMP24)

The two main inputs to the AQUATOR models are inflow records for the rivers and reservoirs from which we abstract water and the profile of demand that we expect during a dry year, to represent the conditions that we will meet during the most challenging years. The models are run to simulate how our current systems, with all of the asset constraints, operating rules and abstraction licence conditions built in, will meet customer demand. The models also simulate the control rules that are used to trigger the use of customer demand restrictions such as Temporary Use Bans. Section 3.3 below describes this in more detail.

The models are run on a daily time step and mimic the operation of the supply system with either a repeat of historic weather or with generated weather patterns with or without factoring for climate change. The outputs are the flows within the system, the resultant reservoir levels and the frequency at which customer demand restrictions are imposed.

We continuously review our deployable output models in conjunction with our Operational and Asset Planning colleagues to ensure that our assessment of supply capability is always reflective of any asset and abstraction licence constraints, so that we can have confidence in our ability to meet customer demands during dry weather. During the 2022 drought we had concerns in our SEWCUS WRZ due to low storage levels in Pontsticill and Llwynon reservoirs, a situation that at the time could potentially be exacerbated through a hitherto unknown compensation flow clause for the Taff Fechan. However, this has now been resolved and our modelling assumptions around these sources remain as per the draft WRMP24.

3.2.1. Hydrological inflows

Inflow sequences are required for all our reservoir and river sources to understand the water available for supply in their respective water resource models. Inflow sequences were previously derived using either transposition of a gauged flow record to an ungauged location, such as the inflow to a reservoir, or through use of a rainfall-runoff model, predominantly using the HYSIM software but with some limited use of the CATCHMOD software, notably for our 2020 Drought Plan.

Requirements at WRMP24 necessitate an improved approach that can estimate the rainfall-runoff characteristics for every catchment from which we take water from the environment. This not only produces a more accurate representation of our supply capability but allows longer statistical inflow data sets to be produced from weather data. These data sets are needed to investigate the response of our supply systems to extreme droughts including climate change.

The need to produce many climate and stochastic scenarios requires model packages that facilitate batch processing and rapid simulation. There were limitations with the previously used software packages, and so we have also taken the opportunity to move to a new platform that is better suited to representing the hydrological processes associated with our predominantly upland, reservoir catchments.

A detailed trial of available rainfall-runoff models by HR Wallingford indicated that the 'GR6J' software best met these requirements and would allow us to fully convert to the use of rainfall runoff models for all inflow timeseries generation. In preparation for WRMP24 we generated sixty-six GR6J river/reservoir catchment inflow models (Figure 21) outputting:

1) A circa 60 year 'historic' inflow record for the period 1961 – 2018,
2) A set of stochastically generated 20,000 years of inflow data to test our drought resilience
3) 12 UCKP18 Regional Climate Model (RCM) and 100 UKCP18 'Probabilistic' sets of perturbations

Full details of the work undertaken to update our hydrological inflows is available in Appendix 5.

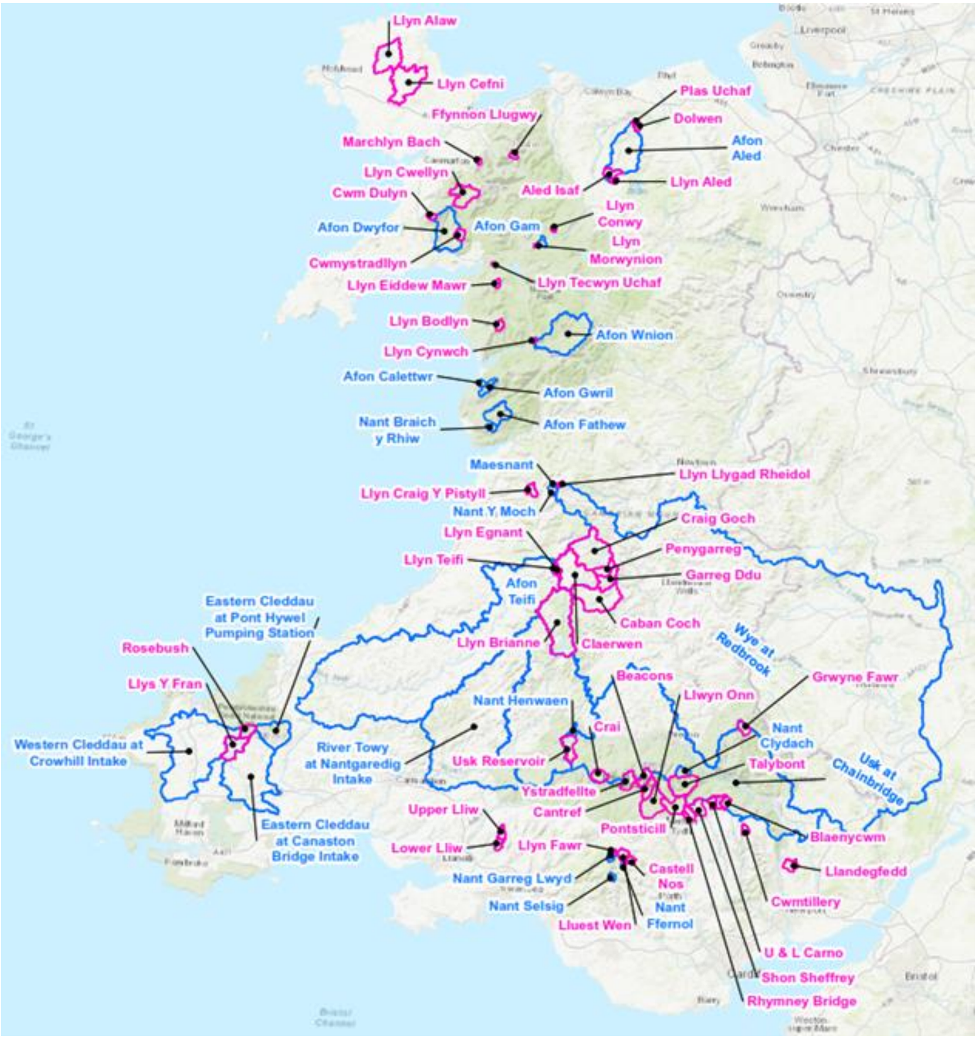


Figure 21 – Location of the 66 GR6J rainfall runoff model development

Taken together, the improvement in our behavioural modelling and generation of hydrological inflows represents a significant step forward in our capability, enabling us to provide a much greater understanding of our water supply system resilience to a range of hydrological events and to better quantify our drought risk. Our calculated DO, using a 'worst historic' drought event as a comparator, has not significantly changed between WRMP19 and WRMP24 (Table 8), confirming that our starting position for WRMP24 is very close to that presented in our Final WRMP19. Where the variation is greater than 5%, Table 9 provides a summary of the reasons for this with fuller details provided in Appendix 6.

However, companies are now required to plan against more extreme drought events than those seen historically and so we have calculated our supply capability under both a 1 in 200 and 1 in 500-year drought event, noting that our 'worst historic' drought is estimated to be around a 1 in 100. Table 1 therefore presents the impact to DO when tested against a 1 in 200-year drought event and unsurprisingly, most zones show a decrease in capability due to the reduction in available raw water. The starting point for our supply capability for WRMP24 cannot therefore be directly compared to that of WRMP19 as the design drought event being simulated is more severe.

	WRMP19 'Worst Historic' DO (Ml/d)	WRMP24 'Worst Historic' DO (Ml/d)	% Change WRMP19 to WRMP24 ('Worst historic')	WRMP24 1:200 DO (Ml/d)	% Change WRMP19 to WRMP24 (1:200)
NEYM	52.0	47.1	-9.4%	47.1	-9.4%
Clwyd Coastal	26	25.3	-2.7%	22.6	-13.1%
Alwen / Dee	56.6	60.5	+6.9%	60.5	-6.9%
Bala	1.77	1.80	+1.7%	1.80	-1.7%
Tywyn Aberdyfi	1.25	1.88	+50.4%	1.88	-50.4%
Lleyn / Barmouth	19.19	18.8	-2.0%	16.9	-11.9%
Blaenau Ffestiniog	1.95	2.64	+35.4%	2.22	-13.8%
Dyffryn Conwy	35.7	35.3	-1.1%	35.3	-1.1%
South Meirionnydd	2.41	2.50	+3.7%	2.50	-3.7%
Ross-on-Wye	6.22	6.72	+8.0%	6.72	-8.0%
Elan / Builth	6.36	6.19	-2.7%	6.19	-2.7%
Hereford	45.91	40.78	-11.2%	40.78	-11.2%
Llyswen	4.39	2.89	-34.2%	2.89	-34.2%
Monmouth	4.44	4.55	+2.5%	4.55	-2.5%
Pilleth	2.31	2.25	-2.6%	2.25	-2.6%
Brecon	4.48*	3.28	N/A	3.28	N/A
Vowchurch	2.36	2.26	-4.2%	2.26	-4.2%
Whitbourne	5.15	5.6	+8.7%	5.6	-8.7%
SEWCUS	422.49	432.25	-2.3%	362.94	-14.1%
Tywi	222	208.85	-5.9%	186.56	-16.0%
M&S Ceredigion	22.53	21.83	-3.1%	21.26	-5.6%
North Ceredigion	12.44	11.61	-6.7%	11.43	-8.1%
Pembrokeshire	74.31	70.79	-4.7%	73.9	-0.6%

Table 8 – Deployable Output comparison between WRMP19 and WRMP24

Zone	Reason for 'Worst Historic' DO variation
NEYM	Improved demand profiles that better represents peak demands in the zone. Peak capacity is unaffected, but the annual average capacity is reduced.
Alwen / Dee	Improved understanding and representation of our supply network has removed a constraint that was previously included in our WRMP19 modelling.
Tywyn Aberdyfi	The updated hydrological inflows are c50% higher at low flows which was the constraint upon our capability at WRMP19. A dedicated study including fieldwork during 2022 has confirmed this increased water availability assessment is robust.
Blaenau Ffestiniog	Increased treatment works capacity at Garreglwyd has been incorporated within our modelling which enables us to present a higher zonal supply capability.
Ross-on-Wye	Supply system improvements means we are now able to import a maximum of 0.7 Ml/d from the neighbouring Hereford WRZ which increases both our peak week and average annual capability.
Hereford	Based on learning from recent dry weather events we have updated our model representation of the constraints in the supply network. This has reduced our supply capability by c11%.
Llyswen	Based on learning from recent dry weather events we have updated our model representation of the constraints in the supply network. It is worth noting this lower annual average DO is purely a function of the demand profile whereby the average demand through the year is much lower than the summer peak demand.
Whitbourne	The reduction in annual average DO is driven by a change to the demand profile to reflect recent dry year peak demand which is now higher than at WRMP19 but this does have the effect of reducing the average annual profile.
Tywi	The updated hydrological inflows for both Crai and Ystradfellte reservoirs are significantly lower and although offset somewhat by the updated inflows to Llyn Brianne being higher, we now see increased demand failures in our water resource model which results in the c6% reduction in 'worst historic' DO between WRMP19 and WRMP24.
North Ceredigion	The updated hydrological inflows for both Craigypistyll and Llyn Llygad Rheidol reservoirs are significantly lower and so we see some additional 'failures' at these sources which causes the c7% drop in DO.

Table 9 – Reasons for Change in DO between WRMP19 and WRMP24

3.3. Drought and Water Resource Resilience

For WRMP19, water companies began the process of gaining a better understanding of the level of drought resilience they had in their supply systems, in response to both WaterUK's "*Water resources long term planning framework*" and the National Infrastructure Commission's "*Preparing for a drier future*". Both reports set out the risks of more frequent and extreme drought events and the actions needed to mitigate these. Our WRMP24 sets out the improved understanding that we have gained through further technical work and analysis of our level of drought resilience, and the investment needed to enhance this as far as possible.

3.3.1. Defining Drought

For water companies, droughts are caused by a combination of prolonged periods of dry weather and higher than normal temperatures. This both reduces the water stored in our reservoirs and that which is naturally available from rivers, whilst increasing customer demand.

A drought, therefore, results in the lowering of water stocks within our reservoirs as less water flows into them and more water is demanded from them.

Water resource zones can cope with different levels of drought though their inherent nature. Zones with greater access to water resources, such as large reservoir catchments or reliable river sources, will be more resilient as it will take a very severe drought for water supplies to run out. Equally, areas where the demand for water is small in relation to the available water resource will also have very high levels of drought resilience.

This means that some areas have such a resilient supply that no ‘plausible’ drought will cause us to run out of water and fail to meet our customers’ demand. The term ‘plausible’ is key to our drought risk analysis since we only test the resilience of our systems against events that the meteorological/hydrological science tells us could happen and are not looking to generate ‘implausible’ droughts purely to empty our water resources.

A good example of this is Llyn Arenig Fawr, a natural lake in North Wales but which has been dammed to form an impoundment and is the sole source of supply in our Bala zone. It has a ‘live’ storage of 1,629Ml with an annual average of demand of around 1.5Ml/d, meaning that in the absence of any rainfall for 2 years, we would still have sufficient supplies available to meet our customer’s demand. However, it is clearly implausible that the climate of North Wales would ever experience zero rainfall for such a prolonged period, even under the most extreme of climate change futures, and so we can be confident this source is extremely drought resilient.

Droughts also impact the environment which is why restrictions are placed on the volumes of water abstracted from rivers and boreholes. During drought periods, our regulators expect us to take timely actions to manage our customer’s demand which both helps to preserve our available supplies and limit the amount taken from the environment.

These actions are defined in our Drought Plan and involve imposing restrictions on domestic customers through Temporary Use Bans (formerly hosepipe bans), Non-Essential Use Bans (restricting some commercial uses of water) and Emergency Drought Orders which authorise the rationing of water supplies through use of standpipes or rota-cuts.

These actions are triggered as storage in our reservoirs declines and crosses below defined drought control lines, such that customer restrictions are gradually introduced as the severity of drought increases.

Figure 22 shows a graph of the typical response of a reservoir during a drought period, a set of drought measure control lines and the actions we will take as we pass through these zones from ‘Normal’ to ‘Severe Drought’. We put Emergency Drought Orders in place to ration demand if reservoir levels fall into their ‘Emergency Storage’ zones. This ‘emergency’ position is defined as the point at which we only have 30 days of supply remaining.

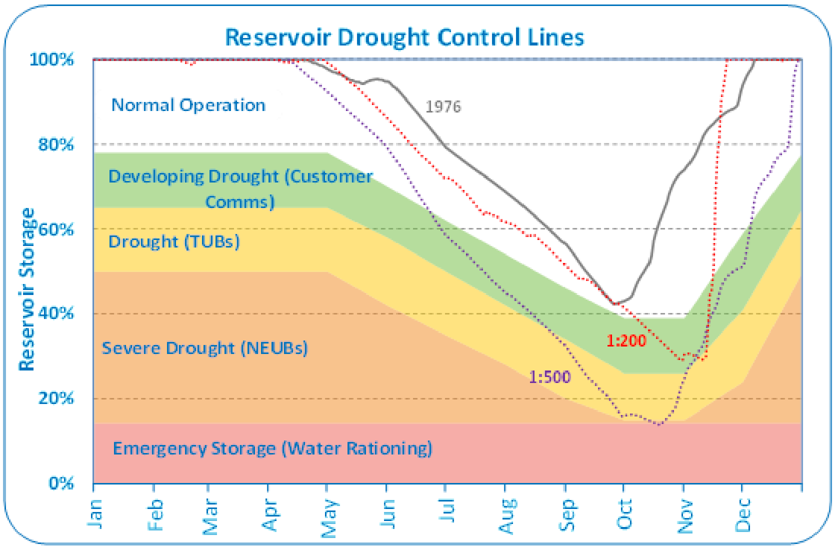


Figure 22- Reservoir Drought Control Curves

3.3.2. The Drought Resilience Measure

A key difference for this Plan is the need to understand our zonal supply capability at a given level of resilience to drought, as measured by the need to implement Emergency Drought Orders. The point of 'failure' i.e. the trigger for implementing these exceptional restrictions upon our customers (last seen in Wales in 1976) would be at our defined 'emergency storage' level within each WRZ.

Guidance from our regulators in relation to this metric states:

"You should define your '1 in 500'[8] supply deployable output using your system response. Your system should be defined at the water resources zone level. System response is preferred over rainfall or effective rainfall because of the problems in presenting duration, rainfall patterns and start and finish months when you evaluate the return period. At this level of risk, small changes in these variables can have a large impact on the deployable output of sources. Also, you can only adequately capture aspects such as system constraints, conjunctive use capability and operational response within a system response metric."

This assessment is problematic as we only have around 60 years of hydrological (river flow and rainfall) data across our supply area as most of these monitoring stations only came online in the late 1960s/early 1970s. We have been asked by Government and Regulators to estimate our supply capability for droughts with return period frequencies ranging from 1 in every 200 years to 1 in every 500 years and so the 60-year data set is inadequate.

We have worked with the industry to agree a method of extending rainfall and flow records by translation from longer hydrological datasets using more advanced statistical analysis. We have generated 20,000 years of statistically plausible rainfall and flow data for each of our catchments and used these to calculate reservoir levels for a range of customer demands. The generation of this extended weather data allows us to estimate the frequency at which each drought control line is crossed and so the LoS of demand restrictions. The relationship between supply capability against return period can then be plotted (See Figure 23).

[8] Note that the '1 in 500' target is only applicable to water companies in England with NRW/WG having not defined an equivalent target for Wales.

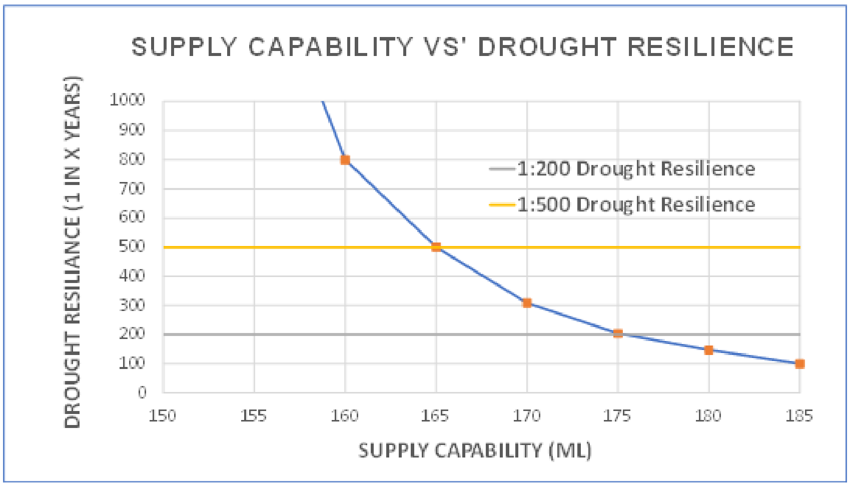


Figure 23 - Supply Capability vs' Drought Resilience

Our current preferred level of service is to impose significant supply restrictions (water rationing via standpipes/rota cuts) no more frequently than 1 in 200 years, on average. i.e. the risk of these significant restrictions is no more than 0.5% each year. Based on this return period, the calculated supply capability from the example plot above would be 175 Ml/d. If we plan to move to a higher level of service of 1 in 500 years on average for these extreme restrictions, then the plot shows that currently this would restrict our system capability to just 165 Ml/d.

Our target for implementing Temporary Use Bans (formerly hosepipe bans) is 1 in 20 years on average and for a drought order (non-essential use ban) it's no more than 1 in 40 years on average. Within this Plan we set out how we will achieve our preferred minimum level of drought resilience for Emergency Drought Orders for all zones, namely, to move from our current 'worst historic' (c1% annual probability) position to a 1 in 200 year standard (0.5% annual probability) by the end of AMP8 (2029-30) and to a 1 in 500 year standard (0.2% annual probability) by the end of AMP10 (2039-40).

The frequency of Emergency Drought Orders rather than the other LoS is the predominant constraint on our supply system capability. For each water resource zone, we have calculated the supply capability at a 1 in 200 and 1 in 500 level of service. These values are then used in the comparison with future demand within a supply/demand balance over the 25-year planning period. Details of the modelling undertaken to calculate this system capability is set out in the following section.

3.3.3. Calculation of system 'Deployable Output'

To provide more detailed information on our level of drought resilience, we have moved away from the previous approach of calculating a single deployable output value based on simulating the maximum demand that can be met within the given model constraints. This was achieved by setting a target level of service and then increasing the demands within the model until these targets are breached. This point marking the maximum supply system performance at the set LoS to drought, as a single deployable output.

We are now able to simulate supply system response to 20,000 years of inflow data for a number of levels of demand with the number of failures recorded for each. This provides the relationship between deployable output against return period (see Figure 24 below). This method is also detailed in the 2019 UKWIR 'Risk Based Planning' report[9]. Full details of the DO assessment are provided in Appendix 6.

[9] WRMP 2019 METHODS – RISK BASED PLANNING (UKWIR, Report Ref. No. 16/WR/02/11)

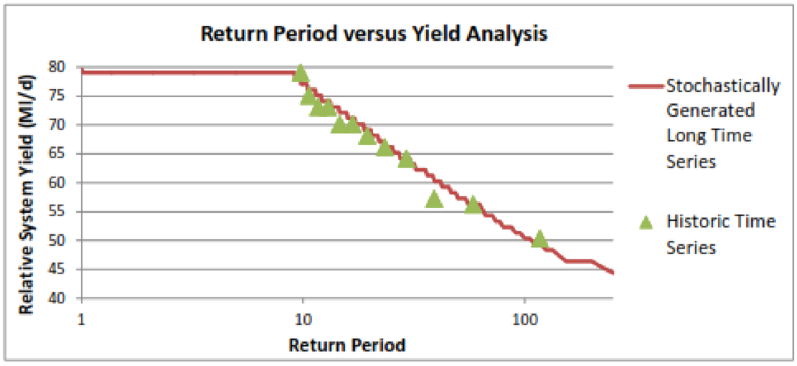


Figure 24 – Example plot of Return Period vs Yield

3.4. Impact of climate change

3.4.1. Our approach to climate change assessment

Guidance asks that we assess the impact of climate change using UKCP18 data but that we should agree our approach to the assessment with regulators, as there is a choice of climate change data sets related to future emissions and global temperature rise.

We have agreed with NRW that we will use a 'medium emission' scenario, the Representative Climate Pathway 6.0 (RCP6.0) within our preferred investment plan, but that we will test our plan against a 'high emission' scenario (RCP8.5) to examine whether we may need to adjust our long-term investment should the future climate follow a path of greater warming and lower rainfall (See Figure 25).

This scenario testing is achieved through application of a temperature-based scaling approach, produced for the water industry by Atkins consultants, taken from the Climate Data tools project. This allows climate change impacts on DO to be assessed without the need for generating whole new sets of rainfall/temperature/PET/inflow data at different emission scenarios and modelling all these through Aquator.

This approach allows us to meet both Welsh Government's requirements and Ofwat's 'high' common reference scenario. Ofwat also require a 'Low' emission common reference scenario (RCP2.6) which we have produced for our deficit zones.

We have raised our concerns, supported by NRW, over the appropriateness of this scenario given that current warming trends indicate we are not on track to achieve this c.1.5 degrees of warming by the end of the century that the RCP2.6 scenario represents.

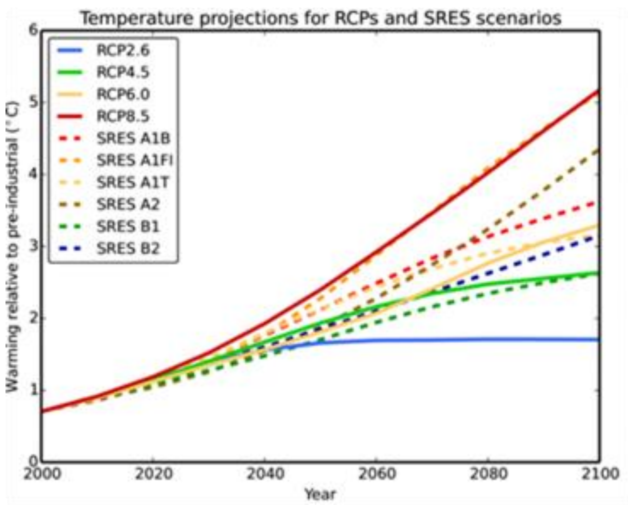


Figure 25 - Climate Change Emission Scenarios

3.4.2. Climate Change Assessment

The approach taken to assessing climate change within our WRMP24 is summarised below with the projections and datasets used given in Figure 26.

1. Undertake a 'Basic Vulnerability Assessment' (Appendix 7) to identify those zones most at risk to climate change and therefore requiring more detailed modelling.
2. Create a climate change influenced (perturbed), inflow timeseries to assess the future impact to our supply capability. The Atkins 'Regional Climate Dataset's project provided climate change perturbed rainfall, average temperature and potential evapotranspiration (PET) data. The perturbation factors are for the 2061-2080 period with the central year being 2070 and therefore these are referred to as 2070s scenarios.
3. Run the climate change influenced data through rainfall-runoff models to produce: i) 12 sets of spatially coherent reservoir and river inflow timeseries representing the outputs from the Met Office's Regional Climate Model, ii) 100 sets of non-spatially coherent inflow timeseries from the Met Office's Probabilistic model projections. Due to computing power restrictions, the 100 probabilistic timeseries were further sub-sampled to 20 to enable the work to be completed in time. All the Met Office projection data is for the 'High' emissions scenario RCP8.5.
4. For WRZs classified as either 'High' or 'Medium' vulnerability, each of the 32 climate change stochastic data sets have been run through our Aquator models to calculate the DO under each scenario. Using the median of these scenarios, the 'Best Estimate' of the reduction in DO by 2070 is calculated.
5. This impact is then scaled back in time from 2070 through to the starting position of 1975. For WRMP24 we are using a curvilinear approach rather than the normal linear approach to recognise that climate change impacts will worsen as we move through the 21st century. This is detailed in the Atkins Climate Data Tools report[10].

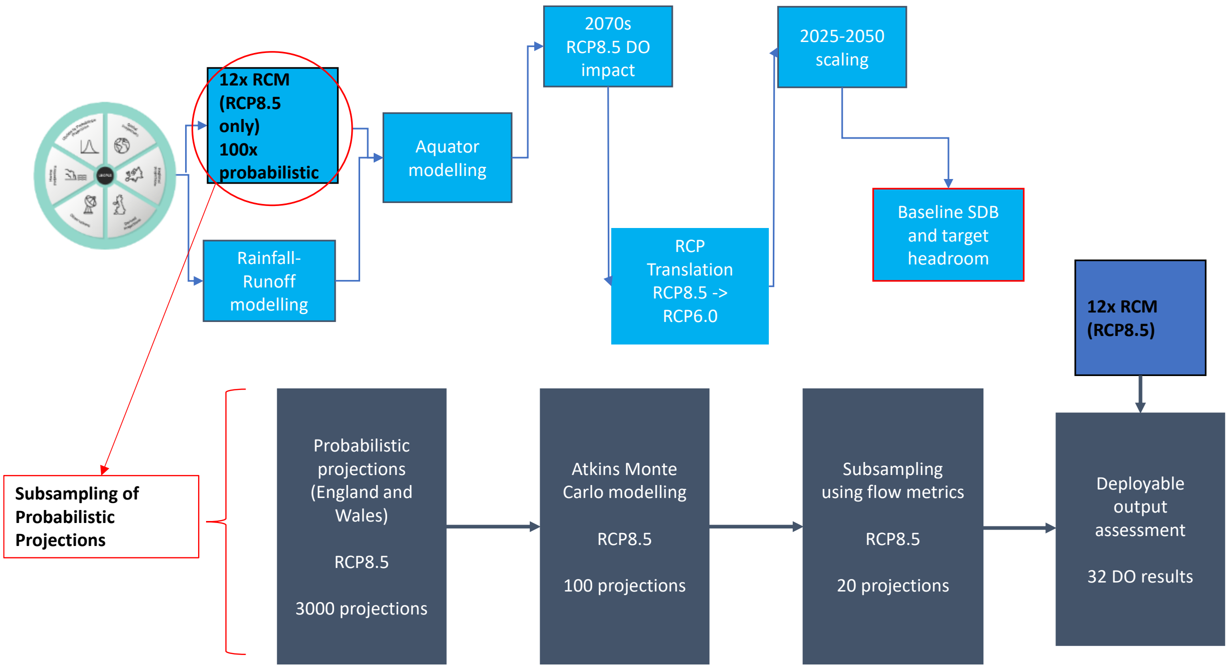


Figure 26 - Overview of climate change DO assessment

[10] Regional Water Resources Planning: Climate Data Tools. Draft Operational Framework for implementing the EA Supplementary Guidance on Climate Change (Atkins, January 2021).

A large number of possible future climates have therefore been produced for each emission scenario. As well as using these to estimate a central view of the impact to our DO i.e. how much this is likely to be reduced in the future as the climate continues to warm, we also use a representative sample to understand the possible range of this impact on our supply capability. The impact on supply is taken as the central outcome from the 12 sets of RCM model output (red diamonds in Figure 27), with uncertainty/variance from the 20 sets of probabilistic projections (orange circles in Figure 27) used to calculate the 'Headroom' allowance.

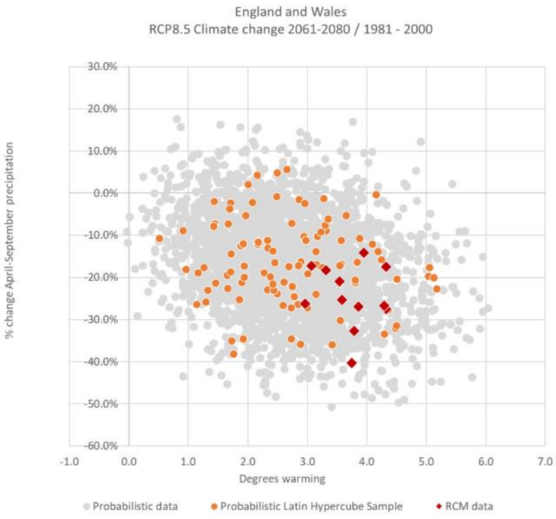


Figure 27 - The 12 RCM projections and 100 Probabilistic projections set against the full UKCP18 outcomes

Our modelling has shown that, broadly speaking, the climate change impact has increased in all zones from that presented in WRMP19, primarily due to the drier nature of the UKCP18 projections compared to those produced by UKCP09, as shown in Figure 28 below. Translating this through to our baseline supply demand balance, in our SEWCUS zone for example, UKCP09 projections reduced our supply capability by 4.3% at 2050. In WRMP24, the equivalent impact at 2050 is 6.3% for a Medium emissions scenario, increasing to 9.2% under a High emissions scenario.

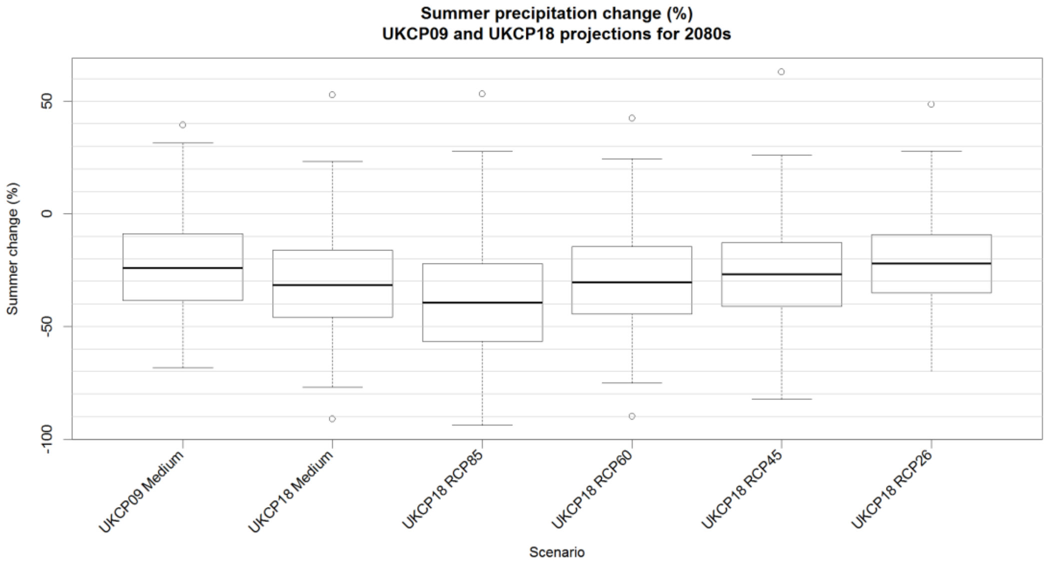


Figure 28 – Comparison of UKCP09 and UKCP18 Rainfall Projections

3.4.3. WRMP19 impact compared to WRMP24

As Table 10 below indicates, climate change is forecast to have a greater impact upon our supply capability than that calculated at WRMP19, albeit noting this is not wholly comparing 'like for like' given that the UKCP18 projections are generally drier than those produced by UKCP09 and that we are now assessing the effect upon more extreme drought events. Nevertheless, it is clear that climate change poses a risk to our future availability to maintain customer supplies and to meet our obligations to the environment and means that investment is required in all zones to meet this challenge.

	2025-26	2035-36	2049-50
WRMP19 DO Ml/d	1031.50	1031.50	1031.50
WRMP19 CC Ml/d	6.55	10.91	13.46
% Impact	0.63%	1.06%	1.30%
WRMP24 DO Ml/d	921.41	921.41	921.41
WRMP24 CC (RCP6.0)	14.57	26.60	36.18
% Impact	1.58%	2.89%	3.93%

Table 10 - Climate Change impact WRMP19 (worst historic) vs WRMP24 (1 in 200)

3.4.4. Independent Assessment of UK Climate Risk

Under the 2008 Climate Change Act, the UK Government is required to publish a Climate Change Risk Assessment every five years. The Third Climate Change Risk Assessment (CCRA3) used an independent assessment of risks and opportunities to Public Water Supplies from the impact of climate change, and deemed that in Wales, for the Public Water Supply sector, sustaining current action was deemed appropriate. The assessment noted that adaptation efforts in the Public Water Supply sector are well advanced, assisted by the five yearly Water Resource Management Plans.

The CCRA3 Technical Report recommended building resilience to 1 in 500 year drought (as recommended by the National Infrastructure Commission) and implementing metering for 95% of households. Our plan is designed to achieve a 1 in 500 year drought resilience by 2040. Our metering strategy is to achieve 95% meter penetration by 2035, aligning with the target set in the CCRA3 recommendation.

3.5. Sustainable Abstraction

With the declaration of a 'Nature Emergency' by Welsh Government and its passing of the Environment (Wales) Act and the Wellbeing of Future Generations (Wales) Act, it is clear this Plan needs to deliver for both our customers and the environment. The most direct way that water resource operations impact upon the environment is through abstraction from rivers and groundwater and/or releases from our reservoirs.

NRW's National Environment Programme (NEP) and the equivalent Water Industry National Environment Programme (WINEP) in England, identifies the investigations and subsequent changes that need to be made to our abstraction licences to meet environmental obligations. The NEP in AMP6 and AMP7 resulted in significant expenditure to manage the impact of reductions in permitted licence volumes at a number of our river abstractions, driven primarily by the requirements of the Habitats Regulations and to a lesser extent the Water Framework Directive.

We have therefore made significant progress in ensuring the volumes of water we take and /or release into the environment are currently sustainable. However, to meet the requirements of the Future Generations Act and ensure the long-term sustainability of our abstractions, we need to consider whether these volumes taken/released will still be acceptable in the long term under a changing climate.

3.5.1. Environmental Destination

To address this question, in England, the Environment Agency's National Framework requires water companies and regional planning groups to set a long term 'environmental destination' to ensure the future sustainability of abstraction. The EA has provided companies with three scenarios for reductions in the volumes of allowable abstraction that should be included in WRMP24 and Regional Plans.

This approach is prescriptive in limiting abstraction licence quantities, based on the current levels of abstraction to that used over the recent past, essentially setting three different levels of abstraction volumes for companies/regions to assess their Plans against.

Through discussions with the EA, the only abstraction we have in England that may be impacted during the AMP8 period is our small (c1 Ml/d) groundwater source at Leintwardine, in Herefordshire. Studies completed in AMP7 as requested under our WINEP, show that abstraction at Leintwardine, alone, may not significantly impact local river flows below environmental flow targets, however, this may be the case when other upstream abstractions are considered in tandem, particularly under low flow conditions. We are therefore seeking funding in PR24, supported by the WINEP, to undertake further investigations into the sustainability of our Leintwardine abstraction, particularly when considered against other upstream influences so that we can deliver any necessary scheme to resolve any licence reduction that may be required during AMP9.

In Wales, NRW have not been as explicit in prescribing potential changes to our abstraction licences, taking a different approach to addressing the future risk that our water resource operations may pose, through application of the Sustainable Management of Natural Resources (SMNR) principles. We are mindful however that the future long-term sustainability of our raw water sources is an area of significant uncertainty and so we are addressing this in two ways:

i) Within PR24 we are by seeking funding for our largest ever programme of water resource environmental investigations during AMP8

ii) To highlight the potential future investment risk, in our revised Plan we are including two scenarios related to sustainable abstraction. The first scenario assesses the impact of a lower abstraction reduction scenario (broadly equivalent to the EA's "BAU+" scenario) and assumes a 5% reduction in DO from 2030 onwards. The second scenario assesses a higher abstraction reduction scenario (broadly equivalent to the EA's "Enhanced" scenario) assuming a further 5% reduction in DO from 2040 onwards. The percentages chosen are based on an approximation of reduction seen in other company's Plan with similar riverine environments to us.

Our AMP8 programme of investigations will be designed to improve our understanding of how to achieve long term sustainable abstraction to meet the requirements of the Environment (Wales) Act 2016. This work will enable us to understand the potential future impact on river flows under climate change and how this may affect ecological needs.

This will be a substantive piece of work which demonstrates our commitment to enhancing the environment of Wales. This will also allow us to link the quantity with quality initiatives on the rivers from which we take water and develop catchment wide solutions. Although flow objectives are an unknown quantity, our WRMP29 will consider how we best respond to these needs once they are better understood. We are working on defining the scope of these investigations, noting that all companies in England have similar challenges and so we will look to collaborate with the various stakeholders across Wales where possible. WRW have begun scoping out what their environmental destination investigations may look like, which provides a useful starting point for us. Broadly speaking their studies will target:

- climate change impacts upon river flows and associated ecology
- a range of growth projections in line with the regional plans; WRMP guidance and Ofwat's long term strategies
- hydroecology requirements to meet WFD objectives
- catchment resilience needs, and balancing this against the resilience needs of water supply across sectors
- examination of the impact that we have and the links between river flow and water quality
- the need to maintain affordability for customers
- potentially the relative abstraction reductions required by all stakeholders on our key rivers

Water companies are included in the list of over 200 public authorities defined in Section 6 of the Environment (Wales) Act, 2016, as having a duty to seek to maintain and enhance biodiversity in the exercise of functions in relation to Wales, and in so doing promote the resilience of ecosystems, so far as consistent with the proper exercise of those functions.

This is an enhanced duty compared to that set out in the Natural Environment and Rural Communities Act 2006 (which the Environment (Wales) Act replaces) as Section 6 duty requires public authorities (including Water Companies) to 'seek to' maintain and enhance biodiversity rather than just 'have regard' to its conservation. To meet that objective, we therefore need to be proactive in understanding the potential impacts of our operations in the medium to long term so we can prepare and mitigate accordingly.

Alongside this research programme, our PR24 submission will seek enhancement funding to continue delivering the requirements of the Water Framework Directive as set out in our NEP, notably in relation to sediment management and the downstream flow regime at our impounding reservoirs.

We are also seeking funding to undertake a joint piece of research with NRW to gather more information into the delivery and effectiveness of catchment management measures and nature-based solutions that will improve water quantity.

Undertaking trials in a small number of representative catchments across our supply area will allow us to better understand the costs and benefits that these types of initiatives can provide, with the aim to deliver more of them in the future to help combat the water resource risks posed by climate change and to fully embed the SMNR approach within our planning processes.

3.5.2. Mothballed Sources

We have 42 abstraction licences that are currently unused, as reported in Table 1 of our WRMP24 planning tables. Due to the nature of these sources, they are unable to be brought back into supply during emergency conditions as they would require significant capital works, notably the installation of new treatment processes, to make them useable for potable water supply. This position was confirmed during the 2022 drought where we undertook feasibility studies into the potential to bring a number of these sources back into supply and concluded that within the timeline of a drought event there was no feasible way of doing so whist meeting all regulatory standards, most notably in relation drinking water quality.

For those unused sources we identified in our 2020 Drought Plan as potential options we would consider bringing back online during a drought, namely Schwyll well, Afon Rhythallt, Milton boreholes, Grwyne Fawr reservoir, Wentwood reservoir, Pant yr Eos and Ynys y Fro reservoirs, we will amend our 2025 Drought Plan to remove them. They therefore remain as potential options for longer term development as part of a strategic water resource solution but cannot be used to support short term water supply issues.

3.6. Drinking water quality

The amount of water a company can put into supply is dependent upon both water availability and treatment capability. If a WTW cannot treat the water feeding it to a wholesome quality, then the water cannot be put into supply, increasing our risk of a supply demand deficit. While raw water quality variations are not uncommon, the average quality has the potential to significantly change in the long-term especially given the potential impact of climate change which could also result in an increase in extreme values. These water quality changes may limit the amount of water that can be put into supply, even if the volume of water required is available.

We have undertaken an initial piece of work to examine the impact of drought events and their resulting effect on raw water reservoir level and the quality and treatability of this raw water. The results show that the drought period itself where the reservoir was at its lowest predicted level was not the main issue.

Historic data suggests that raw water quality did not significantly deteriorate in terms of colour while the volume of water in the reservoir is depleted and at a lower-than-average level. The period following the low level, when the reservoir began to refill, was the biggest influence on the deterioration of raw water quality. The expected rewetting of the exposed sediment banks during refill is found to have a significant impact on quality.

From the data used in the analysis it was found that raw water colour reached its peak approximately 2 to 3 months following the reservoir being at its lowest point when the reservoir was refilling or had already refilled.

However, the refill period would depend on many factors including volume of rainfall, reservoir capacity both during and following the drought/refill period and hydraulic interactions of the catchment and therefore this period is difficult to calculate comprehensively. The resulting elevated colour not only has an impact by itself in terms of additional solids loading but has a direct influence on the concentration of coagulant required, which has a much more significant effect on solids loading.

The experience gained through the 2022 drought provided further insight into catchment water quality following drought periods.

Further work will be undertaken in AMP8 to better understand this relationship, building on the work set out in the following sections that is either ongoing or planned, to help ensure the continued high quality of raw water resources.

3.6.1. Drinking Water Safety Plans

Drinking Water Safety Plans (DWSPs) are our operational tool to facilitate water quality risk assessments, in line with the regulatory requirements governing drinking water in England and Wales.

The source to tap plans, or risk assessments, are critical to how we identify and manage risk to ensure clean drinking water both now and in the future. The DWSPs comprise:

- a detailed asset-by-asset risk assessment for each of our catchments, water treatment works, water quality zones and storage reservoirs
- risks relating to public health, compliance and resilience of supply
- 5 x 5 risk scoring matrix based on consequence and likelihood
- control measures for each hazard/hazardous event and any future controls

The DWSP process is a shared responsibility and adopts a multi-disciplinary approach engaging a range of stakeholders from source to tap. The DWSPs “live” methodology and governance framework is subject to continuous improvement and reporting to ensure we are capturing best practice and achieving excellence in everything we do.

The process generates risks which are promoted into our investment database, supported with root cause analysis and evidence, which are used to prioritise and inform the capital investment programme ensuring we are investing our customer`s money in cost-effective solutions and initiatives.

Our proactive approach means we can identify existing risks but also anticipate future risks, helping us to implement effective controls, ensuring we are trusted to do the right thing and safeguarding water quality and the environment, both now and for future generations. Strategies arising from the DWSP process include our Catchment Management approach, as detailed in the following section.

3.6.2. Catchment Management

Our Process Science and Catchment Management teams provide information on variation in raw water quality and its treatability to ensure that our supply modelling takes account of current and future risks that may limit our supply capability. Within our long-term strategic document "Water 2050", Strategic Response 1 '*Safeguarding clean drinking water through catchment management*' sets out our long-term commitment to this aim, which will ensure that raw water entering our treatment works is of an expected, consistent, and manageable quality - catchment management is seen as our 'first line of defence' in achieving this.

We abstract water for drinking from ~120 catchments, covering an area of almost 11,000km^2 in Wales and parts of England. Figure 29 shows the extent of these catchments across our supply area, dominated by surface water catchments (in blue) with limited groundwater catchments (in red).

Land within our catchments is subject to a variety of land use types and management practices and we own limited land within these areas. We understand the need to adopt catchment management approaches that will increase our ability to react, respond and recover from future events brought about by climate and land use change. Effective catchment management will help us control chemical and energy usage, and the associated carbon emissions associated with water treatment processes.

It encourages investment in the best value solutions that also support the natural capitals approach and promotes collaboration and joint working, allowing us to deliver the best possible service for our customers.

Land management, as well as natural characteristics such as climate, soils, geology and topography, all influence raw water quality. These characteristics are diverse and will change over time. Therefore, we recognise that effective catchment management will only be achieved by working in collaboration with a variety of partners and stakeholders including land managers, academia, local communities and policy makers. Building trusted relationships and influencing policies and practices takes time, therefore it is acknowledged that commitments to catchment management will need to continue over multiple AMPs and the payback period for benefits delivered may take years to realise.

Through the delivery of catchment management solutions, we have an opportunity to achieve multi-benefits such as:

- Carbon Strategy - Restoring peatlands and planting trees to sequester carbon and deliver a more resilient raw water supply reducing treatment energy costs.
- DWI - Supporting the delivery of our Compliance Risk Index (CRI)/ Events Risk Index (ERI) targets through a better understanding of both current and future raw water risks, their potential impacts on WTW and customers.
- Biodiversity Strategy and the Environment (Wales) Act - Contribute to improving terrestrial and aquatic habitats and the Welsh National Forest ambition through new woodland planting.

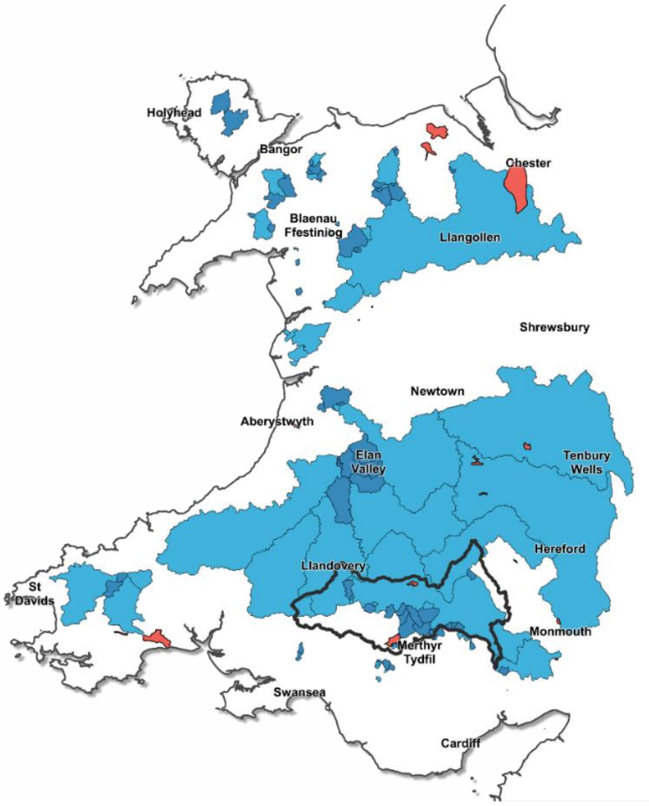


Figure 29 – Welsh Water's Drinking Water Catchments

We are continuing to deliver improvements to raw water quality through the following key workstreams:

Risk Evaluation

This work focuses understanding of current and future challenges and risks to raw water quality as well as allowing us to assess the success of mitigations and solutions. Typical projects include:

- Maintaining Drinking Water Safety Plans (DWSPs) for each catchment to identify current and emerging risks
- Monitoring and evaluation of new and emerging parameters of concern (e.g. PFOS, new Drinking Water Directive standards)
- Monitoring of regulatory raw water quality results, analysing trends and undertaking sub-catchment sampling to inform risks to WTW abstractions
- Undertaking root cause analysis of risks to guide development of appropriate mitigations

Smart Catchments

This work focusses on development of a 'Digital Twin' that will allow us to better predict when raw water deteriorations may occur, so that we can actively manage our abstractions to avoid challenging our water treatment works processes. Typical projects include:

- Installing real-time raw water quality monitoring at strategic sites
- Bathymetric surveys
- Improving our spatial risk mapping, at field and catchment scale, through new earth observation, remote sensing and digital mapping systems
- Forecasting – modelling and prediction of risks for future trends

Mitigations

This work focuses on investment for co-designing solutions with our key stakeholders which will deliver multiple benefits for water, the environment and people, such as:

- Peatland restoration, non-WW land (separate to WP6),
- Precision farming - new technologies/approaches
- Campaigns: PestSmart, NutriSmart, Animal Health/Soil management,
- Forest Ecosystem Design implementation
- Supporting partner projects (eg LIFE bids)
- Exemplar Farm

3.7. Zonal Imports/Exports

3.7.1. Potable water transfers to other companies

Our principle potable water transfers are to Severn Trent Water and Hafren Dyfrdwy. These are relatively small with the transfers to Hafren Dyfrdwy Mid Wales having arisen primarily as a function of the geography of the area where it is more economic to utilise supplies from outside of the company boundary than it is to extend our existing network. The Ross on Wye import from Severn Trent provides the whole of the supply for that WRZ. We have held discussions with Severn Trent and confirm that we are consistent in our reporting of the bulk volumes that are moved between our two companies.

A summary of all our transfers is shown in Table 11 below. These transfers are all potable water and so there are no risks from poor raw water quality. The maximum quantities identified are those that can be provided under drought conditions with agreements in place for the external transfers which guarantees these volumes. The quantities transferred are generally limited by infrastructure constraints and so new asset would be required to increase the maximum volumes. The transfers are all single direction with no ability to reverse the flow.

Export from	Import to	Maximum volume (Ml/d)	Description
Alwen Dee WRZ	Hafren Dyfrdwy	0.16	DCWW export a small amount of water to Hafren Dyfrdwy in the lower part of the Dee system.
South Meirionnydd WRZ	Severn Trent Water	0.12	DCWW and Severn Trent exchange water across the boundary of South Meirionnydd due to the limited supplies in the area.
Severn Trent Water	South Meirionnydd WRZ	0.45	DCWW and Severn Trent exchange water across the boundary of South Meirionnydd due to the limited supplies in the area.
Severn Trent Water	Ross-on-Wye WRZ	9	DCWW imports all of the water for this WRZ
Severn Trent Water	Monmouth WRZ	0.05	DCWW imports a small amount of water from Severn Trent

Table 11 – External transfers of water

Note: Elan Builth WRZ exports water to Severn Trent Water (up to a maximum of 381 Ml/d). However, since this is fully under the control of Severn Trent Water it is excluded from the DO for the zone.

3.7.2. Internal zonal transfers

To fully assess our supply capability, we need to take account of the water that is moved internally between our WRZs. Within Welsh Water we have a number of transfers that help meet demands for water during peak periods. Through a series of operational actions on our potable network we are able to re-zone particular areas of demand onto alternative sources in a neighbouring area. This reduces the demand on either the zone in general or the pressure on a particular source.

Table 12 lists the main internal transfers of water below. These transfers are all potable water and so there are no risks from poor raw water quality. The maximum quantities identified are those that can be provided under drought conditions and are modelled. The quantities transferred are generally limited by infrastructure constraints and so new asset would be required to increase the maximum volumes. The transfers are all single direction with no ability to reverse the flow.

WRZ exported from	WRZ imported to	Max. volume (Ml/d)
Hereford CUS WRZ	Vowchurch	0.46
Hereford CUS WRZ	Ross-on-Wye WRZ	1
Hereford CUS WRZ	Whitbourne	1
Llyswen	Vowchurch	0.13
Dyffryn Conwy	Clwyd Coastal	0.3
Lleyn Harlech Barmouth WRZ	North Eryri Ynys Mon	1
Tywi Gower	SEWCUS	13.5

Table 12 – Internal water transfers

3.7.3. Commercial bulk water transfers

As well as the transfer of potable water, we also have a number of supplies for non-potable water that need to be accounted for when assessing the overall supply capability within a zone.

Full details of these sources are reported to Ofwat and NRW/EA as part of our Annual Reporting requirements. We supply non-potable water in the following areas:

- Pembrokeshire WRZ: raw water is supplied to the industrial area of Milford Haven. This is classified as an export within our supply forecast.
- SEWCUS WRZ: raw water is supplied to a steel manufacturer. This water is directly accounted for in the DO within our supply forecast.
- All WRZ: We have a small number of sources that supply water to single industrial customers. As this water has no connectivity with other supplies in these areas, this water is not included within our supply forecast as it is not available for use by our other customers.

We have bulk supply agreements with three New Appointment and Variation (NAV) companies as follows:

- Albion Eco Ltd – non-potable supply with a daily maximum of 18 Ml/d. This water is provided directly from a single source which has no connectivity with other supplies in our Alwen Dee WRZ and so this water is not included within our supply forecast. We also have a potable supply to Albion Eco for use in processing at the site (maximum 2 Ml/d) and a potable supply for domestic use on the site (average 1,000m3/month).
- ICOSA Water Services Ltd – potable supply from our Alwen Dee WRZ for a maximum of 0.138 Ml/d
- LEEP – potable supply to 250 properties from the Tywi Gower WRZ

3.8. Operational Losses and Outages

As described in the introduction to this chapter we need to account for a number of other factors in our supply demand balances to accurately account for the water that is actually available to meet zonal demands.

3.8.1. Raw Water Losses

Raw water mains are the pipes that connect the raw water source to either the first water treatment point or to raw water storage. For each main, one of two methods can be used to establish the raw losses:

- The actual difference between the raw water source meter and the WTW/raw storage inlet meter where these are present.
- If metering is not available, then losses are estimated using the average leakage rate per km of main multiplied by the known length of the main assessed. The average figure is derived from actual measured losses recorded across our raw water mains.

Occasionally raw water losses are included within the TWOU calculation (for example when the WTW inlet meter location is the raw water meter), in which case no raw losses are included for the purpose of the supply forecast. The calculated raw losses per WRZ for this Plan are presented in Table 13.

WRZ	Raw losses (Ml/d)	WRZ	Raw losses (Ml/d)
North Eryri Ynys Môn	0.46	**Llyswen**	0.001
Clwyd Coastal	0.192	**Monmouth**	0.029
Alwen Dee	0.222	**Pilleth**	0.015
Bala	0.004	**Brecon Portis**	0.012
Tywyn Aberdyfi	0.06	**Vowchurch**	0.011
Blaenau Ffestiniog	0.028	**Whitbourne**	0.002
Lleyn Harlech Barmouth	0.917	**SEWCUS**	4.364
Dyffryn Conwy	1.898	**Tywi CUS**	1.635
South Meirionnydd	0.077	**Mid & South Ceredigion**	0.363
Ross on Wye	n/a	**North Ceredigion**	0.340
Elan Builth	0.06	**Pembrokeshire**	0.748
Hereford CUS	0.035		

Table 13 - Summary raw losses across our WRZ

3.8.2. Treatment Works Operational Use (TWOU)

Our methodology for calculating the TWOU for each individual water treatment works is the same as that used in PR24 but with revised data. This is based on three separate calculations:

- The difference between raw water meter (flow entering a water treatment works (WTW)) and distribution input meter (flow leaving a WTW).
- The wastewater effluent meter flow data.
- The theoretical process utilisation equivalent to the sum of the losses assigned for each specific treatment process that occurs at the WTW.

Where available, the three calculated values are compared and combined to create the allowance. However, we now include the TWOU within our Aquator models which provides a more accurate assessment of the draw upon our raw water sources than applying it as a blanket % reduction to zonal DO as in WRMP19.

3.8.3. Outage allowance

Our modelled DO value assumes that all of our sources are available at all times. This is not always the case and any 'Outages' to water resource capability needs to be accounted for within the supply demand balance. Outage is defined as the temporary (less than 3 months) reduction or loss of DO at the source works. These reductions can be due to planned outage events such as maintenance, or unplanned outage circumstances such as high turbidity of a raw water source.

We have been collecting and analysing potential outages based on WTW metered data on a monthly basis since 2005. Consultation with our operational staff then allows us to screen the genuine outage events from those that would not reduce our output during a drought or high demand period.

For WRMP24 we have undertaken a screening exercise to ensure only the most relevant data is included as an Outage allowance. We have removed any outages that occurred during the winter period (defined as November to February inclusive) – notably power outages – as the stormy weather conditions that caused these outages would not be expected to occur during a drought.

We have also removed all outages from the analysis that were recorded pre-2016 in order to better reflect the current asset performance. This works in two ways; the historic outage may no longer be representative if performance has improved due to asset investment and so we would not want to include a larger Outage allowance, driven by historic events that would no longer occur. Equally, it may be that in the 17 years since we commenced data collection in 2005, asset performance has deteriorated over time and so in this case, inclusion of historic outage data may be understating the level of risk.

Full details of our Outage methodology and calculations are provided in Appendix 8. Figure 30 shows the scale of outage allowance in each of our WRZs for this Plan under the Dry Year Annual average planning scenario expressed as a percentage of Deployable Output.

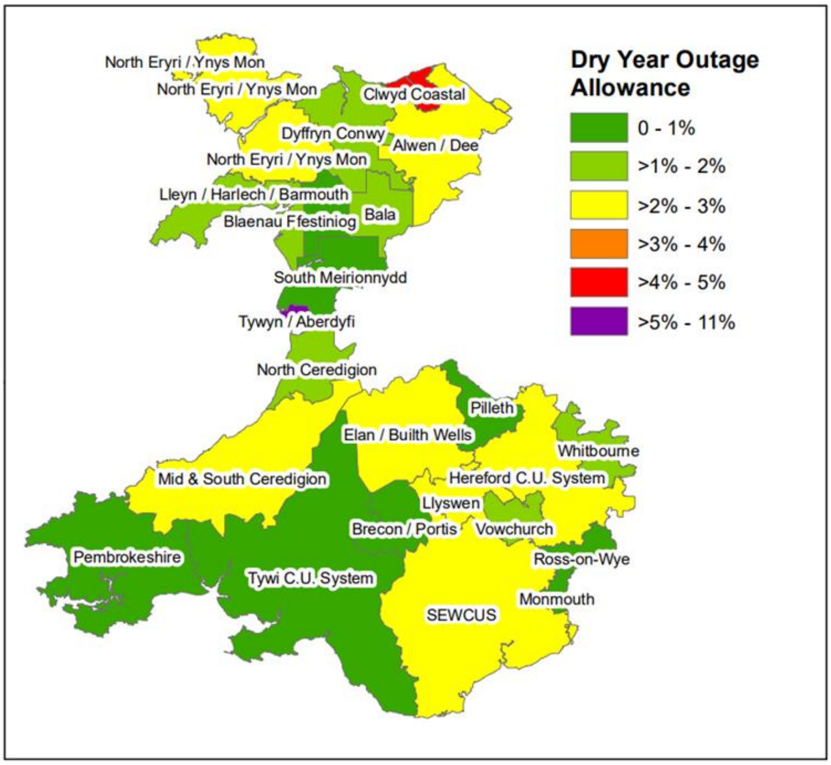


Figure 30 - 'Dry Year Annual Average' Outage allowances as a percentage of DO

Within their consultation response, NRW noted a number of WTW reporting high Outage Allowances, namely Trecastell (Clwyd Coastal), Mynydd Llandegai (NEYM), Carno (SEWCUS), Nant y Bwch (SEWCUS) and Penybont (Tywyn Aberdyfi). The Outage data for each of these works was examined to identify the drivers of the high allowance, the below summarises the key outage events:

- Penybont – Two high magnitude outage events caused by i) a failure of the Kalic dosing pump and ii) a failure of the works process automation. There was a much lower magnitude but longer duration failure caused by issues with the contact tank on site.
- Carno – One long duration/high magnitude outage event due from a planned shutdown to undertake tank cleaning.
- Nantybwch – Three high magnitude outage events due to high levels of turbidity and associated issues with the coagulation dosing process. One longer duration/lower magnitude outage even caused issues with the lime dosing process.
- Mynydd Llandegai – Three high magnitude outage events from planned shutdowns to undertake repair work.
- Trecastell – Several high magnitude/long duration outage events, split between planned shutdowns and failures caused by unexpected poor raw water quality.

We have explored the above outage events in more detail with the relevant water treatment works operators and Process Science staff and for each works, it was reported that whilst measures are in place to reduce their likelihood and frequency, there is still a risk they may occur. We will continue our maintenance programme at these works and look to make improvements where dedicated investment is planned. For the planned outage events we will review whether these can be scheduled to avoid any periods of hot, dry weather to minimise as far as possible the impact to our supply against demand position. It's worth nothing that although an individual works may present a high outage level, across a zone with more than one source the effect is often mitigated somewhat through use of alternative sources of supply.

3.9. Target Headroom

Guidance defines Target Headroom as "*the minimum buffer that a prudent water company should allow between supply and demand to cater for specified uncertainties (except for those due to outages) in the overall supply demand balance*".

Water Companies are required to consider and assess the uncertainty of supply and demand forecast and option values in the development of a WRMP. Accounting for and including an allowance for risk within the long-term water resources planning process is an important way of ensuring a reliable future water supply.

Headroom is reported as an annual allowance defined by its size (in Ml/d) at the start of the planning period and the glidepath the profile takes over the life of the plan. It is vital that target headroom is not estimated to be too large as it may drive unnecessary expenditure, whilst too small an allowance may expose a WRZ and therefore us as a company, to an unacceptable risk of not being able to meet customers' demand for water and hence not being able to meet our planned levels of service.

There have been several significant changes to how water companies plan water resources since the last round of WRMPs were published in 2019. As a result of these changes, the building blocks that are used to develop the WRMP24 are grounded in a more risk averse starting position. The consequence of all these developments in planning between WRMP19 and WRMP24 is that risk that has historically been accounted for in headroom uncertainty is now averted and buffered against explicitly in several other parts of the supply/demand balance components on which a plan is based, such as:

- Longer hydrological data sets are now available.
- Regulatory requirement to plan for more extreme drought events.
- New developments in decision-making (such as Real Options Analysis and Adaptive Planning) are now accepted as legitimate approaches for water resource planning in England & Wales.

Working with Severn Trent Water and South Staffs Water, we commissioned Atkins to undertake a review of the appropriateness of current headroom methodologies and to then recommend how we should approach the calculation of uncertainty for WRMP24. Our approach for this Plan therefore is a programmatic one that builds on our WRMP19 and allows for an appropriate level of risk, but that does not double count risk allowance given the greater focus on scenario testing and adaptive planning. Further details of our Target Headroom methodology for WRMP24 are given in Appendix 9.

In their consultation response, Ofwat stated that our "*…headroom allowance is high compared to most other companies, at a scale of over 11% of the company distribution input during 2025-30. Therefore, this planning assumption contributes significantly to the company supply-demand balance and proposal for investment. The company needs to present sufficient and convincing evidence that the headroom allowance is appropriate in both the short and long term, is not driving unnecessary and high regret investment, and that it has properly accounted for interactions with adaptive planning."*

Following the re-working of our water balance and the production of an updated demand forecast and associated uncertainty bands, our headroom allowances have generally decreased across all zones compared to those presented in the draft Plan. However, we acknowledge that some zones have relatively high headroom allowances when compared to other water companies, notably Blaenau Ffestiniog, North Eryri Ynys Mon, South Meirionnydd, Tywyn Aberdyfi and SEWCUS.

The climate change component is a significant proportion of the overall headroom allowance for these zones, driven by the wide-ranging impact of the UKCP18 Regional Climate and Probabilistic scenarios, that show potentially large reductions in future DO compared to our current position. Given we need to ensure resilience of our supply position then we feel this allowance is valid.

The other key area of uncertainty is around our demand forecast. For this Plan we undertake a Monte Carlo assessment of the prior reported water balance components for each zone rather than a future estimate alone, i.e., the uncertainty is first centralised around the previously observed demand values variation from the WRMP19 projections (excluding 2020-21 which was heavily influenced by COVID) producing upper and lower forecasts scaled to this historic variation before being projected forward with future uncertainties (see the 'DCWW WRMP24 Forecasting Demand Appendix' for more information). This has led to a particularly wide range of uncertainty for the five listed zones, as the demand forecasts for these has been historically hard to predict.

4. Our demand forecast and demand management strategy

(Note. This section has been revised following consultation on the draft WRMP24)

4.1. Introduction

This chapter sets out how we have developed our demand management strategy and used this in updating our demand forecasts. Demand saving initiatives have been a key component of our water resource planning over the past twenty-five years and in this Plan we intend to make a significant step change in reducing both the amount of water supplied to our customers and in the amount of leakage lost from our network. A robust assessment of current and future water needs is critical in understanding the level of drought resilience we can provide to our customers, both for the 2025-30 period and beyond.

Welsh Government Guiding Principles are clear that action is needed to reduce the long-term demand for water to support the principles of the Well-being of Future Generation (Wales) and the Environment (Wales) Acts including future environmental needs. Their ask of companies in the Guiding Principles in relation to managing our demand for water is twofold: namely that we "…*should set out challenging targets and a strategy for reducing per capita consumption for both domestic and business users both for the 5 year period of the WRMP and for the next 20 years*." and that our WRMP demonstrates how we will "*continue to reduce leakage by 2030 and how this will contribute to an overall reduction of leakage by at least 50% by 2050 in line with the water industry target*".

In England, Defra has updated the demand management targets initially set in the Environment Act (2021) though its Environmental Improvement Plan (2023) which states that companies need to:

i) Reduce the use of public water supply in England per head of population by 20% from the 2019 to 2020 baseline reporting figures, by 31 March 2038, with interim targets of 9% by 31 March 2027 and 14% by 31 March 2032
ii) Reduce leakage by 50% by 2050 with interim targets of 20% by 31 March 2027 and 30% by 31 March 2032.

Both the Welsh and UK Governments have referenced the demand management requirements in their Strategic Priorities for Ofwat, published in July and February 2022 respectively. In Wales, Ofwat are required to "*Encourage and incentivise the sustainable and efficient use of water resources, including by encouraging companies to reduce leakage and customer consumption. This may include setting challenging but achievable targets for reducing per capita household consumption and, leakage, and implementing strategies for increasing public awareness and encouraging customer behaviour change.*"

In England, Ofwat are required "…*to challenge water companies to halve leakage across the industry by 2050. Water companies have committed to delivering a 50% reduction in leakage from 2017 to 2018 levels by 2050 and to hold companies to account for their contribution towards reducing personal water consumption to 110 litres of water per head per day (l/h/d) by 2050".*

To deliver against Welsh Government's Guiding Principles and to ensure that we meet the Performance Commitments set by Ofwat on PCC and leakage, we have set challenging targets to achieve a 50% reduction in leakage levels by 2050 and to support our domestic customers to reduce their average use to 110 litres per person per day (l/p/d).

To facilitate this, we plan for a step change in our approach to customer metering, whereby we will undertake progressive metering with a shift to smart meters. This will allow us to encourage customers to become more water efficient as well as support the leakage reduction strategy.

4.2. The Water Balance

The way in which we account for the water that leaves our Water Treatment Works through to our customers taps, including for any leakage from our distribution system and on our customers premises, is called the 'Water Balance'. Following our internal end of year audit process for 2021-22 we engaged in a comprehensive review of the water balance including data components, methodologies and reported outcomes for both Leakage and PCC. This process has resulted in the identification and implementation of a number of improvements across data sources and reporting methodologies, and human resources that contribute to our performance outcomes. The impact of these changes are significant and have led to a greatly improved understanding of true performance and a subsequent need to restate reported performance for prior years in this AMP period.

The changes have resulted in a substantial increase in the estimation of leakage, and reductions in consumption. Whilst this has a marginal impact on distribution input and PCC at the start of AMP8, this has added to the savings needed to achieve the planned 15% leakage reduction by the end of AMP7 through our leakage recovery programme. The demand forecast for AMP8 starts from this revised position. We have also subsequently updated our demand forecasts within the revised dWRMP24 to account for:

- The revised AMP7 leakage recovery position and subsequent leakage reduction target of 10% during AMP8. The leakage programme has been re-optimised within the revised Plan using the industry standard SoLow model. With a higher starting point for leakage, the leakage savings from the metering programme do not wholly meet leakage objectives and further active leakage control options have been included in the revised Plan. AMP8 leakage savings will be greater than18Ml/d while long-term leakage savings have also been adjusted to meet the 50% reduction target by 2050.
- The dry year PCC starting position in AMP8 is similar to that reported in the draft Plan at 148 l/p/d with the same aspiration for reduction in PCC to 110 l/p/d by 2050. We have provided further detail around long-term water efficiency options to demonstrate that our metering strategy is the most cost-efficient way of approaching this target.

4.3. How we forecast demand

The approach taken to demand forecasting is similar to that in WRMP19, with the base year for forecasts updated to 2019/20 – this also ensures that the short-term impacts of the coronavirus pandemic are excluded from the forecast. The general approach to demand forecasting is a component-based approach, the most significant of which are household demand, non-household demand and leakage. Minor components including water taken illegally as well as water company operational use are also included in the forecast to attain the total demand for water. Forecasts are produced for the 25 year planning period from 2025-26 to 2049-50 for each of the 23 water resource zones. Full details of our approach are provided in Appendix 10.

4.3.1. Forecasting household demand

Forecasts of household demand are based upon multi-linear regression modelling developed and produced by Artesia Ltd, an industry leading consultancy in demand forecasting. The process develops an understanding of the impact of observed variables such as demographics, house type, properties, population and occupancy rates and weather parameters on observed household consumption. These models form the basis of projecting future consumption based on forecasts of the variables important to the modelling process.

4.3.2. Forecasting non-household demand

Non-household demand forecasts are largely based upon an econometric model with forecasts being produced at 14 economic-based sectors for each WRZ. The model was initially produced by CACI Ltd during WRMP14 but has since been updated, developed, and run by Welsh Water for subsequent plans. The model is based on observed demand, econometric and climate parameters spanning the period 2000 to 2019 inclusive with forecasts being based on future projections of the same econometric and climate variables but from 2020 to 2100. Variables include inflation, production indices and UKCP18 climate variables, following best practice guidance. Uncertainty around the forecasts has also been produced to allow for scenario planning.

Forecasts also incorporate an element of future water efficiency and climate change impacts. In addition, there remains a small number of unmeasured non-households which make up a very small amount of total demand. These are forecast differently to the measured non-household properties. In this case a volume per property forecast is produced based on a simple reducing future trend and this is multiplied by future forecasts of unmeasured non-household properties to determine a forecast of demand.

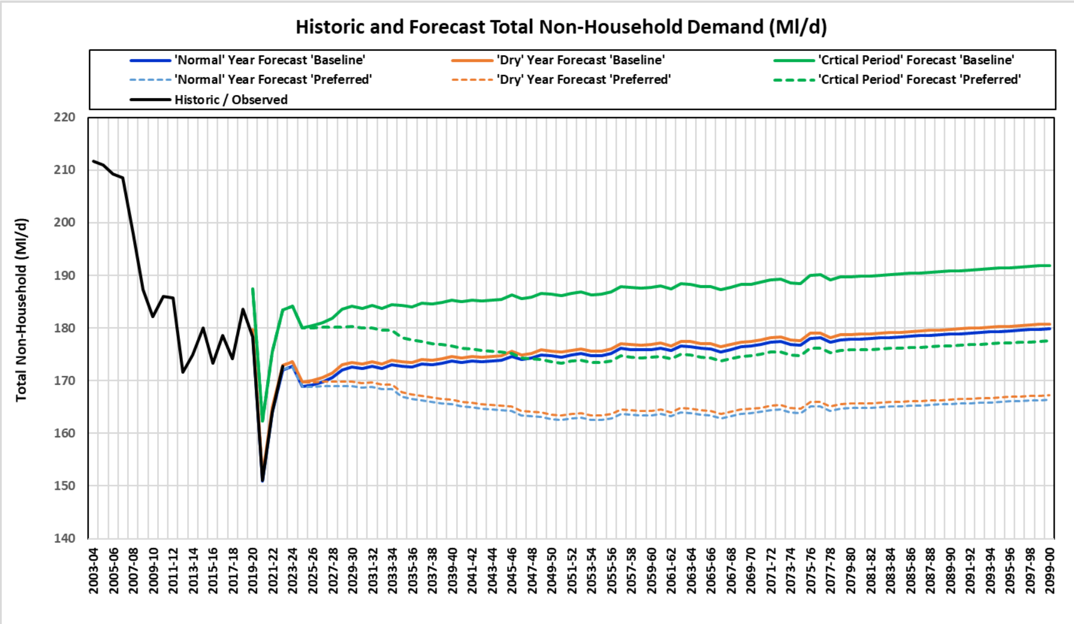


Figure 31 – Baseline and preferred plan non-household demand forecasts

4.3.3. Incorporating Climate Change

Forecasts of Household and Non-Household Demand incorporate climate change. Non-household demand is forecast using an econometric model and various econometric parameters, including climate, form part of the input variables to the process. Forecasts of climate variables are based on the UKCP18 - Regional Climate Models (RCM) RCP 8.5 Emission scenario. The inclusion of climate change on household demand is treated differently and based upon industry best practice outlined in '*The Impact of Climate Change on Water Demand*', UKWIR (2013). Table 14 shows the volume of climate change impact upon demand included within the forecasts.

Component	2019-20	2020-21	2024-25	2029-30	2034-35	2039-40	2044-45	2049-50
Demand (Ml/d)	868.47	884.73	811.06	815.21	816.20	819.45	823.50	830.00
Vol. of Demand due to CC (Ml/d)	0.00	0.21	1.14	2.27	3.41	4.56	5.99	7.46
% Demand due to CC	0.00	0.03	0.19	0.37	0.56	0.74	0.96	1.19

Table 14– Volume of water demand in the baseline (dry year) forecast due to climate change

4.3.4. Normalisation and Peaking Demand

Normal year and peaking to dry year and critical period planning scenarios are undertaken across components and WRZ. Normalisation and peaking are applied to demand as a series of factors rather than absolute volumes added onto forecasts. This allows the adjustment to be relative to the scale of the demand of a component and zone across the forecasting horizon. Note that Leakage is omitted from the normalisation and peaking process.

Base year and subsequent forecasts are firstly normalised to remove any influence of climate on demand prior to peaking to dry year and critical peak. Normal year and dry year factors are both derived from regression analysis of observed consumption data and April to September rainfall levels across the Welsh Water hydrological region. The dataset and analysis span the period 1992 to 2019 inclusive.

Critical peak week determination follows the practitioner framework described within the '*Peak Demand Forecasting Methodology*', (UKWIR, 2006). The critical period is defined as a peak week, determined as the maximum weekly value between the months of April and September for each WRZ. The dataset and analysis span the period 1997 to 2020 inclusive.

4.3.5. Properties and Population Forecasts

As with demand forecasting, the approach to forecasting our properties, population and occupancy data is to project forecasts from a base year. The 2020-21 base year was selected as COVID-19 did not have the same impact on base data as it did demand. Our reported population was unaffected. This is based on resident population and so any individuals home working and not staying away in the week would already be registered to the supply area as the main place of residency.

For WRMP24, Edge Analytics were commissioned to forecast our population and dwellings projections. The data used has been derived from Local Planning Authority projections as published by Welsh Government and are apportioned to our water resource zones. Edge Analytics directly engaged with all local authorities across our water supply area to obtain both site level development data from the local development plans and local population projections. Both are used in the forecasting process to more accurately allocate projections to our water resource zones based on planned development locations. The property forecast shows an overall increasing trend, with a change of categorisation from unmeasured to measured demand linked to the implementation of a progressive metering strategy (See Figure 32).

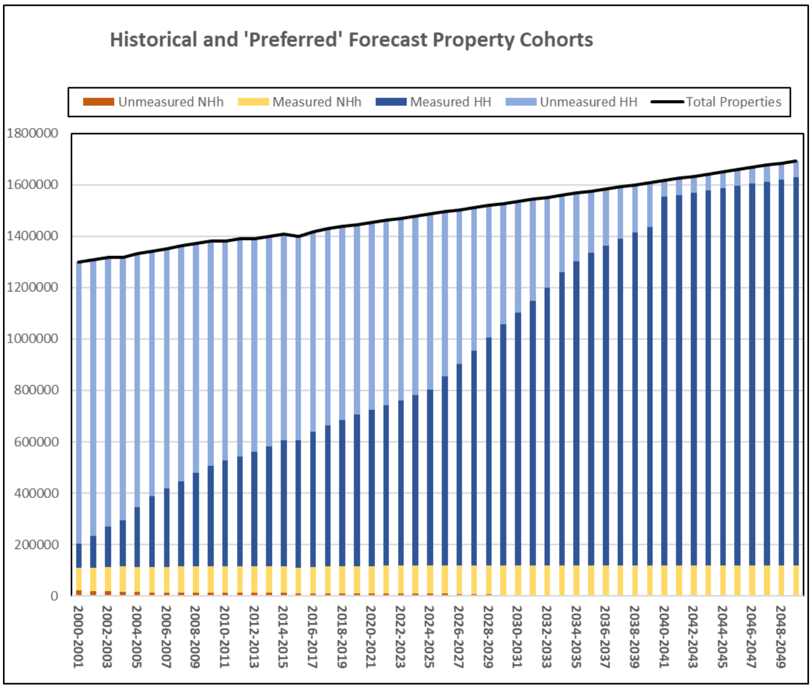


Figure 32 – Historical and forecast property types

Population forecasts in the plan are based on the principle 2018 Trend Based Projections from the ONS. Figure 33 shows these forecasts in the context of our previously observed resident population and the min and max of the forecasts supplied by Edge Analytics, and which are used for scenario generation.

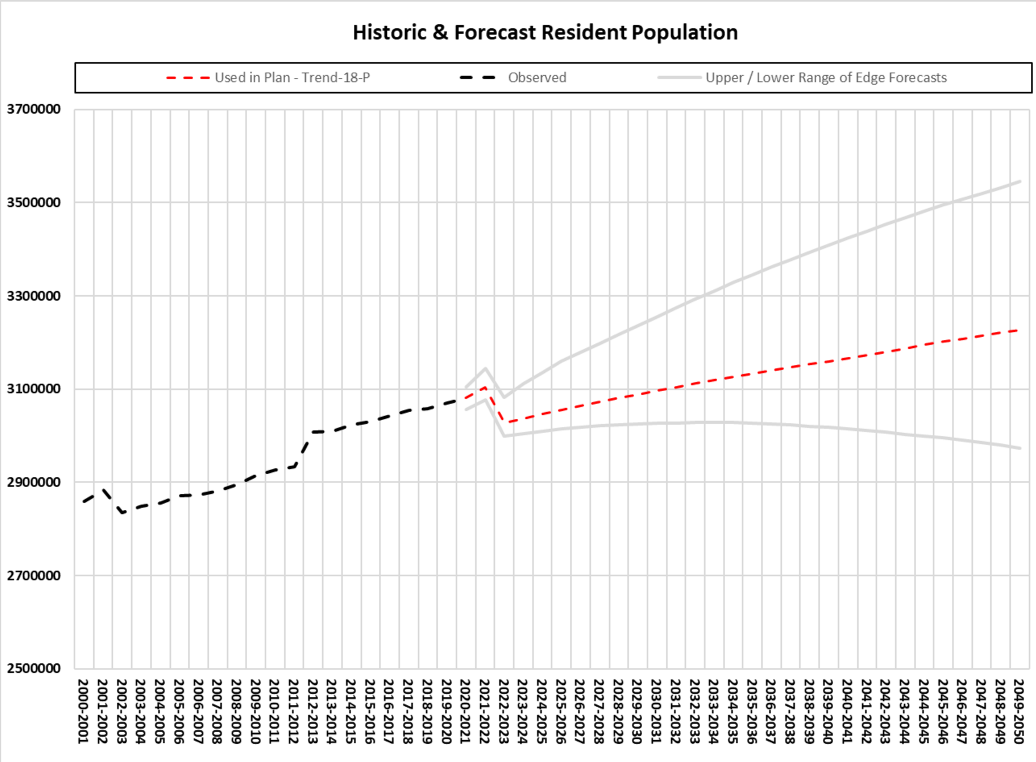


Figure 33 – Resident Population Forecasts

4.3.6. Census 2021

For this revised Plan the results of the Census 2021 have now been incorporated into the demand forecasting process. The Census 2021 results became available at lower geographic scales during March/April 2023 and have underpinned our population estimates for the 2022-23 Annual Reviews.

The latest annual review data has since been incorporated into the property, population and occupancy forecasting mechanism and as such the 2022-23 reporting position sets the starting point for the future forecasts of population and occupancy levels in the WRMP. The main impact of including the Census 2021 results is on the household population estimates which have reduced by c70,000 between the Draft and Revised Draft.

Figure 34 shows the trend in the Mid-Year Estimates produced by the ONS / Welsh Government for Wales and the reported household population estimates from our annual reporting data. It is worth noting that our water supply area is not continuous with the Welsh administrative boundary and includes some English Local Authority areas. However, both show a similar trend, and this is not surprising given the company population estimates are underpinned by the ONS estimates.

Over the course of the ten years between the Census 2011 and 2021 both show growth, officially Wales seeing a 1.4% increase in usually residential population since 2011, however it also shows the large step change when the Census 2021 was released. This does indicate that in prior years the ONS growth underpinning the official Mid-Year-Estimates may have increasingly “over-forecast” population since 2011.

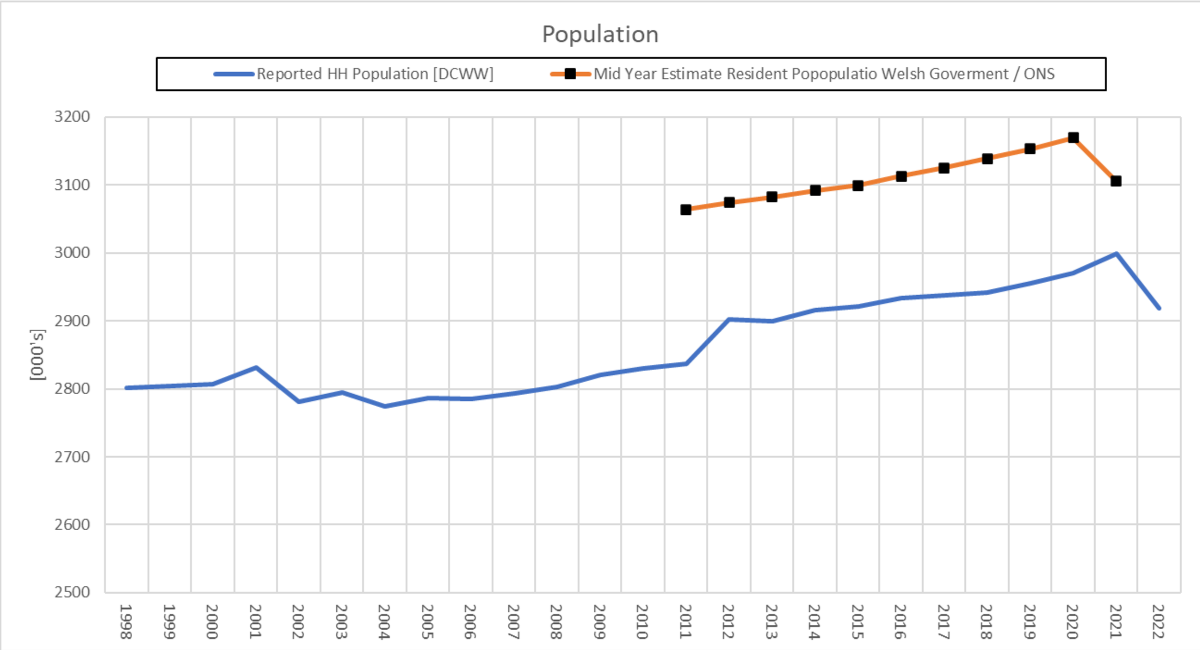


Figure 34 – Population data comparison

The updated household population and occupancy forecasts have also been used in the Household Consumption Forecasting (HCF) process and this will influence future Per Household consumption (PHC) rates, where household occupancy is one of several explanatory variables used by the HCF regression modelling to produce future forecasts of PHC.

The PHC rates are then used to determine future forecasts of household Demand by multiplying forecast PHC by the forecasts of household property counts to produce a future demand volume.

It is difficult to fully separate the impacts of the updated occupancy rates on the PHC outcomes of the HCF. It's estimated that PHC has reduced between 0.5 and 2.4 l/prop/day (1.2 to 6.8 Ml/d in terms of household demand volume) from the use of the Census 2021 data in that process.

The updated household population figures are also used in the derivation of PCC in the demand forecasting process whereby forecasts of household demand in volume (initially derived from PHC x properties) are divided by household population to produce a PCC in litres per head per day. It is estimated that the reduction in household population has increased our PCC estimate by 3 l/h/d.

4.3.7. Consideration of growth and development of non-households

We keep closely engaged with our non-household customers about current and future supply needs. At this stage there is no firm indication of any significant change of non-household demand factors that warrant inclusion beyond the current modelling approach. Forecasts do include some provision for future new growth and development of non-households. The econometric modelling is based on observed data and therefore previous trends in non-household demand, either new growth or changing, will feature in the forecasting.

Forecasts of non-household connections are also included as a variable in the modelling process and are based on using previous trends from the observed numbers of connections at the WRZ and economic sector level. Furthermore, our forecasts project from the non-household demand levels in the base year and so any new demands in the previous years will also be included in the forecast.

The inclusion of significant new demand requirements, not previously in the observed data and which are not accounted for in the forecast process, can be included as a positive or negative 'demand delta' within the non-household forecasting model. This was previously undertaken in WRMP19 plan where the Wylfa Nuclear Power Station was included as scenario but not within the core plan.

There are risks in this approach as it relies on some degree of certainty around the magnitude of the demand, the location (WRZ) and when it is due to occur in the planning horizon. Inclusion of these demand deltas in the core forecasts add risk and uncertainty into the forecasts. It is therefore more pragmatic to include these possibilities as scenarios and are considerations for adaptive planning. For this round of plans no additional non household demands have been included in the core plan.

4.4. Non PWS Demand and Private Supplies

Guidance from Welsh Government asks that our WRMP considers "*local multi-sector needs and include within your supply demand balance forecasts the needs of those customers, such as agriculture and businesses, that have ability to switch to mains during peak demands periods. You should also consider your policy for supporting other water users such as those on private water supplies with no mains connection…*"

In response to this we commissioned ARUP to undertake a review of available data on private water supplies (PvWS) from published and available reports and datasets to inform us of the potential scale of demand. In undertaking this review ARUP were also tasked with identifying the potential uncertainty in the datasets and to propose key actions needed to improve the understanding of this demand in order to develop an appropriate strategy, planning and operational response to these water users where possible.

It was agreed the focus of the assessment would be on 'domestic' water users with no connection to the company water supply grid. Subject to an understanding of the availability and uncertainty in the datasets, additional assessment may be possible to understand how the company could possibly provide alternative supplies to other sectors such as industry, recreation, agriculture, tourism etc.

This review, available in Appendix 12, is therefore an initial step in providing updated information on the potential scale of water demand from water users not connected to the company supply network. The conclusions drawn at this stage are:

In summary the DCWW (Wales only) PvWS demands have been broken down as follows:

- Registered PvWS (potential DUAL supplies) = 1,767 domestic properties (1.1 Ml/d);
- Registered PvWS not considered to have mains supply = 7,412 domestic properties (5.1 Ml/d);
- Registered PvWS Total = 9,179 domestic properties (6.3 Ml/d);
- Potential Unregistered PvWS = 29,205 domestic properties (9.7 Ml/d);
- Total Registered + Unregistered domestic demands = 16.0 Ml/d;
- Total domestic properties with a potential PvWS = 38,384 (2.9% of households in Wales based on Census data
- Assumed average occupancy of 2.31 = 88,667 people (2.9% of the pop. of Wales based on Census data receive water from a PvWS.

To improve our understanding of PvWS and to allow for their inclusion within our long-term water resource planning, ARUP have made a number of recommendations for wider consideration from ourselves and key stakeholders such as Welsh Government, Natural Resources Wales and Local Authorities:

- Ground truthing of a sample of the 'unregistered' PvWS to validate whether they are connected to the grid or not would be invaluable. When possible, this should be undertaken at a sample of locations to 'test' the assumptions with buffer distances used in this research.

- Understanding behaviours and how PvWS users 'switch' where possible between private sources and the mains water grid in dry summers is an important consideration and could be identified by an analysis of the Distribution Input data during peak demands, noting that 2022 could provide an ideal dataset to support this recommendation.

- Seasonality is a key factor in the understanding the PvWS demands. Temporary registered abstractions and sectors such as Agriculture, Camping & Caravanning and Holiday & Tourism are likely to see their peak demands during the summer months; critically when resources tend to be under most stress.
- Liaison with Local Authorities to gather their local knowledge of the PvWS status and trends. Understanding the sources of water to the PvWS sector remains a key challenge and this will also inform the vulnerability of supplies and possible adaptation options. An improved process for registration of PvWS to include specific information on water sources (borehole, springs, rivers, etc.) and demand is fundamental to improving the evidence base and assessment of resilience in this sector.
- Encourage an improved registration record and estimate of individual PvWS demands (currently 200 l/hd/day) to reduce the uncertainty around this longer term. In addition, evidence for the level (magnitude) of demand remains a key information gap and currently can only be based on 'best estimates.' This remains an area for more detailed survey and potentially trialling water consumption at specific property level scale. This is a key action for DWI and Local Authorities in Wales.

4.5. Demand Management

4.5.1. Introduction

The demand management actions can be split into those that achieve water demand saving on our own mains network and those where demand is reduced by our customers either through the repair of leaks from their supply pipes or through encouraging them to use less water.

We understand from our work that the conventional strategy to fix network leaks within the distribution system becomes less effective as we search for ever smaller leaks from our supply systems. We have focused our effort to manage leakage on customer supply pipes and internal plumbing systems through our AMP7 Project 'Cartref'.

There has been significant learning and technological improvement over recent years with the development of 'smart' metering, telemetry and modern data science which offers an advancement in the ability to work more closely with our customers by sharing demand information more readily, as in the power sector, and to both detect and repair leaks more effectively.

We have reviewed current cost/benefit data and it is clear that a step change in approach is required to effectively meet increasingly challenging targets, with our conventional 'find and fix' leakage costs increasing and additional options becoming available.

We are continuing with our detailed investigations into 'background leakage' supported by the Ofwat Innovation Fund project which we are leading. Background leakage is defined as a summation of all leaks which are too small to find using techniques currently available. Estimations of background leakage vary across the industry, with current understanding suggesting that it could represent over two thirds of total leakage by 2050. It is important that we understand the true level of background leakage so that innovative technologies and data science can be employed in future strategies to manage this element.

We are in a position where we should be utilising the latest metering technology to support leakage and customer usage reduction and this can only be achieved by increasing the number of supplies that are metered, even if our customers do not choose to be billed based upon the actual volumes of water received.

The remainder of this chapter outlines our demand management strategy based upon the targets set by Government and Regulators and the findings of our engagement with our customers and stakeholders.

4.5.2. Customer Supply Metering

Our water efficiency strategy in AMP7 has centred on our Project 'Cartref'. This project is about working with our customers and using innovation to reduce wastage of water, either through leakage or inefficient use. We think this is the right thing to do in view of the long-term challenges of conserving our water resources against the background of climate change and a growing population. However, Project Cartref is not just about reducing leakage and consumption. it is also about establishing a conversation with customers about how we can help them.

Our current approach to domestic customer metering is largely reactive with installations only taking place when:

1) We receive a request from existing customers to have a meter installed so they can be billed on a measured basis (known as meter optants). Figure 35, taken from our customer research, shows the main reasons why customers opt to have a meter installed.
2) All new build properties are now required to be metered
3) The replacement of faulty/damaged meters.

We also promote metering as an option to reduce bills for low occupancy low-income households. Around 47% of our customers have a meter installed, based on the most recent Annual Return data (FY 2021-22) which is well below the industry average across England and Wales of 63%. Based on the plans that were submitted at PR19, by the end of AMP7 we will have the second lowest level of meter penetration in the sector. Our meters are mostly manually read, however, we have started to install 'Smart' meters to help kick start our metering strategy going forward.

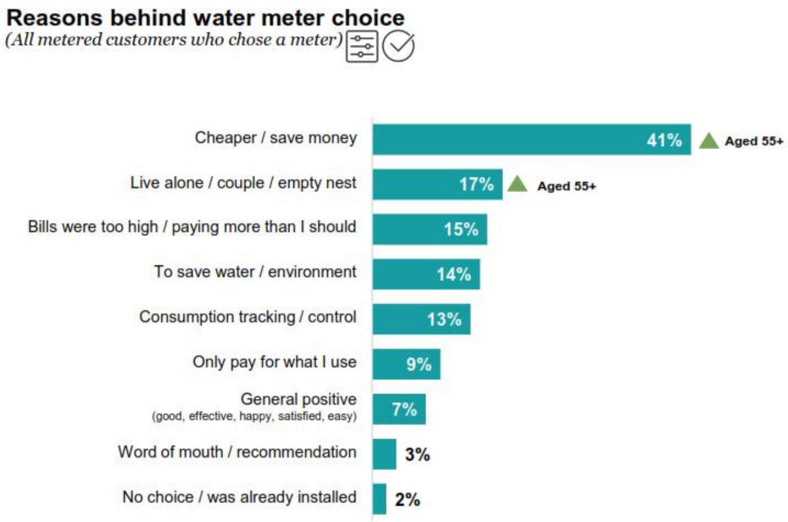


Figure 35 – Results of WRMP24 customer research into meter optants

We have investigated the advance of smart metering in other sectors, and the control it gives consumers over their usage is driving customer expectation of this functionality for their water service. It is unlikely that customers in 2050 will consider our current approach to be acceptable and therefore change is required. To improve this position, as a Business we have agreed a step change in our approach to customer metering and so we will be delivering a large-scale programme of progressive customer metering from AMP8 onwards that will also bring wider benefits, as summarised below:

Per capita consumption (PCC)

Metering allows customers to monitor usage and see the link to their bills. It also underpins our approach to influencing customer behaviour, through an enhanced Project Cartref, our Education programme and various 'nudge' campaigns. Without information on household usage, it makes it difficult for us to demonstrate to customers how their actions can impact on consumption levels.

Leakage

Increased levels of metering within our network provides more accurate information on leakage (supply side and customer side) and therefore allows us to target our leakage activities more effectively. It also means that we are able to reduce the level of judgement in our calculations of customer night use and consumption and report a more accurate leakage figure.

Customer service

Whilst the subject of metering is one that causes concern to customers, they are becoming increasingly familiar with smart metering for their gas and electricity supply, the granularity and frequency of the information that it provides and the control that they have as a result over their expenditure.

However, it is important to note metering drives additional contact and costs that are associated with unmeasured customers. Customer queries can be more complex and take longer to resolve.

Smart strategies

One of our strategic responses within the Welsh Water 2050 strategy is to improve the service performance and resilience of our assets through remote sensing, data analysis and automation, solving problems before they begin. Smart customer metering underpins this strategy by recording and communicating granular consumption data in real time to allow the business to identify changes in recorded consumption and proactively address the underlying causes, as well as meeting the increasing expectations of customers for smart services.

To gather evidence that would help inform our metering strategy, we commissioned customer research specifically into metering as part of the wider WRMP24 customer engagement. The outputs of the customer research (Figure 36 and Figure 37) largely supports our approach as customers recognise that better understanding their usage will help them reduce consumption. They do, however, harbour cost concerns but express support for paying for what is used, thus the progressive metering offers a stepped approach to adoption without making meters compulsory.

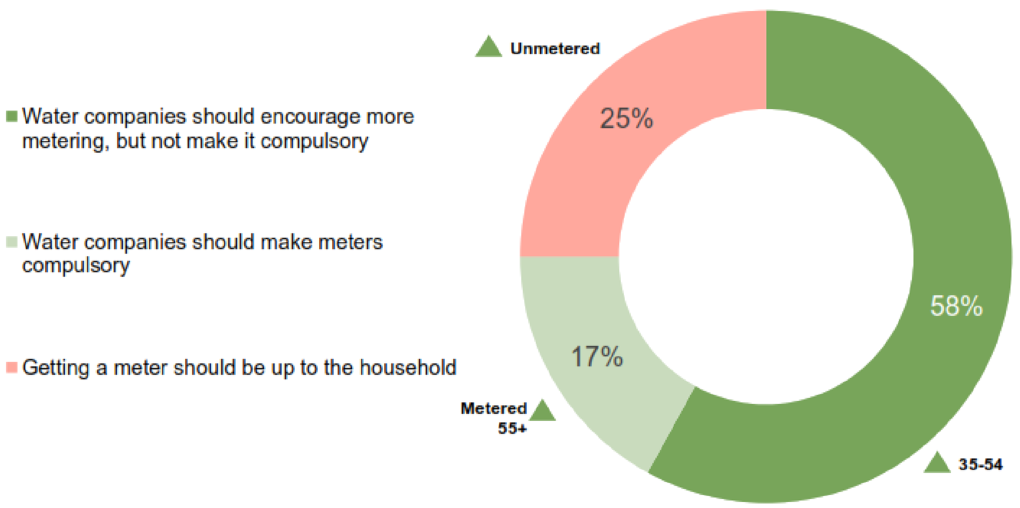


Figure 36 - Customer views on metering

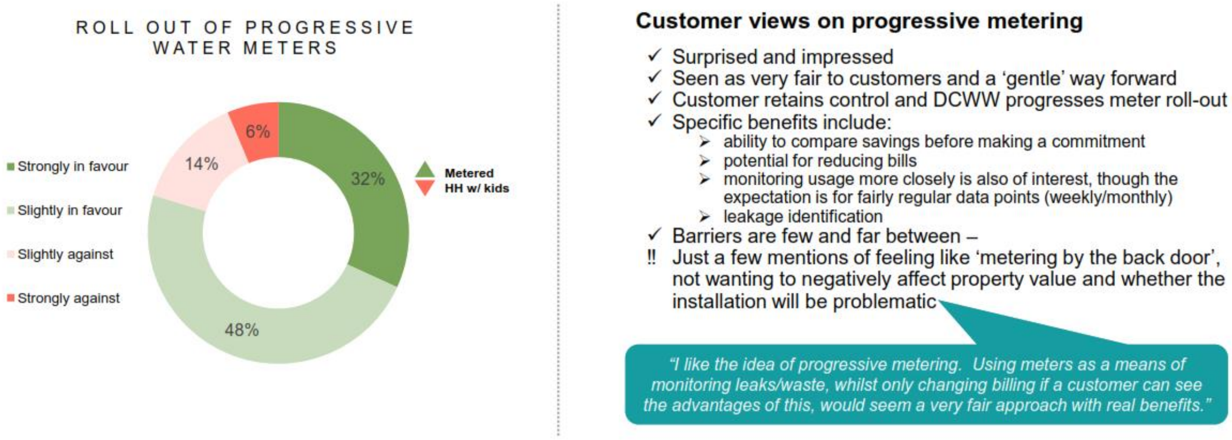


Figure 37 -Customer views on ‘progressive’ metering

4.5.3. Our Metering Strategy

It is clear from our customer engagement work and the views from our stakeholders that we are lagging behind in our thinking on customer metering. Our customers have been clear that metering should not be compulsory with legislation in Wales also not supporting the imposition of metering.

In response, from 2025 we propose to move to a strategy of installing smart (AMR with a technological roadmap to AMI) meters on unmeasured properties by geographical area. In the first instance customers will not be billed through a measured charge and will remain so until there is a change of occupier or the customer opts to switch; this approach is known as ‘progressive metering’. We will continue to monitor developments in smart metering technology and move to AMI meters as the technology matures and costs reduce.

Our progressive metering strategy for AMP8 and beyond is underpinned by an appraisal of the economic, demand-related and business performance outcomes generated by a bespoke metering cost-benefit model. The model allows consideration of a wide range of metering options against a set of operational and retail performance metrics and examines the costs and benefits of each metering option relative to the company’s current metering strategy. Projections of the number of meter installations, PCC and leakage forecasts are derived from our most recent baseline demand forecast for the long-term planning period.

To provide a detailed understanding of each future potential metering strategy, our base year property numbers and meter estate have been categorised into cohorts for household/non-household, unmeasured/measured, meter manufacturer and technology, meter size, age, and location (internal/external). The model examines the economic, demand-related, and business impacts of changes in the meter estate each year under different metering policies. Policy variables include the type of metering and charging/billing, the timing and speed of rollout, and meter replacement (including legacy meters). The model also allows for consideration of alternative AMR/AMI read frequencies and treatment of void properties and joint supplies.

The base year used by the model is 2020/21 and the planning period is to 2049/50 (end of AMP12). Unit costs and benefits are in 2021/22 prices. In line with the WRMP, costs and benefits are discounted over 80 years. Figure 38 presents an overview of the modelling process.

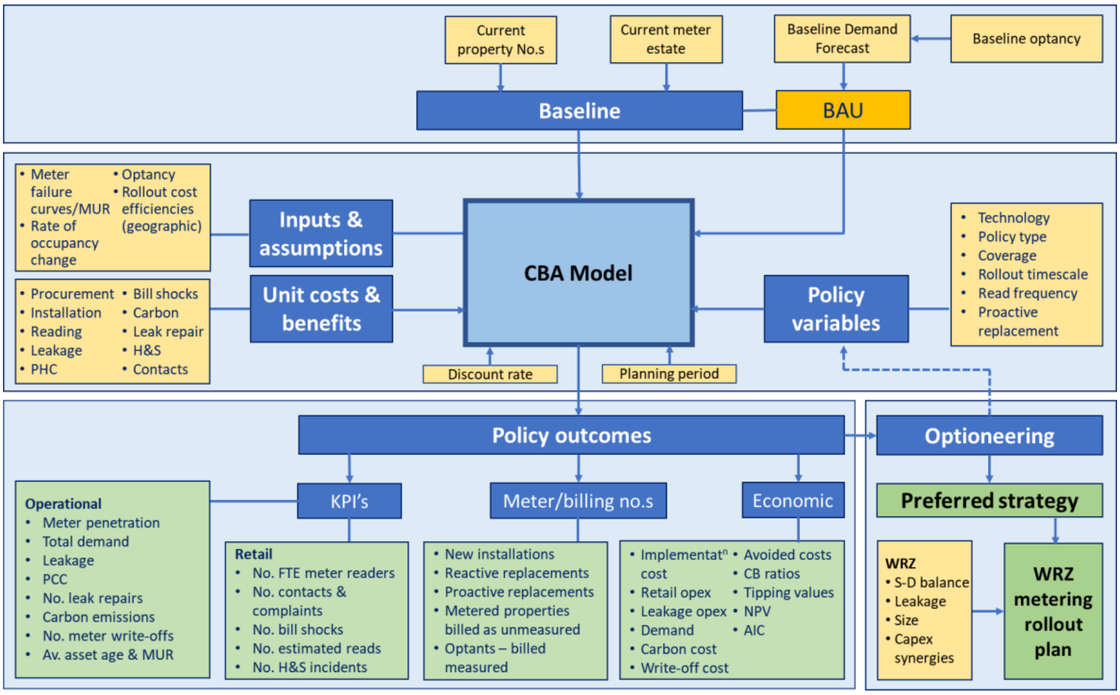


Figure 38 -Metering CBA model - process map

For each policy option the model generates WRZ-level annual and AMP period outcomes for the following performance metrics:

Operational

- Number of new meters installed
- Number of proactive meter replacements
- Number of reactive replacements
- Number of optants (billed measured)
- Meter penetration
- Average meter asset age and MUR
- Demand
- PCC
- Leakage
- Number of additional leak repairs
- Number of legacy meter write-offs
- Carbon emissions

Retail

- Number of FTE meter readers
- Number of health & safety incidents
- Number of contacts & complaints
- Number of bill shocks
- Number of estimated reads

For any given progressive metering policy, the model can generate different geographic delivery plans using one of three methods:

Method 1: Random rollout:

Randomly targets an equal percentage of meter installations in each WRZ across each year of the policy's delivery period. Capex costs are thus evenly distributed across the period.

Method 2: Rollout prioritised by area-level AICs:

Geographically optimises rollout across either DMAs or WRZs, based on relative cost-benefit. While the model targets an equal number of meter installations in each year of the policy's delivery period, installations are prioritised in areas with the lowest AIC. By establishing an optimised delivery plan, Method 2 thus minimises the NPV cost of the policy.

Method 3: Bespoke WRZ-level prioritisation

Implements a pre-determined WRZ-level delivery programme generated outside the model. The plan entails a bespoke WRZ-level prioritisation over the delivery period based on considerations such as WRZ size (feasibility), supply-demand balance, leakage above target, and geographical synergies with other capital delivery programmes.

A full technical report on our metering cost benefit model is available as Appendix 25 to this Plan.

4.5.4. Preferred Metering Delivery Strategy

Following an in-depth optioneering exercise and sensitivity analysis a shortlist of six alternative progressive metering options was presented to DCWW for consideration, from which a preferred option was selected. Figure 39 sets out the core components of the preferred option.

Progressive AMR metering from AMP8 with proactive replacement of meters more than 10 years old

- Proactive installation of external meters on unmeasured properties throughout AMP8 and AMP9, geographically delivered on a prioritised WRZ-by-WRZ basis
- Properties are initially billed as unmeasured but switch to measured charges on change of occupier
- Optancy (switch to measured billing) is encouraged in Year 1 with dual billing
- Void properties and unmeasured NHH's are included in the policy
- Properties on joint supplies remain unmeasured
- 76% meter penetration by the end of AMP8
- Proactive replacement of all meters > 10 years old, area by area, alongside new installations
- Meters currently installed internally are replaced in the same position
- All meters installed and replaced are AMR (potentially AMI ready) meters with leak alarms, capable of providing 30 days' index reads
- Meters are initially read as AMR monthly (dumb meters are read at current read frequencies until replacement)
- Compulsory measured charging introduced in 2040/41 (AMP 11)
- From 2040/41 all meter replacements are full AMI

Figure 39 - Components of our Preferred metering strategy

Through our strategy we will increase the level of metering to 79% by the end of AMP8 and 96% by 2050 (no water company has yet to achieve 100%) and the demand forecasts include savings achieved from both better data and communication with customers and the identification of leakage on customer's properties. The metering strategy is forecast to reduce overall demand by 37.23 Ml/d by the end of AMP8 and 96 .01 Ml/d by 2050.

4.5.5. Water Efficiency

Water metering is an enabler for water efficiency as this allows us to work with customers to support them in understanding and helping them to reduce their consumption. This section sets out our current activities and our future water efficiency strategy, for both household and non-household customers.

Current Activities – Household

We are working with Welsh Government through the Wales Water Efficiency Group which brings together water efficiency objectives and projects. Our forecasts for both household and non-household demand include an element of baseline demand management intervention through our continuing water efficiency which is built into our demand forecasting processes. For households this is a set of superimposed trends on forecasts built from 'residual modelling' on the observed demand data.

For Non-households, previously observed consumption on which the modelling is based will include company led and proactive demand management by the customers themselves and this will be in part, forecast forward during the modelling process.

For the future our regulators have high aspirations and have set stretching targets around demand management that we have translated into targets this Plan sets out to achieve. Table 15 below provides a summary of our existing activities and interventions in terms of water efficiency for households:

Water Efficiency Intervention	Description	Comments
Online access to free issue water saving products	Online access to free issue products such as tap adapters, energy efficient shower heads, leak detection strips and toilet cistern bags. Support through information such as the Get Water Fit application.	A wide range of water saving devices are provided and delivered free of charge to our customers.
Education	Our current education programme delivers school assemblies and workshops to educate children on key aspects of the water cycle, and one element of this is relating to water efficiency.	The current intervention includes water efficiency as part of a broader education programme.
Leaky Loos	Support to customers in terms of identifying leaky loos, for example uploading a short video via a QR code and confirmation if there's a problem along with support in terms of fixing the problem.	This is currently offered as part of our Cartref project.
Virtual Home Audits	We currently offer virtual home audits that complements our offer of free issue water saving products.	This is currently offered as part of our Cartref project.

Table 15 - Existing household water efficiency activities and interventions

Figure 40 provides an example of our Stakeholder Engagement Pack designed to promote Cartref, and water efficiency, within the community.

Figure 40 -Example Project Cartref engagement pack

4.5.6. AMP8 Water Efficiency Strategy - Household

We are planning to upscale our Project Cartref service in line with the Waterwise expectation to provide greater focus on direct customer engagement and social contracts. This upscaling, will be structured to ensure we are working towards the 10 Strategic Objectives identified through the UK Water Efficiency strategy 2030.

The key elements of our water efficiency strategy are:

1. To deliver our metering role out programme
2. Deliver meaningful proactive intervention to support our customers, whether this be direct intervention (products and repairs) or delivering education to change behaviours – through our Cartref programme.
3. To undertake behavioural science investigation that will help us:

- Maximise the upscaling of our Cartref offering
- Understand how to best target customer messaging and communication methods around metering for achieving reductions in both customer supply pipe leakage and usage
- Understand the optimum frequency of meter reading, supported by behavioural investigation around the optimum frequency.

4. Work collaboratively with partners to maximise our delivery mechanisms, but also work to drive change through trialling innovation
5. Improve our billing systems and use data science to enable the full benefits to be realised

We offer many services that we believe could be of interest to a great number of customers but generally a meaningful face to face conversation is required to explain the benefits and achieve customer sign up. These services include social tariffs, priority services registers, lead pipe replacement and metering. Helping customers to tackle leakage and wastage on the part of the network traditionally beyond the responsibility of water companies – i.e. beyond the stop tap – enables these conversations to take place. It is a proactive and preventative approach that will save water, and save money, for this and future generations.

The upscaling of our Cartef programme in AMP8 will include:

- **Leaky Loo Support** – Continuation of our existing Leaky Loo identification and repair offering for customers across our operating area (both to support the metering strategy but also as a general offering). We believe over the AMP this may result in 25,000 customer appointments.
- **Schools** - Our current education programme delivers school assemblies and workshops to educate children on key aspects of the water cycle, including water efficiency. We would look to undertake water efficiency audits and fit outs at 200 schools per annum.
- **Access to products and education** – Promotion of our online Consumption calculator (as the moment this is through our Get Water Fit platform), with access to free water efficiency products, as well as education to promote behavioural change.
- **Water Home Audits** - We will look to identify high users and engage with them to promote a home visit - water audit. During this visit we will work to educate customers in the efficient use of water, as well as provide a free install service for water efficiency products and Leaky Loo repair. We will undertake 25,000 home audits within AMP 8. We have undertaken and are continuing to undertake some larger scale trials of this offering within AMP7 (1,500 a year), which will allow us to develop a high-quality service into the next investment period.

- **Community** - We believe there is significant power in community engagement. To promote reduction in water wastage, and the uptake of our water efficiency home audit, free products and leaky loo offering there is a need for community engagement. Community engagement will be focussed on areas in which we are undertaking progressive metering as well in support of other initiatives across Welsh Water such as the Water Resilient Community programme.
- **Water Efficiency Partnerships** – Working with partners such as through the Wales Water Efficiency Group to look at new ways of delivering savings, an example of this would be flow controller installations (currently trialling at several caravan sites in West Wales and a limited trial on domestic customers), or retrofitting products, providing education as part of the voids process in social housing.

  To create an optimal delivery programme for our water efficiency strategy, Figure 41 summarises the process followed to appraise and identify the options required.

Figure 41 - Process map of our water efficiency option development

1. Literature review – gathering data and evidence in support of the benefits of options that are not currently part of BAU activities, for example UK and international papers and reports.
2. Data collection – collating high-level costs and benefits of activities that are beyond current BAU.
3. Setting constraints – to avoid the risk of double counting the potential savings over the longer-term assumptions were made around what feasible upper limits might be in terms of scaling up BAU options. Consideration was also given to where other options might be limited by customer willingness to consider more drastic interventions such as rainwater harvesting due to potential disruption.
4. Optimisation – linear optimisation was carried out to support the development of best value water efficiency strategies. It is noted this optimisation was undertaken separately for household and non-household to align with regulatory targets.
5. Review – of the long-term programme and costs
6. Refinement – review of the water efficiency strategy and refinement to consider the scope of interventions that carry greater uncertainty, such as behaviour change initiatives.

There is potential for behaviour change to be accelerated, and this could provide a significant opportunity however there is greater uncertainty about the effectiveness of this strategy. We have therefore included a behaviour change option that will require further work over AMP8 to develop fully. In terms of identification of the realistic potential of behaviour change, a collation of studies looking at different interventions provided a range of results and savings11. Figure 42 provides a summary based on the average % change from groupings of different interventions covering information, motivation and behaviour.

[11] Systematic review of household water conservation interventions using the information-motivation-behaviour skills model, Environment and Behaviour Journal, Ehret et al, 2021

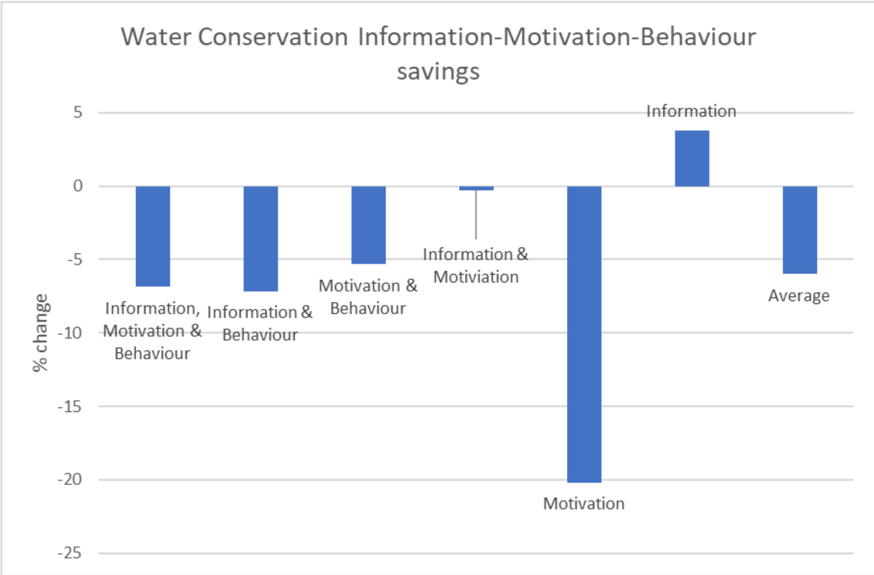


Figure 42 - Water conservation information motivation - behaviours savings

Based on the range of potential savings from the outputs of the studies reviewed, a mean of 6 l/p/d has been used as a reasonable value to assume in our option design as an indication of the potential benefit that behaviour change could possibly achieve, noting however this may require a sustained ongoing effort to maintain this level of saving.

There is greater certainty in terms of selecting physical options that deliver lower water usage in the home, however behaviour change is potentially a much better value and lower cost option. It is therefore part of our strategy to develop this option further in AMP8 through the following activity:

- Improve our understanding of the theory of behaviour change, and research into different theories, models and frameworks that could be used.
- Campaign planning and strategies in terms of defining the audience, intended goals, choosing communication channels and partners and developing a campaign strategy
- Development and testing of messages and materials – key concepts and materials to be used
- Implementation – how to launch and manage campaigns, engage partners and monitor success and failure
- Evaluation of the success overall of the campaign against control groups and presenting findings.

Achievement of 110 l/p/d PCC target using only physical water efficiency interventions such as water saving devices, home audits, leaky loos and greywater recycling/rainwater harvesting would be prohibitively expensive, which is why the delivery of our smart metering programme is critical to achieving this target. Increasingly education and the use of tariffs are likely to play an important role going forward as we achieve higher meter penetration.

Our preferred household water efficiency programme to enable us to reach our 110 l/p/d PCC target, once the savings from smart metering and the Government mandatory water labelling are accounted for, includes a range of options as we believe there needs to be a balance between physical interventions and behaviour change. We included a relatively conservative saving in AMP8 associated with behaviour change but this could potentially grow given the longer-term potential savings.

Behaviour change was included partially, in the form of tariffs and education, however it is recognised that there is likely to be greater potential given a step change in approach to managing customer behaviour. We explored at a high-level what the potential savings could be and deemed this to be better value than some of the more expensive physical options such as retrofitting rainwater/greywater systems.

It may take some time to develop a detailed, comprehensive behaviour change campaign and strategy and there are some fundamental questions such as whether this is best delivered by water companies, governments or third parties, particularly in relation to new government initiatives such as water labelling.

4.5.7. AMP8 Water Efficiency Strategy – Non-Household

At present we do not have a targeted water efficiency offering for our non-household customers, however we recognise the potential opportunities and so have built this into our long term strategy.

From 1 April 2017, all non-household customers of water and sewerage services served by suppliers based wholly or mainly in England have been able to choose their Retailer (i.e. the previous water supply threshold of 5Ml/per annum was removed). In Wales, the Welsh Government decided that there would be no change to the Retail market in areas supplied by water and sewerage companies based wholly or mainly in Wales, and so the competitive retail business market in Wales remains limited to the supply of water services to business customer sites using more than 50Ml of water per annum. This means there are significantly less eligible business customers in Wales and so we continue to have a direct retail relationship with most of them.

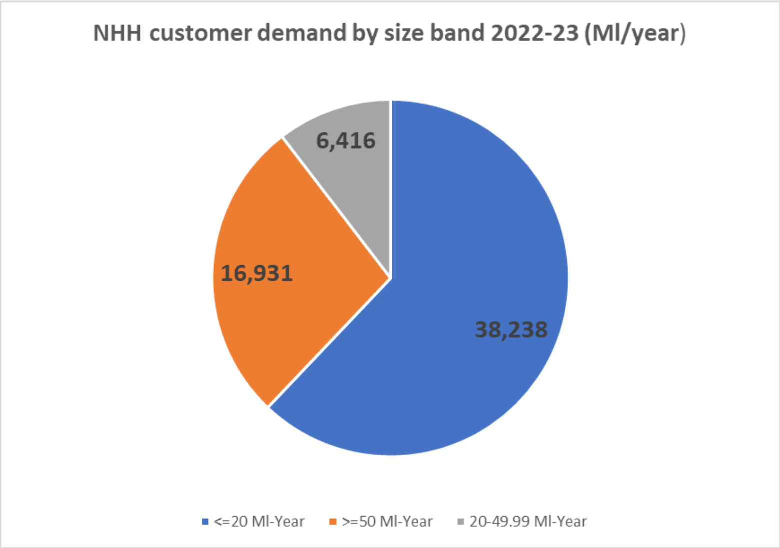


Figure 43 - Breakdown of our Non Household demand

Within their consultation response to our draft Plan Ofwat, amongst others, have asked us to be more ambitious in supporting business to reduce their demand for water. For the English companies, UK Government has set them formal targets for business demand reduction within the EIP, these being a 9% and 15% reduction by 2038 and 2050 respectively, set against a 2019-20 baseline. We do not have a formal target set in Wales but we are mindful of the need to support demand management and have examined the options available to do this and set targets in line with those set in England.

From AMP8 we will increase our support and commitment to Non-household customers in improving water efficiency to reduce waste. A number of opportunities exist, taking on some of the lessons learnt from our existing Cartref strategy, but adapting it to support small and medium-sized businesses (for example, hair-salons, coffee shops, small office blocks and hotels – as well as community buildings such as libraries, community centres and schools). The options considered are:

- **Access to products for non-households -** This will be similar in style to our existing domestic offering, a short questionnaire to obtain demand and also suitability of different products for the site in question. Initial products would include items such as tap aerators (kitchen and bathroom), flush bags, shower heads, leak identification kits. A communication strategy would be developed to promote this to our non-household customers, as well as a method of reporting back.

- **Non-domestic Water Efficiency Audits -** Taking a similar approach to our domestic water efficiency audits, we would target our highest users within the small business market – for example cafes, small shops, hair salons and drinking establishments to offer a visit from one of our Water Efficiency Champions. This visit would aim to install products, provide advice and education to the employees at the site around the waste of water. There would be direct link up to both cost savings (water and other utilities) as well as the environmental benefit of reducing usage and/or wastage.
- **Non-domestic Deep Dive -** A similar process to the Water Efficiency audits, this will however allow a greater time to survey the property and come up with a recommendations report for the customer. This will focus on:
    - Medium size businesses - for example small hotels, office blocks, larger entertainment venues.
    - Council, community and educational sites.

  We will offer the same leak repair service for domestic type installations (taps and toilets), as well as an allowance for products to install. We hope that by having a simplified recommendations sheet we can work with these businesses for them to undertake additional work.
- **Greywater and Rainwater installations options -** Greywater re-use and Rainwater use to offset the use of potable water could be considered. This could be a collaboration between ourselves and those companies interested. We have concerns over the funding of greywater recycling and rainwater harvesting systems on private properties and the retro-fitting of these installations are very expensive compared to other options. We will continue to explore such options through small scale trials in AMP8.
- **Business focused Communications Strategy -** We know that behavioural change through an effective communications strategy can work for the domestic customer, so it seems only natural that we could apply this same logic to our non-domestic market. We have considered a focused campaign (more traditional "boots on ground" and advertising / roadshows etc) to highlight the benefits of reducing consumption to non-domestic customers (water and utility), and would combine this with the power of social media advertising and influencing to maximise return. We will take a collaborative approach to this work through business and trade organisations.

We have looked at the number of properties of each type and estimated the take up of these offers based upon evidence from our Cartref programme. The evidence on take-up for small businesses is better than for the larger ones, as these are more similar to a typical domestic premises.

We have used this evidence to set what we feel are realistic but challenging business demand reduction targets. This is a reduction in non-household demand of 9% by 2037/38 by which time we will have approached most companies. We estimate that we may increase this to an 8% saving by 2050 but we will need to increase our evidence base and have a greater understanding of business behaviour as we move forwards.

4.5.8. Government led water efficiency intervention

Artesia's 'Pathways to Long-Term PCC reduction' (2019) report highlighted that a water labelling programme (with minimum standards) could have a major impact on PCC for a low cost of implementation. A recent Energy Savings Trust report centred in Wales has also highlighted water labelling as the single most cost-effective way of reducing PCC in Wales. The inclusion of the PCC reductions into our preferred plan due to Government-Led intervention around water labelling assumes that the intervention commences no later than 2025-26. The timing is critical and will be monitored as later implementation will defer demand reductions later in the plan meaning more company-led intervention is required as an adaptive pathway. The "*Enhanced-01: Mandatory water labelling with no minimum standards*" glidepath taken from 'Pathways to long-term PCC reduction' Water UK (2019), shown as the orange glidepath in Figure 44 have been used in our forecasts.

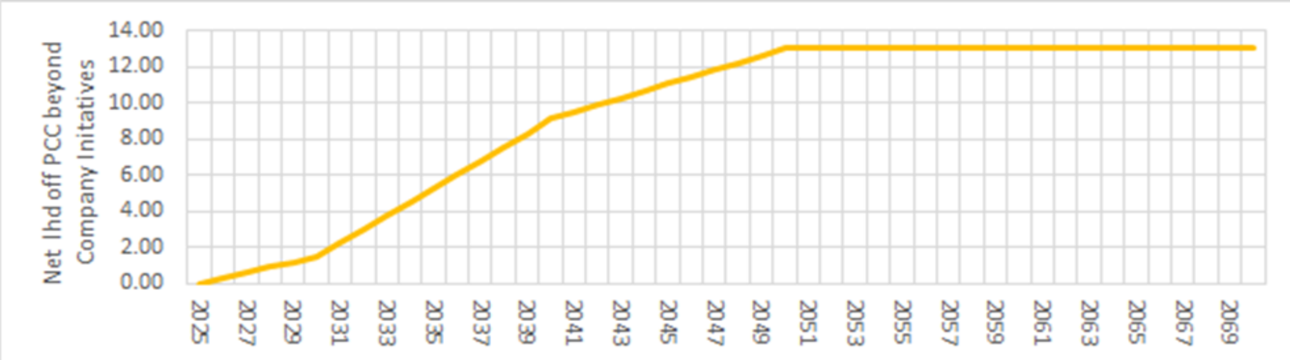


Figure 44 - Government-Led Intervention Glidepaths

4.6. Leakage

The loss of water from our supply systems is an unfortunate consequence of supplying large volumes of water across a vast network of pipes. On a typical day we supply around 850 million litres of water from our 64 water treatment works, through 27,000 km of main to our customers. Leakage is a high priority and emotive issue for our customers and failing to be seen to play our part in reducing levels of water lost can damage the trust our customers have in us. As part of its methodology for PR19 Ofwat established a series of common measures for water companies to set Performance Commitments (PCs) for the AMP7 price control period. In addition, reporting guidance was developed in conjunction with Water UK to ensure companies report upon these PCs in a consistent way.

Leakage is the escape of water from our customers or our own pipes or fittings and service reservoirs, and in the context of regulatory reporting is referred to as “total leakage”. The key factors that influence how much water escapes from the network each day are how many leaks there are in the network, the physical size of each point of leakage and the pressure of water inside the pipe. Total leakage is also impacted by the number of days a leak is allowed to run.

A network with no holes or points of leakage will have zero leakage, but water networks leak for a variety of reasons:

- Corrosion or deterioration of pipes, fittings or seals. This can be accelerated in aggressive soil conditions as an external factor, or internally due to corrosive water quality.
- Poor installation quality or practices, leading to weak joints or other points of weakness.
- Thermal expansion and contraction of pipes, leading to opening of joints or cracks in the pipes.
- Water networks are pressurised, higher pressures and pressure surges can contribute to leakage over time.
- Ground movement and stresses placed on underground pipes due to weather or climatic factors, or due to traffic loading.
- 3rd party damage.
- Structural failure of pipes and fittings. Often due to a combination of the above factors.

Some water pipes have been in the ground for more than 150 years and leaks can break out on pipes from the day they are installed. Once a leak occurs it does not self-heal. It may grow over time or remain constant, but it will continue to leak. A lot of the leakage reduction in the late 1990s was due to efforts to fix a backlog of leaks that potentially could have been running for many years. However, leaks continue to break out and to grow, leading to an increase in leakage, and this has become known as the ‘natural rate of rise’.

A key consequence of this is that every day leaks need to be found and fixed to hold leakage at a steady level. To drive leakage down, the sector must repair a backlog of running leaks and reduce the time leaks are running.

Within the water distribution system there is a large variety of leaks, from small weeps and seeps to very large leaks, some of which appear as bursts on the ground surface, but others can remain undetected for a long time. An implication of this is that there is likely to be many very small leaks in the system, which will be challenging to find and fix; these contribute to what has become known as the background or base level of leakage. This is the leakage level that might be very difficult to reduce using current detection technologies and techniques, without replacing or relining pipes i.e., improving the condition of the asset.

The amount of water escaping from leaks can be minimized by reducing the pressure inside the pipes, but customers expect a certain level of water pressure and in areas with hills and mountains the water needs to be pumped over these, leading to higher pressures. Some boiler systems in homes and commercial premises also rely upon a minimum pressure to operate, and minimum standards are in place to ensure that customers receive sufficient water pressure. However, managing the water pressure in the system is a key part of managing leakage. Pressure transients or surge is a large and rapid pressure variation and is like water hammer in a domestic plumbing system. This can be caused for example where valves are opened or closed too quickly and can be due to the operational actions of water companies or the actions of large commercial customers where water is taken rapidly from the system. This can also cause leaks to break out, so maintaining calm networks is seen as increasingly important.

There is a requirement for water companies to provide an assessment of its sustainable economic level of leakage (SELL). This is required to inform companies' Water Resources Management Plans (WRMP) as part of the business planning process and has historically been used to provide leakage targets for operational leakage management.

While leakage targets and performance commitments have historically been set on the basis of companies' SELL assessments, there has been a growing regulatory concern over past Price Reviews that SELL does not incentivise companies to become more efficient in how they tackle leakage. This is because SELL is typically derived using cost relationships that are based on current policies and associated costs, and these may reflect neither innovative approaches to active leakage control (ALC) nor greater levels of cost efficiency.

Accordingly, the regulatory guidance for PR19 and subsequently draft guidance for PR24 places less emphasis on the SELL calculation as a basis for leakage target-setting. Instead, it calls for water companies to establish leakage targets through the customer engagement process, and to demonstrate how they will meet their more stretching performance commitments through innovation, thus to deliver outcomes for consumers that are both cost efficient and affordable.

4.6.1. Our Leakage strategy

In 2019 the water companies in England, through WaterUK, all signed up to a Public Interest Commitment[12] which included amongst other things, a goal to triple the rate of sector wide leakage reduction by 2030 thereby matching the same level of improvement achieved over the past thirty years (1990- 2020). This is set within a longer-term ambition to halve leakage levels by 2050.

Our updated leakage strategy follows a similar profile in-line with the goal set for the English companies, whereby we will deliver the 15% leakage reduction commitment in 2020-25 with a further 10% reduction (of our 2024-25 position) across the 2025-2030 period.

[12] https://www.water.org.uk/publication/public-interest-commitment/

Thereafter our leakage strategy will follow a profile to achieve a 50% reduction in leakage levels, set against a 2017/18 baseline, by 2050. This long-term target reconfirms our Water 2050 commitment and delivers the requirement from Welsh Government, as set out in their Guiding Principles for WRMP24.

Customer engagement has shown strong support for reducing leakage, seeing this as a key element in forming a 'social contract' between us and our customers whereby they will respond to the requirement to reduce demand if we are seen to be playing our part, demonstrated most explicitly through a commitment to continue driving down levels of leakage. When customers were asked for their views on what we should do to reduce demand (Figure 45) reducing leakage on our distribution network was their first choice, closely followed by reducing leakage on customers' supply pipes.

Leakage reduction options are based upon our current and forecast data in terms of costs and benefits, which is to be supported by a recently awarded Ofwat Innovation Fund project to understand background leakage, that Welsh Water are leading. For this Plan we have looked at the options available to manage demand and developed a strategy that meets our stakeholders' expectations in a cost-effective way. The options looked at are described in Chapter 5 with full details provided in Appendix 24.

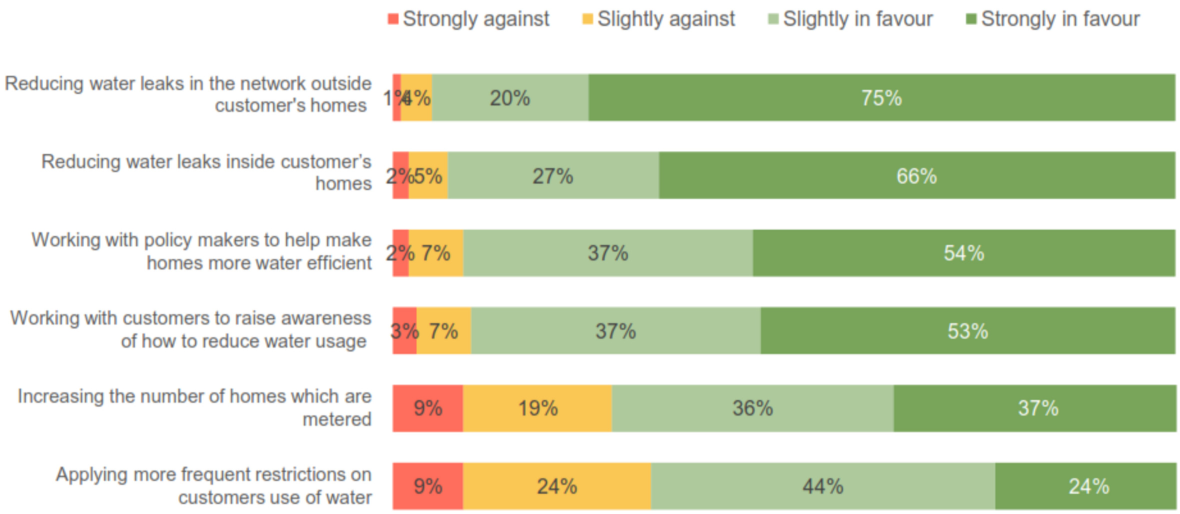


Figure 45 - Customer attitudes to demand-side solutions

In order to develop an effective leakage strategy, we are now using the industry tested SoLow model to better understand our leakage options and the cost relationships at a WRZ-level. These relate the cost of successive interventions to resulting leakage savings, which include both current and future savings associated with leakage growth over time. The model can resolve the complex interactions between types of leakage activity so that savings are not double counted. The model is also able to examine optimal solutions at company level where leakage schemes difference in cost between WRZs due to the local asset performance and condition. The range of external costs and benefits (i.e. environmental, social and carbon impacts) associated with each intervention and its resulting leakage savings can be quantified in financial terms.

The SoLow model takes WRZ-level network characteristics and policies, as well as company-level leakage targets, and optimises which options need to be selected and when. SoLow allows for a large number of flexible policy options and leakage management techniques to be assessed. Relationships between policies, leakage, and network characteristics have been considered within SoLow.

Figure 46 provides an overview of the model optimisation process, whilst fuller details are available in the "WRMP Leakage Options Phase 2" report, included as Appendix 24.

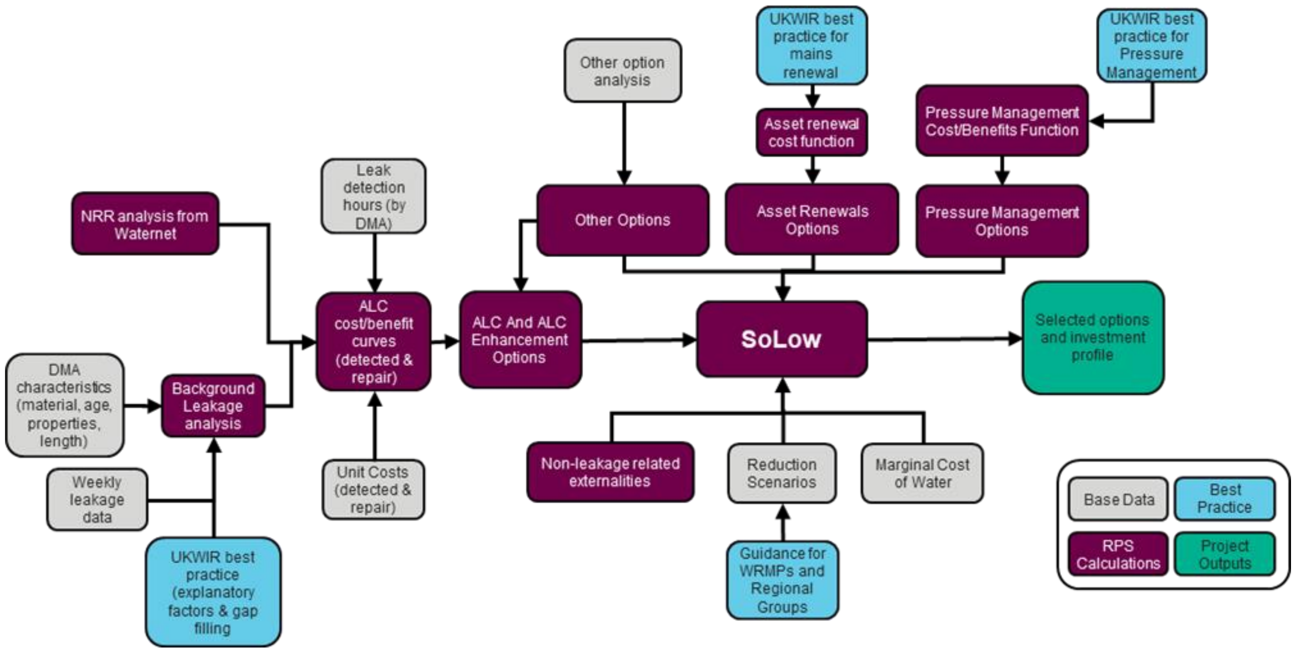


Figure 46 – Flow diagram of the SoLow model optimisation process

Our leakage strategy is constrained by our approach to water efficiency through our metering strategy as described above. This is because the cost of installing meters by far outweighs the cost of fixing customer supply pipes. Hence, once meters are installed, the most cost-effective way of reducing leakage is through working with customers to reduce their leakage rather than reducing leakage within the distribution or trunk mains systems. Our AMP8 leakage strategy, therefore, consists of:

1. The delivery of our 'SMART' metering Plan over AMP8/9

As described above, our metering strategy is designed to achieve good PCC delivery performance during the AMP8/9 periods so that we can achieve our long-term objectives.

The metering strategy also enables the delivery of significant leakage benefit as through smart metering we are able to understand whether there are continuous flows into properties even during the night. This gives a good indication that there is a wastage issue within a property or that there is supply pipe leakage.

We estimate that up to 30% of our leakage takes place beyond the customer property line and we need to help our customers to understand if they have a leak and if so help them to fix this. Once we have identified a potential customer side leakage, we will fund both leak detection and repair. In addition to these leaks identified on customer premises, we can also gain additional information on leakage within our own networks. With additional network monitoring through customer metering, new leaks will be found more quickly and repair in a fast amount of time.

We have processes in place, through data science, to use customer and DMA meter data to undertake volumetric balances within each DMA and identify leakage hot spots. In line with meter delivery, we will scale up the identification of distribution leakage geographically for maximum efficiency. The use of this technology will enable us to better maintain leakage into the future. Our bespoke metering model has been used to understand the benefits gained from the metering strategy described above. We have then used the SoLow model to understand whether this is sufficient, company-wide, to meet our leakage objectives and if not to investigate the most cost effective and best value means of achieving our objectives.

2. Our distribution mains strategy

The strategy to tackle leakage within our distribution system is structured around the Predict, Awareness, Locate, Mend (PALM) principles adopted by Water UK's Public Interest Commitment on leakage and UKWIR through the Zero Leakage project and consists of the following components:

- ***Prevention*** *of Leakage Breakout* – prevention of leakage occurrence through efficient optimisation of the renewal programme to tackle high leakage areas. Effective pressure management will lead to networking calming and help to avoid catastrophic pipe failures.
- ***Prediction*** *of likely causes and location of Leakage* – Detailed analytics of our network sensor data, repair data and mains material data to inform us of high-risk areas and deteriorating assets. This will ensure that detection staff are supported with intelligent data so that informed resource planning can take place.
- ***Responding*** *to Leakage* – The response to leakage events will be quicker and more efficient, allowing for greater coverage of areas with less resource and mitigating the cumulative impact of natural rate of rise leakage. The integration of technological developments will ensure staff are equipped with state-of-the-art detection devices and techniques.
- ***Project Cartref*** - Project Cartref is about gathering water use/leakage data, working with customers and using innovation to reduce wastage of water, either through customer-side leakage or inefficient use. This includes the provision of household water use surveys, house visits by specially trained staff, supply pipe replacement and meter installations.
- **Innovation** – Leakage will continue to push the boundaries of smart network sensing and metering equipment through the framework of specialist research and design companies. Collaboration both internally with the Welsh Water Innovation Team and externally with UKWIR, will allow for an agile, low cost and fail fast approach to innovation.

Prevention of Leakage Breakout

Prevention of leakage across the 27,500Km of the water distribution network is critical to the achievement of the 10% leakage reduction target set for AMP8 and is an essential theme in our journey to 50% leakage saving by 2050. Each year, leakage detection efforts are required to offset the breakout of leaks which account for a volume of approximately 230Ml/d (Natural Rate of Rise), less than half of which being triggered by a customer contact.

The location and repair of these leaks requires a large team and with it, significant expenditure, so prevention presents an efficient solution. In addition to extending the life of the assets and preventing leakage, effective network calming and pressure management have significant benefits to other performance commitments including interruptions to supply, CMEX, mains bursts and customer acceptability.

We will build upon our AMP7 work to create a pressure hydraulic hierarchy, which has been created in GIS. The hierarchy will be managed through industry leading leakage analysis and reporting software, where our estate of over 5,000 dedicated network pressure monitors will communicate every 30 minutes. Algorithmic analysis will determine the performance of each pressure zone and will highlight anomalies for investigation by a team of analysts. This will help prioritise the pressure management programme, enhance the delivery of maintenance and optimisation activity each year as well as feed into the investment cases for the installation and replacement of assets. In addition, collaboration with our supply chain will be undertaken to trial new technology and equipment to extend remote network control capabilities.

Following the success of the calm networks training package delivered at the training centres in Sluvad and Glascoed, aimed at reducing network transients through the operation of the network, the focus will shift to assets and customers. A trial approach of liaison with large commercial customers in AMP7 resulted in significant reductions in transients caused through industrial usage patterns.

Monitoring and analysis of network transients will allow this programme to be adopted into business-as-usual activity for all areas with large industrial users.

There will be collaboration between other investments to ensure the opportunities presented through the delivery of large-scale capital projects including Zonal Studies and Lead Replacement are realised. Proactive replacement of assets which have deteriorated and affect leakage performance or are at a high risk of failing will help to mitigate leak occurrence.

Prediction of likely causes and location of Leakage

Projects through AMP7 have led to a significant increase in both the quality and quantity of intelligent network data collected. This combined with the advancements in data science provide an opportunity to predict where leaks are likely to occur on the network, accounting for weather and climate, soil conditions, flow and pressure characteristics as well as pipe age and condition. This theory has been developed to form 'Project Nemo' which provides a dynamic assessment of the likelihood of leakage on each section of pipe. From this, interventions can be designed so that they follow the most optimum sequence, proving resource efficiency and consistency of approach.

This analysis will also provide the opportunity to further understand the balance between leakage and consumption in seasonal high demand periods, so that leakage detection resources are managed and deployed to the right areas. An individual household monitor for measuring detailed consumption patterns will be delivered in the remainder of AMP7 as part of our Leakage Recovery Plan. This has helped refine the current small area monitor level fast logging analysis as well as provide a more accurate measurement for water efficiency projects and per capita consumption.

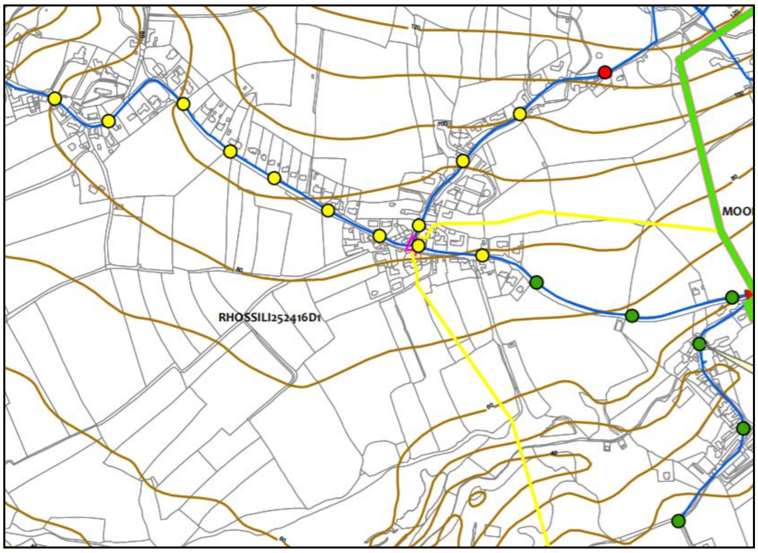


Figure 47 - Example conceptual output from Project Nemo, coloured symbols represent likely location of a leak

Responding to Leakage

Previous strategies have concentrated on improving the effectiveness of targeting and detection methods and have brought about success in achieving leakage reduction targets. However, further improvements are essential to meet the more challenging leakage reduction and cost efficiency targets through AMP8. The in-house developed performance and efficiency monitoring software will be used to drive a programme of improvement in workforce competency and placement. As well as tailoring training for each individual, the programme will provide a better understanding of each DMA's characteristics and how these impact on performance.

Areas can then be categorised providing an optimised and specific entry and exit level and planned work times. This will allow for the assignment of a specific resource to an area, matching the individual and techniques based on both their performance within that DMA type.

Following extensive trials over AMP7, the selection of equipment and techniques available to the leakage delivery team has increased and the processes for their application have been refined. The technologically equipped inspector is now able to perform detection tasks in a consistent and repeatable manner with gains in efficiency being observed. This equipment will be rolled out more widely during AMP8.

There has been significant investment throughout the industry in permanent acoustic network monitors and we will continue to invest in this technology where is provides efficiency over standard active leakage control. In addition, new and emerging technologies including high resolution pressure and temperature monitoring have also been trialled, to understand how they interact within the specific characterises of Welsh Water's network.

Innovation

Innovation is a constant thread throughout both the leakage strategy and operations, as has been outlined in the previous sections. Our plan is to continue to push the boundaries of innovation though collaboration with our supply chain, other water companies and more widely with academia. The internal Leakage and Distribution Innovation team, comprised of innovation champions from around the business, meet on a monthly basis and will continue to deliver projects including the development of a ultrasonic smart meter with in-built acoustic leak sensing technology, smart control of pumping stations, adoption of narrow band internet of things (Nb-IOT) communications into network data loggers.

In addition, the team will work with Data Science to implement the machine learning capabilities to analyse big data to produce insight into leak likelihood and deterioration modelling.

There will also be a continuation of the active participation in the UKWIR zero leakage club projects, which align with Water UK's public interest commitment to triple the rate of leakage reduction by 2030. Welsh Water have also been a founding member of the Wales and South West Leakage Hub, an innovation team involving representatives from Bristol Water, Wessex Water, South West Water and Portsmouth Water, with the goal of sharing innovation learning and challenging the market as a collective.

3. Our Trunk mains strategy

Revisions to the Water Balance has resulted in an increased level of unaccounted for water upstream of our DMAs. Over the remainder of AMP7 we will investigate and reduce leakage on the upstream network as part of our recovery plan in line with our revised methodology. Our trunk mains cover 3,500km and also include losses from our c200 service reservoirs. We will continue our AMP7 strategy with a systematic approach of metering, verification of network configuration, data validation and triangulation across multiple balances in order to ensure a robust estimate of Trunk Main leakage before we can undertake any effective intrusive leak detection and repair. The high-level strategy includes:

i. Investigating Phase

Use of the UKWIR volumetric flow balance method for continual monitoring of trunk mains and service reservoir losses. The current meter coverage, age and condition means that meter accuracy needs to be improved to allow this to be effective due to the large volume of water across our trunk main network and this will be a continued focus for investment in AMP8. This programme of works will involve a combination of new meter installations, meter replacement and meter verification work programmes.

ii. Site Based Interventions

Pinpointing and detection of real losses through leaking fittings, joints or pipe fractures due to the diameter of the pipelines, topography of where these pass through and also distance between fittings prevents traditional acoustic surveys from being effective. We will deploy in-pipe survey technologies as well as continue with exploring innovative solutions such as satellite and drone technologies and fibre optics.

iii. Repairs

We will continue to undertake the repairs through a Capital Delivery led programme due to the engineering challenges and safety hazards as well as the potential customer impact. These will generally be through under pressure techniques such as encapsulation or isolating pipelines for cut outs through the use of flow stops and bypass sections. Some will require full shut down of the trunk main and a pipe length replaced which places risk on discolouration, loss of supply and provision of temporary supplies, by the nature of trunk mains this could be risk to large populations hence why they are delivered through our capital delivery team.

5. Developing 'Best Value' Investment Solutions

(Note. This section has been revised following consultation on the draft WRMP24)

5.1. Introduction

The process of decision making for water resource planning has continued to evolve and for this Plan our Regulators now formally require companies to produce a 'Best Value' Plan, defined in guidance as "*…one that considers factors alongside economic cost and seeks to achieve an outcome that increases the overall benefit to customers, the wider environment and overall society*".

We need to demonstrate to our customers and regulators that our preferred solutions are appropriate to the scale and complexity of problem. This process needs to:

- Align with Government expectations and legislation such as the Future Generations (Wales) Act
- Gather views from our customer and stakeholder engagement
- Deliver overall positive environmental benefit
- Support the achievement of Welsh Water's long term 2050 strategy
- Support an increased drought resilience and higher LoS for customers.
- Provide resilience against climate change
- Link to other business drivers to deliver benefits such as carbon net zero targets, supply system resilience and improved water quality
- Be affordable for customers in the context of the wider Business Plan

Our Plan needs to account for overarching policy decisions and our long-term delivery strategy as well as the diverse nature of each water resource zone. Guidance acknowledges that a best value programme may differ depending on the geographical scale considered and that we should describe our preferred Plan in the context of this. Guidance also asks that the policy aims and aspirations are set as minimum planning criteria to be balanced against other outcomes.

In order for us to be confident that our Plan is 'best value', we have defined seven outcomes in Table 16 that it needs to deliver against.

	Outcomes	Scale
1	Reduce leakage by 10% during AMP8 and 50% of 2017/18 levels by 2050	Companywide
2	Achieve an average PCC of 110 l/h/d by 2050	Companywide
3	Reduce Business demand for water by 12Ml/d by 2050	Companywide
4	Become resilient to 1 in 200 year drought events in AMP8	WRZ
5	Increase resilience to 1 in 500 year drought events by 2039 as a minimum	WRZ
6	Meet all NEP and WINEP investigation and delivery measures	WRZ
7	To develop a cost-effective Plan	Regional and WRZ

Table 16 – WRMP24 Outcomes

The principal objective of this Plan is to ensure that we will always be able to provide sufficient water to meet our customers' demand for water over the next 25 years, particularly in light of the pressures brought by a changing climate. This is reflected in the Plan by ensuring that a positive supply-demand balance is achieved for each water resource zone throughout the planning period.

The Plan must also deliver wider benefits to the environment and society and so the Strategic Environmental Assessment (SEA) we undertake 'scores' how well our Plan performs against a number of key objective, as shown in Table 17.

Topic	Assessment Objective
Biodiversity, Flora and Fauna	1. To protect, restore and enhance biodiversity, including designated sites of nature conservation interest and protected habitats and species, enhance ecosystem resilience and habitat connectivity and deliver a net biodiversity gain.
	2. To protect and enhance sustainable natural resources and the ecosystem services they provide.
	3. To avoid and, minimise the risk of spread of, and, where required, manage invasive and non-native species (INNS).
Soils, Land Use and Geology	4. To protect and enhance soil quantity, quality and functionality and geodiversity and ensure the appropriate and efficient use of land.
Water – Quantity	5. To protect and enhance surface and ground water levels and flows.
Water –Quality	6. To protect and enhance the quality of surface and groundwater resources.
Water – Flood Risk	7. To reduce or manage flood risk.
Air	8. To minimise emissions of pollutant gases and particulates and enhance air quality.
Climatic Factors	9. To reduce greenhouse gas emissions.
	10. To adapt and improve resilience to the threats of climate change.
Population	11. To promote a sustainable economy and maintain and enhance the economic and social well-being of local communities.
	12. To maintain and enhance tourism and recreation.
Human Health	13. To protect and enhance human health and well-being.
Material Assets - Water Resources	14. To promote and enhance the sustainable and efficient use of resilient water resources.
Material Assets – Waste and Resource Use	15. To minimise waste, promote resource efficiency and move towards a circular economy.
Cultural Heritage	16. To conserve and enhance the historic environment including the significance of heritage assets and their settings and archaeological important sites.
Landscape	17. To conserve, protect and enhance landscape and townscape character and visual amenity.

Table 17 – SEA Assessment Objectives

We use the SEA to understand if any option has a significant negative impact that cannot be mitigated. Where the option cannot be re-designed or re-worked to avoid the impact then we would remove it from the Plan and implement a less impactful, though potentially more costly, option.

5.2. Future Scenarios

Within our Final WRMP19 we presented our investment programme which would allow us to meet our stated Levels of Service to our customers by 2024/25 and be wholly resilient to a repeat of a 'worst historic' drought condition (e.g. 1984, 1995, 1976) without recourse to water rationing measures, as were implemented in 1976. As described in Chapter 1 we are on track to deliver the improvements, and these have been considered in our assessment of the supply capability at the start of AMP8.

The starting point for the decision-making process is the formulation of future scenarios. These are a wide range of scenarios which examine a number of possible futures in which either demand and/or water resource availability might be different over time, due to various external influences which could impact the assumptions made within our Plan.

Our preferred planning scenario is described as the 'most likely' which will provide a 1 in 200 year level of drought resilience by 2029/30 and a 1 in 500 year level by 2039/40, without the need for emergency measures, under a medium emission climate change scenario. This scenario assumes that we will meet the demand management objectives and does not include the need for sustainability reductions for the duration of the Plan.

We have then considered scenarios in which:

- Our level of demand at the start of AMP8 is not as planned
- That we only achieve 50% of planned demand management savings throughout the planning period
- That we lose 5% or 10% of our baseline deployable output as a future environmental destination under a changing climate
- That there could be 'low' or 'high' climate change emissions

We have also considered a combination of these potential futures to widen the analysis, further detail on this is provided in Section 5.9.

5.3. Supply Demand Balances – 'Most likely' future Scenario

We have initially examined our current supply demand position against our drought resilience objectives for the most likely scenario, excluding any demand management interventions, which we also call our 'baseline' position. Based upon our latest water balance data for 2022/23, at the start of AMP8 we estimate that company level leakage will be 191 Ml/d and average dry year PCC across the company will be 148 l/h/d.

We have generated Supply/Demand balances for each of the 23 water resource zones under the baseline scenario. These compare water supply capability as described in section 3 (and Appendix 6) against a forecast of the future demand for water over the planning period as detailed in section 4 (and Appendix 10). The assessment also accounts for the uncertainties within our estimates, through the Target headroom allowance, as described in Section 3 (and Appendix 9).

Without any interventions to either increase supply or reduce demand, there are three water resource zones that will not be sufficiently resilient to drought across the planning period, namely Tywi Gower, SEWCUS and Lleyn-Barmouth (Figure 48). It should be noted that the deficit in the Lleyn-Barmouth zone only occurs from 2039/40 onwards when our target level of drought resilience increases from 1 in 200 to 1 in 500. We have then undertaken a full options appraisal of all potential supply side and demand management options; details of this are given in the following sections.

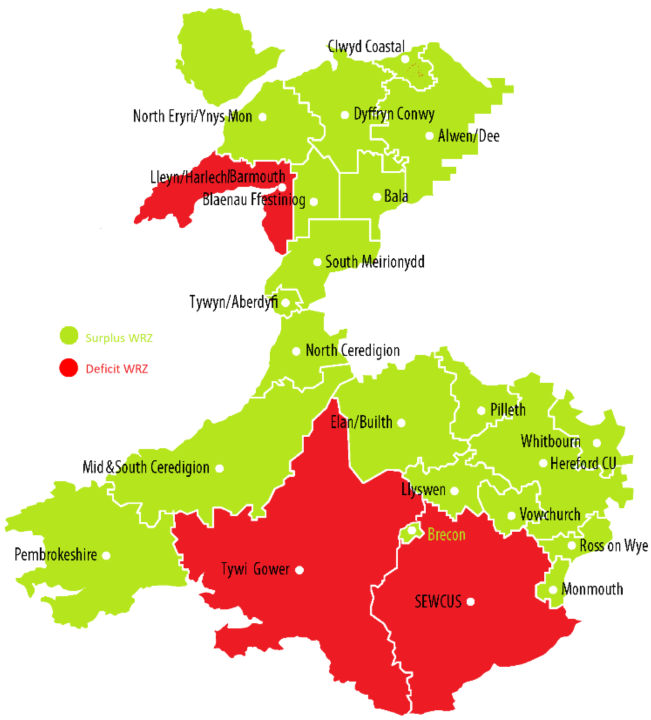


Figure 48 – Baseline Supply Demand position

5.4. Demand management options

5.4.1. Leakage options

For PR24, we have updated our leakage optimisation modelling to explore the costs and leakage savings associated with a broad range of innovative leakage reduction policy options, this to identify the best means of attaining leakage performance commitment for AMP8 and beyond. The analysis considers the numerous leakage control interventions shown in Table 2.

Our understanding of leakage and the available techniques/technology to resolve it has moved forward considerably since our Final WRMP19 was published. Many of the leakage activities can now be undertaken in combination to enhance our detection and resolution efforts. As an example of this we can reduce the size of our DMAs whilst installing acoustic loggers and at the same time pressure manage on our distribution system, all supporting leakage reduction. However, the allocation of benefits to each of these separate activities can be difficult to ascribe for economic assessment and so working with our consultants RPS we have utilised their industry leading SoLow optimisation model identify the most economical route to achieving our leakage reduction targets.

The SoLow model is able to assess a least cost programme across all WRZs or can be formulated to optimise leakage options within a WRZ, but this is dependent upon the magnitude of leakage benefit that is needed. To provide zonal leakage options we have used the model to consider the mix of leakage interventions for increasing levels of benefit. The scale of the benefit increments relates to the size of potential deficit within each WRZ under the most extreme scenarios. This enables leakage options of various magnitudes to be compared with water efficiency or supply side options within each WRZ if there is a forecast supply demand deficit or to achieve our drought resilience targets.

Leakage Intervention	Description	Average AIC p/m3
Active leakage control (ALC)	Our current ALC policy utilises technicians actively searching for leaks within an area, based on flow information that the leakage has risen. Detection and repair costs are found using a relationship between these values and leakage in a specific area. This includes lift and shift acoustic logging.	94
Permanent Acoustic Logging (PAL)	Permanent Acoustic Logging is the permanent deployment of loggers within the network for the long-term monitoring of leakage. PAL deployment reduces routine manual surveying requirements and when a leak is suspected it helps to target ALC detection efforts.	58
Intensive active leakage control (I-ALC)	Intensive ALC can be defined as a systematic and concentrated leakage detection effort in DMAs. This has typically been undertaken in DMAs with historically high leakage that has proven difficult to pinpoint and reduce. Concerted effort is made to significantly reduce leakage within a DMA and this new leakage level is then maintained.	956
Pressure management	Pressure management is a method by which pressure is controlled in areas of the network, accomplished by monitoring flow rate throughout the area. Leakage is prevented through having a pressure-controlled network.	101,502
Distribution mains asset renewal	The replacement of deteriorating/leaking pipework within the distribution network, typically burst driven but can also be driven by target mains lengths.	7,368
Customer Metering (SPL)	The rollout of Smart metering will enable us to identify leakage on the customer supply pipe, compared to our current approach which focusses mainly on our distribution network.	
DMA Subdivision	DMA sub-division is the process of dividing existing DMAs into smaller geographical areas, allowing for greater granularity in data, more in depth analysis, and improved efficiency of leakage reduction.	5,107
Pressure Transients Management	Pressure Transients Management is the implementation of a network optimisation team dedicated to pressure transient repair, as well as the implementation of booster pumps, PRVs, ALC repair activities, and the engagement of high-consumer properties in order to understand and cater the network better to the relevant parties	10,019
Sahara surveying and fix	The Sahara system is a pipe surveyance tool that provides a feed of the internal structure and characteristics of the pipe, as well as an acoustic sensor used to detect pinhole leaks or trapped air pockets.	6,411
Trunk mains active leakage control	Additional ALC targeted at trunk mains. This option relies on the creation of a dedicated trunk main ALC team to identify leaks across the trunk main network, whilst calculating the benefit of installing new meters and/or loggers.	159
Trunk mains active asset renewal	With a similar premise as asset renewal, the renewal of materials in trunk mains was considered as an option. We have not included communication pipes in this option, meaning a mains only policy was considered.	2,284

Table 18 – Description of the Leakage Options considered

Water Efficiency Options and customer metering

As explained in Chapter 4, central to our water efficiency work is the implementation of our progressive metering strategy in AMP8 and AMP9 which is as a key enabler for long-term water efficiency to be effectively targeted through high consumption and continuous flow alerts.

The decisions to be made around our metering programme are i) how quickly do we need to progress our metering programme, ii) how should we prioritise the rollout and iii) what type of metering should be employed.

We have used the metering model described in section 4 to understand the sensitivity around the timing of the metering programme in terms of PCC and leakage benefits achieved. The timing is discussed further in chapter 6, but in general, the later you leave the metering programme the lower the PCC benefit in 2050. This is not only due to the time taken for occupancy change in a progressive metering strategy, it also reduces the time available for behaviour change to take effect. Early intervention will allow us to gather essential evidence to improve our understanding on customer behaviour across Wales and how we can support customers to use less water. We can then improve both the efficiency of our meter role-out and if required amend our strategy for AMP9.

To achieve the long-term PCC target of 110 l/p/d will require a significant increase in BAU activities, as well as the introduction of further interventions, as summarised in Table 19. This information has been used in assessing our preferred options for WRZs that are not resilient to drought once mandated company level demand management objectives are met.

Water Efficiency Intervention	Description	Average AIC p/m3
Online access to free issue water saving products	Online access to free issue products such as tap adapters, energy efficient shower heads, leak detection strips and toilet cistern bags.	78.69
Education	Expansion beyond our current education programme delivering to school assemblies and workshops.	8122.13
Leaky Loos	A more targeted and proactive approach using smart meter data and continuous flow or high consumption alerts to target properties that may not know they have a problem.	1420.38
Home audits	Home audits including home visits, including education and installing water saving devices.	103.73
Tariffs	High-level option to include benefits of tariffs, longer-term option as smart metering is a vital enabler for this. Our customers are not currently supportive of this currently and cost/benefit is uncertain	38.82
Greywater recycling	Longer-term option to consider retrofitting greywater recycling to existing properties with an assumption that the costs are borne by DCWW	N/A
Rainwater harvesting	Longer-term option to consider retrofitting rainwater harvesting to existing properties with an assumption that the costs are borne by DCWW	N/A
Behavioural Change	High level option, based on marketing team coupled with TV advertising campaign for the purposes of deriving a WRMP option. This option is to go beyond current activities relating to influencing behaviour such as the Get Water Fit application for customers.	290.94

Table 19 - Water Efficiency options considered.

5.5. Supply Side Options

We appointed our framework partners Arup to develop a set of feasible supply-side options that would address the baseline supply-demand deficits identified in the SEWCUS and Tywi Gower zones. The optioneering followed a multi-stage, multi-criteria screening approach similar to that adopted for WRMP19.

However, newer guidance on screening criteria related to environmental considerations, regional supply benefits and national significance, was incorporated at the unconstrained options stage, in addition to operational feasibility and social and political acceptability criteria.

The expanded criteria provide an enhanced and more rigorous screening process that is consistent with best practice guidance and regulatory expectations, including the WRPG 2024 Supplementary Guidance: Environment and Society in Decision-making (Wales) and options guidance produced by the All Company Working Group. Figure 49 summarises the optioneering process to develop a list of schemes that are then taken forward into decision making.

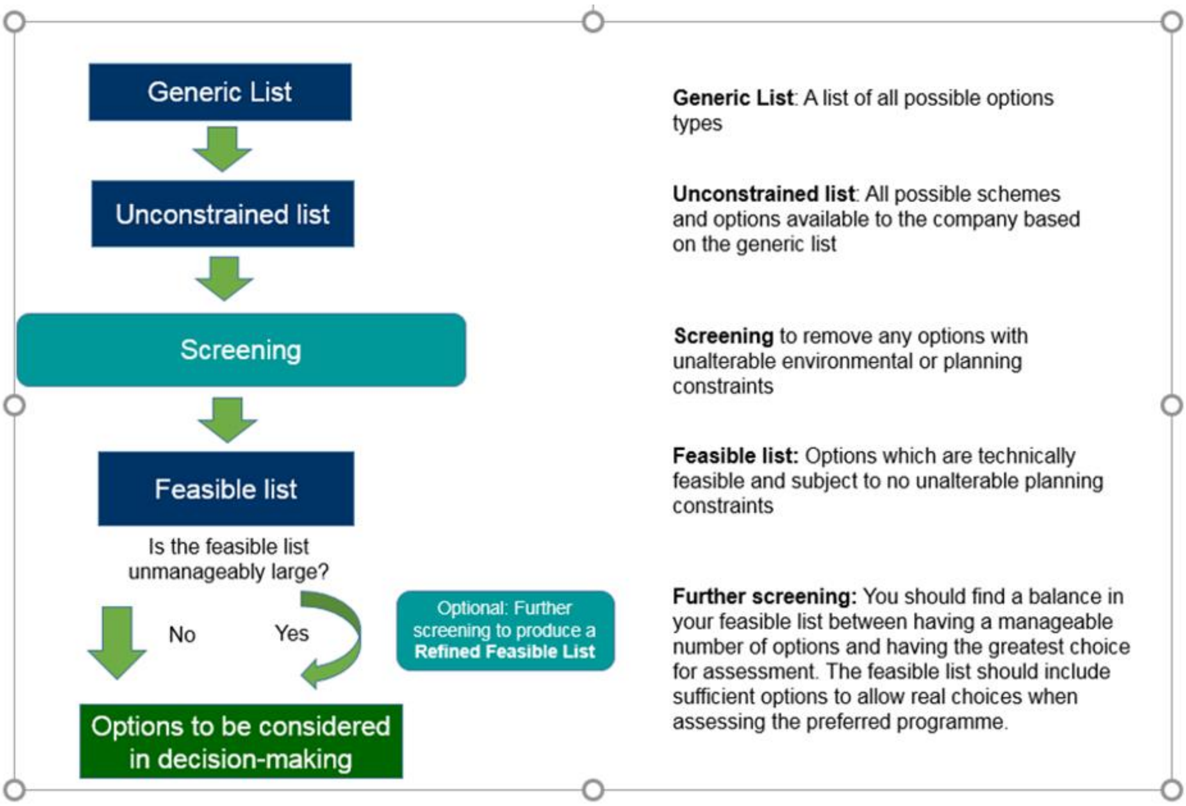


Figure 49 - Options Identification and Screening Process

A multi-criteria assessment was developed in collaboration with ARUP, drawing on the Water Resources West methodology, to produce the long listing of options for the unconstrained list. In addition, a qualitative high-level assessment of the following broad categories was carried out:

- Option benefit – including questions on contribution to national or regional needs and practicability of resource deployment.
- Deliverability and likely feasibility – including questions on technical feasibility and examples of use elsewhere.
- Potential environmental, planning and other regulatory constraints - including questions on designations and avoidance of unmitigable damage to designated areas.
- Political and customer acceptability – including questions on planning and unmitigable socio-economic impact.

The questions associated were framed in such a way as to identify where significant or overriding impacts could not be avoided. These were identified as 'major/significant' criteria and at least one negative response meant that an option was rejected. This approach provides three main benefits:

i. It allows potential environmental, customer and planning considerations to feature in the option assessment process from the outset.

ii. Identifying potential significant or overriding constraints that would result in an option being discounted early in the process meant that effort could be focused on options that are promotable.
iii. It enables early consideration of operational and engineering elements and the inclusion of mitigation requirements in both the engineering assessment and the costing

The coarse screening process identified 37 resource options for further consideration at the fine screening stage:

- SEWCUS – 28 options
- Tywi Gower - 9 options

The 37 options taken through the coarse screening were subjected to a more detailed desk-based, multi-criteria fine screening assessment, primarily led by the engineering feasibility. This approach was selected due to:

- A number of the selected options had the potential for variants/sub-options that utilised the same source
- A number of schemes needed confirmation on the viability of the raw water source

To complete the fine-screening process, a number of workshops were Arup and Welsh Water's operational staff who were most familiar with the existing supply systems to finalise the feasible list of schemes, ensuring that a sufficient number of options were taken forward to support a robust decision-making process.

The desk-based fine screening exercise produced 25 options that were taken forward to the feasible list for detailed engineering and costing assessments, more detail on this is included within Appendix 13.

- SEWCUS – 17 options
- Tywi Gower - 8 options

Through our involvement with Water Resources West and our pre-consultation exercise, we have not identified any feasible supply options from either neighbouring companies or other third parties. We are, however, working with the Canal and Rivers Trust on developing a joint solution to both organisation's water needs along the River Usk.

Through our optioneering work we did not identify any feasible catchment based/nature based solutions that could be developed further and taken through to options appraisal. We acknowledge this is a gap for WRMP24 given the contribution these types of schemes have the potential to make to achieving both more resilient water resources and ecosystems, aligning fully with the principles of SMNR. We are seeking funding in AMP8 to deliver investigations that will help provide information on the nature of our catchments and the associated water resources, with the aim to identify and design schemes that can support long term water and ecosystem resilience.

5.5.1. Zonal resilience and network solutions

Our work to understand resilience to extreme events has highlighted the differences in resilience of individual reservoirs and river sources to drought within each WRZ. When we test our supply system models against increasingly dry events, inflows to reservoirs fail to meet the associated demand on them and storages fall to unacceptable levels. This defines the whole system capability and identifies that there is insufficient network capacity to make up for any shortfall even with optimised control rules in place. This highlights that part of the system has a lower level of resilience to drought and that we need solutions to resolve the imbalance.

This highlights the simplicity of the integrity test which will have various outcomes under differing resilience and climate change scenarios and the complexity that this brings to the options and solution identification process.

The options to meet the supply deficit caused by localised resilience within a zone can be to develop new resource/demand management options for just this part of the zone or to improve network capacity with the rest of the zone. In all cases considered in this plan, the best value option is to better link the less resilient part of the system to that with available water resource. This is because the mandated demand management solutions are insufficient to provide a solution whilst any new water resource options would negatively impact the environment, as opposed to using the existing water resources available within the entire zone. From both a cost and environmental perspective, network improvement provides the best value solutions. An example is provided in section 5.2.4 and within our proposed plan in section 6.

Calculating the benefit to supply capability

As outlined in Section 3 and in technical Appendix 6, the improvement in our DO modelling has enabled us to better identify the cause of any supply shortfalls and to then support the development of schemes to overcome these. We have used our Aquator models to test each of the 25 feasible supply side options under a 1 in 200 and 1 in 500 year design drought event so we can be confident they will provide us with the required resilience. Where options did not provide this level of drought resilience they were removed from further consideration. In some instances, the modelling has shown that to gain the full option benefit, 'enabling' schemes can be required.

Using SEWCUS as an example, DO modelling confirms that the cause of supply failures during drought will be a lack of water resource in the 'high level' of the system. A number of our available water resource options in SEWCUS, such as Wentwood reservoir, provide additional water into the 'low level' part of the system but due to network limitations this water cannot be supplied to where the shortfalls are. Investment is therefore required to upgrade our supply networks across south Wales to allow them to operate as a fully conjunctive supply system rather than the existing design which allows a balancing of 'high level' against 'low level' sources of supply.

Without enabling schemes that provide enhanced network connectivity, the gain in DO from the Wentwood option is effectively 'zero' despite the model abstracting c7 Ml/d from the source. This insight from our modelling has allowed us to work with the option engineering team to design schemes that will deliver water to where it is needed.

Scheme Cost Estimation

Capital expenditure (Capex) cost estimates for the options were produced using our Solution Target Pricing Tool (STPT), which uses cost information from our internal Unit Cost Database (UCD). For AMP7, the UCD has been updated with new information and provides a basis for ensuring cost consistency with our PR24 Business Plan. The STPT was used for all types of schemes, except reservoir raising where it was not considered sufficiently robust due to either insufficient information within the UCD, or the works required were bespoke to the dam type or construction. For these schemes, an alternative Capex costing approach was adopted which relied on Arup and Welsh Water reservoir engineering specialists developing the works needed from a first principle basis.

- Recurring Capex cost estimates (the costs of periodic replacement of time expired scheme elements) were produced based on scheme life (40 years) and asset life expectancy values within the UCD.
- Operational expenditure (Opex) cost estimates were split into Variable costs (chemicals, power, sludge) and Fixed costs (based on an Opex life of 25 years) and were developed from data within our UCD using the STPT.
- A Whole Life Cost (WLC) summary is therefore provided for reference and scheme comparison in the Pricing Tool, based on a 40-year repeat Capex life and 25-year Opex life
- Carbon costing has been fully integrated into the AMP7 Solution Target Pricing Tool, with data generated by the UCD and includes the following:

- Embodied carbon
- Repeat embodied carbon
- Operational carbon (annual total in kg of CO2e)

New guidance from the Department for Business, Energy & Industrial Strategy (BEIS) on carbon costing was released in September 2021 which demonstrated large increases in the underlying carbon values. The UCD has not yet been updated to incorporate these as additional guidance and justification around their inclusion is still required. Full details of the cost process are included in the options engineering assessment methodology note (Appendix 13).

Option	CAPEX	OPEX (assumed all year operation)	AIC (p/m3)
Great Spring to Court Farm	£70,706,927	£1,735,751	36.58
Great Spring to Llandegfedd	£63,441,717	£1,448,033	31.23
Dam raising at Talybont	£3,268,879	£0	30.42
Grwyne Reservoir for river regulation	£10,111,249	£3,888	8.7
Ponthir effluent reuse plus Wentwood	£51,370,220	£2,367,253	39.42
Pant yr Eos to Court Farm	£4,894,143	£0	19.7
Ynys y Fro to Court Farm	£3,997,761	£107,541	17.53
Ynys y Fro and Pant yr Eos to Court Farm	£7,923,170	£108,065	16.64
Reinstate Schwyll	£56,150,615	£2,322,448	39.29
Afon Lwyd to Court Farm	£1,680,132	£118,572	8.75
Afon Lwyd to Llandegfedd	£5,731,885	£351,214	23.68
Nantybwch washwater recovery	£5,348,310	£139,359	50.54
Wentwood reservoir to Court Farm	£17,252,649	£300,352	35.0
Effluent reuse Cardiff and Cog Moors WWTW	£2,545,643	£53,795	56.41
Memorial/Cefn Mably WPSs enhancement	£14,778,048	£1,388,298	22.77
Llwynon Trunk mains upgrades	£5,480,208	£0	2.15

Table 20 – Summary of SEWCUS Feasible Option costs

Option	CAPEX	OPEX (assumed all year operation)	AIC (p/m3)
Bryngwyn washwater recovery	£651,311	£13,379	18.53
Upsize Llangyfelach WPS	£1,853,048	£40,466	8.47
Cwmdu Bridge enhancement	£8,183,665	£0	40.96
Tonna control valve enhancement	£4,324,704	£63,769	15.97
Llyn y Fan Fach Regulation	£24,828,347	£0	19.32
Christopher Road WPS enhancement	£15,776,688	£568,344	59.31
Carn Powell to Llanon upgrade	£2,349,734	£119,115	64.82
Enhanced Felindre supply to support Bryngwyn	£2,355,543	£291,124	25.17

Table 21 - Summary of Tywi Gower Feasible Option costs

5.5.2. Customer preferences on water supply investment

Figure 50 summarises the outputs of our customer engagement work to understand their preferences for options that would increase our supply capability.

What jumps out from these results is the importance of the environment, which has been a clear theme throughout the engagement. Customers are much more against us taking additional water from the rivers and groundwaters and much more in favour of us ensuring that we utilise fully the existing resources we have available. Full outputs from our customer engagement work are available in Appendix 14.

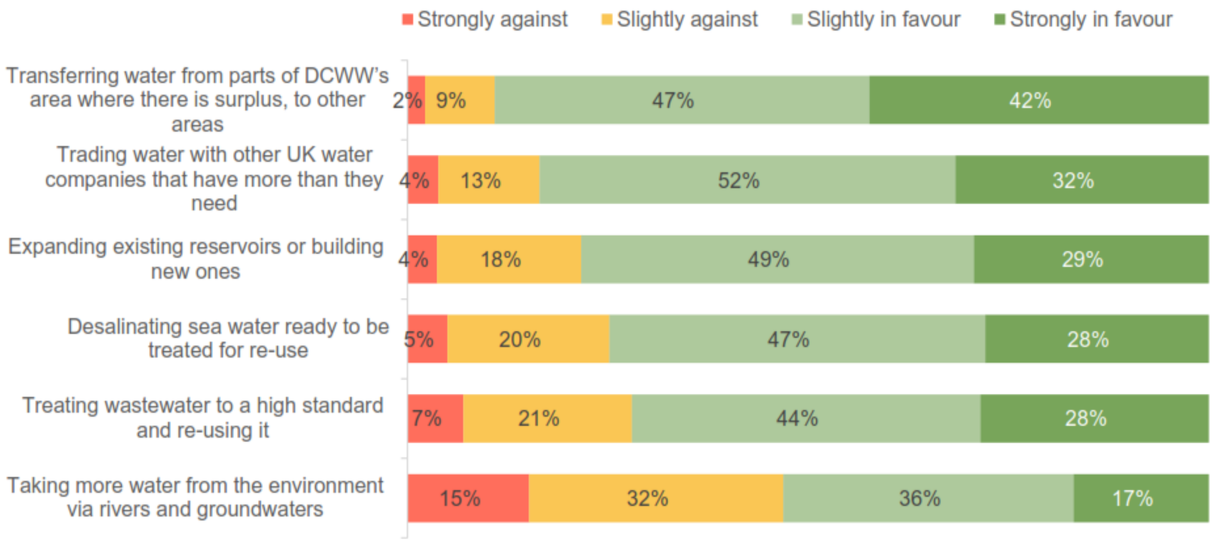


Figure 50 - Customer attitudes to supply-side solutions

5.6. Environmental Valuation of Options

We are taking an integrated approach to the environmental appraisal of this Plan, aligned to that adopted for the Water Resources West regional plan. This approach ensures all the feasible options we have considered have been appraised in accordance with the legislative requirements, notably:

- Strategic Environmental Assessment (SEA)
- Habitats Regulations Assessment (HRA)
- Water Framework Directive (WFD) Assessment
- Biodiversity Net Gain (BNG) and Natural Capital Assessment (NCA)

These appraisals ensure that any adverse effects associated with options are avoided, minimised or mitigated and that any positive environmental effects are enhanced. Appraisal findings were used to support decision making on the selection of the best value combination of demand and supply-side options. This helps ensure that decision making is evidence based, consistent and considers environmental effects.

The assessments have also identified positive effects of our options such as investment in infrastructure provision and increased resilience. It is important to note that our Plan has been appraised to account for interactions with policy objectives contained within other plans and programmes that are relevant to our Plan. This step was important to determine whether our Plan would have any negative effect on these objectives and consequently, inform our decision to amend the Plan, should this be the case. Full detail of the environmental appraisal of our options can be found in the individual assessment reports in Appendices 15 to 18.

In addition, we have other plans and strategies in place to further our environmental work. Our biodiversity strategy sets out our ambitions, objectives, and action plan to maintain and enhance biodiversity and ecological resilience across our operational assets and landholdings, within the fulfilment of our functions.

The strategy enables the business to continue delivering its core functions whilst supporting Natural Resources Wales and Welsh Government to address the biodiversity crisis we face. In so doing we will help to safeguard our environment for future generations to come and meet the expectations of customers.

5.6.1. Sustainable Management of Natural Resources (SMNR)

SMNR is a long-term goal for all of Wales, including industries, local government, and communities. The decisions we make today will affect our customers and the environment we all share for generations to come. Wales faces many challenges, such as securing energy, creating jobs, tackling poverty and inequality, adapting to climate change, and improving people's health and well-being. Meeting these challenges needs fresh ideas, and new ways of working. This includes our understanding of how we maintain, improve, and use our natural resources. For Welsh Water to be a more resilient business, and to continue to sustainably undertake our work, we need to work with nature and work in partnership with others to secure long-term benefits for everyone, including the environment. When our environment is working at its best, society thrives.

The Environment (Wales) Act introduces several measures to improve and protect the environment in Wales. It presents a change in methods to support and improve environmental issues; by encouraging a systemic approach and integration with the Future Generations Act, and the Planning Act, using an SMNR approach. To create a framework for SMNR action, NRW have introduced 4 aims:

1. Stocks of natural resources are safeguarded and enhanced
2. Resilient Ecosystems
3. Healthy places for People
4. A Regenerative Economy

Many of our existing plans and strategies are already delivering against the above aims. This WRMP for example will support the safeguarding of natural resources whilst our Biodiversity Action Plan will support the achievement of Resilient Ecosystems. As SMNR is a new approach we are advancing the 4 Aims of SMNR in 4 pilot catchments, each catchment has unique characteristics that allows us and our stakeholders, to test the myriad of aspects and approaches to SMNR.

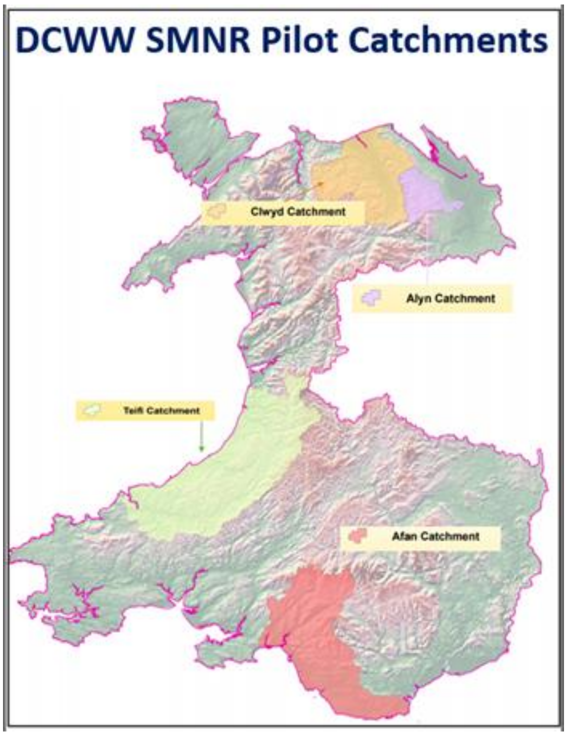


Figure 51 – Location of DCWW's pilot SMNR Catchments

5.7. Customer and Stakeholder Engagement

Given our unique business model and the requirement of guidance, we have taken a collaborative approach to plan development through active engagement with regulators, stakeholders and customers. In order to support the development of our plan, we have conducted a fresh round of customer research, building on previous research undertaken at company level.

To ensure acceptance of the WRMP24, we have held regular monthly progress meetings with NRW to review and agree processes and planning assumptions. We have undertaken dedicated formal pre-consultation with OFWAT, the Consumer Council for Water (CCW), NRW, EA, National and Regional environmental interest groups and all local authorities. Environmental engagement has also been completed through presentations to the DCWW Independent Environmental Advisory Panel. Alongside this we ran a wider pre-consultation exercise, contacting over 300 stakeholders to seek their views on the development of our WRMP24.

5.7.1. Customer Engagement

Customer engagement consisted of both qualitative and quantitative preference survey work as well as in depth questioning of an online community over 4 weeks, to better understand customer rationale. We also held a series of online roadshows with the Water Resource West member companies with a dedicated Welsh session focussed on our WRMP24.

For our quantitative survey, 800 of our customers were contacted, consisting of 700 online and 100 computer assisted telephone interviews (CATI), to maximise the opportunity for different customer groups to take part and enable us to gather robust customer opinion on supply and demand side solutions. To complement this, a qualitative online community with 30 DCWW customers, to explore in depth rationale behind customer preferences and priorities. This comprised an online community lasting one week (part of a wider 4-week community), with c.90 mins of activities, enabling us to start high level and build towards a more informed viewpoint.

Key insights from the research, which have fed into our Plan are summarised below:

1) Customers are often surprised to see that there is potential for water shortfall in Wales, and at how little rainfall is currently captured for water supply purposes. This reflects a knowledge gap around the source of water supplies in Wales and the impact of climate change.
2) Solutions that customers prioritise to address any shortfalls focus on doing more with existing resource rather than building new infrastructure – expanding storage via disused reservoirs, increasing water transfers tackling network leakage, and DCWW helping them to reduce their consumption.
3) Customers accept that this combined demand and supply side response will result in bill increases. They are prepared to help fund these measures, but also sound a note of caution around ensuring that bills remain affordable given the current cost of living crises.
4) Despite very little recent experience of restrictions on water use, customers in Wales claim they will accept their wider civic responsibilities during times of drought. They prioritise bans on water usage and even rationing of water, over DCWW taking more from the environment.

Outputs from customer research undertaken by CCWater in 2021[13] show very similar findings to those from our engagement surveys and so provides further support to our preferred programme of schemes that will be taken forward, which is set out in Section 6.

[13] WaterVoice, Views of current customers on water resources. Summary report, Output from October 2021

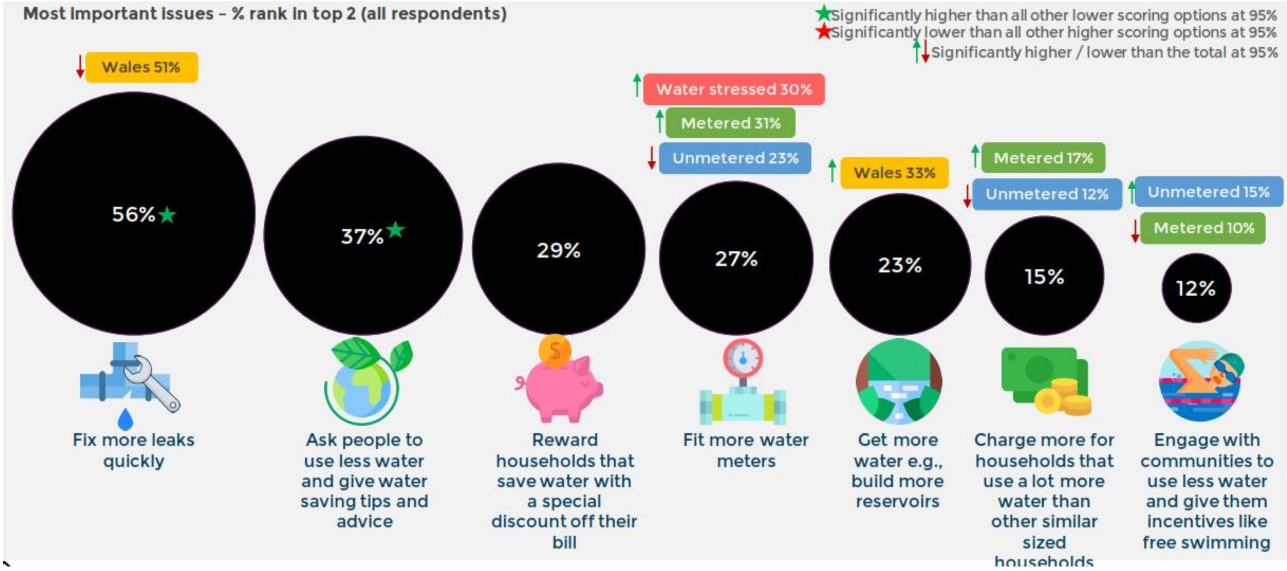


Figure 52 -Outputs from CCWater's 2021 Customer survey

5.8. Best Value Decision making

Our approach to investment decision making needs to assess how the planning objectives can be met under a range of potential futures and examine the portfolios schemes required to meet these scenarios. The planning objectives have been set at both regional and zonal level, and we need to assess what a least cost and best value investment plans look like and the trade-offs between objectives over the range of possible futures.

The process is influenced by the complexity of the size of the problem under review. As stated above, our zonal supply demand balances, prior to intervention, are in line with our problem characterisation, with most zones having a water resource surplus, against resilience targets, with only two zones having a significant deficit position, namely SEWCUS and Tywi Gower, with the reasons for this and options to resolve well understood. Table 22 shows the zonal problem characterisation and zonal deficit position for the 'most likely future' case.

On the face of it, the resolution of the drought resilience objective is very straight forward, however, given that the demand management and cost objectives need to be considered at company level the Decision-Making guidance (UKWIR 2016) suggests that a hybrid approach is most appropriate, taking account of both the scale and complexity of the problem. The process is simple for most zones as there is no supply-demand deficit with only the achievement of our company level demand management objectives to be considered.

In looking at the cost benefit of alternative options for the two deficit zones, the lowest cost way of meeting resilience targets as quickly as possible are through network schemes that resolve the imbalance in water resources across the zones during drought events. However, these do not support the environment by reducing water demand and our regulators have influenced this trade-off by setting demand management targets on both PCC and leakage as part of a 'best value' way forward in maintaining supply resilience.

Our initial review also demonstrates that the least cost programme to achieve our leakage targets does not include a substantial metering programme based on cost alone. However, the development of a substantive metering programme is needed to meet per capita consumption targets.

Given the policy constraints set by Government and Regulators, the decision-making process firstly needs to look at the most cost effective way of meeting leakage and PCC objectives and then the resolution of any remaining supply demand balance deficits within specific zones.

WRZ	Problem Charact. Status	Resilient to 1 in 200 (2030)	Resilient to 1 in 500 (2040)	Size of Deficit	Level of S/D change since WRMP19	Solution understood?
NEYM	L/M	Yes	Yes	N/A	L	N/A
Alwen Dee	L	Yes	Yes	N/A	L	N/A
Clwyd Coastal	L	Yes	Yes	N/A	L	N/A
Bala	L	Yes	Yes	N/A	L	N/A
Lleyn - Barmouth	L	Yes	No	S	L	Yes
Blaenau Ffestiniog	L	Yes	Yes	N/A	L	N/A
Tywyn / Aberdyfi	L	Yes	Yes	N/A	H	N/A
Dyffryn Conwy	L	Yes	Yes	N/A	L	N/A
South Meirionnydd	L	Yes	Yes	N/A	L	N/A
Ross-on-Wye	L	Yes	Yes	N/A	L	N/A
Hereford	L	Yes	Yes	N/A	L	N/A
Llyswen	L	Yes	Yes	N/A	L	N/A
Monmouth	L	Yes	Yes	N/A	L	N/A
Elan / Builth	L	Yes	Yes	N/A	L	N/A
Brecon	L	Yes	Yes	N/A	L	N/A
Pilleth	L	Yes	Yes	N/A	L	N/A
Vowchurch	L	Yes	Yes	N/A	H	N/A
Whitbourne	L	Yes	Yes	N/A	L	N/A
SEWCUS	M/H	No	No	M	H	N/A
Tywi Gower	L	No	No	M	H	N/A
M & S Ceredigion	L	Yes	Yes	N/A	L	N/A
North Ceredigion	L	Yes	Yes	N/A	L	N/A
Pembrokeshire	L/M	Yes	Yes	N/A	M	Yes

Table 22 - Summary of our WRZ supply demand position

The decision process initially examines solutions under the 'most likely' scenario and then considers alternatives to this, based on a set of risks that could plausibly occur. For each scenario, the options to meet the company wide demand management objectives are first reviewed and then options to meet any residual resilience objectives at zonal level are considered. Our process is shown on Figure 53 with stages described below.

For each plausible scenario our decision-making process will:

1) Consider a least cost approach to meeting company level leakage using the SoLow model.
2) Consider a least cost approach to meeting PCC targets at company level using the bespoke metering and water efficiency models.
3) Balance available demand management options to meet our long-term demand targets.
4) Review all options against social and environmental metrics.
5) Review the impact of an optimised demand management programme on zonal S/D balances to assess whether resilience objectives are met across the 23 WRZs.
6) Review the sensitivity of cost, on targeting demand management on any deficit zones rather than supply side interventions.
7) Review results and generate a 'Preferred Plan' under the most likely future scenario, ensuring this has met all our objectives.
8) Considerers 'Preferred Plan' under all plausible future scenario

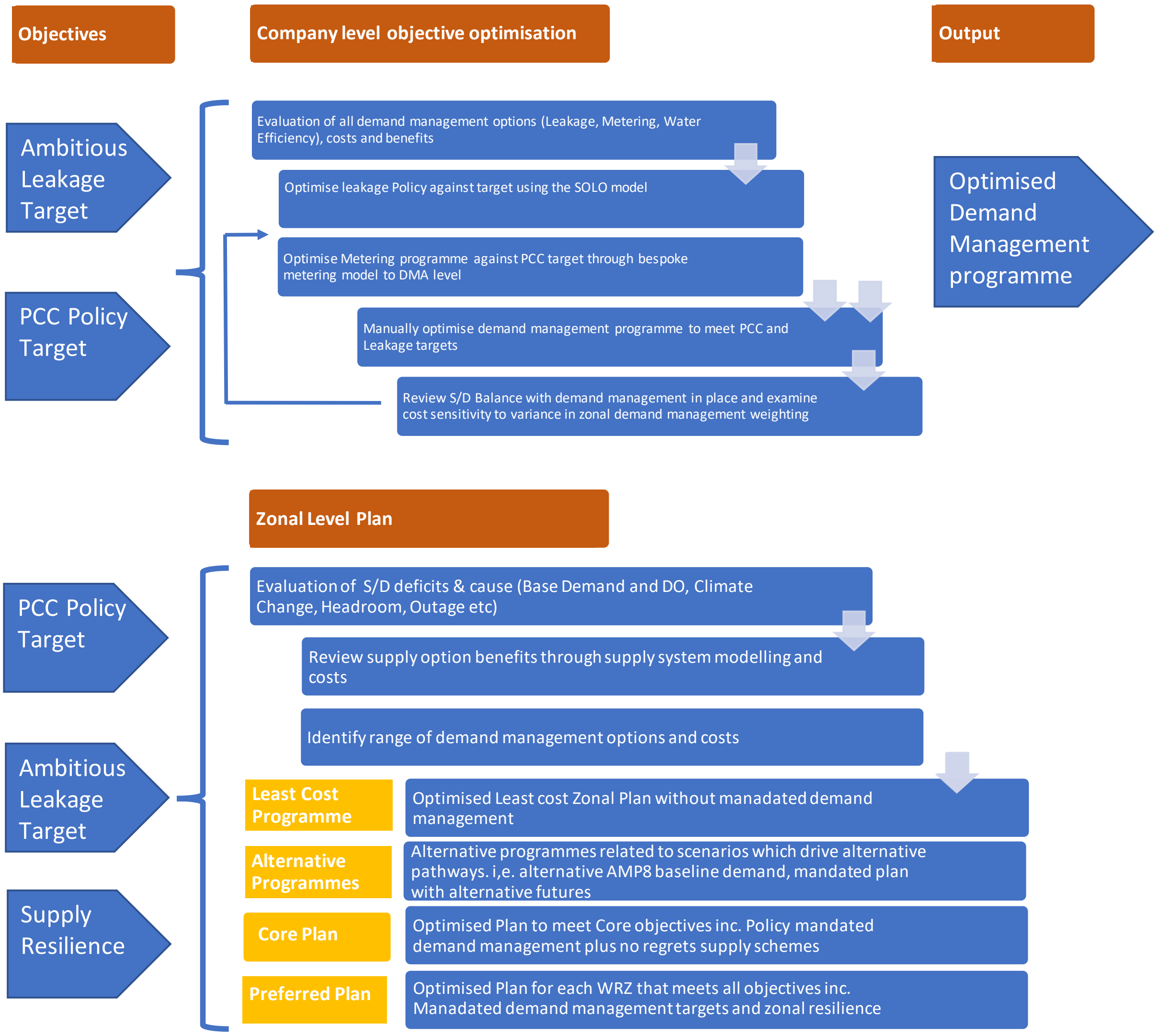


Figure 53 – Decision-making hierarchy

5.9. Testing the Plan

The WRMP has been tested and developed in such a way that it has assessed the preferred programme of investment, our 'Preferred pathway', against a range of future scenarios. Scenario planning between the WRMP and LTDS is aligned. In addition to the OFWAT 'Core' scenario we are in the process of defining and assessing additional company specific scenarios for the LTDS, which are in part informed by the WRMP. This work is ongoing and as such the WRMP has acknowledged them and as far as is reasonably practicable assessed them.

Further work will be undertaken as the we continue to refine and develop our LTDS company specific scenarios. The company specific scenarios are likely to include variations in forecast PCC reductions and customer behavioural changes which are key variables for both the WRMP, DWMP's and LTDS. Other scenarios to be considered include potential differences in policy and regulation adopted by the Welsh Government that are not adopted in England (e.g. a variance in approaches to adopting EU standards on drinking water quality). There are many areas where policy and even legislation differ in Wales and this trend may be expected to continue.

5.9.1. WRMP Scenario Testing

The WRMP has considered a wide range of plausible scenarios, summarised in Table 23. These closely align with the four core Ofwat scenarios as described in Table 24. We have described how these four key themes of Ofwat's common scenarios relate to our Plan and the future risks each poses.

Scenario Name	Leakage	HH Customer Usage	Environment	Climate Change
Most likely	10% by 2030, 50% 2050	110 l/p/d 2050	Low (0% reduction DO)	RCP6.0
Most likely + Medium ED	10% by 2030, 50% 2050	110 l/p/d 2050	BAU+ (5% reduction DO 2030 onwards)	RCP6.0
Demand + Medium ED	10% by 2030, 50% 2050	50% of 110 l/p/d	BAU+ (5% reduction DO 2030 onwards)	RCP6.0
Most likely + Enhanced ED	10% by 2030, 50% 2050	110 l/p/d 2050	Enhanced (5% reduction DO 2030, 10% reduction DO 2040)	RCP6.0
Demand + Enhanced ED	10% by 2030, 50% 2050	50% of 110 l/p/d	Enhanced (5% reduction DO 2030, 10% reduction DO 2040)	RCP6.0
Demand + Low ED	10% by 2030, 50% 2050	50% of 110 l/p/d	Low (0% reduction DO)	RCP6.0
Compound High	10% by 2030, 50% 2050	50% of 110 l/p/d	Enhanced (5% reduction DO 2030, 10% reduction DO 2040)	RCP8.5
Compound Low	10% by 2030, 50% 2050	110 l/p/d 2050	Low (0% reduction DO)	RCP2.6
Most likely + higher AMP8 DI starting position	10% by 2030, 50% 2050	110 l/p/d 2050	Low (0% reduction DO)	RCP6.0
Compound High High	50% of assumed savings	50% of 110 l/p/d	Enhanced (5% reduction DO 2030, 10% reduction DO 2040)	RCP8.5

Table 23 – Summary of the scenarios assessed

	Climate Change (Ofwat Descriptor)	Technology (Ofwat Descriptor)	Demand (Ofwat Descriptor)	Environmental Ambition (Ofwat Descriptor)
High	UKCP18 probabilistic projections, RCP8.5, 50th percentile probability level	Smart water supply network by 2035: automatic detection of potential leaks; 100% smart meter penetration by 2050.	Wales: population, property and occupancy forecasts derived from the latest local authority population and property projections published by the Welsh Government, as used in the latest round of WRMPs, in line with the WRPG. Building regulations and product standards: assume no change over the period to 2050.	In Wales, companies and regulators to work together to develop a common high scenario, which assumes Natural Resources Wales tightens measures in the future to reduce abstraction to support the environment.
Low	UKCP18 probabilistic projections, RCP2.6, 50th percentile probability level	Smart water supply network by 2040: automatic detection of potential leaks;	Wales: As above. Building regulations and product standards: assume the introduction in 2025 of a mandatory government-led scheme to label water-using products,	In Wales, assume that Natural Resources Wales' policy and regulatory approach towards abstraction reduction remains the same to 2050.

Table 24 - Ofwat Common Reference Scenarios

5.9.2. Climate Change

Welsh Government and Natural Resources Wales guidance for WRMP24 is that companies in Wales are only required to test their plans against a 'medium' and/or 'high' climate change scenario (RCP6.0 and RCP8.5 respectively) to reflect the warming to date that has been seen. The WRMP has also been tested against climate scenario RCP2.6, to comply with OFWATs LTDS requirements. The RCP2.6 scenario will be used to inform any 'no regrets' investment with the outputs of RCP6.0 informing the most likely plan.

In general, the assessment against the three climate change scenarios has not identified a large degree of differentiation in terms of the supply demand position in the early AMP periods, though the variation becomes more pronounced later in the period, particularly under a high emissions RCP8.5 scenario.

The climate modelling and forecast impacts are based on the best available data provided by the Met Office and as such there is a reasonable degree of confidence in the outputs, with no further data collection or model development planned in the short term to address concerns over data accuracy. Two important areas have been identified for further assessment in AMP8 i) the effects of climate change on future environmental flow requirements, ii) the impacts of reduced water availability/water quality due to climate change for private water supplies and the potential implications for public supplies. Increased risks with private supplies from climate change have led the Welsh Government to ask water companies start to considering the longer-term implications and is likely to be an evolving area of consideration.

5.9.3. Demand

Growth analysis within the WRMP24 aligns with the high and low scenarios. The WRMP has looked at demand and population growth as outlined in section 4.

This has used Welsh Government published data on Local Planning Authority projections. Subsequent engagement with local authorities has been undertaken to obtain site level development data and population projection forecasts. These population forecasts have been looked at under a low and high future scenario.

In addition, demand forecasting for commercial and industrial usage has been undertaken through engagement with non-household customers. Large new commercial or industrial forecasts are not included within the core plan due to sensitivities around location and demand. Any significant new or changed non-household customer demands that have a reasonably high level of certainty are looked at under alternative/adaptive pathways.

The outputs of the demand testing have been incorporated within the wider WRMP with the core pathway being largely in line with the low demand forecast scenario. Both forecast population growth and forecast growth in commercial demand are in general, relatively modest.

Due to the combined quality of the Local Authority Plans, and subsequent refinement of those plans through targeted engagement there is a reasonable degree of confidence in this data set as the best available. As such there is no requirement, in the short term, to undertake additional demand forecast modelling or data collection. This will be undertaken as part of the WRMP29 process. Our demand scenario testing therefore focuses on the risks of underachievement of our demand management programme and the alternatives that may be needed to maintain levels of drought resilience.

5.9.4. Abstraction

At present Natural Resources Wales has not set a policy of formal abstraction reduction and as such this is not a feature of our most likely pathway. As described in earlier sections of the Plan, we have undertaken scenario testing around potential future reductions to our supply capability and the results of this are set out in Chapter 6. We know from our previous experience of abstraction licence changes following the Habitats Directive Review of Consents process that there is potential for significant reductions in water availability and investment required to address this, so it’s important that we start planning for this as early as possible.

5.9.5. Technology

The WRMP has included consideration of the different impacts of technology specifically around smart water supply networks and smart meter penetration. These technological impacts have been tested to consider when metering advances are likely to occur under the low and high Ofwat reference scenarios.

Technology impacts are largely limited, currently, to domestic metering. We are currently focusing our metering plans initially on wide scale rollout of AMR or AMI ready meters, moving to dedicated AMI meters longer term. It is considered that advances in technology are unlikely to be material with respect to the WRMP at least in the short to medium term.

There are continuing advancements in this area and although the confidence is high with respect to understanding existing opportunities from technology this will be an area which will likely evolve more substantially than the other core reference scenarios over time.

5.9.6. Adaptive Planning

Guidance asks that we consider taking an adaptive management approach to our long-term planning where there is either significant uncertainty at any stage in the planning period or there is a strategic decision to be made in the plan’s medium term which has a long lead-in time to deliver.

Although no strategic decisions are required against long lead time items in our Plan, we have tested the level of uncertainty in meeting objectives using scenario planning. These scenarios demonstrate whether we can meet objectives under less likely but plausible potential futures and where this is not the case, we need to understand whether we can adapt our Plan to resolve any shortfalls against these and the implications.

A good example is where we are planning to undertake studies in AMP8 regarding the environmental sustainability of river abstractions under different climate futures. We do not understand the impact, but we have undertaken scenario sensitivity analysis to identify the water supply resilience impact if we need to amend abstraction licences.

We have then looked at what our response might be to this through an adaptive plan, an example of how this is constructed is shown in Figure 54. Section 6 details our most likely and alternative pathways at both company and zonal levels, where appropriate.

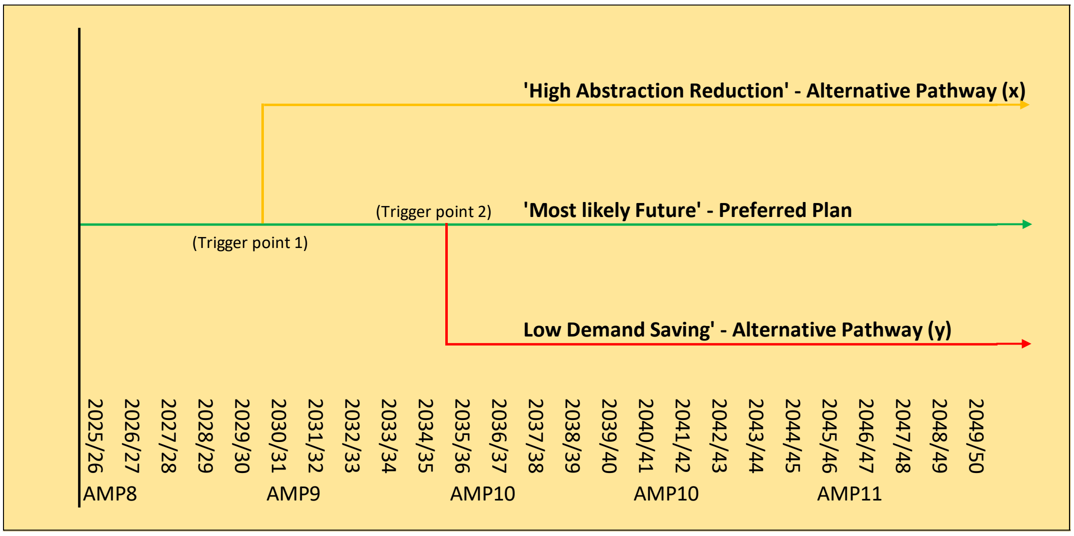


Figure 54 - Example Adaptive Pathways

Where our scenario testing indicates that schemes are needed for all or most of the alternative pathways, and that these investments are likely to deliver outcomes efficiently, these are effectively 'low regret' options that would form part of our 'Core Plan'. The process to identify these additional options is similar to that used in developing the plan for the 'most likely' scenario with the SoLow optimiser used to examine the additional leakage options available, whilst we use our overall Decision Lab optimisation tool to compare these with available supply side options.

The final stage in the process is a review of the programmes that will meet the range of plausible futures to assess the overall 'Best Value' programme. This will provide the best chance of achieving our longer-term objectives as this is a no regrets position his overall strategy, therefore, acts to de-risk the Plan related to currently unknown sustainability reductions in AMP9 or any under delivery against estimated customer usage change. The optimisation output for each zone is provided in chapter 6 at both a company and zonal level.

6. Our Preferred Plan

(Note. This section has been revised following consultation on the draft WRMP24)

6.1. Introduction

The objective of this Plan is to ensure that Dŵr Cymru Welsh Water will always be able to provide sufficient water supply to meet our customers reasonable demand over the next 25 years. The plan uses our current knowledge of our water supply systems and best available evidence to estimate the risk of not achieving this goal, and science and engineering to formulate a plan of action going forward. We have been guided by our regulators, interested parties and our customers in making decisions on the most appropriate course of action, taking account of the uncertainties in both the available evidence and unknown future circumstances.

Government and Regulators have set clear expectations for this Plan, notably in relation to the role of demand management, the safeguarding of environmental standards, and the improvement of resilience to climate change. Through our engagement work it has become apparent these priorities align with our customers' views and so these themes are the primary drivers for our preferred programme of investment.

The detailed work undertaken here has provided a far greater level of understanding of the future water supply problems that could exist and has enabled us to prepare for the risks. The decision-making process described in Section 5, with the outputs of our wide-ranging scenario testing included within this section, has enabled us to produce our 'Preferred' plan, to highlight where an alternative programme of interventions could be needed over time and where we need to prepare, through further investigation or advancement of detailed design in order to better understand known uncertainty or reduce the timescales for delivery if future risks materialise.

Whilst the majority of our WRZs have good resilience to drought and the projected impacts of climate change, we have identified two zones where investment in water supply assets is needed is needed in the short term with further investment needed in two additional zones to further improve our level of drought resilience over time.

Furthermore, there is a foreseeable risk in a small number of zones that it would be prudent to prepare for future risk. Whilst our ambitious demand management strategy, described in Chapter 4, is not wholly driven by the need to resolve forecast supply demand balance shortfalls, there would be significant criticism of a WRMP which has insufficient ambition around leakage performance or does not encourage our customers to reduce their consumption and provide long-term benefit to the environment.

This section sets out our investment decisions for our 25 year WRMP24. This is driven by our business objectives including our intentions for demand management which are targeted in line with national policy. Although these are effectively mandated within the Plan, we still need to deliver these, cost effectively.

In addition, we also need to ensure that we improve the level of drought resilience to our customers and reflect on future potential risks so that we can adapt our Plans if necessary.

Within Section 6 we therefore describe the following:

- An investment pathway aligned to the most likely scenario or set of scenarios
- A core pathway showing low-regret investment, in line with Ofwat definition
- Alternative pathway(s) with a set of trigger points linked to potential future scenarios

6.1.1. The Future Drought Resilience Position

The biggest risk our customers face during a drought is that we reach a point where the only way we can continue to maintain supplies to everyone is through rationing the available water. Given the risks this poses to drinking water quality and public health, our Plan seeks to reduce the chance of reaching this position to as low as possible. Previously we planned to minimise this risk to that seen during historic droughts, these having a return period of around 0.7% (1:150) chance each year of our water supplies reaching this position but for this Plan, our long-term aim is to reduce the risk to an annual chance of no more that 0.5% (1:200) as soon as possible and to a 0.2% standard (1:500) by 2039/40, effectively getting as close to 'never' as we currently can. Most of our zones meet these resilience criteria but there are three zones where investment is required to achieve our target service levels, namely SEWCUS, Tywi Gower and Lleyn Harlech - Barmouth.

The SEWCUS and Tywi Gower zones are not currently achieving our target levels of drought resilience due to an identified lack of sufficient resource availability in the smaller, upland reservoirs and network restrictions that means we can't fully utilise the larger lowland sources to support during periods of prolonged dry weather. Sections 6.2 and Section 6.3 describe our programme of investment to achieve both our company mandated targets in relation to demand management and to meet the wider our desired levels of drought resilience under a 'most likely' future scenario, following the decision-making process set out in Section 5. Given the many future uncertainties it is likely that at some point we will need to adapt our investment programme and so Section 6.4 details the scenario testing completed to identity any 'alternative' programmes of investment if we encounter alternative plausible future situations.

6.1.2. Company level supply demand position

It is useful to show, at a company level, how our overall supply against demand position is changing for our preferred planning strategy. Figure 55 shows a picture of a growing shortfall against the level of customer demand, from around 2% in 2030 to around 5% by 2050.

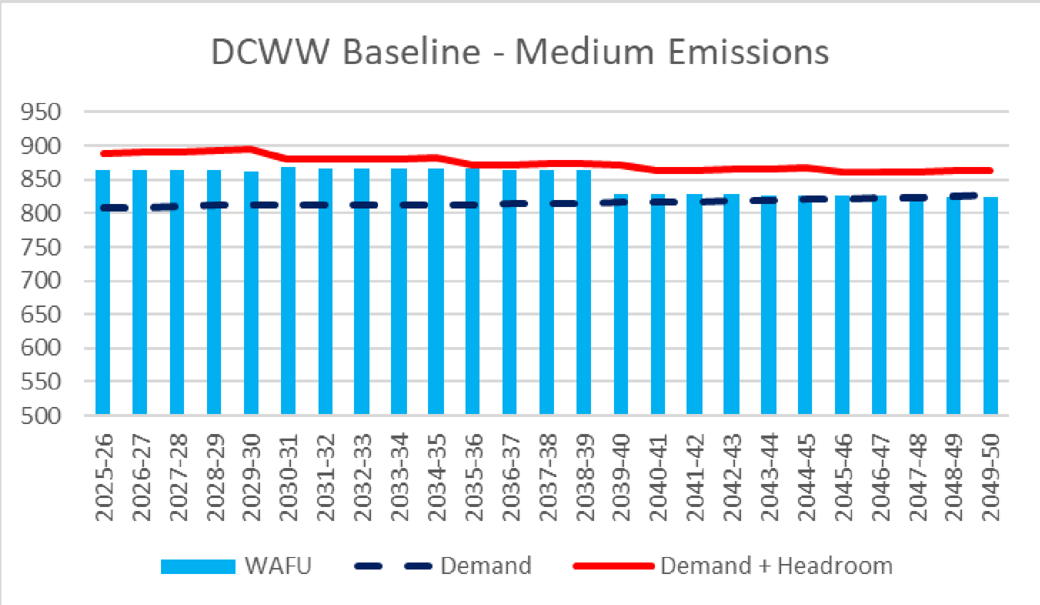


Figure 55 – Our company-level 'dry year annual average' supply demand starting position

The three primary drivers for this across the 25 years of the planning period are:

1. The move to a higher level of drought resilience – our DO drops from 1016Ml/d (worst historic drought) to 919Ml/d under a 1 in 200 year drought scenario and to 886Ml/d under a 1 in 500 year drought scenario.
2. Climate change – 21Ml/d reduction in supply capability at 2025-26, increasing to 26Ml/d reduction by 2049-50

3. ‘Dry Year’ demand – without interventions, this is forecast to increase from an average of 808Ml/d in 2025-26 to 826Ml/d by 2049-50

The largest impact therefore is the move to provide customers with a higher level of service against the implementation of extreme measures during a drought.

Given the variation in the makeup of our water resource zones the following figures present the supply against demand starting position for our three operating areas. The healthy water resource position of our North Wales masks to a certain extent the more localised issues in our Southeast and Southwest operating areas where deficits as a % of customer demand by 2050 are 7.5% and 11% respectively, underlining the need for investment to strengthen our drought resilience.

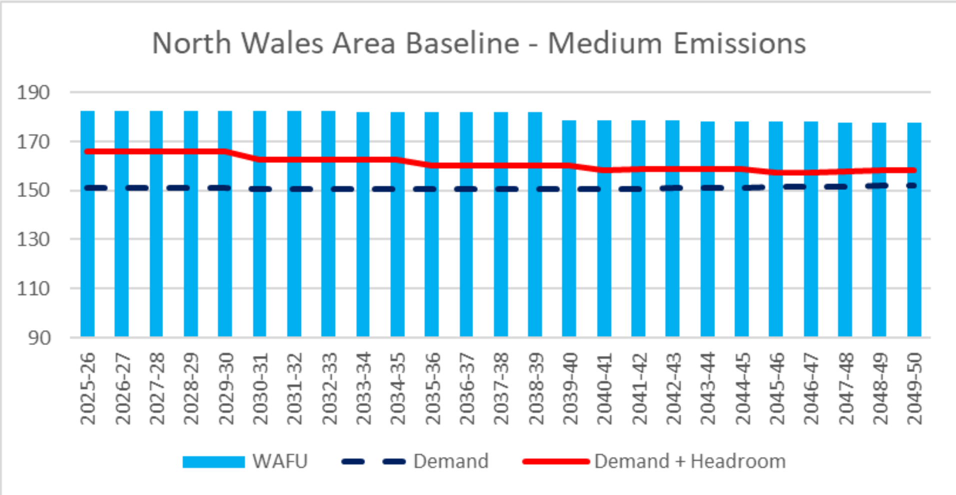


Figure 56- Our North Wales operational area ‘dry year annual average’ supply demand starting position

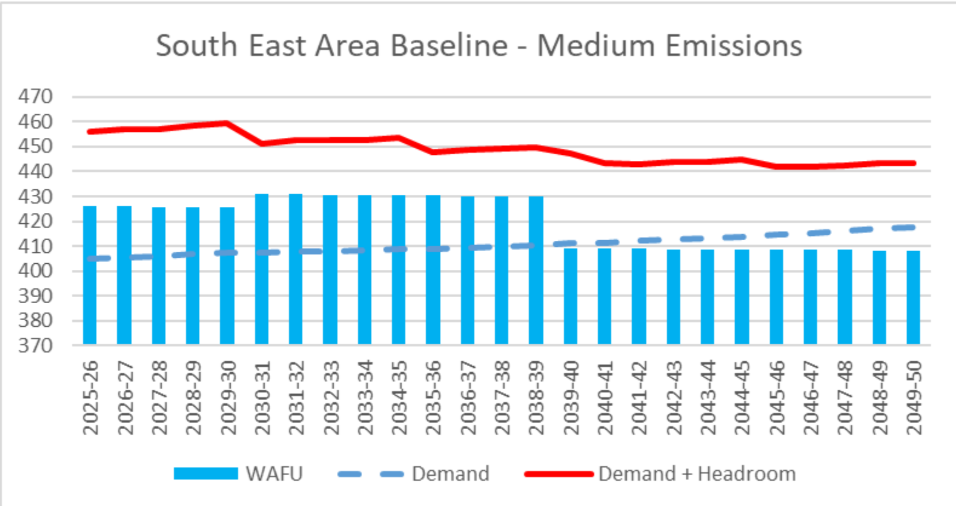


Figure 57 - Our Southeast Wales operational area ‘dry year annual average’ supply demand starting position

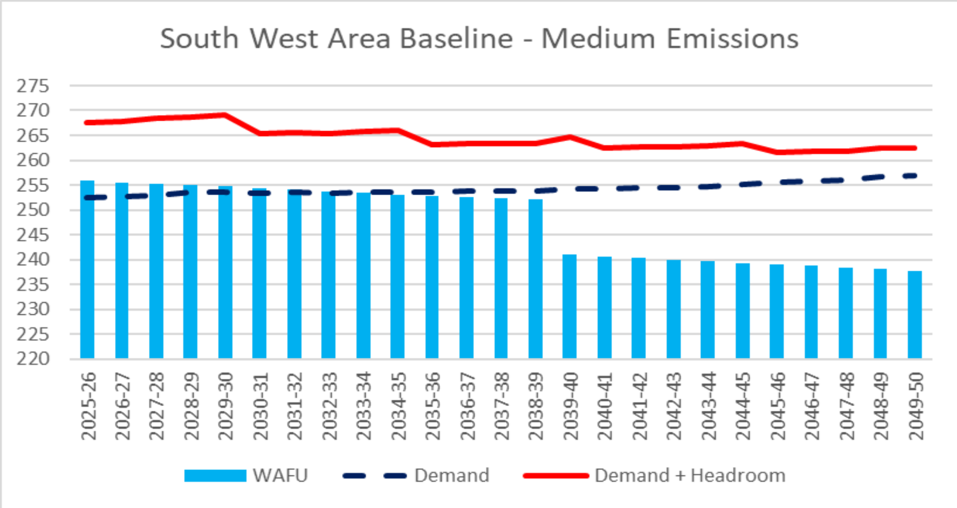


Figure 58 - Our Southwest Wales operational area 'dry year annual average' supply demand starting position

6.2. Meeting Company level objectives – Customer Usage (PCC)

We have developed an ambitious, long-term demand management strategy that recognises we need to take action to reduce leakage and help customers use water wisely. Our stakeholder and customer engagement shows strong support for this, and the strategy aligns with regulatory expectations. Our water efficiency strategy is designed to reduce PCC down to 110l/p/d.

6.2.1. The water efficiency programme

The delivery of our Smart metering programme forms the cornerstone of our demand management strategy and is critical to us achieving significant reductions in both the amount of water lost each day through leakage and in the amount of water used by our customers. We have undertaken work to confirm the appropriateness of our delivery programme to ensure it remains 'Best Value' for our customers, particularly the profile of the metering roll out at a zonal level so that we achieve both our desired levels of drought.

The AIC values for water efficiency options provided in chapter 5 show that customer metering provides the most cost-effective way of reducing PCC. Whilst other options may be comparable in relative cost they cannot provide anywhere near the level of water efficiency savings needed.

With our engagement work supporting metering as the fairest way to pay for water services, our metering programme will be delivered through AMP8 and AMP9.

Our Metering Delivery Programme

We have appraised five alternative delivery programmes, for comparison with our preferred delivery plan, to confirm that we have selected the 'Best Value' strategy that delivers our long-term ambition to reduce customer usage and supports our shorter term aims around levels of drought resilience; all the while balanced to ensure affordability.

Our preferred delivery programme is aimed at balancing the costs against targeting those WRZs which are:

a) Showing a supply demand balance shortfall
b) Have known higher levels of leakage/usage
c) Experience high demands that put pressure on our treatment works and distribution systems

The delivery programme has been further adjusted to support efficient delivery management. Figure 59 shows our preferred delivery profile by zone together with the planned percentage across each of the 10 years. It can be seen that the profile of delivery is broadly split 60/40 across AMP8 and AMP9, reflecting that it is our two largest WRZs (SEWCUS and Tywi Gower) we are targeting early in the programme given their lower than planned drought resilience.

By 2049-50, effectively all households will be billed on a measured tariff. Our plan also includes metering all unmeasured non-household properties between 2025 and 2035. Unlike household metering, we have forecast a negligible impact on demand from this option but is supported by our customers. The metering programme also supports our leakage reduction strategy relating to customer supply pipe leakage, as described in the next section.

		2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
8001	North Eryri / Ynys Mon										
8012	Clwyd Coastal										
8014	Alwen / Dee										
8020	Bala										
8021	Tywyn / Aberdyfi										
8026	Blaenau Ffestiniog										
8033-34	Lleyn - Barmouth										
8035	Dyffryn Conwy										
8036	South Meirionnydd										
8101	Ross-on-Wye										
8102	Elan / Builth										
8103	Hereford C.U. Area										
8105	Llyswen										
8106	Monmouth										
8107	Pilleth										
8108	Brecon										
8110	Vowchurch										
8111	Whitbourne										
8121	SEWCUS										
8201	Tywi C.U. Area										
8202	Mid - South Ceredigion										
8203	North Ceredigion										
8206	Pembrokeshire										
	% Annual rollout	**9%**	**11%**	**11%**	**11%**	**15%**	**10%**	**9%**	**9%**	**10%**	**6%**

Figure 59 – Proactive Smart Metering Delivery Programme

Table 25 compares the AICs of the five alternative strategies across all WRZs against our preferred delivery plan.

1) Slower rollout

This scenario assesses the benefits of delaying our smart meter programme by two AMP periods. Although this defers investment, this strategy delivers lower PCC savings due to the delay in change of Occupancy. This means that we would not achieve our 110 l/h/d PCC target by 2050 and this would also slow the benefit to drought resilience.

2) Even rollout

This scenario assesses an evenly spread delivery programme across all WRZs over the two AMP periods and so no prioritisation is made i.e. 10% of all currently unmeasured properties in each WRZ, would be proactively metered each year, for 10 years. This delivery plan has two key flaws, i) a drop in efficiency in the management of a larger number of contractors across the region, ii) a lack of targeting of benefit towards those zones with lowest resilience.

3) Least cost

This scenario assesses the prioritisation of proactive meter delivery purely on the basis of lowest cost across the whole company on a DMA basis so just as with Scenario 2, the water resource resilience position of a zone does not influence the meter roll out nor does the practicality of delivery.

4) AMI from AMP8

This scenario assesses the benefits of introducing full AMI smart metering through AMP8 and AMP9 rather than currently planned for AMP11 and AMP12, thus bringing forward our programme significantly.

5) AMI ready from AMP8

This scenario assesses an interim position whereby acknowledging that the move to full AMI smart metering is technically difficult to deliver within a two year timeframe and currently cost prohibitive, there are 'AMI Ready' smart meters available that can be installed and read as per an AMR network but when required, can be used to their full AMI capability.

The results in Table 25 show that there is only a marginal cost saving to be achieved from adopting either scenario 1 or 2 against our preferred strategy. This does not outweigh the benefits of a delivery programme which targets those zones that have lower than planned drought resilience. A similar but stronger argument applies to Scenario 3 whereby although the cost savings are more substantial, this significantly delayed roll out would require us to deliver either more expensive water efficiency and leakage options or less sustainable supply side options to maintain our drought resilience. It is also less likely that we would achieve the long-term PCC target of achieving 110 l/h/d.

AMR vs AMI

We have used current AMI network costs in our scenario 4 and 5 assessments. These indicate that although full AMI smart metering is expected to enhance the reductions in customer usage through providing real time data to influence behaviour, this is at a higher cost with the overall programme proving more expensive. We have examined the sensitivity of network costs (See Appendix 25) and AMI costs would only be comparable to AMR if network cost fell below £1.50/meter/yr. In addition, the rollout of AMI across the Welsh region would not be practicable until network coverage and reliability has improved significantly.

This said, we are still investigating the implementation of AMI ready meters and the pathway between AMR and AMI in AMP8 through discussions with meter manufacturers. Investigations into use of Long-Range Wide Area Networks and IoT technology are ongoing along with procurement of meters. We have asked for manufacturers views on potential pathways between AMR and AMI and we will be refining our strategy over the coming 2 years prior to meter delivery. Given that the anticipated cost of AMI ready meters is not significantly greater than AMR meters, we may opt for AMI ready meters but not use their full functionality either until network costs have fallen considerably or possibly not at all if this remains cost prohibitive in the short to medium term.

In the longer term, as meters reach end of life, the expectation is that AMI will become the preferred option. We have included for the additional benefits of AMI metering, in their ability to provide greater information to our customers, in our calculations from AMP10 onwards.

Scenario	Preferred (AIC)	1/ Slower Rollout (AIC)	% change	2/ Even Rollout (AIC)	% change	3/ Least overall Cost (AIC)	% change	4/ AMI (AIC)	% change	5/ AMI Ready (AIC)	% change
North Eryri / Ynys Mon	1,314	1,276	-3%	1,275	-3%	1,285	-2%	1,698	29%	1,679	28%
Clwyd Coastal	1,506	1,503	0%	1,437	-5%	1,537	2%	1,941	29%	2,106	40%
Alwen / Dee	1,206	1,169	-3%	1,173	-3%	1,162	-4%	1,592	32%	1,573	30%
Bala	1,422	1,329	-7%	1,397	-2%	1,408	-1%	1,800	27%	1,780	25%
Tywyn / Aberdyfi	1,747	1,777	2%	1,576	-10%	1,742	0%	2,280	31%	2,240	28%
Blaenau Ffestiniog	1,047	979	-7%	991	-5%	999	-5%	1,409	35%	1,392	33%
Lleyn – Barmouth	1,376	1,334	-3%	1,340	-3%	1,324	-4%	1,807	31%	1,783	30%
Dyffryn Conwy	1,272	1,265	-1%	1,200	-6%	1,169	-8%	1,754	38%	1,726	36%
South Meirionnydd	1,430	1,354	-5%	1,372	-4%	1,388	-3%	1,838	28%	1,813	27%
Ross-on-Wye	551	437	-21%	519	-6%	489	-11%	1,074	95%	1,044	89%
Elan / Builth	1,201	1,151	-4%	1,140	-5%	1,128	-6%	1,639	36%	1,613	34%
Hereford C.U. Area	1,468	1,343	-9%	1,462	0%	1,455	-1%	1,905	30%	2,054	40%

Llyswen	1,094	1,008	-8%	1,074	-2%	1,050	-4%	1,500	37%	1,598	46%
Monmouth	1,261	1,183	-6%	1,209	-4%	1,184	-6%	1,648	31%	1,626	29%
Pilleth	1,423	1,343	-6%	1,405	-1%	1,408	-1%	1,739	22%	1,841	29%
Brecon	1,769	1,703	-4%	1,691	-4%	1,817	3%	2,135	21%	2,111	19%
Vowchurch	1,648	1,481	-10%	1,680	2%	1,647	0%	2,041	24%	2,015	22%
Whitbourne	821	668	-19%	829	1%	779	-5%	1,258	53%	1,235	50%
SEWCUS	1,234	1,156	-6%	1,209	-2%	1,234	0%	1,547	25%	1,510	22%
Tywi C.U. Area	1,072	1,029	-4%	1,067	0%	1,048	-2%	1,433	34%	1,371	28%
Mid - South Ceredigion	1,108	1,017	-8%	1,093	-1%	1,084	-2%	1,459	32%	1,370	24%
North Ceredigion	1,539	1,498	-3%	1,464	-5%	1,511	-2%	1,905	24%	1,883	22%
Pembrokeshire	1,121	1,066	-5%	1,112	-1%	1,092	-3%	1,504	34%	1,458	30%

Table 25 - Comparison of AICs(p/m3) of the potential meter rollout programmes

We have modelled and optimised the additional water efficiency interventions that will be needed to meet our long-term targets. With the implementation of our demand strategy, household usage is forecast to be c105 Ml/d lower than it would have been in 2050, with the aim of hitting the PCC glidepath target of 110 litres per person by 2050 in a 'dry' year.

Figure 60 below shows the relative magnitude of each element of demand reduction. In AMP8 and AMP9 most demand management savings will come from the progressive meter policy which will reduce both customer supply pipe leakage and customer usage. We have assumed that government led water labelling of goods will support this effort.

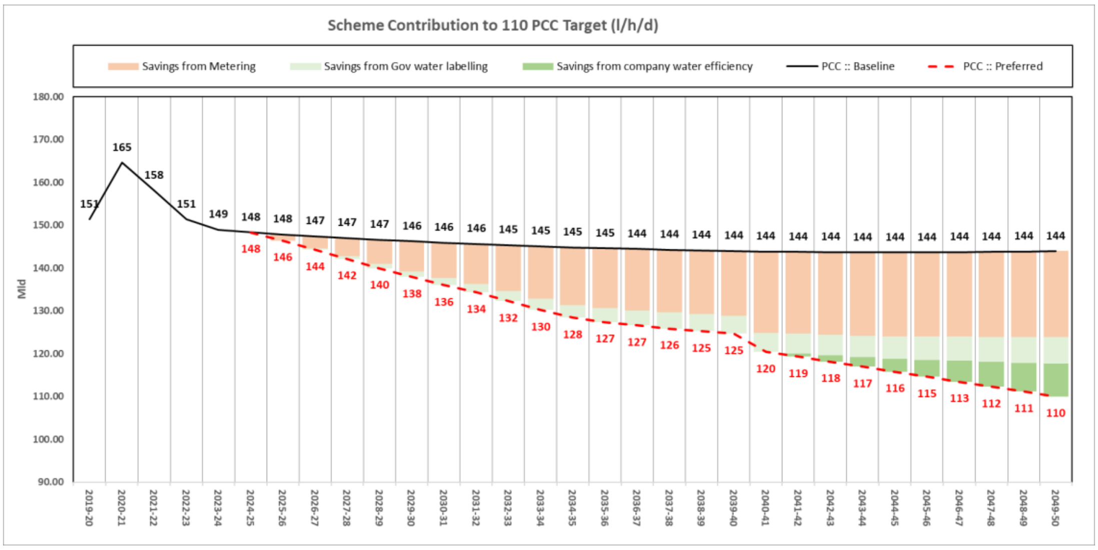


Figure 60 – Option benefits to achieve PCC target of 110 l/h/d

6.3. Meeting Company level objectives – Leakage reduction

Through our water balance re-statement, reported leakage volumes at the start of the planning period have increased since those presented in the draft Plan (Section 4). However, we have retained our ambition to achieve a 10% saving in leakage during AMP8 and a 50% reduction by 2050, set against a 2017-18 baseline. We have amended our targets in line with the percentage savings, which means that we plan to deliver an 18Ml/d reduction during the AMP8 period and an overall reduction of 87 Ml/d by 2050 (Figure 61), compared to 14 Ml/d and 56 Ml/d respectively in the draft Plan.

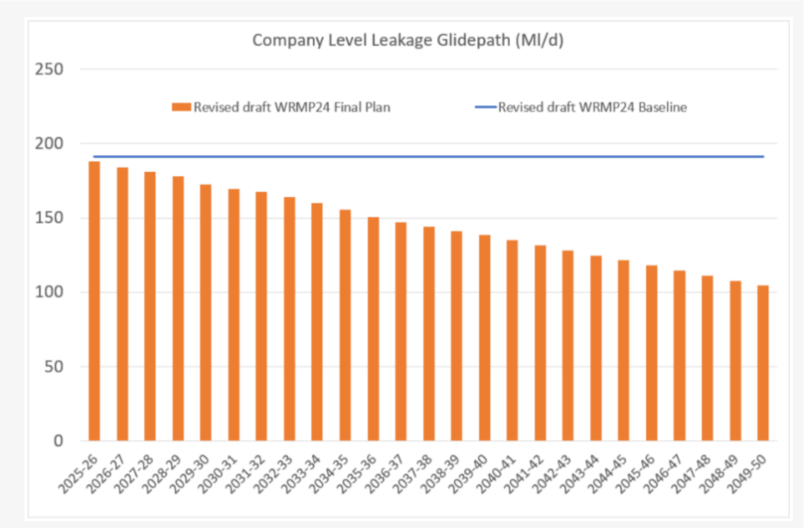


Figure 61 – Leakage reduction glidepath (%'s set against 2024-25 position)

As described in section 5, we have used the SoLow model to inform our decision making on leakage saving delivery. Metering for solely leakage benefit is far more costly than many of the other techniques for leakage saving. However, to achieve an effective PCC reduction pathway we will implement our metering delivery programme. Once meters are installed to identify continuous flow and the potential for leakage, then the cost/benefit of fixing customer supply pipe leakage is cost effective against other leakage options. We will help the customer to resolve any leakage on the supply pipe and within the property and will ensure the supply is 'leak free' and in a 'good plumbing state'. This policy and the impact on CSP Leakage from metering is included in the forecasting across the progressive metering period (2025 to 2041).

In addition, the installation of smart meters enables the discovery of distribution mains leaks previously undiscovered through conventional active leakage control or via customer reporting as we can undertake a full flow balance within DMAs. Any new leaks can be better targeted and repaired in a shorter duration due to enhanced awareness through more regular meter readings.

Chapter 5 and section 6.2 above described how our preferred demand management programme has been designed to achieve 'best value' for customers through focussing metering effort initially in those water resource zones identified as having a supply demand balance deficit. This also enables leakage reduction to be equally focused in these zones.

The proposed AMP8 leakage savings are achieved through both CSPL savings and conventional find and fix activity. With the metering strategy in place, The SoLow model has been used to examine a least cost pathway to achieving our long term target. A summary of the components of our preferred leakage strategy at a company level is presented in Table 26.

As Table 26 highlights, the planned 87Ml/d reduction in leakage across the 25 years of this Plan comes from three main components, the largest of which (c40%) being the savings we expect to achieve from repairing leakage on customer properties that has been identified from the installation of smart metering.

Traditional leakage repair (ALC) on our distribution network has a smaller role to play (c30%) than in previous plans and its delivery is set to later in the planning period to achieve our 2050 target once we have maximised the available leakage savings from our smart metering rollout.

The third component (c19%) is targeting leakage on our trunk mains network, an area recently identified as being a source of significant volumes of leakage, particularly where we have older asbestos cement mains. The costs to achieve our target leakage reduction of 50% by 2050, rise sharply in the last 15 years of the planning period as the leakage saving becomes difficult to find with more expensive asset renewals required. However, by profiling the delivery in this way, it is anticipated that technological advances will allow us to deliver the required leakage reductions in the longer term for a lower cost than currently estimated.

	2024-25	2025-26	2029-30	2034-35	2039-40	2044-45	2049-50
Total leakage (Ml/d)	191.31	187.79	172.72	155.53	138.46	121.44	104.40
Reduction from 2024-25 (Ml/d)		-3.52	-18.58	-35.74	-52.83	-69.91	-86.92
Reduction from 2024-25		-2%	-10%	-19%	-28%	-37%	-45%
Customer supply pipe leakage - Smart metering		3.23	17.10	31.46	32.8	34.11	34.59
Active Leakage Control - Distribution network		0.29	1.48	4.28	10.34	17.93	25.71

	2024-25	2025-26	2029-30	2034-35	2039-40	2044-45	2049-50
Permanent Acoustic Logging		-	-	-	0.01	0.01	0.01
Intensive Active Leakage Control - Distribution network		-	-	-	1.19	1.74	2.02
Pressure Management		-	-	-	1.15	1.27	1.32
Asset Renewal – distribution mains		-	-	-	1.94	2.57	3.58
DMA Subdivision		-	-	-		0.06	0.06
Pressure Transients		-	-	-	-	0.09	0.13
Sahara		-	-	-	-	0.03	0.03
Active Leakage Control - Trunk mains		-	-	-	5.40	10.94	16.63
Asset Renewal – Trunk mains		-	-	-		0.62	2.16
Trunk Main Monitoring		-	-	-	-	0.55	0.68

Table 26 –Components of our 'preferred' leakage glidepath

6.3.1. Non-household Demand

As described in Chapter 4 consultees have asked us to be more ambitious in supporting businesses to reduce their demand for water. For the English companies, UK Government has set formal targets for business demand reduction, these being a 9% and 15% reduction by 2038 and 2050 respectively, set against a 2019-20 baseline. We do not have a formal target set in Wales but we are mindful of the need to support demand management.

For this Plan we have set targets in line with available evidence around savings in potable water use that can be achieved across small, medium and large businesses, these being a 9% saving by 2037/38 in line with targets in England and an 11% saving by 2050.

We aim to achieve these reductions through a range of water efficiency measures, as described in Section 4, with the largest contributor being the savings we hope to make through the "deep dives" whereby we would visit our business customers and undertake a detailed review of their onsite processes and usage of water to identify where efficiencies can be achieved.

Table 27 shows the estimated reductions from business demand management activity from the 2019/20 position and Table 28 shows the breakdown by scheme to achieve this.

	2019-20	2025-26	2030-31	2037-38	2040-41	2045-46	2049-50
Business Demand (Ml/d)	183.29	171.74	170.73	167.08	166.21	165.130	163.61
% reduction		6%	7%	9%	9%	10%	11%

Table 27 – Business demand reductions (Individual year % reduction against 2019-20)

	2025-26	2030-31	2037-38	2040-41	2045-46	2049-50
Online Access to Products (Ml/d)	0.051	0.52	0.84	0.94	1.13	1.27
Non-Domestic Water Efficiency Audits (Ml/d)	0.078	0.77	1.25	1.41	1.69	1.90
Non-Domestic Deep Dives (Ml/d)	0.35	3.55	5.77	6.49	7.78	8.75
Non-Domestic behaviour change (Ml/d)	2.41	0.00	0.00	0.00	0.00	0.00

Table 28 – Scheme contribution to the achievement of our Business demand reduction target

	2025-26	2030-31	2037-38	2040-41	2045-46	2049-50
Smart metering	0.02	0.14	1.42	2.11	1.87	1.89
Water labelling	0.00	0.20	0.92	1.19	1.48	1.72
Online Access to Products - free issue	0.00	0.00	0.00	0.00	0.05	0.05
Education	0.00	0.00	0.00	0.00	0.02	0.02
Leaky loos	0.00	0.00	0.00	0.00	0.01	0.01
Home Audits	0.00	0.00	0.00	0.00	0.09	0.10
Tariffs	0.00	0.00	0.00	0.00	0.29	0.31

Table 29– Scheme contribution to the achievement of our Household demand reduction target

6.4. Impact of Demand Management Delivery

As shown in Table 30 and Figure 62 below, at a company level the overall demand for water in a ‘dry year’ is forecast to be c206 Ml/d lower by 2050 than it would have been, because of our demand strategy.

	2025-26	2029-30	2034-35	2039-40	2044-45	2049-50
Forecast demand without interventions (Ml/d)	808.26	811.95	812.84	815.98	819.93	826.33
Forecast demand with interventions (Ml/d)	800.18	764.80	717.34	685.42	650.24	620.83
Reduction in household demand from smart metering (Ml/d)	-4.01	-19.98	-38.40	-42.65	-51.02	-50.22
Reduction in household demand from Government water labelling (Ml/d)	0.00	-3.77	-14.33	-26.01	-32.42	-39.88
Reduction in household demand from DCWW led water efficiency initiatives (Ml/d)	0.00	0.00	0.00	0.00	-6.37	-16.19
Reduction in non-household demand from DCWW led water efficiency initiatives (Ml/d)	-0.55	-4.81	-6.99	-9.06	-10.01	-12.32
Reduction in customer side leakage from smart metering (Ml/d)	-3.30	-17.25	-32.41	-37.74	-42.72	-45.79
Reduction in distribution side leakage (Ml/d)	-0.22	-1.33	-3.37	-15.11	-27.16	-41.12

Table 30 - Forecast savings from our demand management strategy

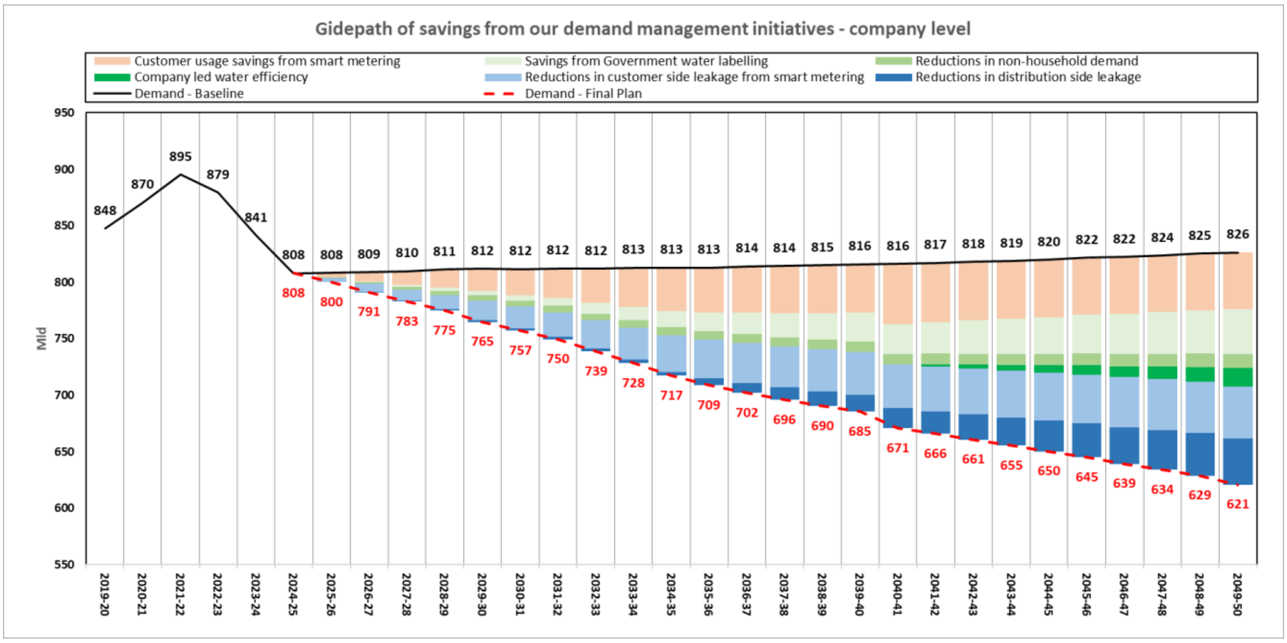


Figure 62– Glidepath of savings from our demand management strategy

Our SEA considers the impacts of our demand management programme to understand if any option has a significant negative impact that cannot be mitigated (See Appendix 15). This is not the case for the demand management options with little to differentiate these in terms of wider social and environmental metrics. Table 31 below is an example for metering with some temporary negative impact in terms of construction but more general positive impact. This is similar for the majority of demand management options and so the wider metrics do not influence the 'Best Value' decision to any significant extent.

	SEA Objectives	Construction -ve	Construction +ve	Operation -ve	Operation +ve
1	Biodiversity	0	0	0	0
2	Sustainable Natural Resources	0	0	0	0
3	INNS	0	0	0	0
4	Soils Geodiversity and Land Use	0	0	0	0
5	Water Quantity	0	0	0	+++
6	Water Quality	0	0	0	0
7	Flood Risk	0	0	0	0
8	Air Quality	---/?	0	0	0
9	Greenhouse Gas Emissions	---	0	0	+++
10	Climate Resilience	0	0	0	++
11	Economy	0	+++	0	+++
12	Tourism and Recreation	0	0	0	0
13	Human Health and Well-being	0	0	0	+++
14	Water Resource Use	0	0	0	+++
15	Waste and Resource Use	--	0	0	0
16	Cultural Heritage	0	0	0	0
17	Landscape	0	0	0	0

Table 31 – SEA assessment criteria and outcomes for our metering option

6.5. Individual Water Resource Zone Plans

6.5.1. Introduction

Without any intervention, we calculate that we have three zones that will not meet our drought resilience targets. We have been tasked by our regulators to set and adhere to the stretching demand management targets described above. We have optimised the delivery of these across our water resource zones in a way that is close to least cost but is weighted towards reducing demand in those areas where we have a deficit against our resilience targets.

For Lleyn Harlech - Barmouth, the zone does not reach resilience to a 1 in 500 year drought at 2039/40. However, with proposed demand management actions in place this target is met.

For two zones, SEWCUS and Tywi Gower, there is a deficit from the start of the planning period and this section details our preferred programme of investment to ensure long term drought resilience. The benefits of our leakage and metering strategies are accounted for within our preferred Plan. Each section details our investment plan to ensure that the zones reach resilience targets as soon as possible within the period. It can be seen from the cost tables in section 5 that some supply side options have a considerably lower cost than the demand management options within our preferred investment plan. However, our plan aims to meet ‘Best Value’ criteria, accounting for customer and stakeholder priorities which in turn offer environmental benefits.

6.5.2. SEWCUS Drought Resilience

Our WRMP19 showed the SEWCUS system to be resilient under worst historic drought conditions, such as those experienced in 1976 and 1984 and likely to be resilient to a 1 in 200-year drought. However, through the use of more accurate catchment and system models with greater granularity, we have identified variations in resilience across the zone particularly when stressed by extreme drought. Under these conditions the ‘high-level’ reservoir systems have a lower relative storage than Llandegfedd, our key ‘low-level’ reservoir. The existing network connectivity is the limiting factor in our ability to better balance water resource between the ‘high’ and ‘low level’ systems.

The improvement in our understanding of catchment hydrology and reservoir inflows has meant that modelled drawdowns better reflect reality and show that during a drought, it will be the lack of storage in our Taff Fawr and Taff Fechan reservoirs that would cause any failures to meet customer demands.

This restriction in network capability to balance areas of ‘surplus’ resource against areas of ‘shortfall’ is exacerbated by climate change. Our modelling of the UKCP18 projections shows that the reduced inflow into our reservoirs means we see more years of ‘failure’ particularly in the Taff Fawr and Taff Fechan reservoirs. This supply capability, when set against our forecast baseline demand for water and an allowance for uncertainty, produces the starting supply demand position shown in Figure 63.

The drought of 2022 provides a good test of our current water supply assessment and also where these are inaccurate. During the period from March to September the storage levels in the reservoir systems declined, in line with our forecasts based upon recent hydrological assessments and this has given us confidence in the ability of our models to predict the response of the supply systems to extreme drought conditions. We also saw storage in our high level Taff reservoirs fall far more quickly than those in the low level Llandegfedd part of the supply system. This indicates a system constraint which does not allow us to effectively balance our water resources across the zone.

We also experienced a further constraint in abstraction from the River Usk, under very low flows, whereby our Prioress Mill pumping station experienced issues with abstracting our maximum permitted volumes when regulating from Usk reservoir.

The concern only relates to times when regulating the maximum 50 Ml/d which means we are permitted to abstract c70 Ml/d in total, however, we found that the pumps could not abstract more than 50 Ml/d due to the depth of water in the river being insufficient. We have undertaken further investigation and we now understand the issue.

The resolution is the need for investment in our Llantrisant pumping station, a kilometre or so downstream of Prioress Mill on the River Usk which would allow us to abstract within the current combined abstraction licence conditions the same volumes of water. However, to do so, we would need an effective fish screen in place. We have therefore not made any changes to the assumptions in our SEWCUS water resource model but are seeking funding through PR24 to deliver the intake screening required to maintain environmental compliance.

Against our 'most likely' future, the 'baseline' SEWCUS supply against demand balance shows a deficit across the 25 year planning period to 2050 (Figure 63)

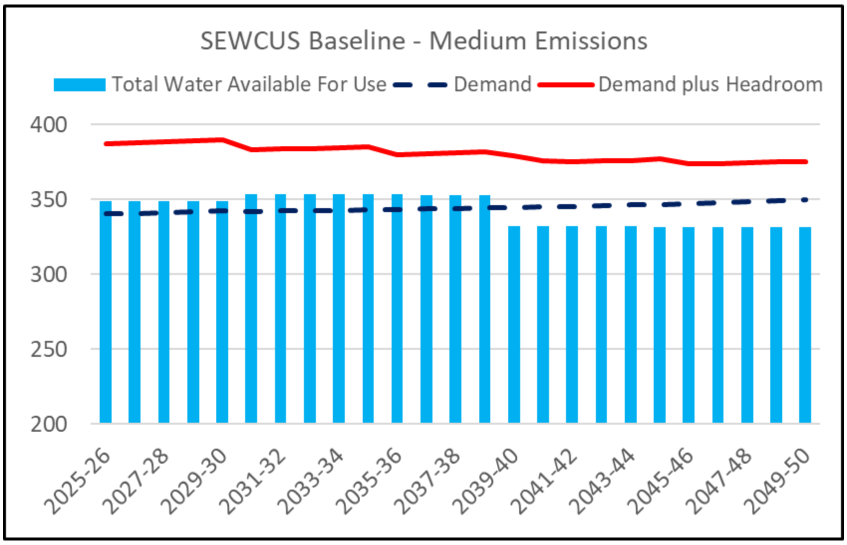


Figure 63 - SEWCUS S/D Balance with no Interventions

We have used our improved supply system models to understand the factors constraining our ability to effectively balance the water resources across the zone during very dry periods and what asset improvements might be needed to make use of the 'spare' water resource in Llandegfedd. It is clear that greater use of the Sluvad WTW is needed and the ability to move more water into the demand areas supplied by the Llwynon and Pontsticill (or new Cwm Taff project) WTWs. The model interrogation has shown there are essentially two factors at play that are contributing to the very low levels seen in the Taff reservoirs during drought:

1) The primary way in which we transfer water between the 'Low level' and 'High level' areas of SEWCUS is via the Memorial pumping station. Examination of the Aquator model performance during severe drought shows that the pumping station is used to its maximum capacity and so we cannot increase our level of deployable output.

2) There is the potential for poor water quality in the water main from Llwynon WTW southwards into Cardiff. To mitigate we maintain a minimum flow of 11 Ml/d in the main to retain turnover of water approximately every 24 hours thus ensuring an acceptable level of water pH. We do not currently have sufficient control systems in place to manage this issue.

As shown in the options engineering report (Appendix 13) we have appraised a wide range of supply side options for the SEWCUS zone, such as the reintroduction of currently unused sources (Grwyne Fawr, Wentwood reservoirs), new sources of water (Afon Lwyd, Great Spring) and interzonal transfers of water.

We have compared the cost of these projects against further demand management schemes using our Decision Lab optimisation tool. Given the cause of the deficit, demand management would need to be targeted within the SEWCUS Pontsticill or high-level zones to provide benefit. We have already targeted these zones within the overall demand management programme discussed above with the metering delivery Plan focusing on the SEWCUS zone (see Figure 59 above).

It's clear from our modelling that only options that provide additional resource into the 'high level' part of the zone will increase that area's drought resilience – the majority of the feasible options provide additional resource into the 'low level' area of SEWCUS and so do not provide an overall gain in zonal DO.

We have therefore rejected schemes that provide no benefit to meeting the cause of the DO constraint. Only three options remain that will provide benefit and the two least cost schemes that in combination increase zonal resilience within target have been selected as our preferred solution. These both directly benefit the 'high level' area and that in turn deliver our target levels of drought resilience in SEWCUS, namely:

1) A scheme that increases the capacity of the Memorial pumping station and associated network to allow increased supplies from the Sluvad/Court Farm WTW system to reduce the required outputs from the Llwynon/Pontsticill (Cwm Taff in AMP9) WTW.
2) A scheme that allows us to safely reduce the flow down the Llwynon trunk mains to zero, thus preserving storage in the Taff reservoirs and making them more drought resilient.

Although our long-term leakage and metering plans reduce zonal demand over time, this is insufficient to provide the required zonal resilience during the AMP8 and AMP9 periods. It is the twin track approach of supply and demand side schemes, as shown in Figure 64, that is needed to ensure sufficient levels of drought resilience are achieved during the 2025-2030 period.

The overall benefit to WAFU of the network enhancement schemes is 39Ml/d at a capital cost of c£20.3m which provides good value. Table 32 shows how often the additional capacity of the solutions would need to be used during varying drought return periods. Schemes utilisation is high, even in less severe dry years. The schemes also provide additional resilience to the high-level system works outages which will be needed in delivering the Cwm Taff scheme.

Return period (y)	Memorial/Cefn Mably WPSs enhancement – no. days operated/yr	Llwynon Trunk mains upgrades – no days operated/yr
500	140	95
200	126	83
100	113	75
50	96	68
10	41	38

Table 32 - Preferred supply side option utilisation

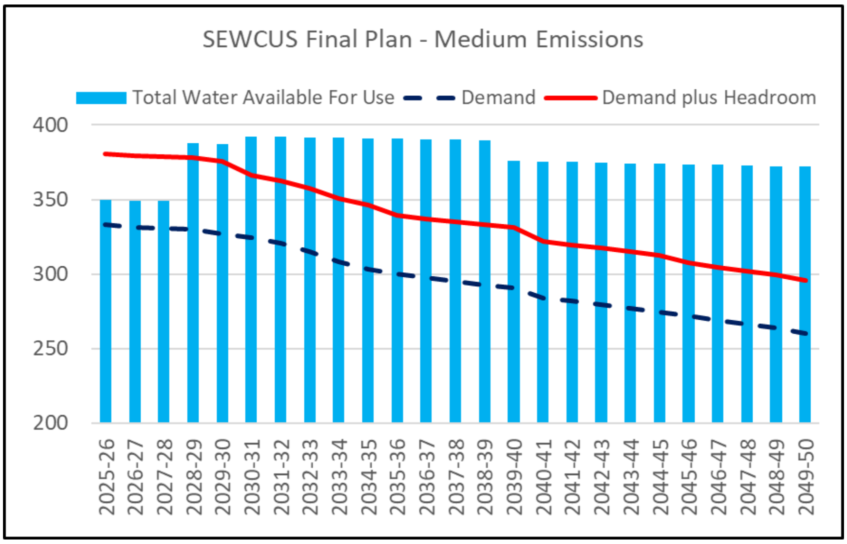


Figure 64 – SEWCUS Final Plan S/D Balance

Our programme of investment needed to meet the 'most likely' future for SEWCUS includes the delivery of the demand management programme and two network improvement schemes. This programme is 'Best Value' under the decision-making criteria set out in Section 5, in that delivery of <u>all interventions</u> will:

i. Provide enhanced resilience to drought, achieving 1 in 500-year resilience by end of AMP8 under a medium climate change emissions scenario
ii. Provide resilience against climate change, in line with Welsh Government and Natural Resources Wales guidance, when tested against a high emissions scenario
iii. Deliver environmental benefit through reducing the demand for water (c18 Ml/d reduction in an average year by 2030) thus contributing to achievement of SMNR aims
iv. Enhance the efficiency of our operations by making better use of existing resources rather than developing new resource, aligning with our customer preference.
v. Enhance our SEWCUS network connectivity which will provide wider supply resilience benefit during WTW outages or major bursts on the network
vi. Has no significant unmitigated environmental and social impact as described within the SEA of the Plan

6.5.3. Tywi Gower

In our WRMP19 we reported a positive supply demand position in the Tywi Gower zone, indicating good resilience under historic drought conditions, such as a 1976 or 1995, and that the system would be resilient to more extreme drought events of at least a 1 in 200 year return period. However, the use of locally derived inflows through our new rainfall runoff models and the development of greater network granularity in our Aquator models, have identified restrictions in the zone that constrain our supply capability during more extreme droughts.

The more realistic modelled behaviour of our reservoirs during dry weather has shown that both Ystradfellte and Crai storage would fall to very low levels, frequently breaching their defined emergency storage provision and hence triggering extreme measures (standpipes, rota cuts) more frequently than our target of 1 in 200 years on average. This pattern has been seen during the recent dry weather in 2020 and 2022 where Llyn Brianne storage held up well (and does in our modelling) but Crai and Ystradfellte both crossed their 'Developing Drought' lines. Usk reservoir storage can be supported through use of the abstraction from Manorafon.

The output of our modelling shows there is 'spare' resource in Llyn Brianne that could be utilised to offset the 'failures' in Crai and Ystradfellte but there are limitations into the network connectivity between the Felindre WTW and the Crai and Cefn Dryscoed WTW systems. This restriction in network capability becomes more pronounced when we model the impacts of climate change through use of the UKCP18 scenarios. The even lower catchment inflows into the Crai and Ystradfellte reservoirs means that further action is needed to reduce the demands on these sources.

The impact of this was observed during the 2022 drought event when the Crai and Ystradfellte reservoir volumes reduced to low levels while storage in the far larger Brianne Reservoir was in a relatively healthy position (See Figure 65).

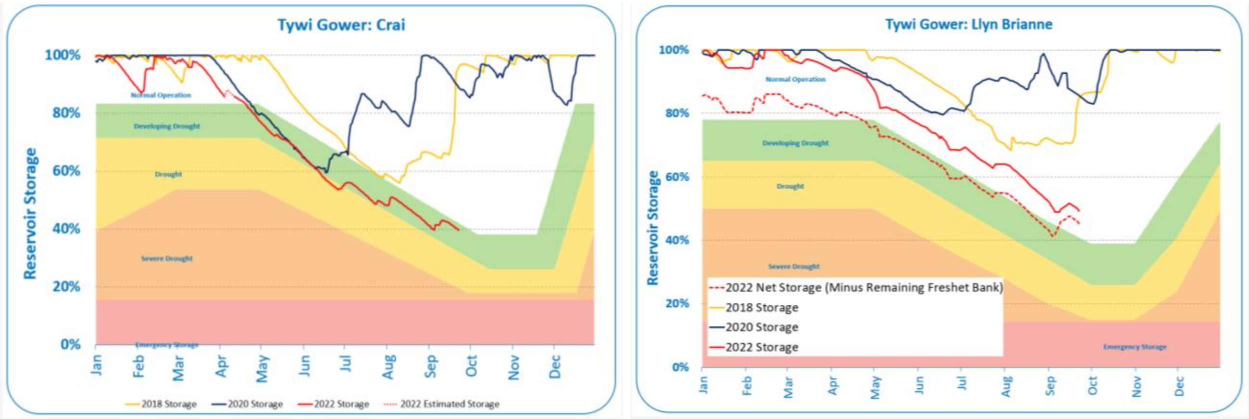


Figure 65 – Relative storage levels in the Tywi Gower reservoirs during the 2022 drought

Against our 'most likely' pathway, the 'baseline' Tywi Gower supply against demand balance shows a deficit across the 25 year planning period to 2050 (Figure 66).

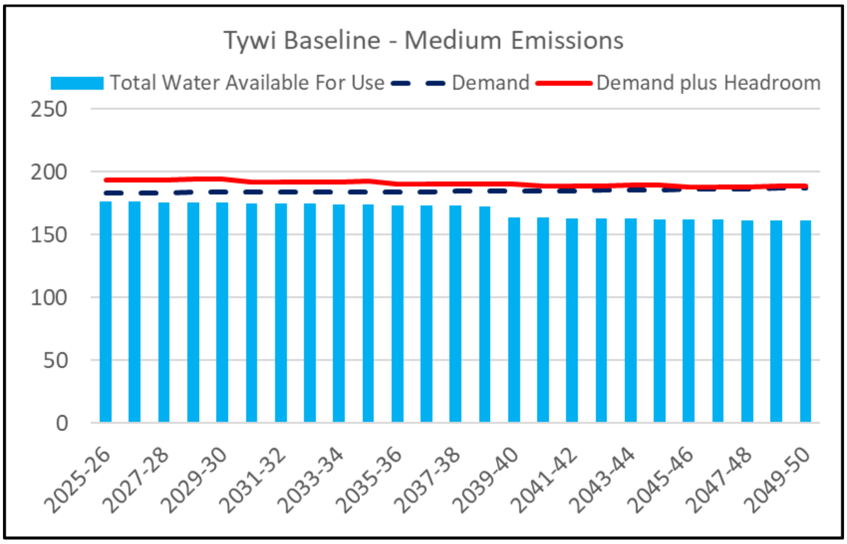


Figure 66 - Tywi Gower Baseline S/D Balance

The enhanced network representation that our Aquator models provide means we can use these to identify where the limitations are to our ability to move water between the various Tywi systems. The model interrogation has shown there are essentially two factors at play contributing to the very low levels seen during drought, in the Crai and Ystradfellte reservoirs:

1) Within the current Tywi Gower system the main connection between the Felindre and Crai systems is via the existing Christopher Road pumping stations. This essentially allows us to reduce the area supplied by Crai WTW and to supplement this with water from Felindre WTW. However, our modelling shows that during a drought, the hydraulic constraints of the network limit the area which can be supplied from Felindre prevent us from sufficiently reducing demands on Crai to preserve storage.
2) A similar pattern is seen for the Cefn Dryscoed system whereby the scope to reduce the area supplied from this works is limited. Water from Felindre can support Cefn Dryscoed by reaching the area from Neath and Skewen towards Tonna, but our modelling shows that during drought, this support and reduction in demands is insufficient to preserve storage in Ystradfellte.

As detailed in the options engineering report (Appendix 13) although we have appraised a wide range of supply side options for the Tywi Gower zone, the feasible list of schemes is much smaller than that of SEWCUS, with limited ability to either introduce new sources of water or re-introduce currently disused sources. We have however worked closely with our engineers to design schemes that will address the identified pinch points and enable a better balancing of supplies across the zone, thus increasing the overall supply capability and delivering a higher level of drought resilience. Our preferred supply side schemes for Tywi Gower are detailed below, as shown in Table 33, they have fairly high utilisation rates, even in less severe dry years.

1) A scheme that increases the capacity of the Christopher Road pumping station and associated network to allow increased supplies from the Felindre WTW system to reduce the required outputs from Crai WTW, which in turn reduces the abstraction needed from Crai reservoir.
2) A scheme that allows us to safely reverse the flow through the Tonna control valve, which is the key asset for controlling the balance of supply between the Felindre and Cefn Dryscoed systems. Water quality issues mean that currently this is a difficult operation to achieve and so this scheme will significantly upgrade the asset to allow more frequent and greater operation of this flow reversal.

Although the metering programme is targeted on the Tywi zone early within the Plan, this is insufficient to provide zonal resilience during the AMP8 period and the demand management schemes do not provide the additional resilience against outages at the Crai or Cefn Dryscoed water treatment works. In addition, the schemes mitigate against alternative future risks as detailed in section 6.7.

The overall benefit to WAFU of the network enhancement schemes is 31Ml/d at a capital cost of c£20.3m which provides good value. Table 33 shows how often the additional capacity of the solutions would need to be used during varying drought return periods. The utilisation of both schemes is relatively high, even in less severe dry years and as stated above add significant resilience to the customers served from the Crai and Ystradfellte reservoirs and associated works.

Return period (y)	Christopher Road WPS enhancement– no. days operated/yr	Tonna enhancement – no days operated/yr
500	202	166
200	186	144
100	163	125
50	141	105
10	74	42

Table 33 - Tywi Gower option utilisation

As with the SEWCUS zone, the Tywi Gower Plan generates increased capability to meet at least a 1 in 500 drought resilience by 2030 through demand management activity. As with all zones, this mitigates risk around future climate change impact pathway, customer usage behaviour and some potential environmental needs, as demonstrated in the scenario testing described in Section 6.4. It is the twin track approach of supply and demand side schemes, as shown in Figure 67, that is needed to ensure sufficient levels of drought resilience across the planning period, particularly when the effects of climate change are accounted for.

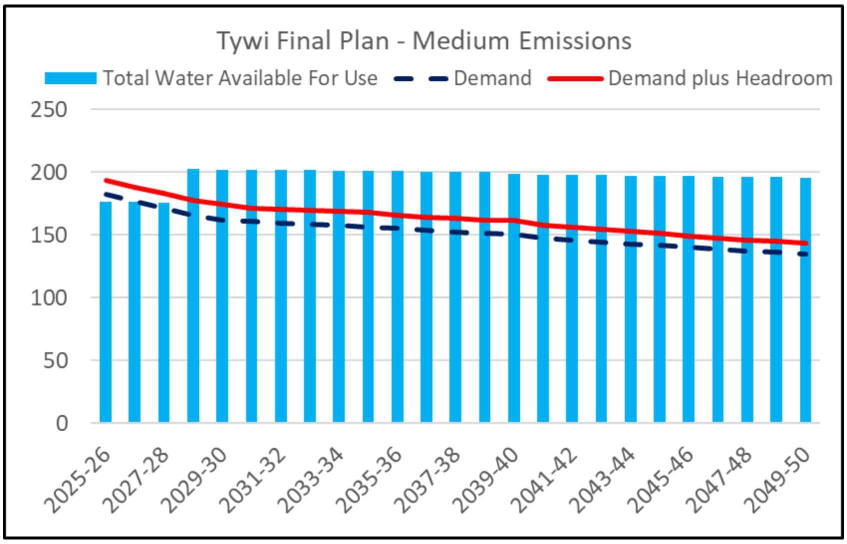


Figure 67 - Tywi Gower Final Plan S/D Balance

6.5.4. Clwyd Coastal

Within our WRMP19 we reported a surplus supply demand position for the Clwyd Coastal zone, when tested against worst historic droughts, such as 1976, 1984 and initial analysis suggested the zone was resilient to more severe droughts such as those occurring 1 in 200 years on average. Within our draft Plan we identified that the zone had a minor supply demand shortfall when tested against more extreme drought conditions. We have since re-appraised our supply demand balance, notably our forecast demand and the plans we have to reduce leakage in the zone. Given the scale of reduction in leakage volumes we anticipate making in the remainder of AMP7, we are now forecasting this will provide us with a robust supply demand position against our target levels of drought resilience.

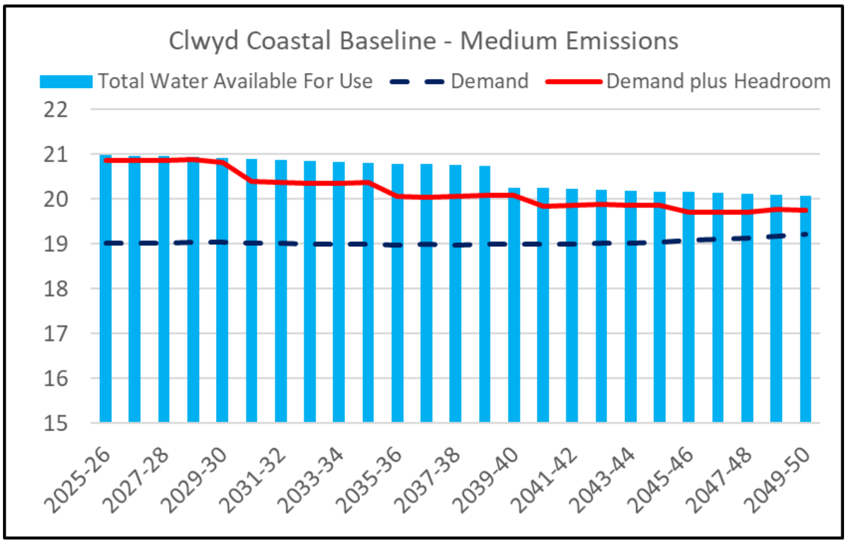


Figure 68 – Clwyd Coastal Baseline S/D Balance

6.5.5. Lleyn-Barmouth

In the WRMP19 Plan we reported a positive supply demand position for the zone against a repeat of worst historic drought periods. We have now revised many of the components of the balance based on improved evidence including latest climate change data. The position has remained positive with proven resilience to at least a 1 in 200 year drought but without any intervention we will not reach our higher 1 in 500 year drought resilience target (see Figure 69).

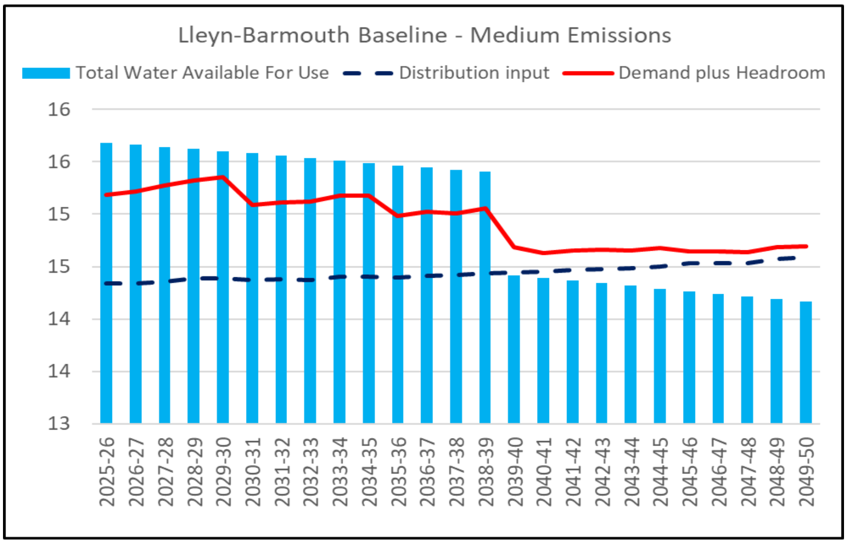


Figure 69 - Lleyn-Barmouth Baseline SDB

Our preferred Plan overcomes this balance deficit through our demand management proposals so that we meet our higher drought resilience objectives throughout the planning period (Figure 70).

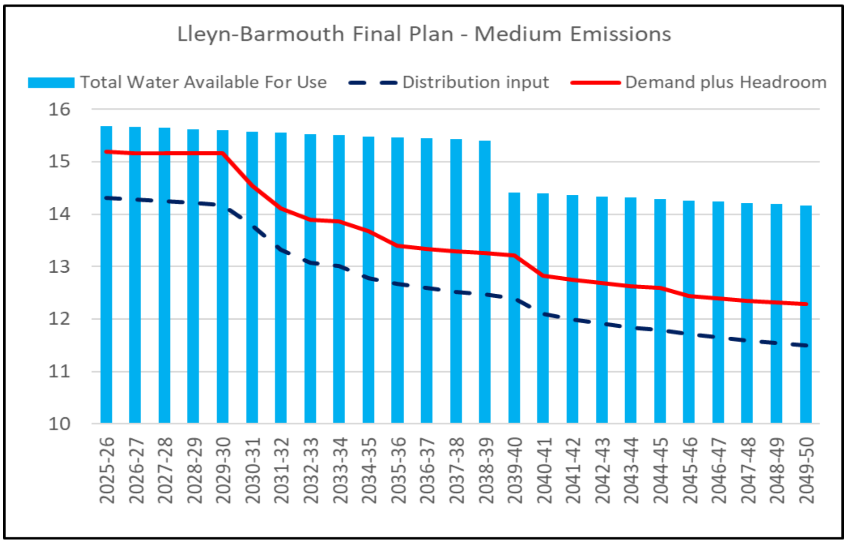


Figure 70 - Lleyn Barmouth Final Plan SDB

6.5.6. Mid & South Ceredigion

For WRMP19 we reported a healthy surplus through the planning period for the Mid & South Ceredigion zone and estimated that we would be resilient to a 1 in 200-year drought event. This position was reported against the Dry Year Annual Average but since then, recent hot, dry weather events including summer 2022, have presented significant pressure upon our peak supply capability.

Within our draft Plan we identified that the zone had a supply demand shortfall when tested under critical period conditions and proposed a scheme to upgrade our treatment works capacity at Llechryd, together with an increase in the daily abstraction volume, to provide additional water to meet these peaks in demand. We have since re-appraised our supply demand balance, notably our forecast demand and the plans we have to reduce leakage in the zone that we have recently identified on our trunk mains. Given the scale of reduction in leakage volumes we anticipate making in the remainder of AMP7, we are confident this will deliver a robust supply demand position and provide our customers with high levels of drought resilience, whilst benefiting the environment through reducing the water we need to take from the Afon Teifi.

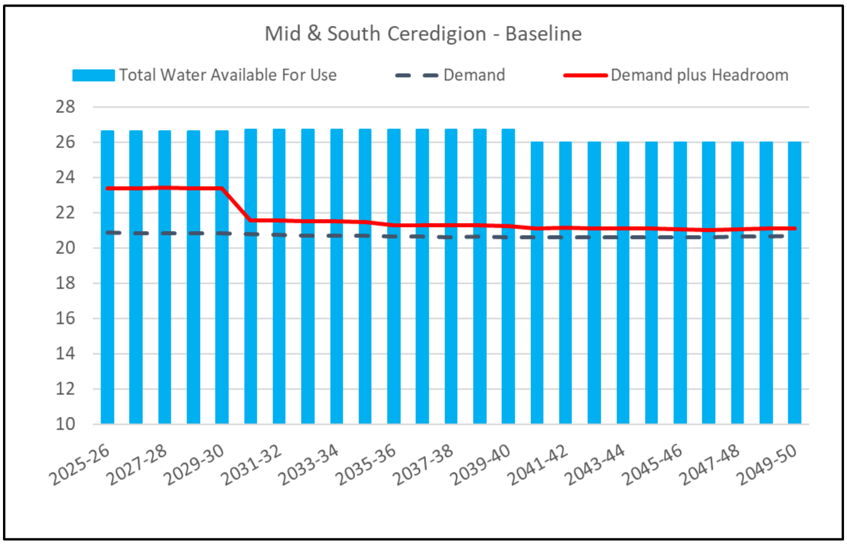


Figure 71 - Mid & South Ceredigion S/D Balance – Critical Period

6.5.7. Pembrokeshire

In our WRMP19 we reported that with the proposed solution at our Canaston Bridge pumping station in place to support storage in Llys-y-Fran, the zone would be resilient to a 1 in 200-year drought event. This position was reported against the Dry Year Annual Average though we also noted that our critical period capability was constrained by our maximum supply capacity across the Cleddau Bridge into South Pembrokeshire.

Since WRMP19, work has commenced to upgrade Canaston Bridge to enable a constant rate of abstraction using variable speed drives and updated automation and control systems. This work is ongoing and is programmed for completion in 2023. The temporary pumping arrangement put in place during the summer of 2022 essentially replicated the benefits we will get from delivery of the permanent scheme and helped ensure that despite the very dry weather we experienced, the only restrictions we had to place upon our customers was a Temporary Ban on Water Use.

We have also delivered work to resolve the supply restriction into South Pembrokeshire by installing a new booster pumping station adjacent to the Cleddau Bridge. This has enabled South Pembrokeshire to be supplied from Bolton Hill without resorting to tankering and enabled the removal of an over-land main across the Cleddau Bridge which was installed in 2018 to help meet peak demands.

As shown in Figure 72 these improvements to our supply capability, together with our planned reductions in demand, will deliver the required level of drought resilience for the zone until late in the planning period. The planned demand management activity will significantly increase the drought resilience across the zone and could help to support industrial growth into the future.

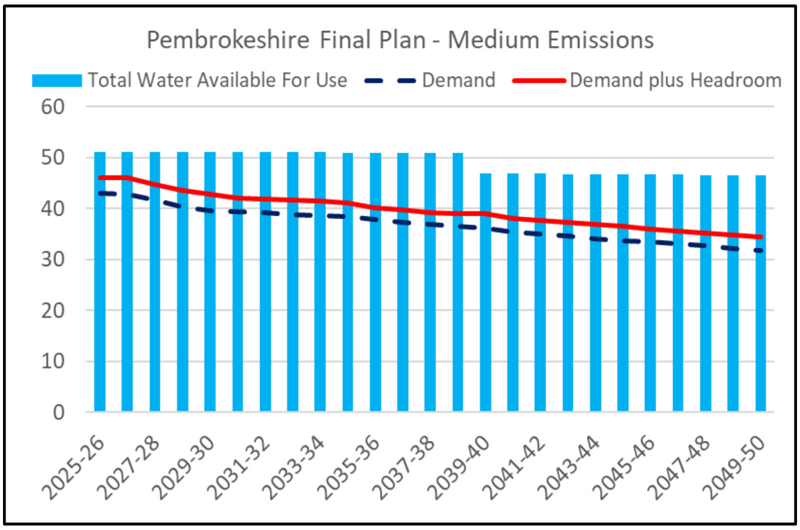


Figure 72 - Pembrokeshire Final Plan S/D Balance

6.5.8. Hereford CUS

As set out in WRMP19 and confirmed here, we have a high level of drought resilience in the zone, primarily due to the large and reliable source of water from the River Wye at Hereford. Drought risk in this, and the neighbouring zones, is driven by peak demands which test the limits of our network infrastructure and often means we have to resort to augmenting supplies by road tankers for a number of weeks at a time during periods of hot sunny weather during the summer months.

The critical period supply demand balance baseline shows a relatively tight position (Figure 73) though future demand savings from our strategy greatly improve this. However, there is risk to this supply position from likely reductions to the allowable abstraction for our groundwater source at Leintwardine.

Studies completed in AMP7 as requested under our WINEP, show that abstraction at Leintwardine, alone, may not significantly impact local river flows below environmental flow targets, however, this may be the case when other upstream abstractions are considered in tandem, particularly under low flow conditions.

The Environment Agency have provided us with an initial view of the level of abstraction reduction that may be required by abstractors. We plan to complete additional collaborative studies in AMP8 to better understand the ecological risks in the catchment as a whole and to confirm the scale of licence reduction that would be required, to determine if any additional schemes are required for delivery in AMP9.

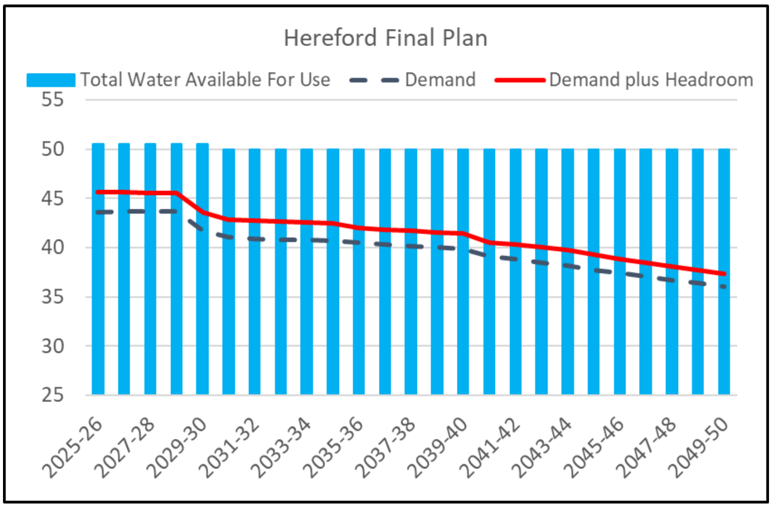


Figure 73 - Hereford Baseline S/D Balance

6.6. Testing the Plan

6.6.1. Scenario testing

Our Plan is based on long term forecasts of supply and demand needs and meets our objectives under the 'most likely' future environmental and social circumstances that we might encounter. The investment pathway for this scenario includes an allowance for uncertainty, but there are some key assumptions within our Plan that could change into the future which may require additional investment to address. Our regulators have asked that we explore the impacts of this through stress testing of our plans to a range of plausible future scenarios, including Ofwat's PR24 Common Reference Scenarios. The outputs from this testing have informed the makeup of our 'core' pathway of investment that would be required under all possible future scenarios. We have also identified alternative pathways due to potential significant deviations from our 'most likely' pathway.

The three areas of most significant risk for our Plan are:

1) Environment – our supply capability is reduced due to changes made to our permitted abstraction volumes in order to achieve environmental objectives for those waterbodies we take our water from. We abstract from a number of rivers that are designated as Special Areas of Conservation (SAC) and we know from previous work on the Habitats Directive they are highly sensitive to changes in flow, meaning the effects of climate change will likely pose a significant challenge to maintain their high ecological status. Alongside this, we already have known sites of concern, such as our groundwater abstraction at Llanerch Park, one of our key sources of supply in the Clwyd Coastal zone and so this scenario also addresses the impact of these upon our supply capability. To ensure any reductions in available abstraction are made using the best available evidence, we plan to deliver our largest ever set of NEP investigations in AMP8, meaning that potentially from AMP9 we could see changes to our abstraction licences, hence why this scenario starts with a 5% reduction in DO from 2030.
2) Demand – our plan relies heavily on achieving significant reductions in the volume of water used by our customers and so if these are not achieved, our drought resilience might be lower than targeted. Our demand reductions are on an unprecedented scale and rely heavily on customer behaviour changing significantly and so this is clearly an area of significant uncertainty and one where underachievement will leave our drought resilience lower than expected.
3) Climate change – our surface water systems are vulnerable to the effects of climate change, notably the likely increased effect of drier summers and this situation is worsened if the world warms at a higher rate than our Plan assumes. We have adopted a medium emissions scenario as our most likely pathway but with the latest science indicating that we are currently on an emissions path that would exceed this, we have tested our Plan against a warmer future to ensure it is robust. Guidance from Welsh Government is clear that companies in Wales need to be fully resilient to climate change.

To assess these areas of risk, our Plan has been tested through changing the following assumptions from our 'most likely' pathway:

Component	Most Likely	Alternative	Ofwat Common Reference Scenario
Environment	Zero reduction to DO	5% reduction to DO from 2030, 10% reduction to DO from 2040	'High' environment
Demand	Leakage reduces by 87 Ml/d by 2050. Customer usage reduces by 119 Ml/d by 2050	Leakage reduces by 87 Ml/d by 2050 Customer usage reduces by 59.5 Ml/d by 2050	'High' demand
Climate Change	RCP6.0	RCP8.5	'High' climate

Table 34 – Changes to our planning assumptions

We have appraised all our WRZs against the above alternative scenarios, both individually and in combination, to understand what, if any, additional schemes are required over and above that set out in our ‘most likely’ investment pathway. To ensure our ‘Core’ pathway contains all the required ‘no regrets’ investment we have also tested our Plan against ‘Low’ scenario criteria, notably incorporating the impact to our supply capability of lower-than-expected climate change.

We have also appraised the impact to our drought resilience of not achieving the full savings from our AMP7 leakage reduction plan, meaning that we would start AMP8 at a higher leakage level than forecast. However, as a scenario on its own it is much less severe than the ‘high’ scenarios we’ve tested and does not result in any additional investment required, over and above that set out in our preferred plan and we still achieve our target levels of drought resilience by 2029/30. If this scenario were to occur, then we would adjust our AMP8 delivery plans accordingly to recover this leakage. The outputs of this scenario do not therefore form part of either our ‘core’ plan or any alternative pathways within.

Our testing has identified that of our 23 zones, there are 5 (SEWCUS, Tywi Gower, Clwyd Coastal, Lleyn-Barmouth, Pembrokeshire), where additional future investment may be required to maintain our drought resilience under the most extreme alternative futures explored. The following section describes our approach within each zone and shows any alternative investment pathways and associated trigger points that will form part of an adaptive future plan.

6.6.2. Scenario Testing results

Against our most likely pathway, we have tested five common alternative pathways:

1) High environmental destination – assumptions as per ‘most likely’ but with DO reduced by 5% from 2030 and 10% from 2040
2) Low demand savings - assumptions as per ‘most likely’ but with our assumed savings in customer usage reduced by 50%
3) High environment + climate change– assumptions as per ‘most likely’ but with DO reduced by 5% from 2030 and 10% from 2040, high emissions scenario RCP8.5
4) Low climate change– assumptions as per ‘most likely’ but using the low emissions scenario RCP2.6
5) Compound High– assumptions as per ‘most likely’ but with DO reduced by 5% from 2030 and 10% from 2040, high emissions scenario RCP8.5, assumed savings in customer usage reduced by 50%

From the above, it’s clear that scenarios 3 and 5 will have the largest impact upon our supply demand position, which is borne out in the charts below whereby these generally show that across all 5 zones, additional investment would be required to maintain a supply resilience against objectives into the future under the most extreme scenarios.

The effect of including potential sustainability reductions and lower than expected reductions in customer usage, means these two areas need to have their own pathways to address them given we feel these are highly plausible risks that could materialise as we progress through AMP8. The graphs below show the supply demand position under each scenario for the zones at risk.

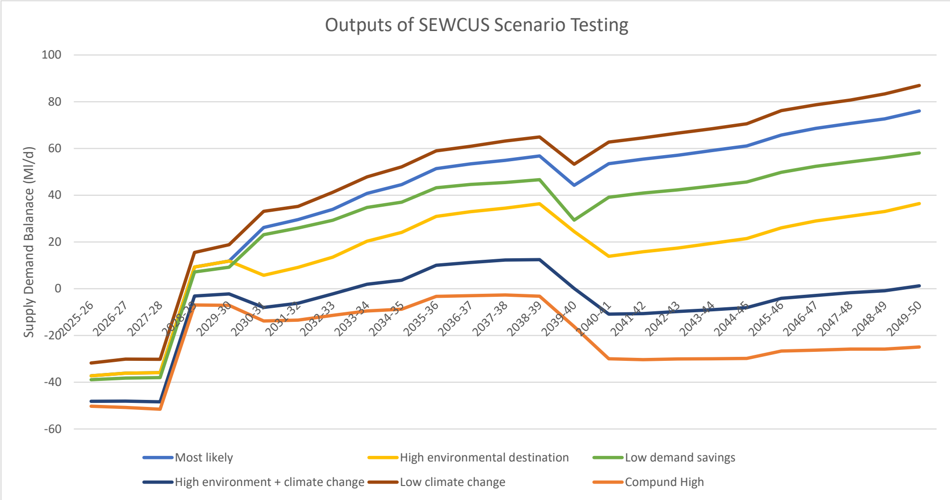


Figure 74 – Results of SEWCUS scenario testing

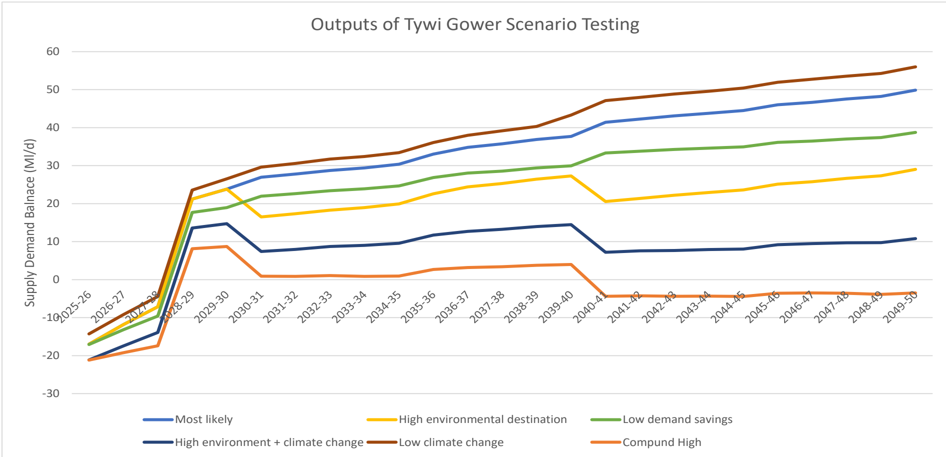


Figure 75 - Results of Tywi Gower scenario testing

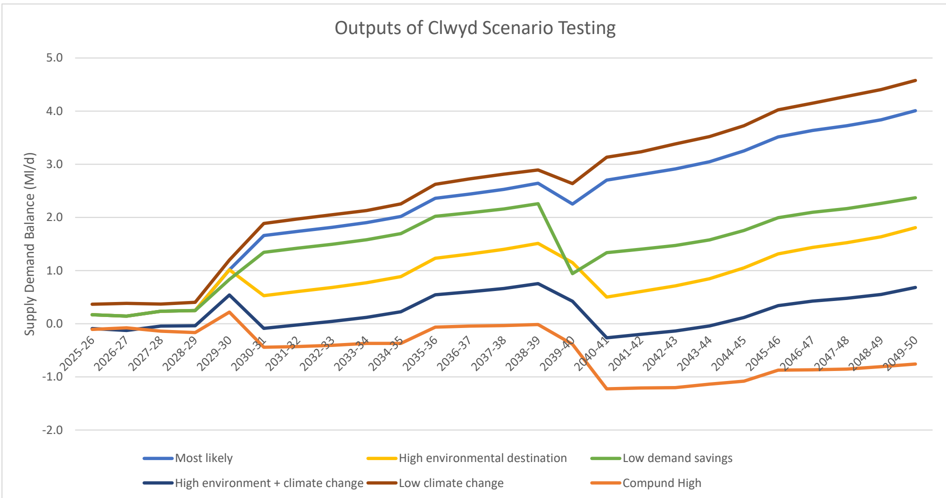


Figure 76 - Results of Clwyd Coastal scenario testing

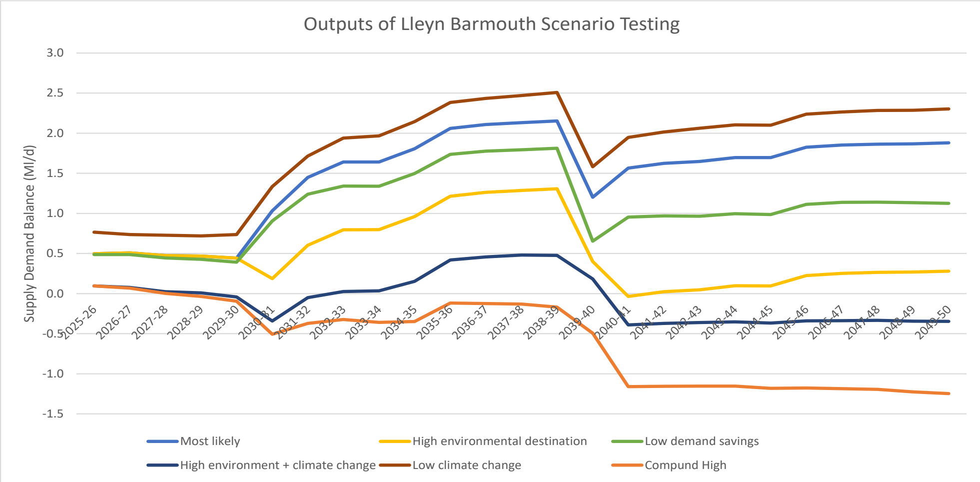


Figure 77 - Results of Lleyn Barmouth scenario testing

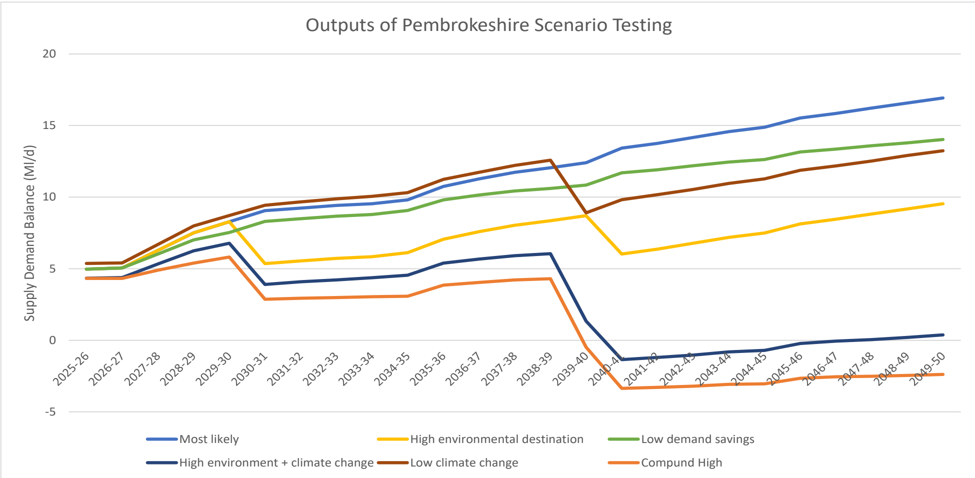


Figure 78 - Results of Pembrokeshire scenario testing

6.7. Adaptive Planning and Alternative Pathways

The results of our scenario testing suggest that our Plan may need to adapt to future risks and so we have developed additional pathways to meeting our objectives under the three potential futures, namely:

1) 'Most likely'
2) 'Sustainable Abstraction'
3) 'Compound high'

6.7.1. Most Likely Pathway

Our 'Most Likely' pathway at a company level is made up of the following components:

- Leakage – 10% reduction during AMP8, 50% reduction (from 2017/18) by 2050
- Per Capita Consumption – reduced to an average of 110 l/h/d during a dry year
- Business demand – 11% reduction (against 2019/20 levels) by 2050
- Drought resilience – achieve 1 in 200 by 2029/30 and 1 in 500 by 2039/40

Table 35 summarises the delivery profile of our preferred set of schemes to achieve these targets whilst Table 36 provides a high level summary of the associated costs.

	AMP8	AMP9	AMP10	AMP11	AMP12
Leakage reduction Ml/d	18.58	17.20	17.07	17.03	17.03
Business demand reduction Ml/d	4.81	2.18	2.07	0.95	2.31
Household demand reduction Ml/d	23.76	28.98	15.92	21.14	16.48
Water Available For Use increase Ml/d	65.41	64.61	78.22	76.76	75.31

Table 35 – Summary of the key elements (company level) of our preferred Plan

	AMP8	AMP9	AMP10	AMP11	AMP12
Smart metering £m	110.69	73.55	5.09	20.61	14.66
Leakage £m	4.44	5.10	50.79	59.54	93.37
Business water efficiency £m	4.78	6.17	2.99	1.66	3.46
Household water efficiency £m	8.97	8.97	8.97	19.54	47.35
Supply side £m	45.01	0.00	0.00	0.00	0.00

Table 36 - Summary of the Capital costs (company level) of our preferred Plan

We have estimated the potential impacts to our customer's bill from delivering the enhancement expenditure identified in Table 36 and have set this out in Table 37. This is a very high level estimate and is used to provide an indication of the impact this level of enhancement expenditure could have upon future customer bills.

	AMP8	AMP9	AMP10	AMP11	AMP12
Enhancement Spend Preferred Plan (£m)	173.90	93.79	67.84	101.36	158.84
AMP period bill impact (£/yr)	6.96	7.50	5.43	8.11	12.71
Cumulative bill impact (£/yr)	6.96	14.46	19.89	27.99	40.70

Table 37 - Estimated increase to customer bills from WRMP24 enhancement

6.7.2. Additional Options for Adaptive Planning

For each zone we have followed our decision making process described in Section 5 to identify the additional 'Best Value' programme of schemes that would be required under this pathway. Under these scenarios we still need to meet all objectives so the logic around achieving PCC and Leakage target remains. The key objective under these scenarios is to meet drought resilience within each zone. This can be achieved through additional demand management effort or through supply side schemes. The lowest cost demand management options are utilised within the preferred programme with additional demand management costs increasing substantially as the number of available options diminish.

A summary of the options available is given below; note that the capital costs stated for the additional leakage options are just the "transition" costs i.e the spend required to make the saving only. We have provided summary details of the network transfer options as a comparator against the available demand management options. In all cases these network schemes are a much lower cost and provide 'Best Value' given they deliver enhancement to our drought resilience and other business risks, such as interruptions to Supply.

SEWCUS

The scenario deficits in the SEWCUS zone are shown in Figure 74 above. We have already appraised a number of supply side options in Chapter 5 and so those that do not form part of our preferred plan are all available for selection. The DO benefit of the available schemes is dependent upon the order of use. For example, the majority of these schemes provide no yield until our planned network enhancements under the 'most likely' scenario are completed, as these allow us to fully move water around the zone. Nominal values are given in Table 38. The Afon Lwyd option has been excluded as it may be required to support the Canal and Rivers Trust demand at Brecon if needed (See section 6.9).

Supply Scheme	AIC (p/m3)	Nominal Yield (Ml/d)
Grwyne Fawr for regulation	9	10
Great Spring to Court Farm	36.58	30
Great Spring to Llandegfedd	31.23	30
Minor dam raising at Talybont	30.42	5
Ponthir effluent reuse plus Wentwood	39.42	30
Ynys y Fro and Pant yr Eos to Court Farm	16.64	10
Reinstate Schwyll	39.29	20
Nantybwch washwater recovery	50.54	2
Wentwood reservoir to Court Farm	35.0	5

Table 38 – Additional Options in SECWUS available for selection

The key Demand management options with lowest AICs are:

- Active Leakage Control – 1.32 Ml/d for £0.77m (average AIC 109 p/m3)
- Permanent Acoustic Logging – 0.63 Ml/d for £1.75m (average AIC 4,796 p/m3)
- Intensive Active Leakage Control – 0.10 Ml/d for £0.176m (average AIC 407 p/m3)
- Pressure management – 0.19 Ml/d for £0.976m (average AIC 1,188 p/m3)
- Distribution mains Renewal – 2.44 Ml/d for £126.25m (average AIC 7,756 p/m3)
- Trunk Mains Active Leakage Control – 8.57 Ml/d for £12.70m (average AIC 187 p/m3)
- Trunk Mains Monitoring – 1.83 Ml/d for £27.33m (average AIC 3,071 p/m3)

The deficits and chosen solutions under each pathway are:

Alternative Future 1 – Sustainable Abstraction – 10.9 Ml/d deficit from 2030/31

i. Reinstate Pant yr Eos and Ynys y Fro (option ref: SEW036c) –2030/31
ii. Talybont minor dam Raising (option ref: SEW007) – needed from 2040/41

Alternative Future 2 – Compound High – 30.31 Ml/d deficit from 2040/41

i. Reinstate Pant yr Eos and Ynys y Fro (option ref: SEW036c) – needed from 2030/31
ii. Talybont Dam Raising (option ref: SEW007) – needed from 2040/41
iii. Utilisation of Grwyne for regulation to Prioress Mill (option ref: SEW009) – needed from 2040/41
iv. Reinstate Wentwood reservoir (option ref: SEW064) – needed from 2040/41

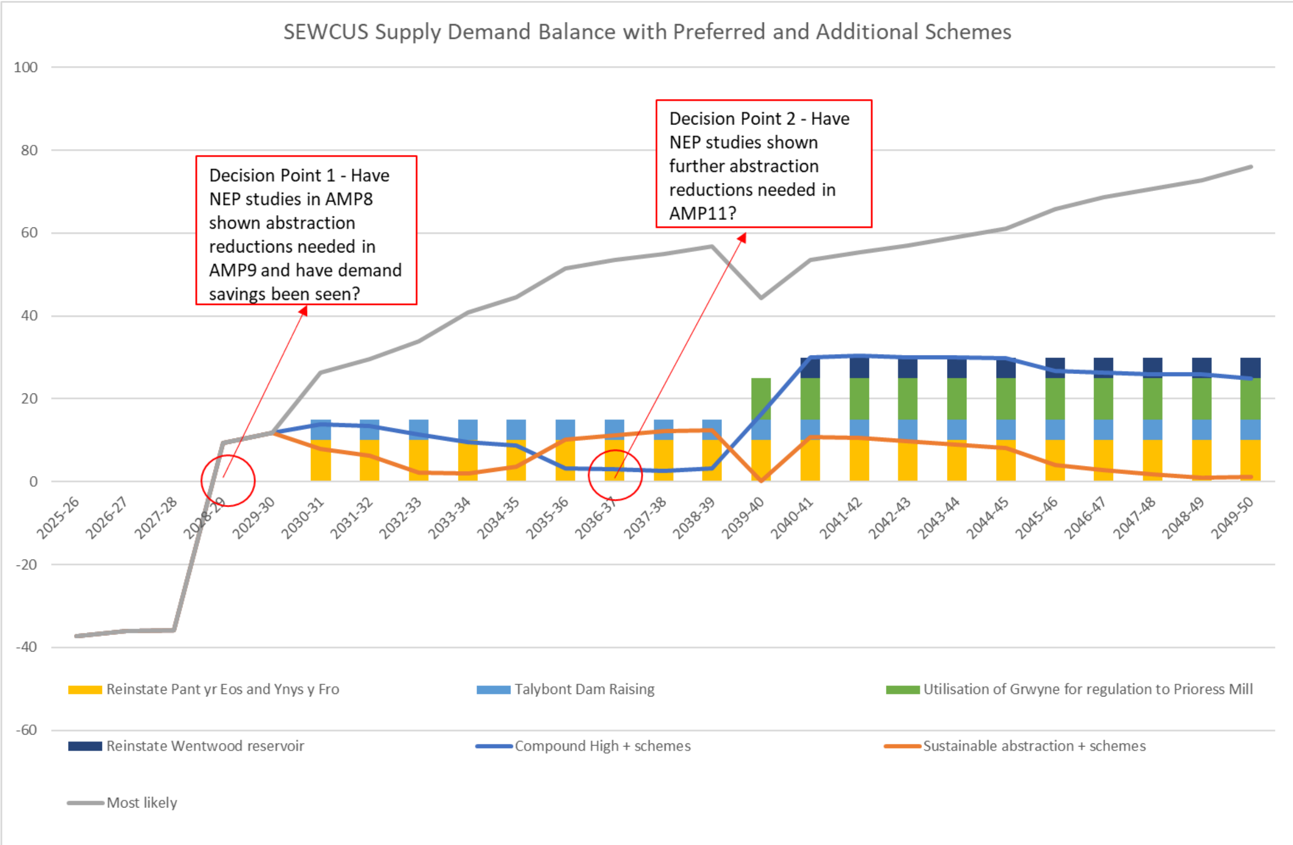


Figure 79 - Additional SEWCUS Schemes to mitigate alternative futures 1 and 2

Under a high emissions pathway alone, the point at which we would meet our desired level of service would be delayed by 2 years. However, if this is combined with abstraction licence reductions in AMP9 then we would need further investment that would be detailed within our WRMP29. Under the combined high pathway, we would need to trigger the introduction of new schemes in AMP10 to support abstraction licence reductions in AMP11.

Tywi Gower

The scenario deficits in the Tywi zone are shown in Figure 75 above. The zone has substantial water resource, with the preferred Plan making best use of this through strategic network transfers.

- Bryngwyn WTW washwater recovery (option ref: TWG03)
- Active Leakage Control – 0.07 Ml/d for £0.026m (average AIC 87 p/m3)
- Permanent Acoustic Logging – 0.24 Ml/d for £0.47m (average AIC 364 p/m3)
- Distribution Mains Renewal – 0.62 Ml/d for £25.6m (average AIC 9,240 p/m3)
- Trunk Mains Active Leakage Control – 2.02 Ml/d for £3.02m (average AIC 198 p/m3)
- Trunk Mains Monitoring – 0.10 Ml/d for £7.93m (average AIC 11,594 p/m3)

The imbalances and the preferred solutions are:

Alternative Future 1 – Sustainable Abstraction – no additional deficit forecast

Alternative Future 2 – Compound High – 4.38 Ml/d deficit from 2040/41

i. Bryngwyn WTW washwater recovery (option ref: TWG03) – needed from 2040
ii. Trunk Mains Active Leakage Control

Even under the sustainable abstraction pathway there would be no need for further investment required. Under the 'combined high' pathway we would see a small deficit against target resilience which we could resolve relatively easily through additional focus on demand management and or Bryngwyn washwater recovery. As can be seen on Figure 80, without the proposed network reinforcement schemes in place, the position would be very different with significant deficits under the majority of future scenarios. This emphasises the need for these schemes.

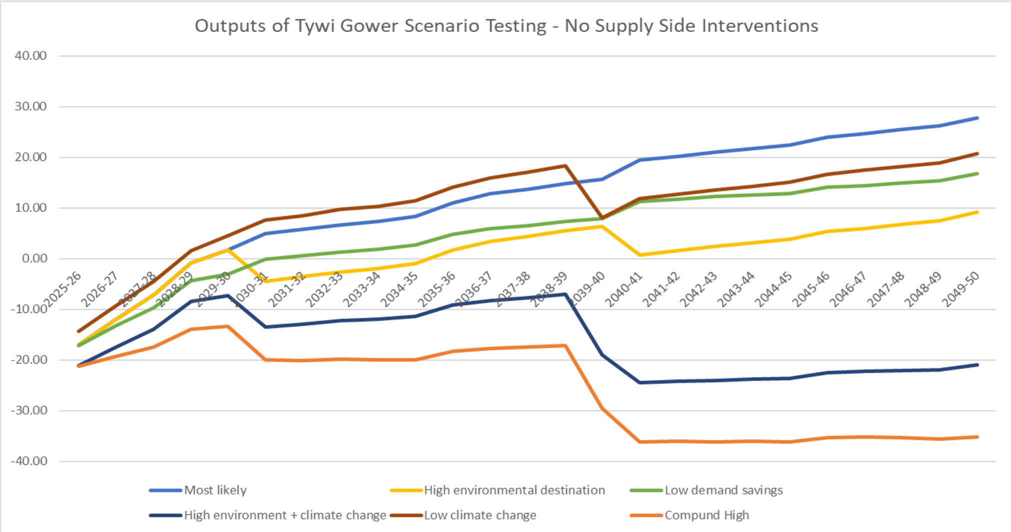


Figure 80 - Results of Tywi Gower scenario testing - no supply side options

Clwyd Coastal

The zonal deficits for the two future scenarios are:

Adaptive Pathway 1 – Sustainable Abstraction – 0.26 Ml/d deficit from 2030-31

Adaptive Pathway 2 – Compound High - 1.22 Ml/d deficit from 2040-41

Options to resolve are:

- New link main between the Alwen and Clwyd supply zones - max 1.5 Ml/d for £2.9m (average AIC 22.6 p/m3)
- Active Leakage Control – 0.06 Ml/d for £0.028m (average AIC 74 p/m3)
- Permanent Acoustic Logging – 0.08 Ml/d for £0.12m (average AIC 286 p/m3)
- Intensive Active Leakage Control – 0.03 Ml/d for £0.055m (average AIC 255 p/m3)
- Pressure management – 0.03 Ml/d for £0.051m (average AIC 394 p/m3)
- Distribution mains Renewal – 0.14 Ml/d for £2.93m (average AIC 3,214 p/m3)
- Trunk Mains Active Leakage Control – 0.40 Ml/d for £0.59m (average AIC 163 p/m3)
- Trunk Mains Renewal – 0.10 Ml/d for £2.68m (average AIC 2,826 p/m3)
- Trunk Mains Monitoring – 0.16 Ml/d for £2.02m (average AIC 2,811 p/m3)

The solution is straight forward in both cases and given the risk we will undertake detailed design work on the Alwen to Clwyd Coastal link main during AMP8. A decision to construct this scheme would then be taken as part of WRMP29.

Lleyn Barmouth

The scenario deficits in the Lleyn Barmouth zone are shown in Figure 77 above. Our proposed demand management strategy substantially mitigates against a higher climate change emissions scenario and potential sustainable abstraction reductions during AMP9, however this may create a small water resources deficit. The options to resolve are:

- New link main between the Cwellyn (North Eryri Ynys Mon WRZ) and Cwm Dulyn supply zones - max 0.6 Ml/d for £0.51m (average AIC 19.8 p/m3)
- Active Leakage Control – 0.16 Ml/d for £0.06m (average AIC 78 p/m3)
- Permanent Acoustic Logging – 0.17 Ml/d for £0.18m (average AIC 219 p/m3)
- Intensive Active Leakage Control – 0.10 Ml/d for £0.17m (average AIC 364 p/m3)
- Distribution mains Renewal – 0.06 Ml/d for £1.44m (average AIC 2,453 p/m3)
- Trunk Mains Active Leakage Control – 0.34 Ml/d for £0.65m (average AIC 184 p/m3)
- Trunk Mains Renewal – 0.17 Ml/d for £7.71m (average AIC 6,659 p/m3)
- Trunk Mains Monitoring – 0.001 Ml/d for £0.31m (average AIC 42,487 p/m3)

Under these extreme scenarios we would take a twin track approach through increased find and fix effort and link the zone to the north with North Eryri Ynys Mon. This would provide some additional resilience against treatment works outages.

Adaptive Pathway 1 – Sustainable Abstraction – 0.39 Ml/d

i. New link main between the Cwellyn (North Eryri Ynys Mon WRZ) and Cwm Dulyn supply zones

Alternative Pathway 2 – Compound High –1.25 Ml/d

ii. New link main between the Cwellyn (North Eryri Ynys Mon WRZ) and Cwm Dulyn supply zones
iii. Active Leakage Control
iv. Trunk Mains Active Leakage Control
v. Permanent Acoustic Logging

Given the risk identified we will undertake detailed design work on the most appropriate network link scheme to the Lleyn Barmouth zone during AMP8. A decision to construct the scheme would then be taken as part of WRMP29.

Pembrokeshire

The scenario deficits in the Pembrokeshire zone are shown in Figure 78 above. Our proposed demand management strategy substantially mitigates against a higher climate change emissions scenario and potential sustainable abstraction reductions during AMP9. Small water resources deficits occur in both of the alternative futures:

Alternative Pathway 1 – Sustainable Abstraction - Pembrokeshire – 1.35 Ml/d deficit from 2030/31

Alternative Pathway 2 – Compound High – 3.36 Ml/d deficit from 2030/31

The potential options to resolve are:

- New link main with the Tywi Gower WRZ – max 5 Ml/d for £23.98m (average AIC 65.8 p/m3)
- Active Leakage Control – 1.07 Ml/d for £0.82m (average AIC 162 p/m3)
- Permanent Acoustic Logging – 0.63 Ml/d for £0.83m (average AIC 210 p/m3)
- Intensive Active Leakage Control – 0.15 Ml/d for £0.24m (average AIC 296 p/m3)
- Trunk Mains Monitoring – 0.17 Ml/d for £5.39m (average AIC 7.974 p/m3)

For both pathways, the preferred solution would be to construct a new link main with the between Tywi Gower and Pembrokeshire WRZ. This is both least cost and would provide additional resilience to the Pendine source in the south of the Pembrokeshire zone. Given the risk we will undertake detailed design work on the link main during AMP8 with a decision to construct this scheme taken as part of WRMP29.

We have estimated the high level costs to deliver these two alternative pathways and ensure our levels of drought resilience are maintained in the face of the identified risks. As shown in Table 39 and Table 40, the estimated cost increase over the whole 25 year programme is £39m and £71m for Alternative Pathways 1 and 2 respectively.

	AMP8	AMP9	AMP10	AMP11	AMP12
Smart metering £m	110.69	73.55	5.09	20.61	14.66
Leakage £m	4.44	5.10	50.79	59.54	93.37
Business water efficiency £m	4.78	6.17	2.99	1.66	3.46
Household water efficiency £m	8.97	8.97	8.97	19.54	47.35
Supply side £m	45.01	35.53	0.00	3.27	0.00

Table 39 - Summary costs for Alternative Pathway 1 - 'Sustainable Abstraction'

	AMP8	AMP9	AMP10	AMP11	AMP12
Smart metering £m	110.69	73.55	5.09	20.61	14.66
Leakage £m	4.44	5.1	53.81	60.43	93.37
Business water efficiency £m	4.78	6.17	2.99	1.66	3.46
Household water efficiency £m	8.97	8.97	8.97	19.54	47.35
Supply side £m	45.01	39.48	10.12	17.55	0.00

Table 40 - Summary costs for Alternative Pathway 2 - 'Compound High'

Core Pathway

Our 'core' pathway includes all the options and associated investment within our 'most likely' pathway as these are required under all scenarios. In addition, we will progress with design work for 3 network schemes as low cost 'no regrets' interventions. These will then be 'dig ready' if future water resource pressures materialise including growth within these zones. Our 'core' investment pathway will, therefore, also include for:

1) Clwyd Coastal link main design work – high risk of abstraction licence reductions and so we will commence design work in AMP8
2) Pembrokeshire link main design work – zone is vulnerable to drought and so any under delivery of demand management and/or loss of licence, as we abstract from two SAC designated rivers, would cause supply concerns and so we will commence design work in AMP8
3) Lleyn Barmouth link main design work – zone is vulnerable to drought and so any under delivery of demand management would cause supply concerns and so we will commence design work in AMP8

6.8. Summary of our Preferred Programme

In summary, we have undertaken a thorough and detailed analysis of the potential risks to our water supply systems in terms of the availability of water resources to meet demand over the next 25 years. This assessment has shown that for the SEWCUS and Tywi Gower water resource zones there is a risk of not achieving target levels of water resource resilience.

Our proposal is to deliver a demand management programme which includes:

- Continuation of our 'find and fix' leakage programme to maintain and improved performance over time using new technology.
- A progressive customer metering programme delivered over the AMP8 and AMP9 periods. This supports a 10% saving in leakage over the AMP8 period and supports our domestic customers in reducing their usage to 110 l/p/d by 2050. This will increase the level of metering to 76% by the end of AMP8 with 67% billed on their consumption. The long-term target is to meter 96% of households by 2050.
- Four network improvement schemes, two in the Tywi Gower and two in the SEWCUS water resource zones
- Delivery of the design for strategic inter zonal network transfer schemes, namely: Alwen Dee to Clwyd Coastal, North Eryri Ynys Mon to Lleyn Harlech-Barmouth, and Tywi Gower to Pembrokeshire. This could also enable future NHH demand to be met in the Pembrokeshire zone (see section 6.10).
- Commitment to undertake joint investigations with NRW in AMP8, to assess the future sustainability of our abstraction licences under a changing climate and to look further into Nature Based Solutions.

The outcome is that we will meet increased drought resilience targets for all of the Dŵr Cymru water resource zones by 2031 or earlier for most zones. This is a robust programme of measures which secures water supplies under the future plausible pathways tested.

Delivery of our Plan will mean that the demand for water will on average be 205 Ml/d lower by 2050. This will reduce the need for abstraction from the environment and deliver an overall net gain, supporting Welsh Government's SMNR aims to enhance the environment and biodiversity of Wales.

6.8.1. Environmental benefits of the Preferred Programme

Carbon

Wales has strengthened its legislative framework to reduce greenhouse gas emissions through The Environment (Wales) Act 2016 and has set out its legal commitment to achieve net zero emissions by 2050, whilst pushing to get there sooner. In April 2019, the Welsh Government declared a climate emergency, which poses a direct threat to the health, economy, infrastructure and our natural environment. As one of the largest energy users in Wales, we need to adapt the way we deliver our services to allow us to deal with the challenges we face in the years and decades to come.

To help protect our environment, we chose an ambitious, pro-active response to achieving a net zero future, and are committed to reducing our total carbon emissions by 90% by 2030 and achieving carbon neutrality by 2040. Our roadmap to deliver this is split into five core pillars:

- Harnessing Nature
- Saving Water
- Powering a Cleaner Future
- Tackling Fugitive Emissions
- Offsetting Carbon

This Plan sets out how we will deliver the second pillar "Saving Water" through our demand management strategy, with Figure 81 below showing these – the highest reductions are earlier in the planning period as the grid will decarbonise over time, meaning that the biggest benefits are to be found through early intervention when energy use is still from fossil fuel sources. This further supports our preferred strategy of prioritising smart meter delivery in AMP8 and AMP9 rather than delaying.

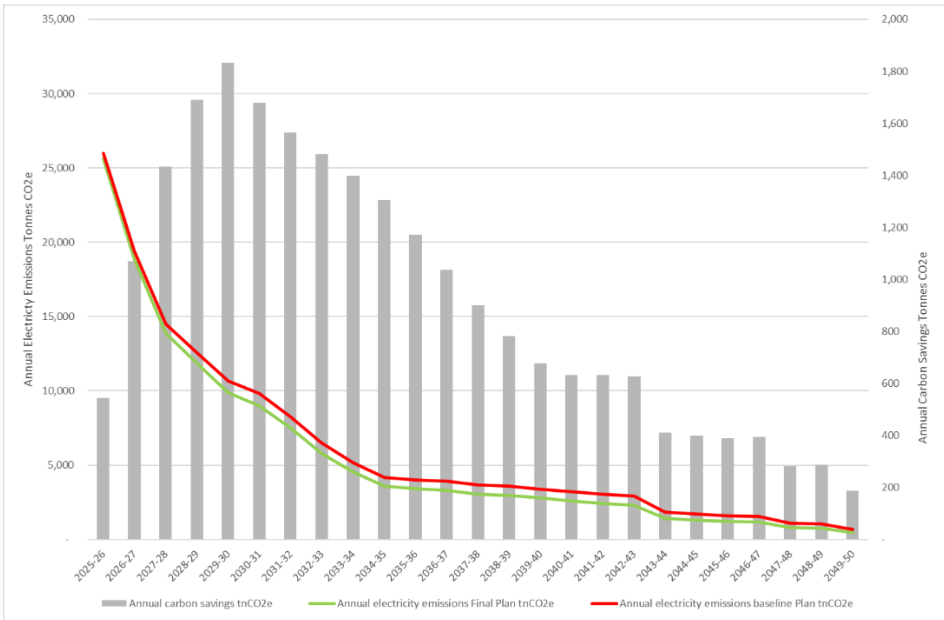


Figure 81 – Reduction in electricity emissions (tnCO2e) from our demand management strategy

Biodiversity

As well as reducing the carbon emissions associated with the production of drinking water for our customers, significantly reducing the demand for water means that we will need to abstract less from our rivers, reservoirs and groundwaters. Within Table 41 we have tried to assess what this could mean for some of our largest abstractions which take their water from rivers designated as SAC's. We have run our AQUATOR supply models for both the SEWCUS (Prioress Mill, Monmouth) and Tywi Gower (Nantgaredig) WRZs, simulating an historic year (in this case 1976) with our current and forecast level of demand at the start and end of the 25 year planning period. The results of the modelling show significantly reduced abstraction volumes meaning more water left in the river that will provide resilience for the ecosystems under a changing climate.

	Annual abstraction (Ml/yr) at 2023/24 demand levels	Annual abstraction (Ml/yr) at 2049/50 demand levels	% Reduction in Annual Abstraction
River Usk at Prioress Mill	39714.19	28190.05	29.02%
River Wye at Monmouth (Wye Transfer)	30803.62	24264.80	21.23%
River Towy at Nantgaredig	45305.56	32760.06	27.69%

Table 41 -Forecast reduction in abstraction volumes from our demand management strategy

6.9. Alignment with our Drought Plan

As well as a Water Resources Management Plan, we have a statutory requirement to produce a Drought Plan every five years. Although the Drought Plan is a short term, operational document that sets out the actions we would take to manage a drought across our supply area, they are complementary in a number of key aspects:

- Level of Service – the frequency of imposition of customer restrictions is consistent between both Plans.
- 2) Our drought triggers for implementing customer side measures to restrict demand are consistent between both Plans.
- 3) Deployable Output modelling across both Plans utilises the same asset constraints, base demands and hydrological understanding.

The extensive work undertaken for this Plan to significantly improve our understanding of how resilient our supply systems are to drought will all be built upon in our Drought Plan 2025. The investment identified in this Plan, and the greater level of drought resilience it provides, will be accounted for when we come to review our drought triggers and the actions these drive. We will also fully incorporate the learning from the 2022 Drought to help improve our understanding of the effectiveness of the actions we took.

Our current Drought Plan is available at: https://www.dwrcymru.com/en/our-services/water/water-resources/final-drought-plan-2020

6.10. Future Water Trading

A National Framework for Water Resources in England was set up in 2020 to explore the long-term needs of all sectors that depend on a secure supply of water. Five regional groups have been set up including Water Resources West to produce plans which assess regional water resource needs and options to resolve both inter-regional deficits and options for water transfers between regions.

The Regulators Alliance for Progressing Infrastructure Development (RAPID) made up of Ofwat, Environment Agency and Drinking Water Inspectorate was also established to help accelerate and manage the funding of potential strategic water resource schemes through a 'Gated' process.

As we were unable to demonstrate a significant benefit to our customers, a decision was made by DCWW in 2021 not to promote trading water with neighbouring companies at that time. This was based upon a scalable water trading option (50–100 Ml/d) that would use both existing, disused or under-used sources for use in the SEWCUS zone. This enabling the water that we currently abstract from the River Wye to be transferred to either STW or to south-east England via a proposed STT link main which is not currently planned until 2040.

Although this trading option is not being considered within this planning cycle we will continue to work with the Water Resources West regional group and our neighbouring companies to understand whether this position will change into the future.

6.10.1. New supply to the Canal and Rivers Trust

Under 'New Authorisations' legislation, the Canal and River Trust's (CRT) abstraction at Brecon will come into the licensing system in December 2022 and will need to comply with Habitats Regulations. This will significantly reduce how much water can be taken from the river to support the losses from the Monmouthshire and Brecon Canal, meaning it will need to close from time to time for extended periods.

Although there is limited water available within the Usk catchment, we have assessed options to support the canal through potential use of releases from the Usk Reservoir.

During dry weather we rely heavily on the use of Usk reservoir to provide regulation water for downstream abstraction at Prioress Mill in the SEWCUS WRZ. Reducing the available water for regulation, will impact our drought resilience unless we can develop additional resource to replace it.

Working closely with CRT we have incorporated their demand for support water from Usk reservoir within our supply demand assessment for the SEWCUS WRZ. In parallel we commissioned APEM consultants to undertake an environmental assessment of the proposed increased releases to ensure they would not cause any deterioration of WFD and Habitats Regulation targets for the River Usk. The study has initially concluded that to maintain environmental compliance there would need to be seasonal restrictions placed upon the maximum release volume. This means that at certain times throughout the year we could not release enough water to support both the c30 Ml/d need of the canal and our 50 Ml/d regulation need at Prioress Mill.

To operate against these environmental constraints, within our supply capability assessment we can prioritise the available release volumes for CRT's use with the remainder available for ourselves, however, this will impact our supply capability and our operational costs. Figure 82 shows that our supply capability is reduced when operating this way, primarily due to lower levels of storage in Llandegfedd. Assuming that our AMP8 network enhancements and demand reduction are fully achieved, then our assessment shows that will be able to meet both the requirements of CRT and our drought resilience target of 1 in 200 by 2030 and 1 in 500 by 2040.

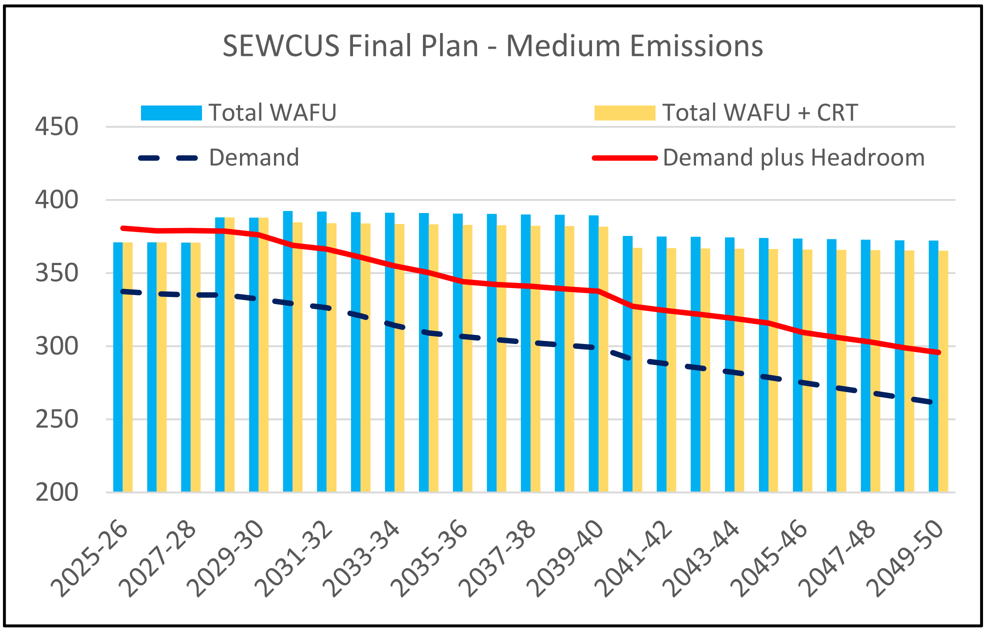


Figure 82 - SEWCUS supply demand position with and without CRT

This robust position is wholly reliant on the delivery of our network enhancement schemes, anticipated to be delivered by the end of AMP8 and our demand management strategy set out in this Plan. Any earlier support for the Canal will be undertaken under a 'best endeavours' approach.

There remains some uncertainty around the requirement for support water as the Trust are currently challenging the loss of their abstraction licences.

The risks around alternative futures also remain and so we plan to continue development of the most likely alternative schemes that would be needed in SEWCUS, notably the Afon Lwyd, Grwyne Fawr and Court Farm WTW.

This will enable us to move quickly in AMP9 to deliver these enhancements if the identified risks with our AMP8 programme materialise, so we can maintain the required levels of drought resilience for ourselves and CRT.

As with any trading option we will seek a reasonable income from the sale of water to the Trust but given the current uncertainty around the need we have not completed a commercial agreement. Current tariff structures are not relevant to this supply which will need a new cost reflective contract to ensure value for our customers. If and when this is undertaken, we need to ensure that this water transfer is not detrimental to the environment and that our customers are reasonably rewarded for the water supply. We are taking the principle that that our customers will not subsidise those of the Trust.

In that we have options to support the anticipated canal demands, will continue to work with CRT and NRW to find the best value solution.

6.10.2. Other non-potable water demand

We are aware of a number of other industrial customers that may need further non-potable water supply in the future. We are working with both the Pembrokeshire net Carbon Zero project, Albion Water and others to understand their future needs for water and where we are able to provide support for these. However, we have not moved to a level of certainty with any of these that warrant their inclusion within our Plan beyond this statement.

Appendices

1) Security statement
2) Problem characterisation
3) Assurance letter
4) Aquator model builds
5) Inflows review
6) Deployable Output assessment
7) Basic Vulnerability Assessment
8) Outage assessment
9) Headroom assessment
10) Demand forecasting
11) Valuestream/Decision making
12) Non-Public Water Supply
13) Supply side options engineering and costing
14) Customer engagement
15) Strategic Environmental Assessment
16) Habitats Regulations Assessment
17) Natural Capital Assessment
18) Water Framework Directive assessment
19) Zonal summaries
20) WRZ integrity
21) Demand allocation and demand profile methodology
22) WRSE climate data scaling methodology
23) Afon Fathew flow investigation
24) Leakage options and the SoLow optimisation model
25) Metering options and the optimisation model