DRAFT

WATER RESOURCES MANAGEMENT PLAN

2024

OCTOBER 2022

CONTENTS

TABLE OF TABLES

Cover image: Llwyn Onn Reservoir, Brecon Beacons

TABLE OF FIGURES

EXECUTIVE SUMMARY

INTRODUCTION

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.

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 850 Ml/d today. About half of this is down to reduced leakage, the rest is due to 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.

OBJECTIVES FOR THE PLAN

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.

Although the regulatory guidance provided for this round of planning has some different aspects and approaches, the core process remains the same as that put forward for WRMP19, being to assess our water supply capability against the future demand for water. Where there is a deficit in capability then both demand management and new supply options are considered, and a future plan is developed.

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's operating area

Water Resource Planning Zones

THE WATER RESOURCE MANAGEMENT PLAN 2019

The key drivers for our WRMP19 plan 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 c10.5 Ml/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 as 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.

PRINCIPLES FOR THE WATER RESOURCES MANAGEMENT PLAN 2024

Based on, and in response to regulatory guidance, the key goals 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 third parties
- Build our Plan into, and maintain consistency with, the 'Water Resources West' Regional Plan

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'.

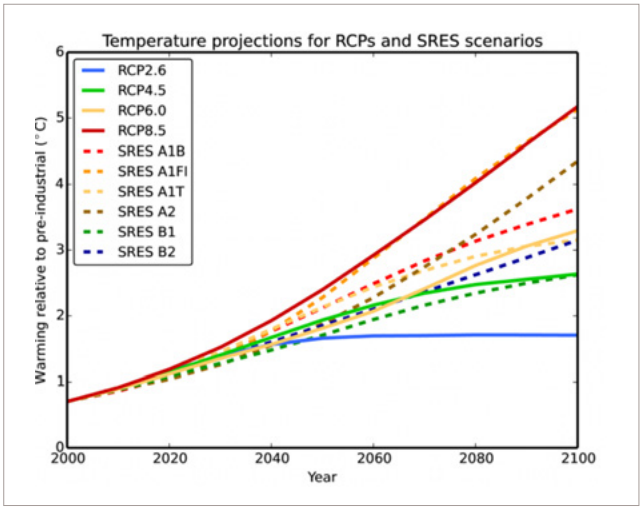
Where there is a supply/demand deficit, all feasible demand management and water supply enhancement options are developed with cost and benefit metrics calculated. A decision-making process is then followed to examine the trade-offs between performance metrics and generate a 'best value' societal and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

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.

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. Through discussions with Regulators in the development of our PR24 WINEP and NEP, the only reduction in abstraction volume likely to be required during the AMP8 period is that at Leintwardine in Herefordshire. Studies completed in AMP7 indicate that summer flows are inadequate for ecological needs and so we will likely need to reduce our abstraction from the source during low flow periods.

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.

This will be a significant piece of work which demonstrates our environmental integrity. 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.

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. Outturn data is consistent with that provided in our Annual Performance Report to Ofwat. 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.

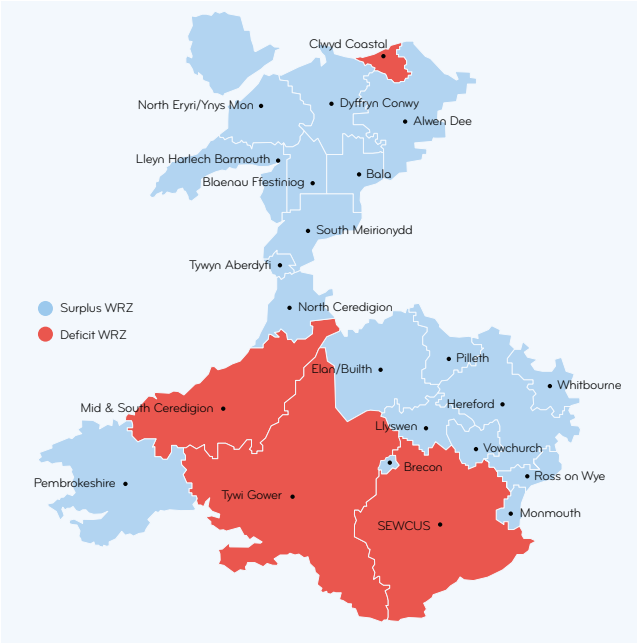
Household demand has been generated from a technique called multivariate regression and is built from detailed household water use surveys. The modelling accounts for demographics, house type, property and population forecasts and weather parameters.

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.

We are forecasting a 15% leakage reduction in AMP7 which is the starting point for our supply/demand balances. Our strategy to reduce demand is outlined in the 'Our Proposed Plan' section below.

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. Four zones (see Figure overleaf) are not resilient to our preferred 1 in 200 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 16Ml/d), the Mid & South Ceredigion zone (Deficit up to 1.1Ml/d), the Clwyd Coastal zone (Deficit up to 0.4Ml/d) and the South-East Wales Conjunctive Use System (SEWCUS)(Deficit up to 43.5Ml/d. Mid and South Ceredigion zone is forecast to be in deficit when tested against a peak week 'critical period' planning scenario, whilst the other zones are forecast to be in deficit under an 'annual average' planning scenario. 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.



DEFINING A BEST VALUE INVESTMENT PROGRAMME

Guidance expects solution decisions to be based not solely on cost but on a wider range of social and environmental metrics. This is similar to a multi-capitals approach in terms of criteria but without full monetisation and weighting of metrics to explore the trade-offs between candidate options and programmes.

However, our approach is also aligned 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.

This mandated policy is part of our preferred plan within all zones and acts to improve water resource resilience over time through the planned delivery of a 'Smart' metering programme. 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 built a decision making tool ('ValueStream') jointly with Water Resources West companies. The weightings around both financial and non- financial criteria such as 'social wellbeing' or 'carbon emissions' have been set through expert workshops including stakeholders and take account of customer preference work.

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 Resources West member companies with one focussed on our WRMP24.

As anticipated, stakeholder responses mirrored regulatory guidance to maintain and improve water supply resilience whilst requesting substantive improvement in demand management activity to reduce our impact on the environment.

LEARNING FROM THE DROUGHT OF 2022

THE DROUGHT EVENT OF 2022

Between March and August this year, Wales received just 56.7% of its expected rainfall, the third driest six-month period since records began in 1865. In August alone, 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 also supports with good evidence the need for the asset investments presented in this Plan. The following sections describe the key schemes.

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 1 in 200 year drought events without the need for emergency drought orders.

THE TYWI GOWER ZONE

Although customer restrictions have not been put in place elsewhere, we have been closely monitoring the areas of the Tywi Gower zone supported by the Crai and Ystradfellte reservoirs. These concerns have significantly lessened in September with both reservoirs having responded relatively well to rain in early September. 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 to manage the risk and lower level of resilience.

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 this summer 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.

THE MID AND SOUTH CEREDIGION ZONE

Of particular concern has been the Mid and South Ceredigion zone, a tourism area, 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. This is in line with our analysis which shows that our current peak supply capability is insufficient to meet peak demands. We are planning to invest in the Llechryd works and to make some network changes to overcome this issue.

OUR PROPOSED PLAN

To meet customer and stakeholder aspirations, the WRMP24 needs to meet the demand management challenges of further significant reductions in leakage and customer water use as measured by PCC.

The work presented here does not show that demand management is needed in all zones as supply/demand deficits only exist in four areas. However, there is an over-riding expectation from our regulators, stakeholders, and customers that we should be ambitious around leakage performance and supporting our customers to reduce consumption, both of which will benefit the environment.

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.

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.

Our plan is to follow a profile in-line with this commitment, whereby we will deliver the 15% leakage reduction commitment in 2020-25 with a further 10% reduction in 2025-30. Thereafter, the leakage reduction will follow a profile from 143Ml/d in 2025 down to 86.6 Ml/d by 2050 that meets our long-term delivery strategy outcomes.

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.

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 a 'Smart meter' 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 propose to make a 10% leakage saving in AMP8, of which the majority will be saved on our customers' pipes.

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 of background leakage so that innovative technologies and data science can be employed in future strategies.

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 with Automated Meter Reading (AMR) 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 will continue to monitor developments in smart metering technology and move to Advanced Metering Infrastructure (AMI) meters as the technology matures and costs reduce.

Through our strategy we will increase the level of metering to 76% by the end of AMP8 and 95% by 2050 (no water company has yet to achieve 100%). Our demand forecasts include savings achieved from both better data and communication with customers and the identification of leakage on customers' properties. The metering strategy is forecast to reduce overall demand by 34.6Ml/d at the end of AMP8 and 96Ml/d by 2050.

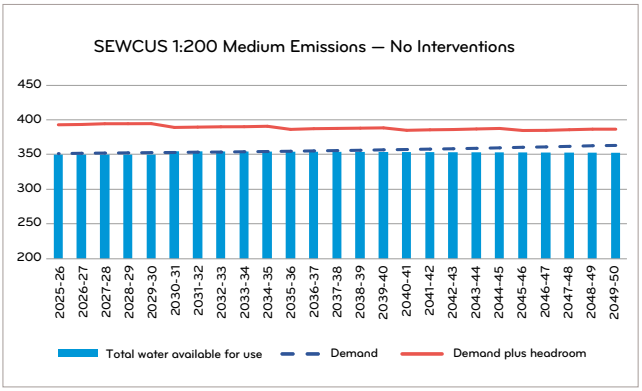
Our customer research supports this approach as customers recognise that better understanding their usage will help them reduce consumption. The progressive metering offers a stepped approach to adoption without making meters compulsory.

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.

The improvement in our understanding of catchment hydrology and reservoir inflows at all sites has meant that modelled drawdowns are now more accurate and show that during a 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 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 inflows 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, produced the starting supply demand position below.



The range of options considered include:

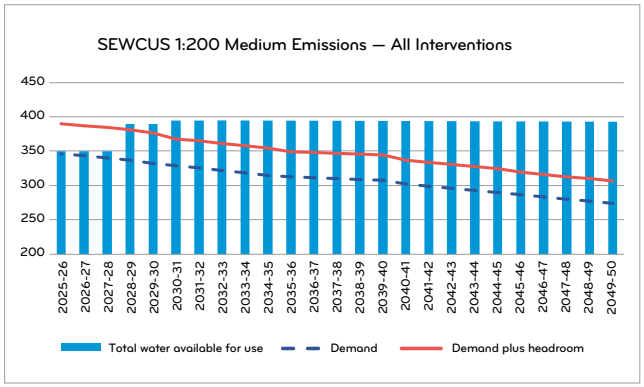
- Additional demand management;
- Network enhancement to optimise and balance water resources
- Making use of existing disused sources or under-used abstraction licences;
- Raising reservoir levels.

If financial cost and scheme yield are considered alone, then the least cost solutions would not include demand management options. These are driven by the requirements of Government and our Regulators desire for social and environmental improvement. The benefits of reduced leakage and water usage through metering have, therefore, been built into the SEWCUS programme prior to considering the other options to meet the supply/demand balance.

The only options that provide benefit to the system are those that improve the resilience of the SEWCUS high level area. Of three options available, increasing the capacity of the link from Talybont WTW is a costly option due to length of mains upgrade and operational cost. The two least cost options are:

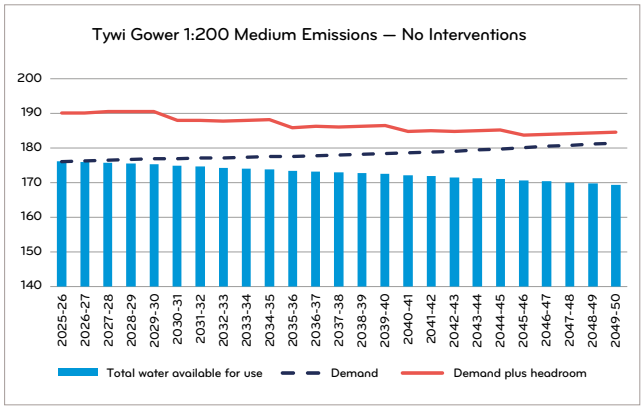
- Llwynon trunk mains minimum flow control;
- Cefn Mably/Memorial Pumping station enhancement.

Both are required to ensure resilience and form, alongside demand management options, the 'Best Value' Plan. The supply demand balance for the final plan is shown in the figure below.



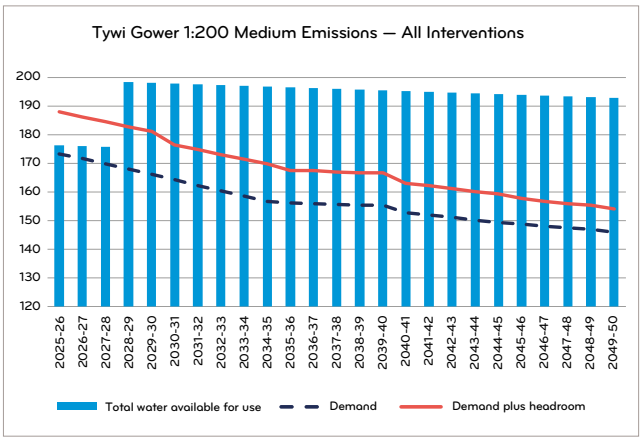
TYWI GOWER

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 20 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 or 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 below.

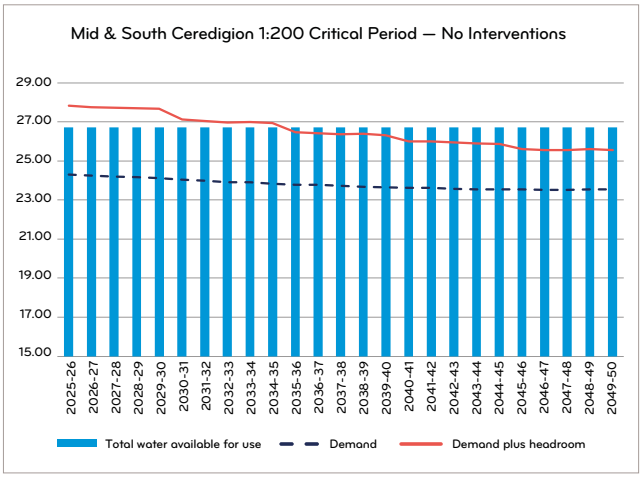


The plan for Tywi Gower not only meets the current day target of meeting resilience to 1:200 year droughts but generates increased capability to meet at least a 1:500 drought resilience by 2030 through demand management activity. As with all zones, this mitigates risk around future climate change impact pathway, customer usage behaviour, and environmental needs.

MID & SOUTH CEREDIGION

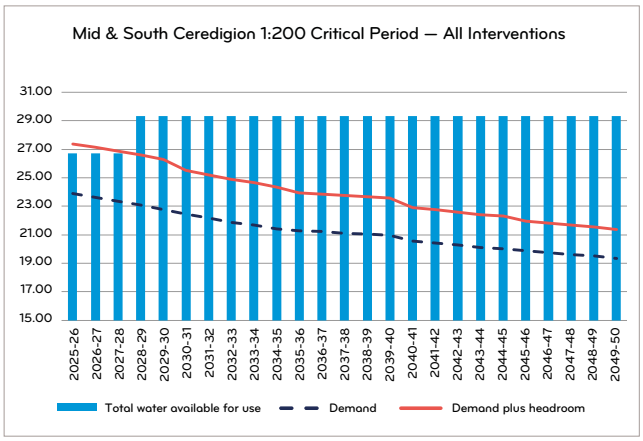
Analysis shows that the Mid and South Ceredigion meets resilience targets, as reported in the WRMP19, however improved evidence has identified issues meeting peak demands. Recent hot, dry weather events, including summer 2022, have tested the limits of our peak supply capability : the output from our Strata Florida and Llechryd treatment works needed to be supplemented by supplies brought in by road tankers from the Capel Dewi WTW system in the neighbouring Tywi Gower zone.

This confirms that our current peak supply capability is insufficient to meet peak demands, particularly in the light of the extreme high temperatures seen during July which pushed demands higher than ever experienced before and which are likely to be repeated more frequently as our climate warms (See figure below).



The most cost effective option is increasing the maximum output of our Llechryd WTW, which would provide us with the additional capacity and ensure we can adequately meet peak demands in the future. We have discussed with NRW their latest 'Abstraction Licensing Strategy' which indicates that additional water could be licensed for abstraction in the lower reaches of the Teifi.

With delivery of both our demand management strategy and the upgrade to Llechryd WTW, our investment will ensure long term resilience against climate change and more extreme drought events by providing sufficient treatment capacity to meet peaks in demand (See final plan figure below). At the same time we will seek to reduce demand although as the peaks are largely driven by tourism our metering programme may have less of an impact.



CLWYD COASTAL

The Clwyd Coastal zone in north-east Wales has a marginal supply/demand deficit under a 1:200 year drought scenario and would be in deficit if the target were to have higher resilience. A further driver within the zone is the potential reduction in abstraction licence at Llanerch Park boreholes with investigation proposed in AMP8. A small change to abstraction allowance would reduce the zonal level of resilience and drive the need for a solution. Given the risks around environmental needs, climate change and customer usage we propose to follow an adaptive plan whereby we will complete detailed design work for the network reinforcement scheme in AMP8 for delivery in AMP9 if required. This will mitigate scheme delivery risk.

HEREFORDSHIRE

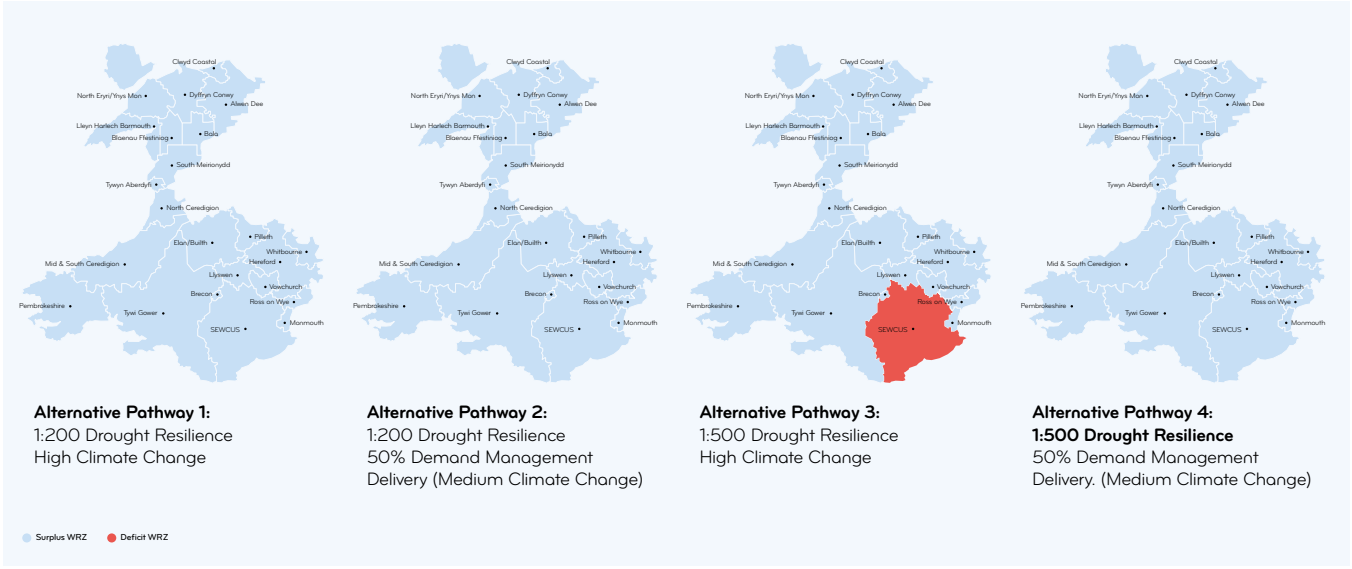
Environmental investigations show that the abstraction from our Leintwardine borehole could reduce local river flows below environmental flow targets during dry conditions. We will need to complete additional confirmatory studies in AMP8 to understand the licence conditions that will be needed to ensure sustainable abstraction. The worst case is that no abstraction will be allowed under very low flow conditions, and this would require network reinforcement to secure water supply to the Leintwardine area. The Environment Agency have asked that funding be secured to deliver both investigation and solution delivery in AMP8.

TESTING THE ZONAL PLANS

The long-term impact of leakage and customer usage policies generates an increased water resource surplus which over time provides greater drought resilience and enhanced benefit to the environment, as our take from the rivers and groundwaters is reduced. Our objective is to move to a 1 in 500 drought resilience position by 2040 to align us with the position being taken in England, ensuring that our customers receive at least an equal, if not better, Level of Service.

Assuming the full delivery of our preferred investment programme within the proposed timescales, we should achieve this higher resilience target across all zones by 2030/31. There are however three key risks that could impact the achievement of this. We have tested our preferred plan against various individual and combined future pathway scenarios. This confirms that the planned network investment is required to achieve resilience targets under all scenarios. Demand management will need to overcome the potential climate change impact over time to increase resilience from 1:200 year to 1:500 year droughts. If our customer behaviour reduces demand by 50 % of that estimated in our 'Core' plan, then the 1:500 year resilience target would be met under an RCP 6.0 climate change projection. Lower ambition on demand management increases the risk of meeting resilience targets under 'high' climate change impact.

We have also examined the investment requirements under the Ofwat common reference scenarios including a 'Low' climate change emissions scenario (RCP2.6). This would not eliminate the need for network improvements to secure resource zone integrity and with the potential impact between climate change scenarios in AMP8/9 being relatively low.



Alternative Pathway 1:
1:200 Drought Resilience
High Climate Change

Alternative Pathway 2:
1:200 Drought Resilience
50% Demand Management
Delivery (Medium Climate Change)

Alternative Pathway 3:
1:500 Drought Resilience
High Climate Change

Alternative Pathway 4:
1:500 Drought Resilience
50% Demand Management
Delivery. (Medium Climate Change)

Supply/demand position at 2030 (end AMP8) with WRMP24 interventions. (Note The SEWCUS zone moves into a surplus position in 2031)

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 our 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 our 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.

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, 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, so as 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. We have 23 discrete water supply systems across our operating region 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 2).

1.1.1. WATER 2050 – OUR LONG-TERM VISION

We have just reviewed and updated our Welsh Water 2050 document which 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 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 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.

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.

Figure 1 — Our Operating Area

Figure 2 — Water Resource Zones for WRMP24

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 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 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, v10. (Ofwat/EA/NRW, December 2021)
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
Water Industry Act 1991 /Water Act	States the statutory requirement for long term Water Resource Plans
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.
Well-being of Future Generation (Wales) Act 2015	**7 Well Being Goals:** – 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:** – 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

The 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.

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.

1.3. 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 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 water supply capability against future demand for water. Where there is a deficit in capability then both demand management and new supply options are considered, and a future 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%.

Our supply against demand assessment for the WRMP19 identified three WRZs (Figure 4) that were forecast to be in 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 supply demand deficits, an overview of these is given below:

Figure 4 — WRMP19 Deficit Zones

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 under the Habitats Directive review of consents. The Pembrokeshire WRZ was forecast to fall into deficit in both the annual average and critical period scenarios from this time. (See Figure 5).

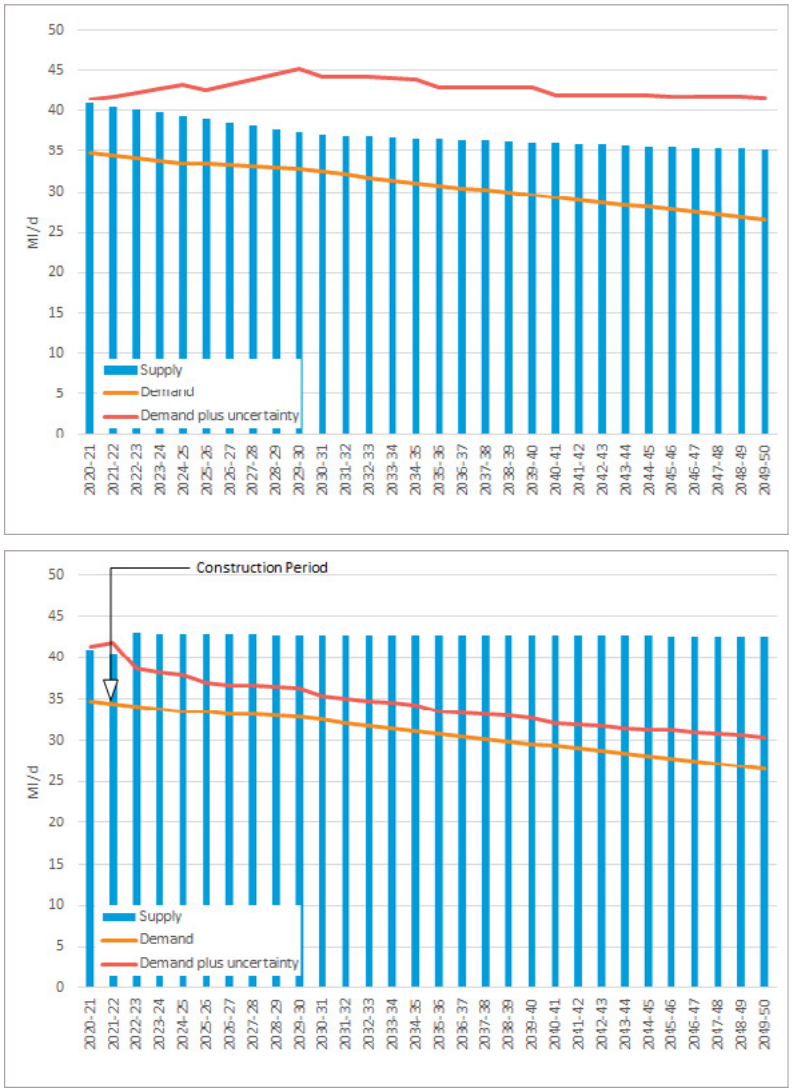


Figure 5 — WRMP19 Supply demand balances for the Pembrokeshire WRZ

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 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 in June 2023, ensuring our proposed level of service is maintained in the interim.

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. We have progressed the design of the scheme but have also gained further evidence from the recent drought regarding aquifer behaviour and the potential resilience to drought. We will review this evidence prior to completion of the scheme in AMP7.

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 now indicate that the existing sources may be more resilient under extreme drought conditions than first thought and so we have recently commissioned further investigations into the yield of our existing Afon Fathew source, to confirm the need and capacity for the development of the Afon Dysynni source. If this new evidence shows that the scheme is still required, we will deliver this later in AMP7 than first planned.

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. To date we are on target to achieve this having achieved a c10.5 Ml/d reduction already; 167.95 Ml/d (2019/20) to 157.41 Ml/d (2021-22).

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. Since 2019-20 our average household PCC has risen from 159.68 l/p/d to 174.66 l/p/d at the end of the 2021-22 financial year, although this was a slight reduction compared to 2020-21.

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 back 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 7.2 Ml/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 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.

Although customer restrictions have not been put in place elsewhere, we have been closely monitoring the areas of the Tywi Gower zone supported by the Crai and Ystradfellte reservoirs. These concerns have significantly lessened in September with both reservoirs having responded relatively well to rain in early September. Concerns remain around low levels in the SEWCUS zone, notably in the Llwynon and Pontsticill reservoirs (Figure 8).

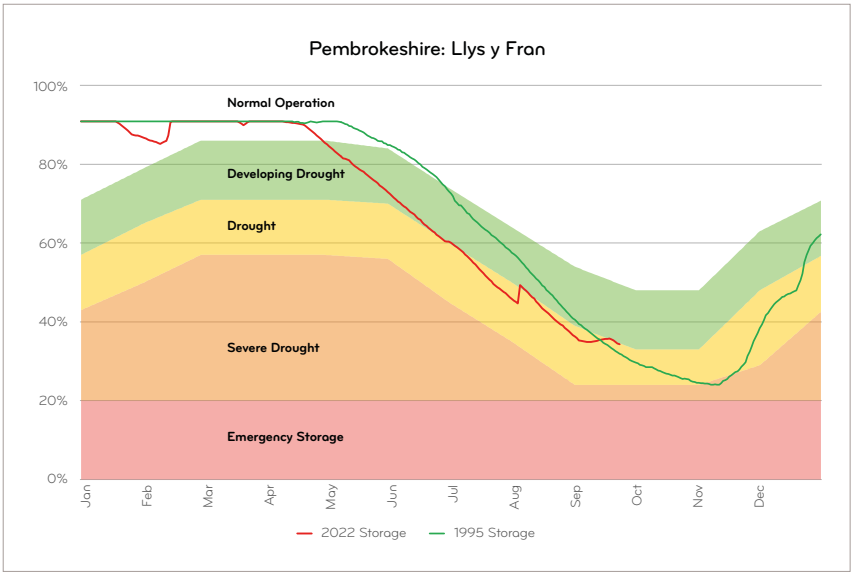


Figure 6 — Llys y Fran storage (2022 vs actual 1995)

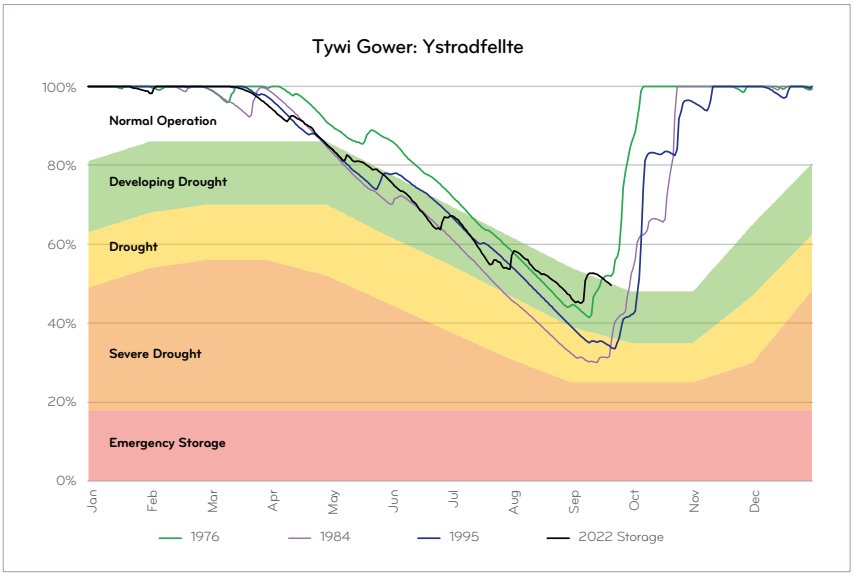


Figure 7 — Ystradfellte storage (2022 vs modelled historic droughts)

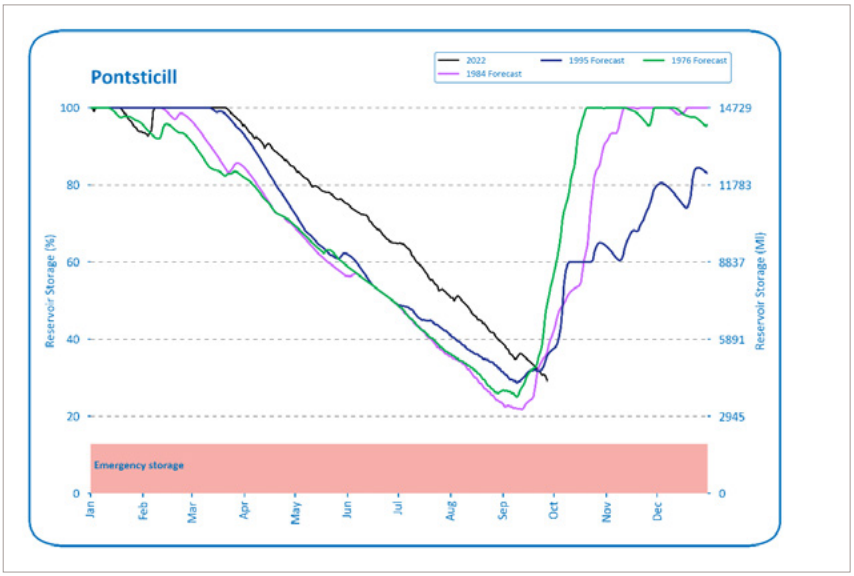


Figure 8 — Pontsticill storage (2022 vs modelled historic droughts)

Our experiences from the summer 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.

There have been exceptionally high demands across our region over the summer period with heat waves occurring in both July and August. Of particular concern has been 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. This is in line with our analysis which confirms that our current peak supply capability is insufficient to meet peak demands. Section 6 provides further detail around the proposed solution.

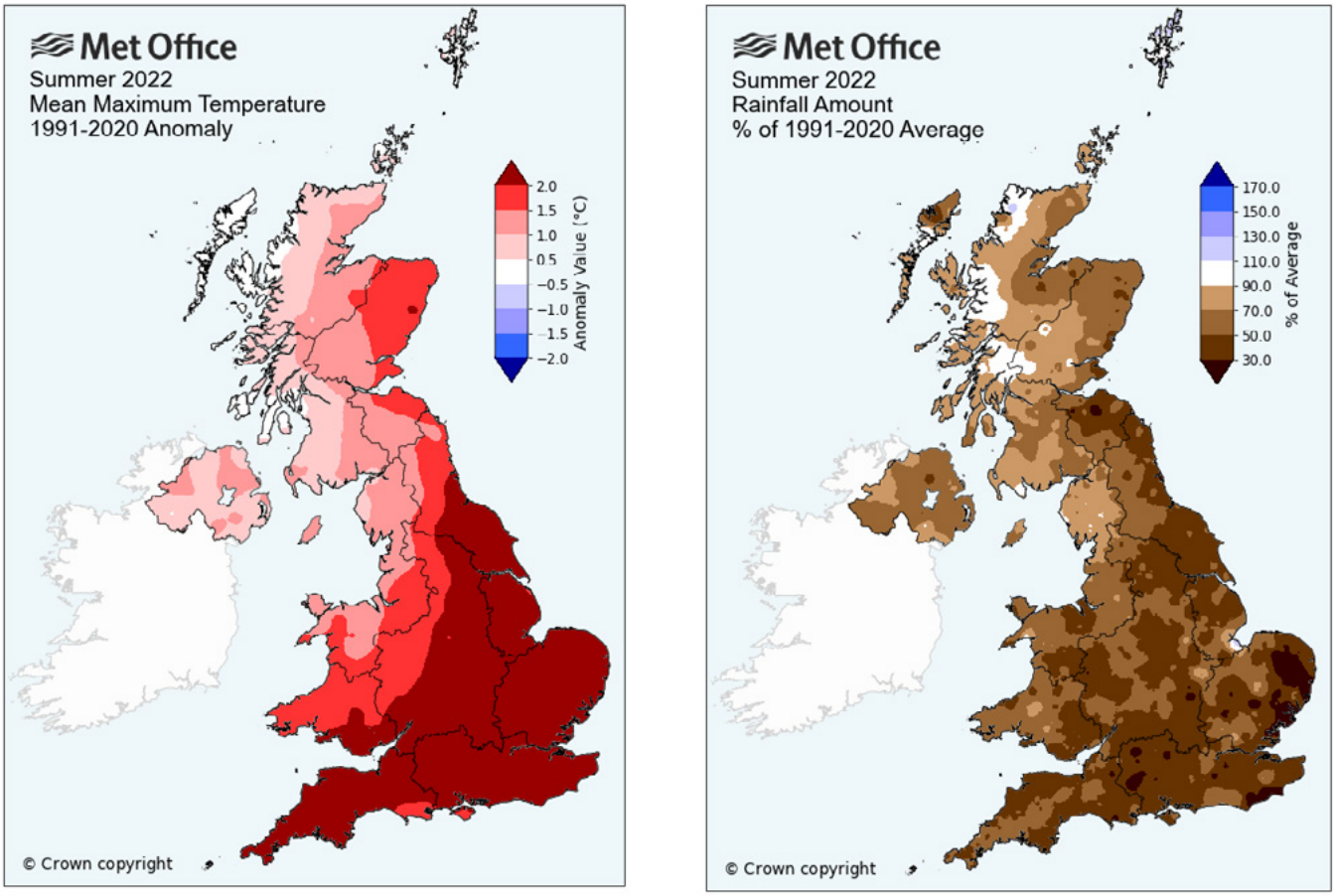


Figure 9 — Key summer 2022 meteorological stats[3]

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 WRMP24 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 third 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. Of the aspects in Table 2, the most meaningful change from the previous WRMP relates to the need for improved 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 key 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.

With no immediate obligations for specific abstraction licence changes to protect the environment, our demand management strategy will improve water supply and environmental resilience over time. The identified supply deficits over the next five years are relatively small and relate to localised water resource shortfalls.

2.1.1. 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. An outcome of this approach is that investment in assets may be undertaken in a modular way, allowing informed decisions to be made if and when future triggers related to uncertain scenarios materialise.

Our long-term 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 Invest Delivery Process (IDP). Investment decisions are made based on multiple factors not just lowest cost. Consideration is given to societal and environmental benefits of different interventions.

The LTDS is recognised as a critical activity but remains relatively new, as such the LTDS is being continually refined. We have focused on developing a core pathway which outlines the necessary investment to meet the company's long-term strategic objectives if there are no changes to operating environments in the future. Investment identified under this pathway is needed under all future operating conditions, or to keep options open, and as such can be considered no regrets investment which will be required under all future circumstances.

The WRMP is a critical input into delivering the LTDS and the ambition outlined by the company. As such the LTDS and WRMP have been 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. We are in the process of undertaking customer engagement to inform and refine the LTDS as part of PR24 planning.

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 should be 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 will cover the anticipated common Ofwat Performance Commitments, plus a set of 'supporting outcomes' which cover other elements of our 2050 ambitions, such as improved resilience and climate change adaptation.

Ofwat expects the outcomes to be developed through the collaborative process in Wales (i.e. the PR24 Forum) and that they should also 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.

Outcome	Measure	2050 Target
Leakage Reduction	Leakage (Ml/d)	85
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 a 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 full assessment is available in Appendix 2.

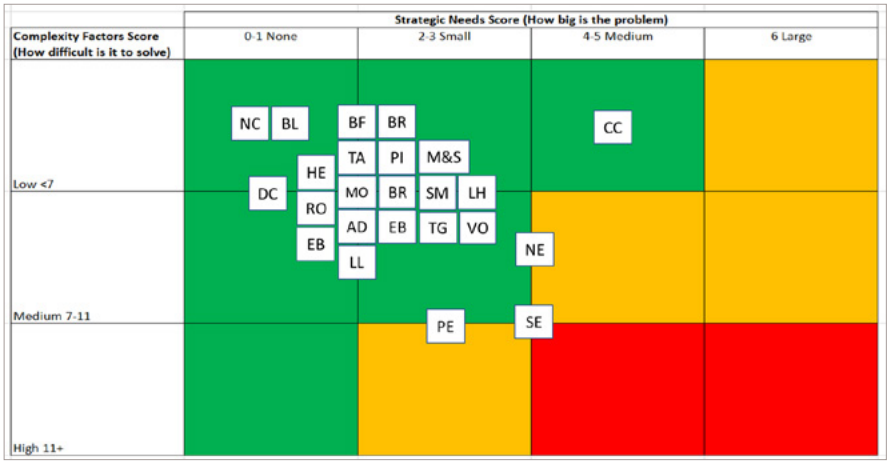


Figure 10 — WRMP24 Problem Characterisation

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.

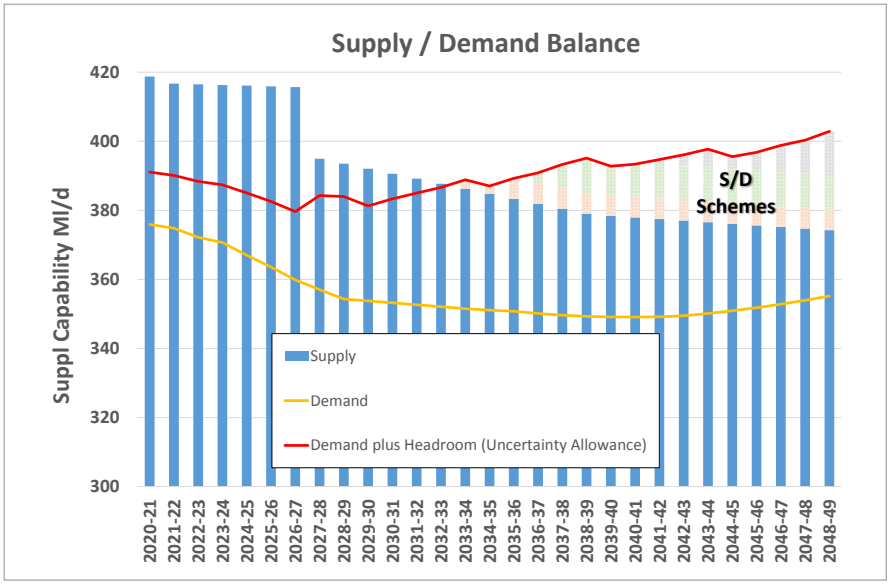


Figure 11 — Example supply demand balance graph

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 six 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.

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 temporary water 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.

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. 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.

Llyn Brianne

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.

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.

Environmental Destination guidance from NRW 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.

From a planning perspective, the unknown level of future sustainability reductions will influence our overall strategy, particularly with regard to the programming of demand management savings. It could be argued that we may not need our proposed leakage and usage reductions until sustainability reductions are understood. However, this could significantly delay the sustainable abstraction or put water supply resilience at risk. Our strategy is to gain the savings from demand management so that we have the opportunity to promote environmental improvement in line with Government policy and/or improve our level of water resource resilience.

Within the PR24 NEP we propose using 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.

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.

4. Addendum on UKCP18 scenarios for use in Water Resources Management Plan 2024 (Wales). Natural Resources Wales, May 2021.
5. https://www.gov.uk/government/publications/meeting-our-future-water-needs-a-national-framework-for-water-resources

'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.

Similar to 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. We have developed a tool to assess a 'Best Value' set of schemes by appraising options against a wider set of criteria than just financial. 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 12 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.

The overall output is a 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.

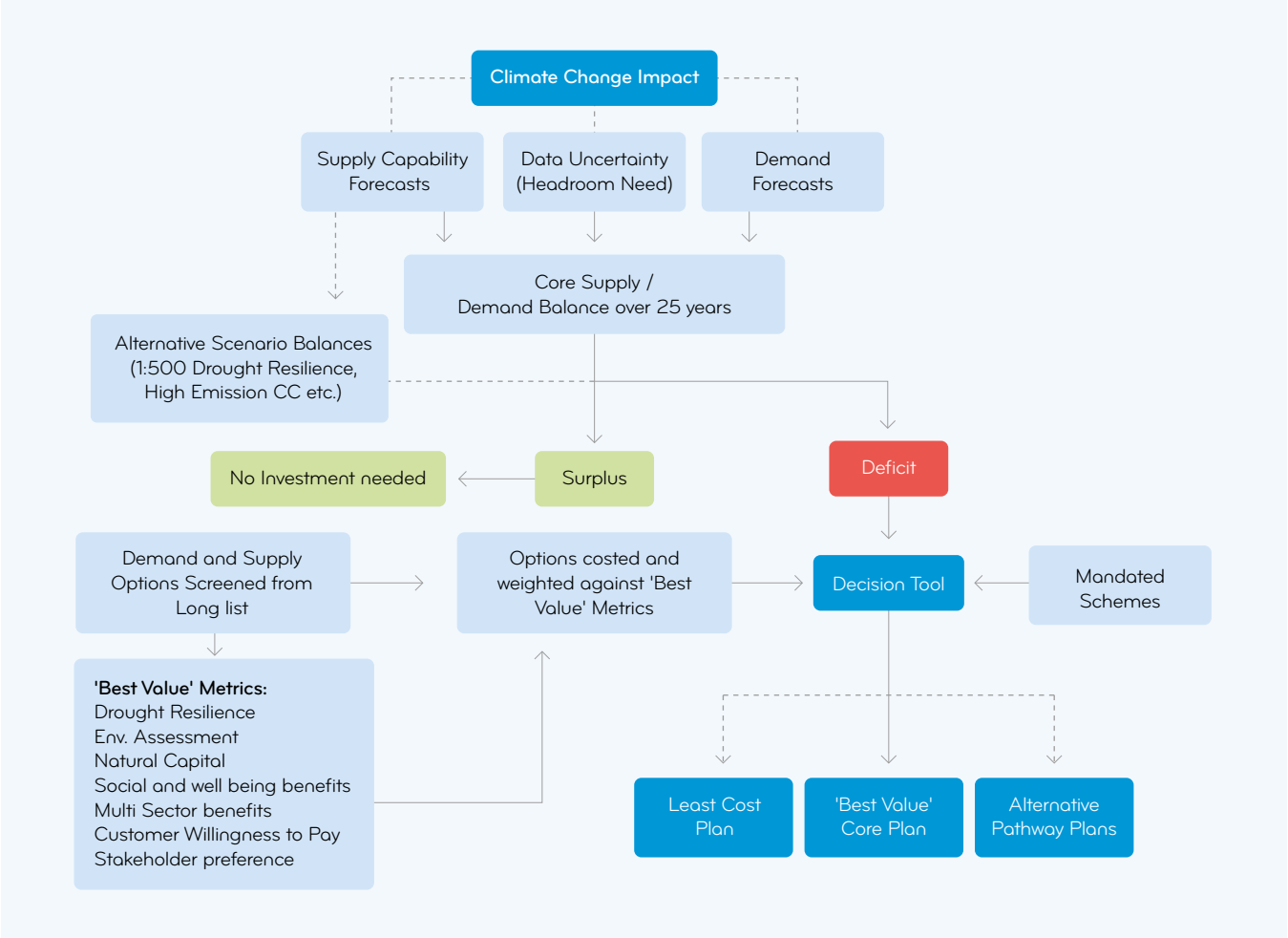


Figure 12 — 'Best Value' Decision Making Process

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.

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.
- Takes account of all relevant evidence – Uses best available evidence such as UKCP18 data including 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 and 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 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 March and we received 13 responses including those from NRW, EA and Ofwat. Table 4 provides a high level summary of the responses received 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 January and with Ofwat/RAPID (EA/NRW also invited) on the 28th January, providing opportunity for more detailed scrutiny of our proposals for WRMP24. On the 9th February 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.

Name	Organisation	Key feedback summary
James Evans, MS Brecon & Radnorshire	Senedd Cymru - Welsh Parliament	Discuss your plans in more detail and the priority areas for future years
	Bishton Community Council	Local sewerage issue
Peter Everall	Business Customer	Population growth in Pembrokeshire
Mark Walters	Carmarthenshire Council	Seeking continued engagement should we propose any options
Liz Cornwell	Bristol Water	Option development of Great Spring
Gail Davies Walsh	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
Richard Edmunds	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
Richard Blackwell	WRW	To continue the joint working and inform WRW should DCWW put forward any strategic transfer options
Tracy Nettleton	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
Jon Johnson	CCW	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

Table 4 — Summary of Pre-consultation feedback

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.

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 have 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.

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 five 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 zones that border other water companies have been included within the regional plan with the information provided within our 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.

Pontsticill Reservoir, Merthyr Tydfil

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 similar to 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 eight 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 company areas. On average we abstract around 850 million litres a day (Ml/d) for public water supply. This normally increases by around 15–20 percent 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 percent, and in some localised areas by more than this.

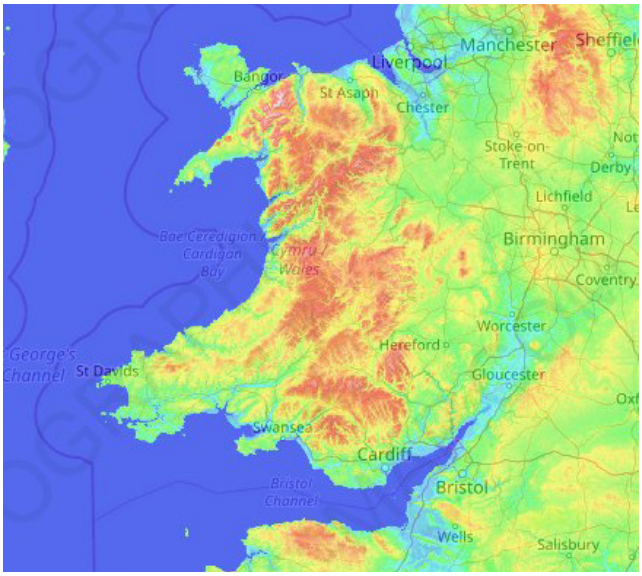


Figure 13 — Topographical map of Wales[7]

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 of the area, which offsets the high rainfall to some degree. Our supply areas 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 14 — 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 15 — 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 16 — 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 17 and Figure 18 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.

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, abstraction 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.

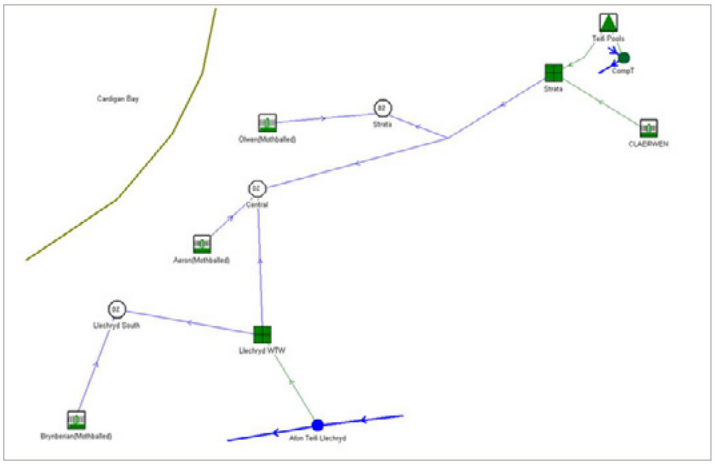


Figure 17 — WRAPSIM schematic of the Mid & South Ceredigion WRZ (WRMP19)

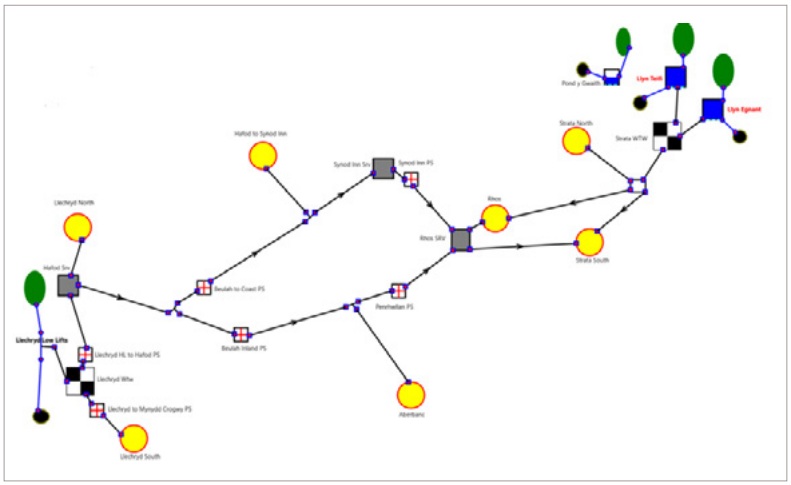


Figure 18 — AQUATOR schematic of the Mid & South Ceredigion WRZ (WRMP24)

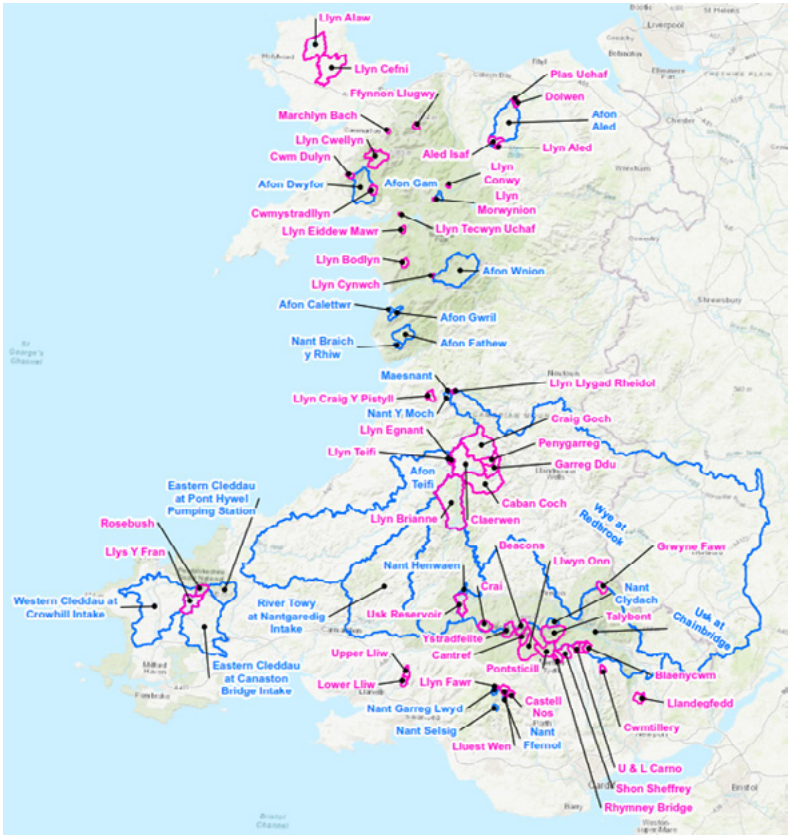


Figure 19 — Location of the 66 GR6J rainfall runoff model development

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 the WRMP24 we have generated sixty-six GR6J river/reservoir catchment inflow models (Figure 19) outputting:

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

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

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 reservoirs 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 resources 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 1,629 Ml with an annual average of demand of around 1.5 Ml/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 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 volumes 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 20 shows a graph of the typical response of a reservoir during a drought period, a set of drought measure trigger 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.

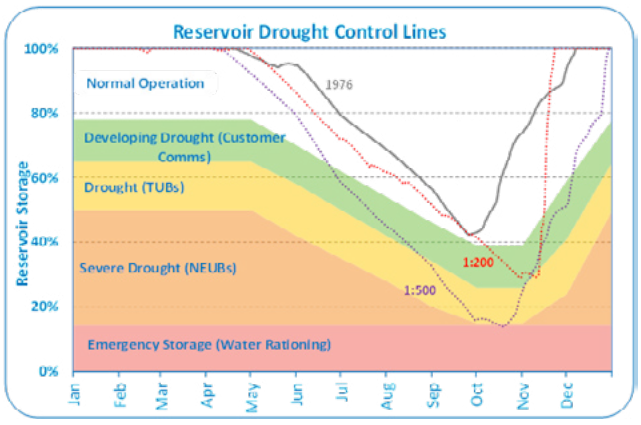


Figure 20 — Reservoir Drought Control Curves

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 demands on the reservoirs. 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 21).

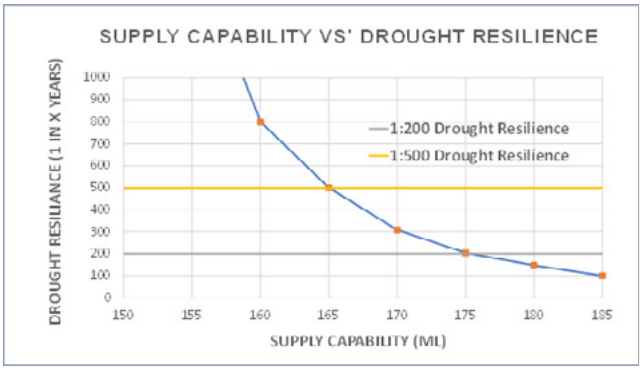


Figure 21 — Supply Capability vs' Drought Resilience

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, over time, increase our level of drought resilience for Emergency Drought Orders to a 1 in 500 year standard (0.2% annual probability), aiming to achieve this for all zones 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.

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.

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 LOo 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 22 below). This method is also detailed in the 2019 UKIWR 'Risk Based Planning' report[9]. Full details of the DO assessment are provided in Appendix 6.

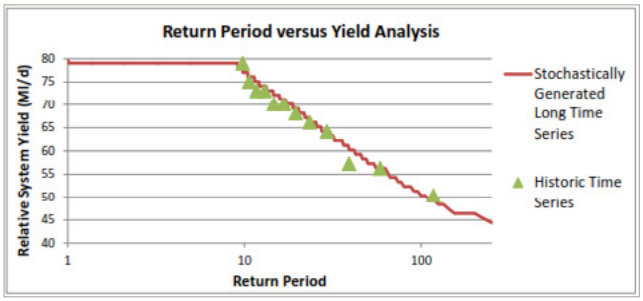


Figure 22 — Example plot of Return Period vs Yield

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 through the use of 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 23).

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.

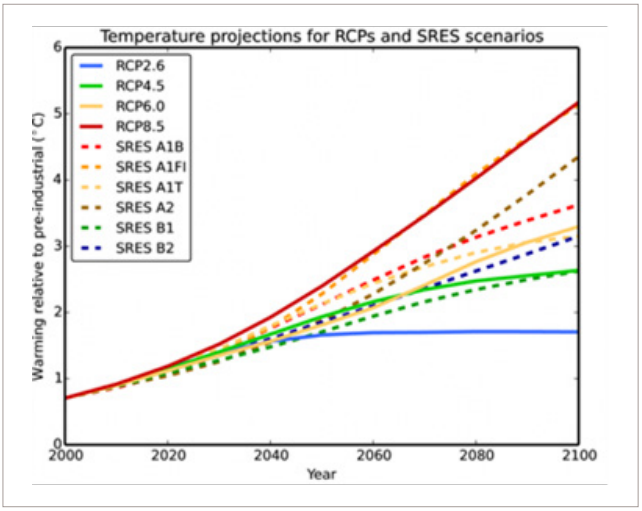


Figure 23 — Climate Change Emission Scenarios

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 24.

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 the 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].

9. WRMP 2019 METHODS – RISK BASED PLANNING (UKWIR, Report Ref. No. 16/WR/02/11)
10. Regional Water Resources Planning: Climate Data Tools. Draft Operational Framework for implementing the EA Supplementary Guidance on Climate Change (Atkins, January 2021).

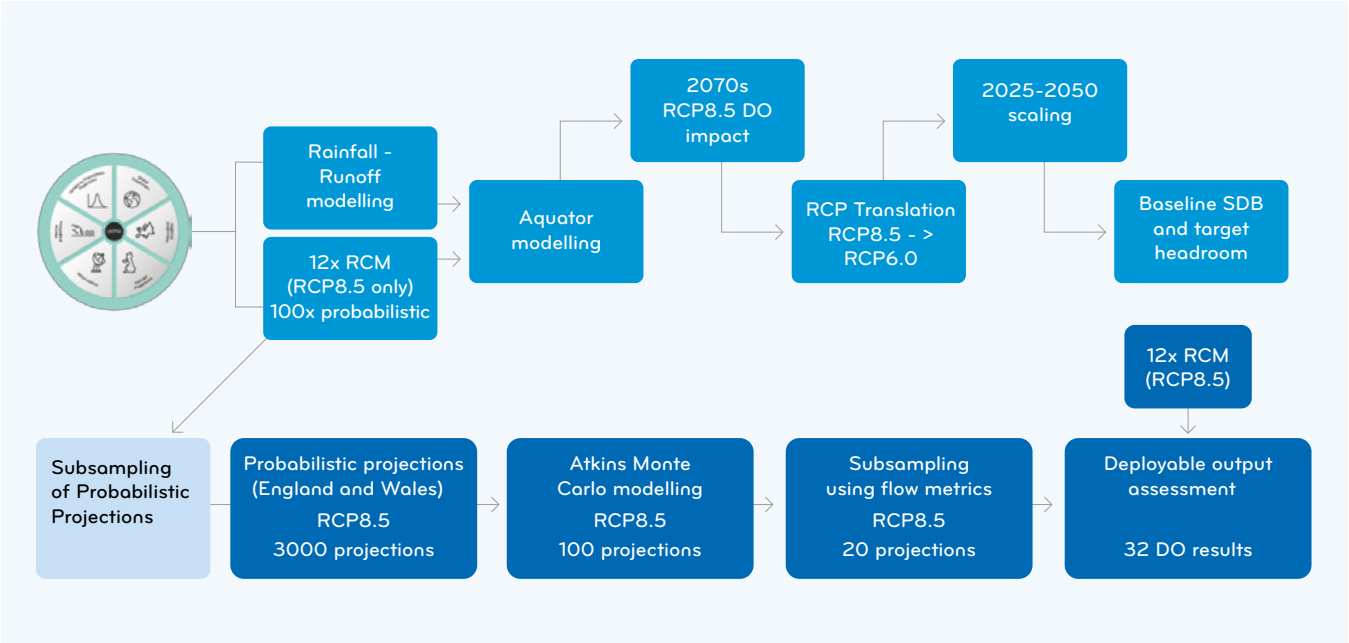


Figure 24 — Overview of climate change DO assessment

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 25), with uncertainty/variance from the 20 sets of probabilistic projections (orange circles in Figure 25) and used to calculate the 'Headroom' allowance.

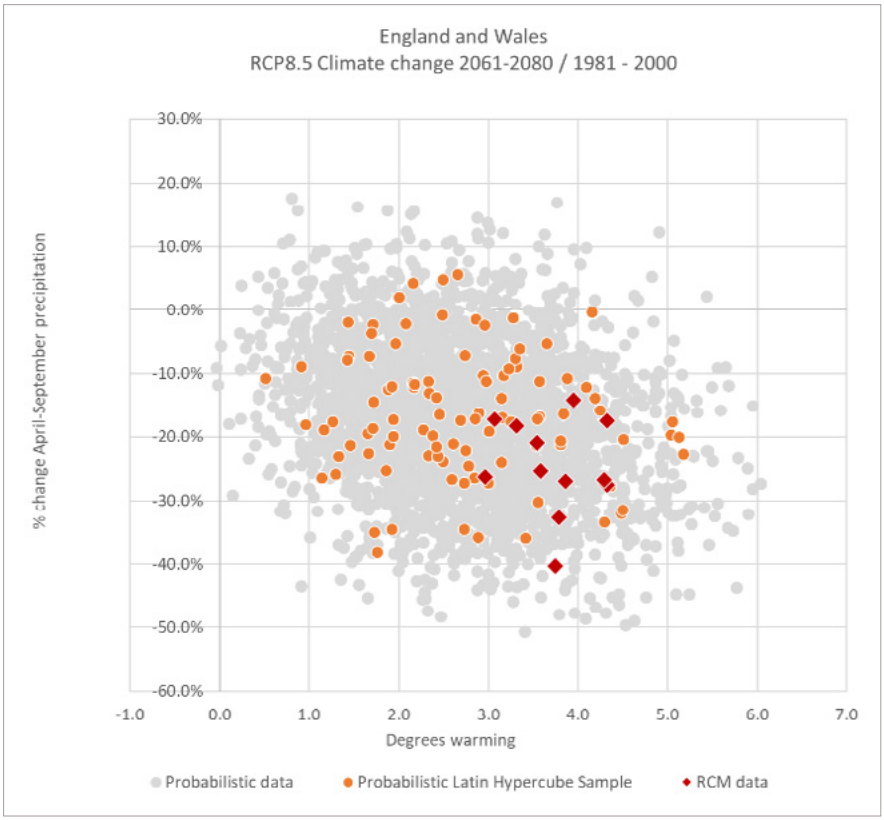


Figure 25 — The 12 RCM projections and 100 Probabilistic projections set against the full UKCP18 outcomes

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 26 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.

3.4.3. 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 Resources 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 1:500 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.

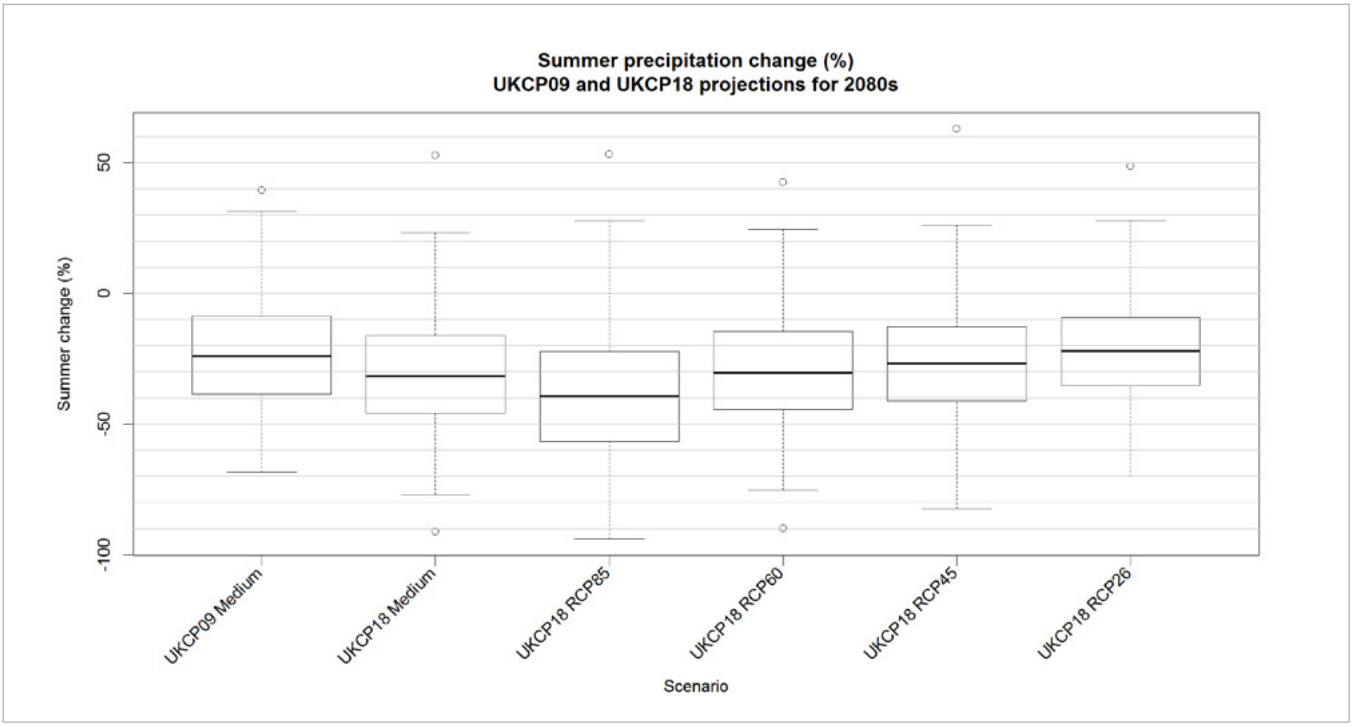


Figure 26 — Comparison of UKCP09 and UKCP18 Rainfall Projections

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 indicate that summer flows are inadequate for ecological needs and there is risk of 'Deterioration' as defined by the Water Framework Directives, and so we will likely need to reduce our abstraction from the source during low flow periods. 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, and to deliver any necessary scheme to resolve any licence reduction that may be required.

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 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. 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.

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.

3.6. 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 potential impact this would have on the quality and treatability of 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 following the dry weather event, 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 to model the results 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 over the current drought period is providing 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 catchment water quality and its treatability to ensure that our supply modelling takes account of current and future risks that may limit our supply capability to meet customer demand. 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 27 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 collaborations 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, 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 support 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 achievement 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.

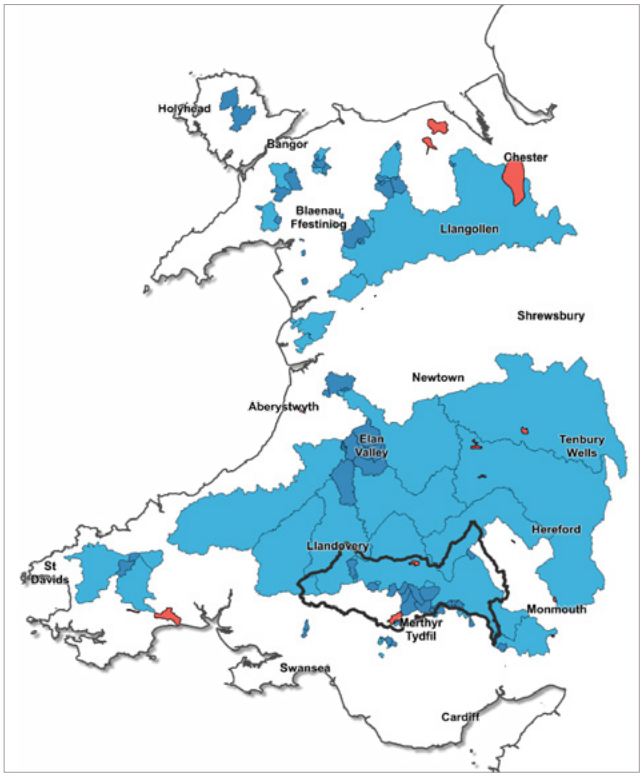


Figure 27 — Welsh Water's Drinking Water Catchments

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 (e.g. LIFE bids);
- Exemplar Farm.

3.7. ZONAL IMPORTS/EXPORTS

3.7.1. POTABLE WATER TRANSFERS TO OTHER COMPANIES

Our principle potable water transfers of water are to Severn Trent Water and Hafren Dyfrdwy. These are relatively small with the transfers between ourselves and Hafren Dyfrdwy in the Mid Wales areas 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 transfers are shown in Table 5 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 5 — 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 6 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	Maximum 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 6 — 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.

Alwen-Dee WRZ
Raw water is provided directly from a single source to Albion Water. As it has no connectivity with other supplies in that area, this water is not included 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.

3.8. OPERATIONAL LOSSES AND OUTAGES

As described in the introduction to the 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 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 when 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 7.

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

Table 7 — 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 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.

The three calculated values are compared, where available and combined. 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 percentage 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 three 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 28 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.

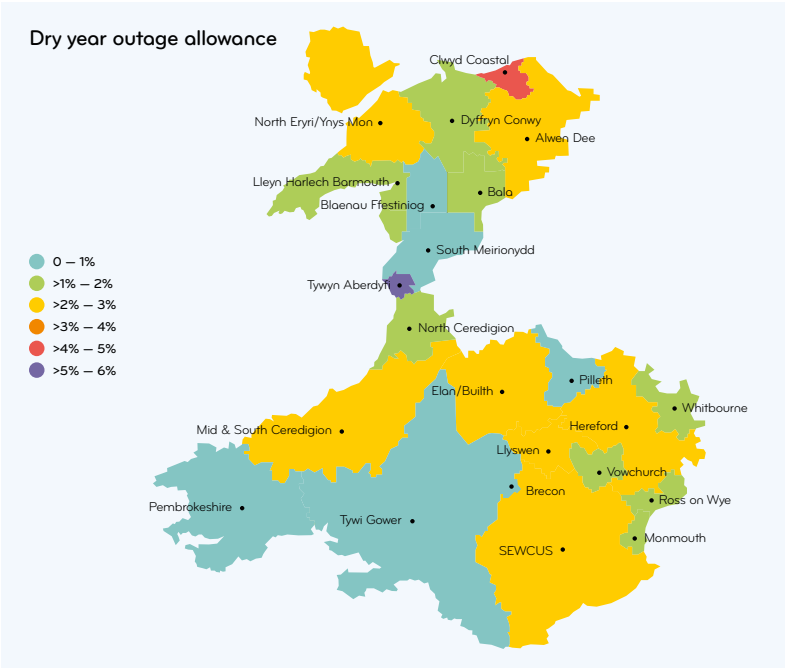


Figure 28 — 'Dry Year Annual Average' Outage allowances as a percentage of DO

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 our 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 a value of Target Headroom that is too small 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 preferred plan are grounded in a more risk averse starting position. The consequence of all these developments in planning from WRMP19 moving to 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.

Elan Valley

4. HOW WE FORECAST DEMAND

4.1. INTRODUCTION

This chapter sets out our demand management strategy, including how we forecast demand for the coming years and the options considered to reduce demand. Demand management has been a key component of our water resource management planning over the past twenty-five years. Over that time, we have halved the quantity of water lost to leakage, culminating in a 15% reduction in leakage levels in just five years, between 2020 and 2025.

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. The ask of companies is that their WRMP24 sets out measures to reduce both their own water use through savings made in the amount of water lost from leakage and to enable and promote a reduction in the amount of water used by customers. To deliver on this 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. HOW WE FORECAST DEMAND

The approach taken to demand forecasting is similar to that in WRMP19, with the base year for forecasts moving to 2019/20 – so 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.

4.2.1. 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 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.

4.2.2. 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.

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.

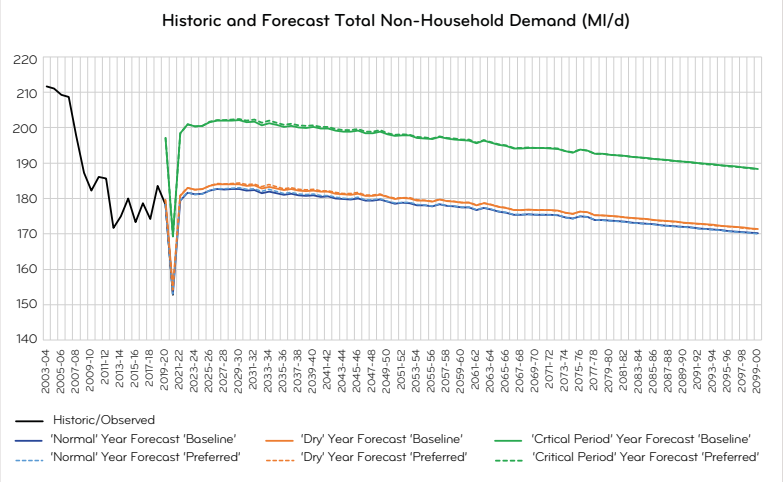


Figure 29 — Baseline and preferred plan non-household demand forecasts

4.2.3. 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). The following table shows the volume of climate change included in the forecasts.

Component	Inc Or Exc CC	Component	2019-20	2020-21	2024-25	2029-30	2034-35	2039-40	2044-45	2049-50	2099-00
DI Baseline	Inc CC	Ml/d	861.91	845.79	779.63	784.05	786.61	790.96	796.18	803.49	879.89
Vol. Due to CC		Ml/d	0.00	0.29	1.48	2.96	4.29	5.64	7.23	8.86	26.36
% of DI		%	0.00	0.03	0.19	0.38	0.55	0.71	0.91	1.10	3.00

Figure 30 — Volume of water demand in forecast due to climate change

4.2.4. 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 the 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.

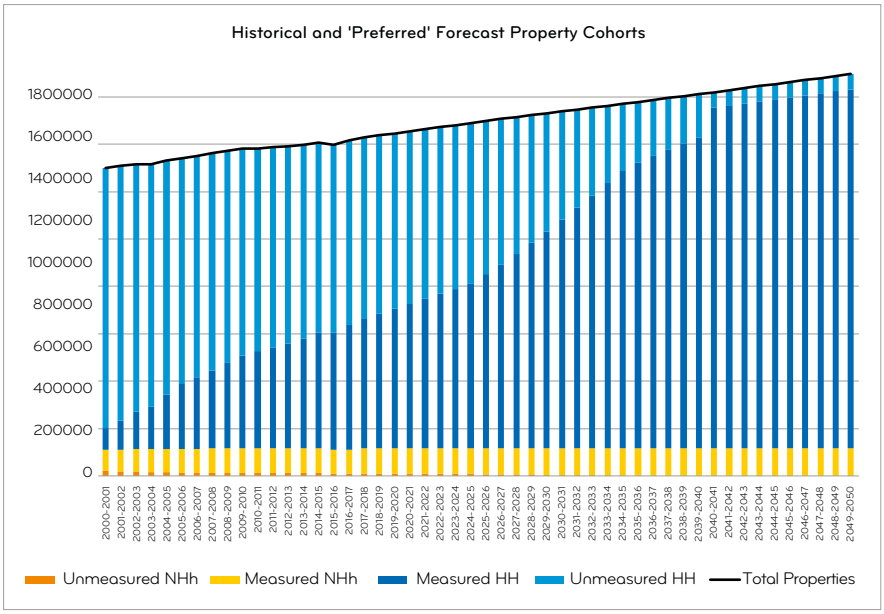


Figure 31 — Historical and forecast property types

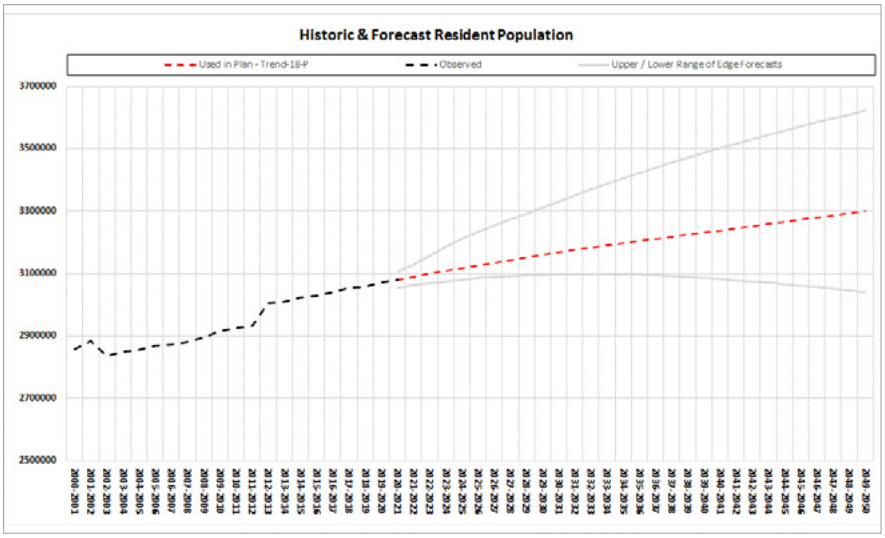


Figure 32 — Resident Population Forecasts

4.3. 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 (SeeFigure 31).

Population forecasts in the plan are based on the principle 2018 Trend Based Projections from the ONS. Figure 32 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.

4.3.1. CENSUS 2021

The results of the Census 2021 have come too late to be included within our Draft WRMP24 and are currently not available at the scale required to be used in our demand forecasts. If this data becomes available in time for the Final WRMP24 then we will review our data in light of this to confirm the population figures are broadly aligned. We note that the headline figures from the Census 2021 show that the population of Wales is the largest it has ever been at over 3.1 million people. This is an increase of 1.4% since the Census 2011 although the results show significant regional variation which is a key factor within water resources planning – Newport for example saw the highest growth rate at 9.5% whereas Ceredigion's population declined by 5.8%.

4.3.2. 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 indication of any significant change of non-household demand factors that warrant inclusion in our forecasts 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, 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 is 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. 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. As part of our Annual Performance Reporting for 2021/22 we have committed to undertaking a full review of the compliance of both PCC and Leakage reporting with the guidance. The review could impact the calculation of these measures and so demand forecasts may need to be adjusted in the final plan.

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.
- Third 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 similar to 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.

4.4.1. OUR LEAKAGE STRATEGY

In 2019 the water companies in England, through WaterUK, all signed up to a Public Interest Commitment[11] 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.

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 ourselves 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 33) 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 detailed in section 5.

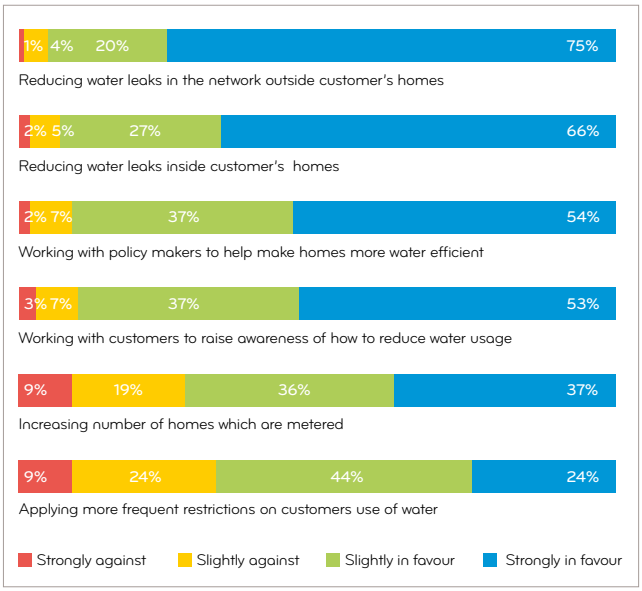


Figure 33 — Customer attitudes to demand-side solutions

4.4.2. WATER EFFICIENCY

In terms of water efficiency, this is largely part of our 'business as usual' work. We are working with Welsh Government through the Wales Water Efficiency Group which brings together water efficiency objectives and projects. Our forecasts of both household and non-household demand include an element of baseline demand intervention through water efficiency which is built into the modelling 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.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11. https://www.water.org.uk/publication/public-interest-commitment/

5. DEVELOPING 'BEST VALUE' SOLUTIONS

5.1. INTRODUCTION

The process of decision making for water resource planning has continued to evolve and so 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 consider our WRMP19 to have delivered the 'Best Value' solutions to the identified supply demand shortfalls in the Pembrokeshire, Tywyn Aberdyfi and Vowchurch zones. For WRMP24 our drivers are similar, but we have improved evidence particularly around water resource resilience and a stronger remit for solutions to enhance the environment in which we operate. This aligns fully our Company 2050 mission to become a world-class, resilient, and sustainable water service for future generations.

5.1.1. THE SUPPLY/DEMAND POSITION

Our Supply/Demand balances have been generated for each of the 23 water resource zones. Our baseline position indicates that four zones will not be resilient under our preferred planning scenario – 1 in 200 year level of drought resilience for emergency measures, tested against a medium emission climate change scenario – within the 25-year period to 2050. The zones with an identified shortfall are Tywi Gower, Mid & South Ceredigion, SEWCUS and Clwyd Coastal (Figure 34). Testing our baseline against a higher level of drought resilience, in this case a 1 in 500 year level of drought, the Lleyn Harlech Barmouth zone also falls into deficit (Figure 35). It should be noted that the deficit in the Mid-and South Ceredigion zone is driven off the critical period planning scenario as although it is resilient to drought from a water resources perspective, it is in deficit with respect to peak demand. We have also undertaken wider scenario testing to understand the sensitivity around other variables such as demand and climate change emissions and consequent potential impact to our investment programme. These are set out later in this section of the report.

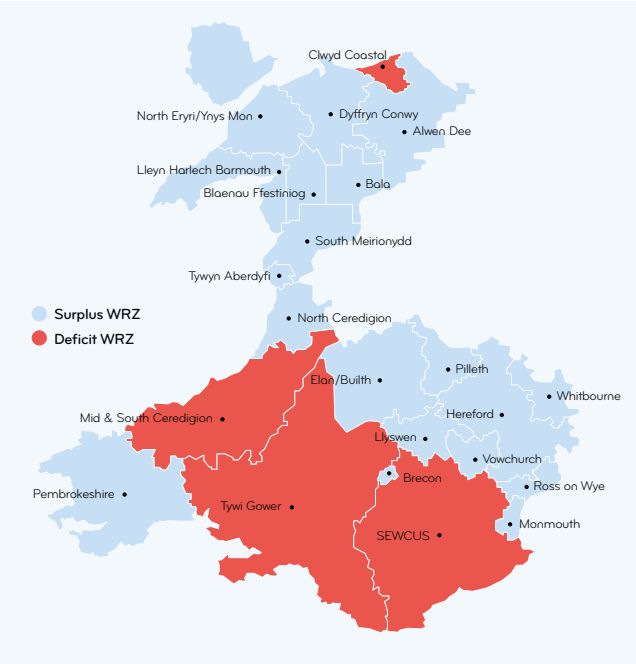

Figure 34 — Deficit zones, 1 in 200 drought resilience, medium emissions

Figure 35 — Deficit zones, 1 in 500 drought resilience, medium emissions

5.2. DEFINING A BEST VALUE INVESTMENT PROGRAMME

We need to demonstrate to our customers and regulators that our preferred solutions are appropriate to the scale of issue within the individual WRZs and represent the 'best value', rather than purely the least cost, solution. 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.

Guidance also expects companies to make decisions based not solely on cost, but through a valuation process that utilises a wide range of social and environmental metrics. However, the process also needs to account for overarching policy decision driven by long-term delivery strategy and the nature of the problem within each water resource zone. Figure 36 shows the decision-making hierarchy.

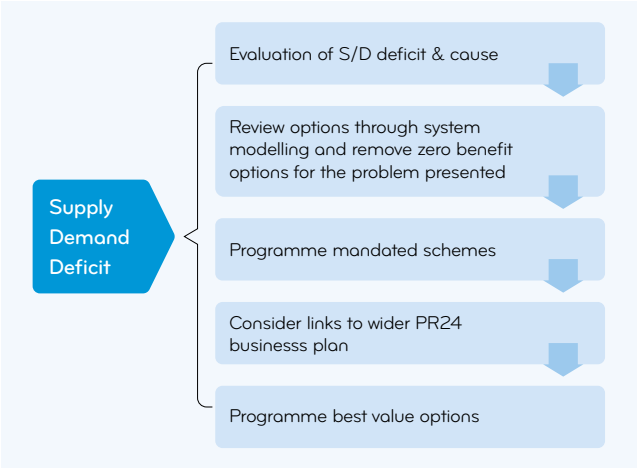

Figure 36 — Decision-making hierarchy

5.2.1. 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 and the even if new water resource options are available, this 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.

5.2.2. POLICY LED SOLUTIONS

Our demand management policy is aligned to our long-term delivery outcomes directed by Government, regulator 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.

This mandated policy is part of the overall solution within deficit zones but will act to improve water resource resilience in all zones over time. This will provide the best chance of achieving our longer-term objectives as this is a no regrets position to both deliver and inform the business risks around smart meter delivery, customer-side leakage improvement and customer usage reduction behaviour during the AMP8 period. Secondly, as demonstrated in our sensitivity analysis in section 6, the associated reduction in demand will reduce the volumes of water abstracted from the environment.

This 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.

5.2.3. BEST VALUE DECISION TOOLS

'Best Value' Decision criteria for this plan include the scheme cost (CAPEX, OPEX) and scheme benefits in terms of gain in deployable output but also broader values including social and environmental benefits. These criteria have not been prescribed but are required to link to wider guidance and so provide line of sight to legislative objectives, notably for this Plan embedding the principles of SMNR into to our decision making to align with the Environment (Wales) Act. This is similar to a multi-capital approach in terms of criteria but without full monetisation. Metric weighting can then be used to explore the trade-offs between candidate options and programmes.

To help support the development of our best value programme, we have tested our options through the decision-making tool ('ValueStream') that was developed through the Water Resources West regional planning group. The tool is based on multi-criteria analysis (MCA) and is designed to accommodate a range of metrics and objectives into the decision making. The tool takes different value metrics and weights them according to relative preferences to form an optimisation which maximises value according to the values and weights (see Figure 37).

The selection of metrics to be used and their weightings (were set following a series of expert workshops involving all Water Resources West stakeholders informed by the group's understanding of customer preferences and stakeholder views as well as the technical definitions of the metrics. Full details of the development of 'ValueStream' are set out in Appendix 11.

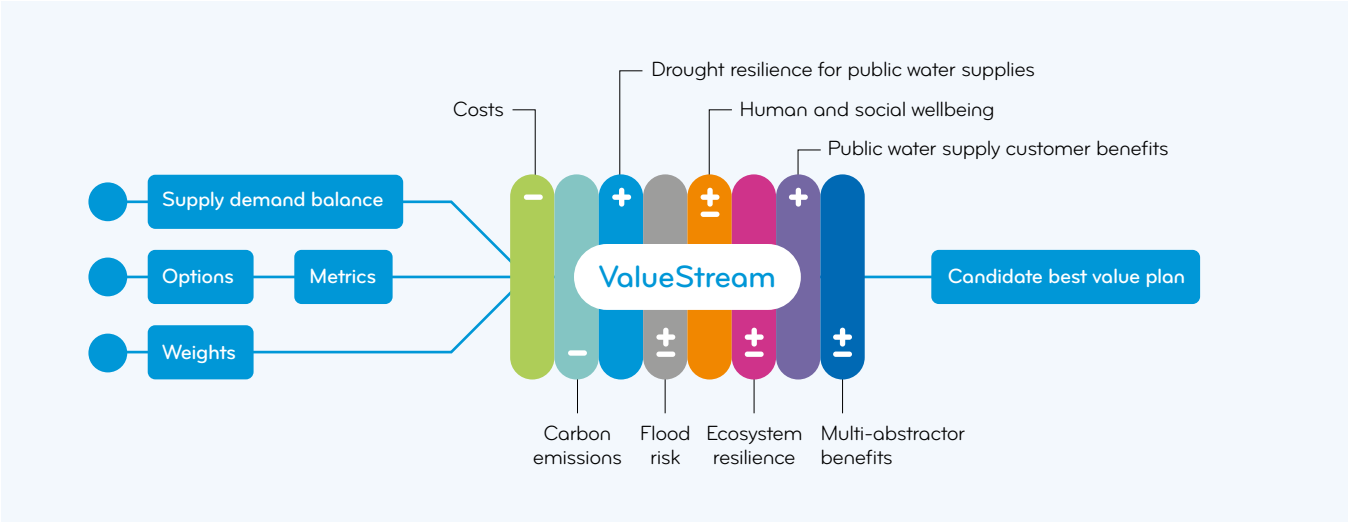

Figure 37 — 'Best Value' Decision metrics

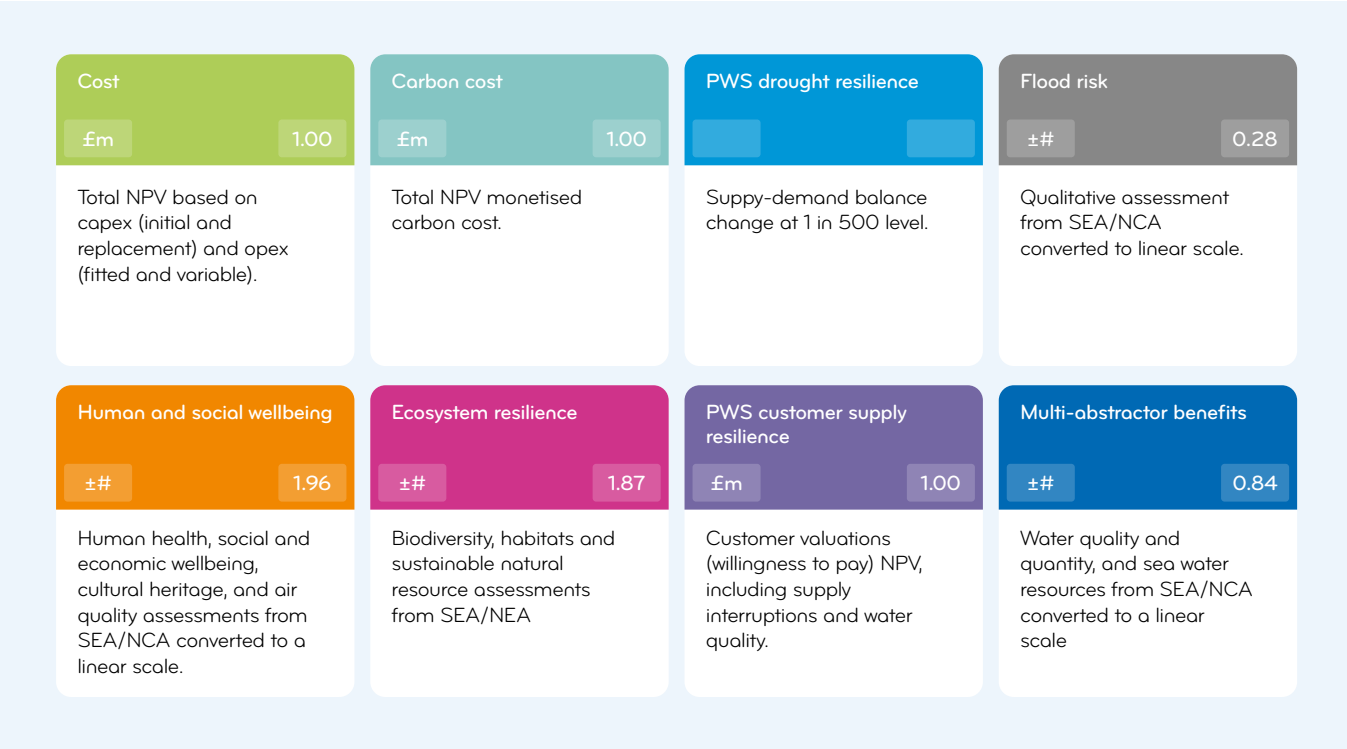

Figure 38 — ValueStream metrics and weightings

5.3. DEMAND MANAGEMENT OPTIONS

For PR24, we have expanded our leakage optimisation modelling framework to explore the costs and leakage savings associated with a broad range of innovative leakage reduction policy options, thus to identify the least cost means of attaining leakage performance commitment for AMP8 and beyond. The analysis undertaken considers the following leakage control interventions:

- Find and fix activity (based on a continuation of DCWW's current policy);
- Intensive find and fix activity (based on a more intensive specialised form of DCWW's current policy using);
- 'Lift and shift' acoustic data loggers;
- Permanent leak localising data loggers;
- AMR and AMI Smart Metering;
- Changes to repair policies for customer supply pipe (CSP) leaks;
- Asset renewal (mains, communication pipes and customer supply pipes, in various combinations);
- Reductions in trunk main losses by means of repair or renewal.

WRZ-level cost relationships have been developed for each intervention option. 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 range of external costs and benefits (i.e. environmental, social and carbon impacts) associated with each intervention and its resulting leakage savings are also quantified in financial terms.

The two key options that could provide significant demand management savings are further find and fix effort or a focus on customer supply pipe leakage using 'smart' metering technology. We understand that conventional find and fix strategy becomes less effective as the search for ever smaller leaks is needed whilst efforts to manage leakage on customer supply pipes and internal plumbing systems have been a focus through Project Cartref in AMP7. Technological improvement through 'smart' metering, telemetry and modern data science offers an advancement in the ability to detect these leaks more effectively.

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.

We are 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 of background leakage so that innovative technologies and data science can be employed in future strategies to manage this element.

Table 8 shows indicative companywide incremental cost values for leakage options. As described above, conventional find and fix is becoming increasingly expensive. The most cost-effective approaches are now focussed on customer side leakage through new metering technology. This is mainly due to the benefit not only to savings from SPL but the potential benefit to customer usage. The use of advanced metering also provides the opportunity to improve find and fix targeting through large dataset analysis.

Leakage through find and fix	AIC
Leakage through find and fix	£83.6p/m^3
CSP Leakage benefit from metering	£81.4p/m^3
Combined find and fix plus metering (There is also benefit to find and fix through metering/demand analysis)	£47.9p/m^3
Metering – leakage and demand savings combined	£22.3p/m^3

Table 8 — Leakage Options

For this draft Plan we have appraised at a company level, four demand management schemes broadly summarised as:

1. **Leakage** – 56 Ml/d reduction by 2050 reduction through 'find and fix' activities, at an AIC of 84 p/m^3
2. **Metering** – delivery of our metering strategy will bring both leakage benefits from the customer supply pipe as well as enabling us to work with our customers to encourage more water efficient behaviour. This should provide around 138 Ml/d reduction in demand by 2050 with an AIC of 22.3 p/m^3
3. **CSP Metering** – delivery of our metering strategy but just fixing leakage where its detected on the customer's supply pipe. This would deliver around 38 Mld by 2050 at an AIC of 81.4 p/m^3
4. **Combined** – options 1 and 2 delivered together to reduce demand by around 157 Ml/d by 2050 at an AIC of 48 p/m^3

In terms of water efficiency, this is largely part of our 'business as usual' work. We are working with Welsh Government through the Wales Water Efficiency Group which brings together water efficiency objectives and projects. This work has a substantive part to play in reaching the targets set within our long-term delivery strategy but will not provide the substantive savings required during the AMP8 period. The savings during the AMP8 period are built into our demand forecast.

5.3.1. OUR METERING STRATEGY

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

- 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 39, taken from our customer research, shows the main reasons why customers opt to have a meter installed;
- All new build properties are now required to be metered;
- 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%. 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.

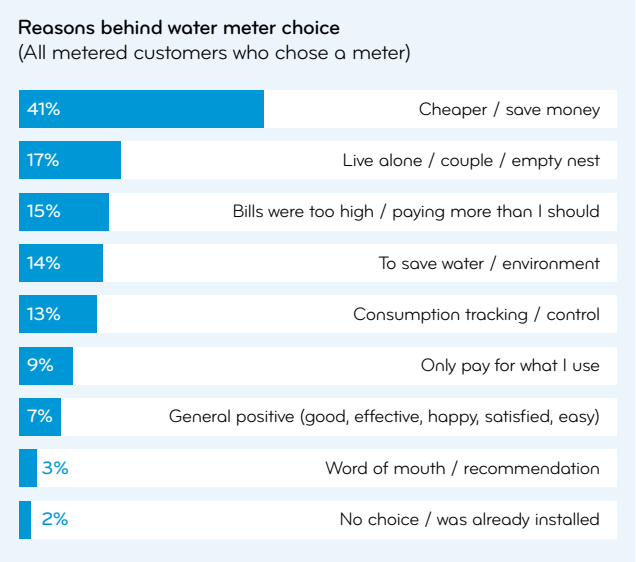

Figure 39 — Results of WRMP24 customer research into meter optants

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. 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 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 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 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. to run alongside that usage will help them reduce. The outputs of the customer research (Figure 40 and Figure 41) 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.

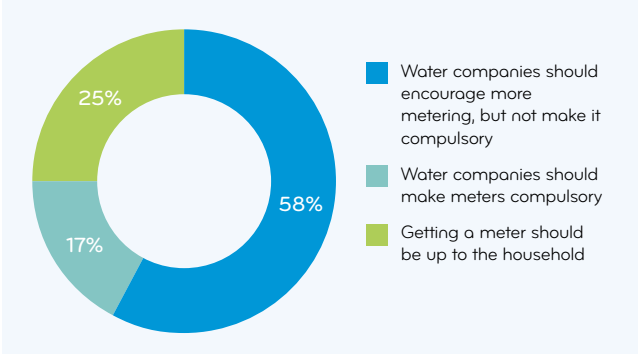

Figure 40 — Customer views on metering

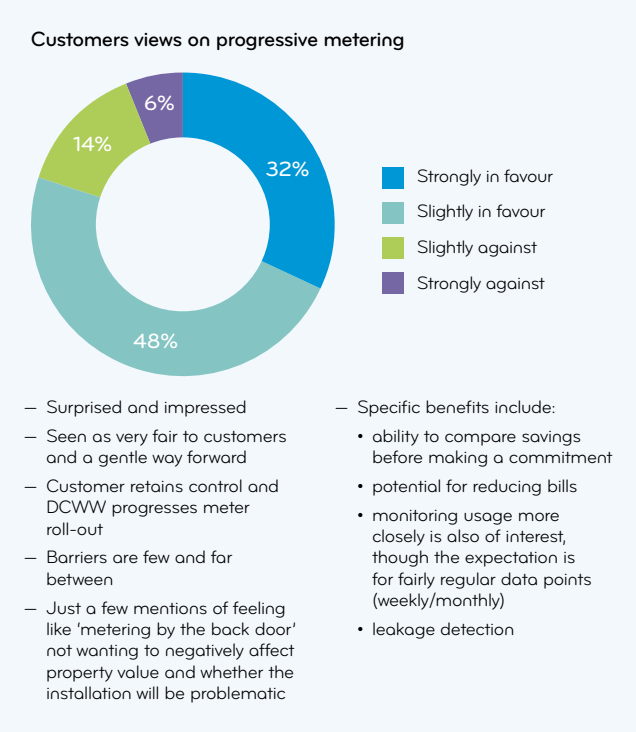

Figure 41 — Customer views on 'progressive' metering

From 2025 we propose to move to a strategy of installing smart (AMR) 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 will continue to monitor developments in smart metering technology and move to AMI meters as the technology matures and costs reduce.

Through our strategy we will increase the level of metering to 76% by the end of AMP8 and 95% 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 34.6Ml/d at the end of AMP8 and 96Ml/d by 2050.

5.4. 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 original outputs from 'Pathways to long-term PCC reduction' Water UK (2019), shown as the orange glidepath in Figure 42 have been reviewed and updated by the Water Resources South-East Region (WRSE) during Regional Plan preparation. An alternative, more conservative set of reductions were produced and have been used in our forecasts.

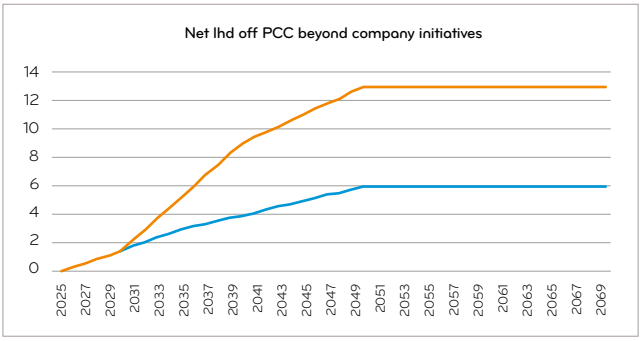

Figure 42 — Government-Led Intervention Glidepaths

5.5. COMPANY LED INTERVENTION AND WATER EFFICIENCY — PROJECT CARTREF

Project Cartref is about working with 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. Project Cartref is about establishing a conversation with customers about how we can help them. We offer many services that we believe could be of interest to a great many more customers, but a meaningful face to face conversation is required to explain the benefits. 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 – 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. Highlights of the Cartref programme include:

Schools
Our current education programme delivers school assemblies and workshops to educate children on key aspects of the water cycle. One element of this is around Water Efficiency. We would look to undertake water efficiency audits and fit outs at 200 schools per annum.

Water Home Audits
The Cartref programme will look to identify high users and engage with them to promote our virtual water audit and access to free products. We will undertake 25,000 home audits within AMP 8.

Community
We believe there is significant power in community engagement. In order 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, tapping into key stakeholders and partners in communities we are targeting. Community engagement will be focussed on areas in which we are undertaking progressive metering.

5.6. 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 maybe 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 wider consideration from ourselves and key stakeholders such as Welsh Government, Natural Resources Wales and the 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.

5.7. 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. Based on experience during recent dry weather events we have also engineered high level options for the Mid & South Ceredigion and Clwyd Coastal zones to address potential deficits under scenario testing.

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 43 summarises the optioneering process to develop a list of schemes that are then taken forward into decision making.

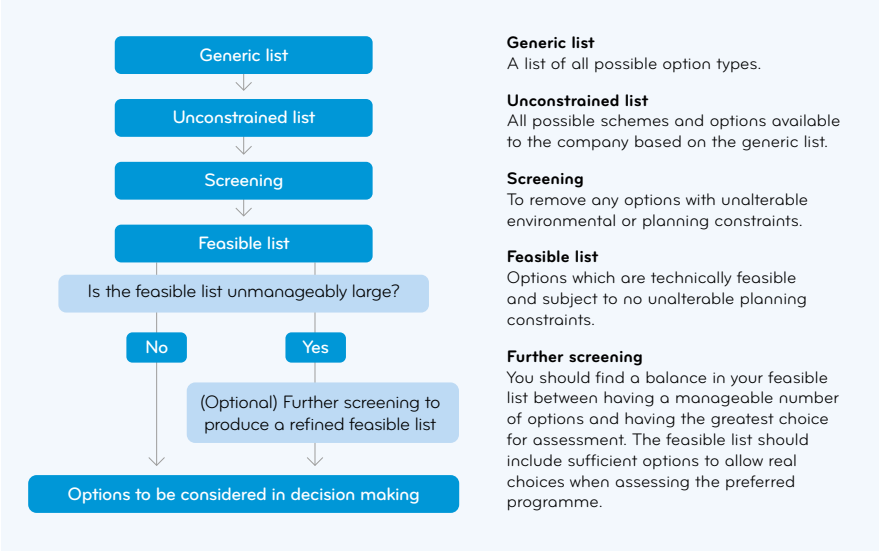

Figure 43 — Options Identification and Screening Process

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:

- It allows potential environmental, customer and planning considerations to feature in the option assessment process from the outset;
- 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;
- 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 43 resource options for further consideration at the fine screening stage:

- Mid & South Ceredigion: 6 options;
- SEWCUS: 28 options;
- Tywi Gower: 9 options.

The 43 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 32 options that were taken forward to the feasible list for detailed engineering and costing assessments, more detail on this is included within Appendix 13.

- Mid & South Ceredigion: 6 options;
- 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.

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 32 feasible supply side options and calculated the benefit to zonal DO. 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.

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 schemes where it was not considered sufficiently robust due to either there was 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 CO_2e).

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/m^3)
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	£7,483,287	£1,388,298	22.77
Llwynon Trunk mains upgrades	£2,002,742	£0	2.15

Table 9 — Summary of SEWCUS Feasible Option costs

Option	CAPEX	OPEX (assumed all year operation)	AIC (p/m^3)
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	£1,232,570	£63,769	15.97
Llyn y Fan Fach Regulation	£24,828,347	£0	19.32
Christopher Road WPS enhancement	£8,319,738	£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 10 — Summary of Tywin Gower Feasible Option costs

Option	CAPEX	OPEX (assumed all year operation)	AIC (p/m^3)
Upsize Llechryd WTW	£2,604,984	£117,054	30.07
Claerwen transfer	£17,544,196	£223,630	29.6
New network connection with the North Ceredigion WRZ	£16,479,014	£287,401	28.62
Deri Goch WPS enhancement	£180,302	£6,152	6.35
Llyn Egnant dam raising (0.5m)	£1,370,000.00	£0	142.83
Llyn Egnant dam raising (1m)	£1,617,000.00	£0	171.5

Table 11 — Summary of M&S Ceredigion Feasible Option costs

5.7.1. CUSTOMER PREFERENCES ON WATER SUPPLY INVESTMENT

Figure 44 summarises the outputs of the 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.

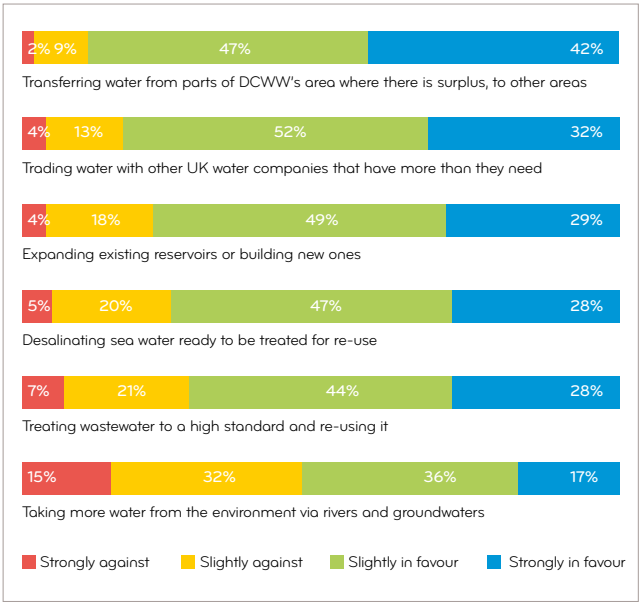

Figure 44 — Customer attitudes to supply-side solutions

5.8. 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 and national plans and programmes that are relevant to our regional 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 our 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.

5.8.1. 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 four 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.

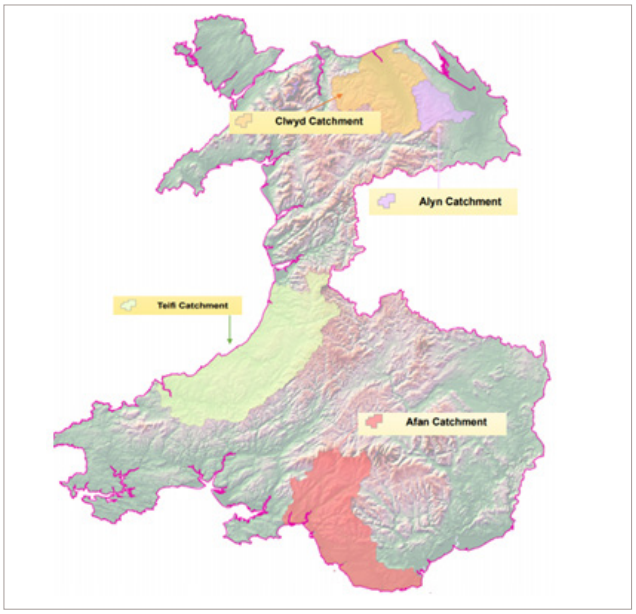

Figure 45 — Location of DCWW's pilot SMNR Catchments

5.9. 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.

5.9.1. 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 computers 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:

- 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;
- 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;
- 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;
- 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[12] 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.

5.10. 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 already a number of areas where policy and even legislation differ in Wales and this trend may be expected to continue.

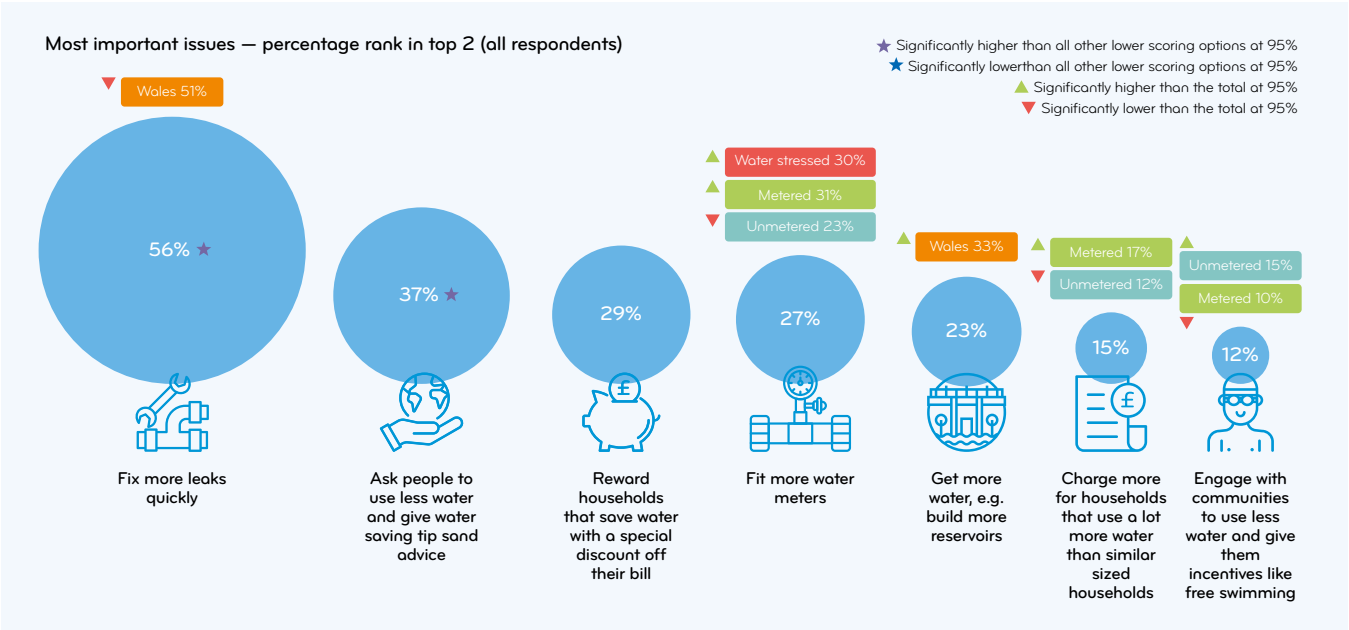

Figure 46 — Outputs from CCWater's 2021 Customer survey

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

5.10.1. WRMP SCENARIO TESTING

The WRMP has considered the four core Ofwat scenarios as summarised in Table 12 below:

	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 12 — Ofwat Common Reference Scenarios

5.10.2. 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, in order to comply with OFWATs LTDS requirements. The RCP2.6 scenario will be used to inform the no regrets core pathway with the outputs of the 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 future intervention requirements within the short and medium term. As outlined within the WRMP, future supply/demand balances can be achieved under all three different climate scenarios utilising existing supply side assets. Climate change testing reinforces this position and demonstrates that the sensitivity is around the timing of implementing identified demand side interventions e.g. acceleration of AMI metering if the RCP8.5 climate scenario becomes dominant.

The climate modelling and forecast impacts are based on best available models 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 identified for further assessment involves the effects of climate change on environmental flow requirements, private water supplies and the potential implications for public supplies if some of these private supplies become unviable due to lack of resource or declining water quality caused by climate change impacts. Increased risks with private supplies from climate change have led the Welsh Government to ask water companies start to consider the longer-term implications. This is discussed under section 5.6 of the WRMP and will be an evolving area of consideration.

5.10.3. 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 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.

5.10.4. ABSTRACTION

At present Natural Resources Wales has not set a policy of abstraction reduction and as such this is not a feature of the WRMP24 scenario testing or core pathway. The assumption agreed with NRW is that reductions in abstraction are not currently required and so DCWW has not tested its plan against the Ofwat 'High' and 'Low' environmental scenarios.

Work is ongoing as part of the LTDS/adaptive planning process to further assess and understand the potential implications, locations and timescales of any future restrictions. So far consideration has been given to the possible number of sustainable abstractions that could be retained, as well as the impact of maintaining river health during dry years resulting in the need to release water from reservoirs.

Analysis to date has indicated that any future abstraction restrictions of this nature would likely lead to the need to advance metering and leakage reduction programmes rather than requiring supply side capital projects. This could change if the abstraction reductions were more dramatic than currently envisaged. We will draw on our experience and data gained from the drought period of 2022 in this assessment.

Investment is being identified for AMP8 focusing on data collection and modelling to provide a better view of likely future impacts if NRW were to change from its current position and therefore, to improve the confidence in this scenario. This funding would ensure that all future options are kept open, and no opportunities are closed off / lost which is entirely consistent with the application of adaptive planning.

5.10.5. 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 at this time to domestic metering. DCWW are currently focusing metering plans initially on wide scale rollout of AMR meters, moving to 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.

5.10.6. COMPANY SPECIFIC SCENARIOS

Work is still ongoing to define company specific LTDS scenarios. As such these have not been fully tested within the WRMP with analysis ongoing. Due to the sensitivity though, specific focus has been given to the scenario where PCC savings are lower than forecast. This analysis can be seen within scenarios 6 and 7 of the WRMP and would potentially form part of an alternative pathway. Trigger points would be based on actual vs forecast PCC levels at different stages of smart meter penetration.

5.10.7. SUMMARY

The WRMP has been constructed and tested in line with the LTDS and adaptive planning principles which are central to DCWWs BAU process for both strategic and tactical assessments. The WRMP24 has been tested against the four Ofwat core scenarios: climate change, demand, abstraction and technology. Outputs of the scenario testing have reinforced DCWWs preferred investment programme and interventions as outlined in the WRMP24. Testing against the Ofwat scenarios has identified that the preferred programme is sensitive to the timing of undertaking identified interventions rather than a need to undertake alternative interventions. Appropriate trigger points will indicate when interventions may need to be accelerated in line with an alternative pathway. LTDS is by nature a continuous improvement process and the WRMP will continue to be refined alongside the LTDS.

Usk Valley

6. OUR PREFERRED PLAN

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 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 under if future risks materialise.

This Chapter describes and validates a programme of investment needed to resolve forecast water supply deficits and which will also achieve the wider targets that have been set for this Plan.

Whilst the majority of our WRZs already 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. 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 the following two sections, 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 as reflected in our long-term delivery strategy.

6.1. OUR DEMAND MANAGEMENT PROGRAMME

We have developed an ambitious, long-term demand management strategy that recognises that we need to take action to reduce leakage and help customers use water wisely. Our customers support this, and the strategy aligns with regulatory expectations. Our leakage strategy is designed to reduce leakage by a further 10% between 2025 and 2030 and reach 50% of 2017-18 levels by 2050. Household demand is forecast to reduce by 100 Ml/d of against the baseline position with the aim of hitting the PCC glidepath target of 110 litres per person by 2050 in a 'Normal' year. The following figure outlines our demand reduction pathways and the contribution of the intervention in terms of reducing baseline to reach our preferred position. (CSP – Customer Supply Pipe)

Figure 47 below shows the relative magnitude of each element of demand reduction. In AMP8 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. In addition, technology is increasingly supporting the identification and efficiency in fixing leaks in the distribution system. We have included for savings from the introduction of technology within our demand management forecast.

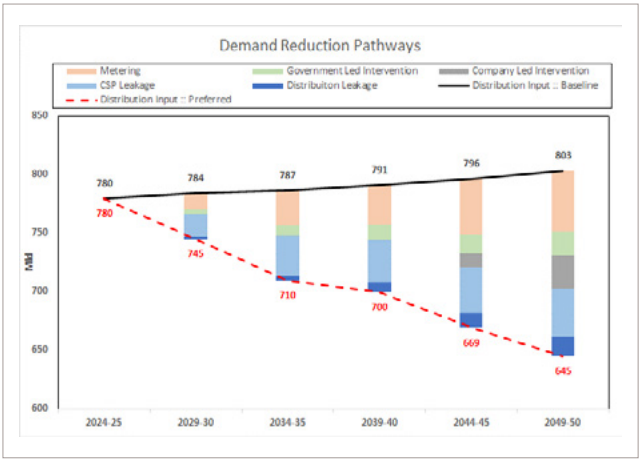

Figure 47 — Components of our demand management strategy

6.1.1. SMART METERING

The key delivery pathway for customer side leakage reduction is a significant change in company metering policy from 2025. This change will reduce demand and increase security of supply over time. It is also a fundamental pathway in delivering to the ambitious PCC target of 110 litres per person by 2050.

Progressive AMR metering from 2025 with proactive replacement of meters more than 10 years old

- Proactive installation of meters on unmeasured properties (excluding joint supplies) area by area, over AMP8 and AMP9).
- Properties are initially billed as unmeasured but switch to measured charges on change of occupier.
- Optants (switching to measured billing) continues, and is encouraged with dual billing.
- Void properties and unmeasured NHH's are included, reaching a meter penetration of 75% at end of AMP8.
- Proactive replacement of all meters exceeding 10 years old, area by area, alongside new installations.
- All meters installed and replaced are AMR meters capable of providing daily consumption data
- Compulsory measured billing introduced in 2040/41 (AMP 11).
- From 2040/41 all meter replacements are AMI.

Figure 48 — Progressive metering plan extract

Over the course of AMP8, the penetration of installed meters will rise from 50 to 75% reflecting our progressive approach to installing meters on unmeasured customers and offering dual billing, whereas the number of households billed on a measured tariff will increase from 50 to 65%.

The programme will see the move to smart AMR meters and our cost-benefit model currently suggests that a move to AMI meters would take place in 2030, although as technology develops over the coming years our plans may adapt for earlier adoption. Our plans are to move all remaining household properties onto a measured tariff during 2040-41, subject to regulatory approval. By 2049-50, effectively all households will be billed on a measured tariff.

Our 'preferred' 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.

6.1.2. LEAKAGE REDUCTION STRATEGIES

As previously mentioned, our progressive metering policy is planned to commence in 2025-26. The installation of meters across this period is estimated to provide benefits in terms of Customer Supply Pipe (CSP) Leakage the mechanism of impact being through increased leak awareness and reduced run times.

The installation of meters will assist in the discovery of leaks previously undiscovered through conventional active leakage control or via customer reporting. Any new leaks would be found and repaired in a shorter duration due to enhanced awareness through meter readings interval and consumption.

The installation of meters will also be complimented with a comprehensive policy around supply pipe leakage resolution. This aims to provide assistance to the customer to resolve any leakage on the supply pipe and within the property and ensures the supply is 'leak free' and in a 'good plumbing state' at the point of being moved onto the measured tariff. This policy and the impact on CSP Leakage from metering is included in the forecasting across the progressive metering period (2025 to 2041).

Additional leakage options are included to ensure the target glidepaths are met. This is on the basis that in some cases the CSP Leakage impacts of metering may not fully meet the glidepath transition required each year and that additional leakage reduction options maybe required. These options focus on distribution network leakage and includes Active Leakage Control (ALC), primarily in the shorter term, and some element of mains renewal later in the plan as a more cost-effective option to further reduce leakage levels and build network resilience.

The following Figure 49 and 50 show the impact of the progressive metering programme on the glidepath transitions in terms of CSP Leakage and additional reductions on distribution leakage.

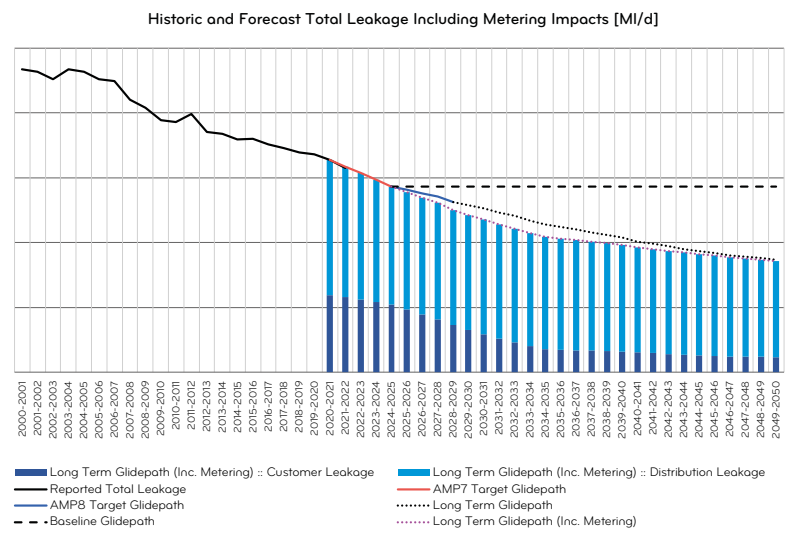

Figure 49 — Customer Supply Pipe & Distribution / Network Leakage Glidepaths

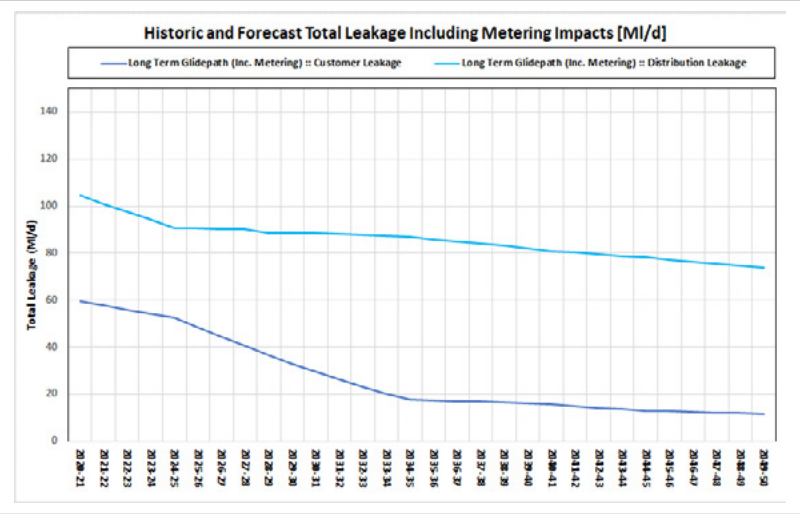

Figure 50 — Customer Supply Pipe & Distribution / Network Leakage Volumes

	Leakage Volume (mld)							
Component	2020-21	2021-22	2024-25	2029-30	2034-35	2039-40	2044-45	2049-50
CSP Leakage	59.46	57.77	52.30	32.86	17.63	15.99	12.89	11.64
Distribution Leakage	104.34	100.83	90.72	88.46	86.78	82.13	78.18	73.88
Total Leakage	163.80	158.60	143.02	121.32	104.41	98.12	91.07	85.52

Figure 51 — Components of the 'preferred' Leakage Glidepath

In general, distribution leakage has a much smaller role to play across this plan as the majority of the leakage glidepath transitions are achieved through the CSP Leakage reduction associated with the metering rollout. As the reductions from CSP Leakage reduce and flatten, more reductions through distribution leakage are required to ensure the overall leakage glidepath transitions are achieved.

Furthermore, including metering impacts on the leakage glidepaths pushes the leakage levels below the 'required' glidepaths. The metering programme will be rolled out on an 'area by area' basis, and its primary driver is not around a required leakage reduction per se. The leakage benefits are a consequence of the timing and scale of the metering rollout and are therefore dependant on the numbers of meters installed per annum.

6.2. INDIVIDUAL WATER RESOURCE ZONE PLANS

For the four zones that have been shown to have a supply demand deficit in the planning period, as well as those zones where we see risks of shortfall under scenario testing, 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 where we plan to make water supply system investment to complement our demand management savings. It can be seen from the cost tables in section 5 that some of the supply side options available have a lower incremental cost than the demand management options within our preferred investment plan. However, our plan aims to meet 'Best Value' criteria, account for customer and stakeholder imperatives which in turn offer environmental benefits.

6.2.1. 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, 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' reservoirs will have 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 two systems.

The improvement in our understanding of catchment hydrology and reservoir inflows at all sites has meant that modelled drawdowns are now more accurate and show that during a drought it will be the lack of storage in our Taff Fawr and Taff Fechan reservoirs that would cause the 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, produced the starting supply demand position in Figure 52.

Against our 'Core' planning scenario of achieving drought resilience to a 1 in 200 year, the 'baseline' SEWCUS supply against demand balance shows a deficit across the 25 year planning period to 2050 (Figure 52)

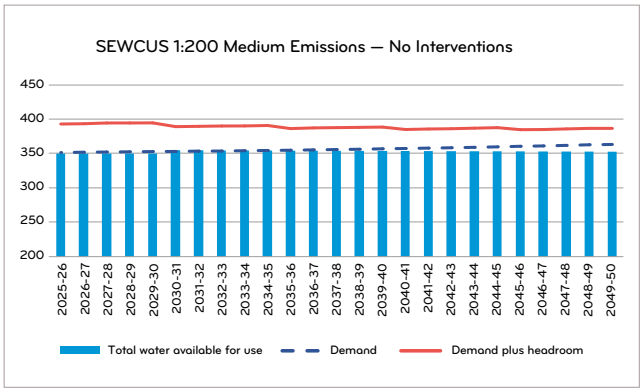

Figure 52 — SEWCUS S/D Balance with no Interventions

We have used our improved supply systems 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 water more into the demand areas supplied by the Llwynon and Pontsticill (soon to be Cwm Taff) 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 11Ml/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 Llwyd, Great Spring) and interzonal transfers of water. However, 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 a 1 in 200-year level of drought resilience in SEWCUS (and will support moving to a 1 in 500-year level of resilience), 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 zonal resilience during the AMP8 period as shown in Figure 53. It is the twin track approach of supply and demand side schemes, as shown in Figure 54, that is needed to ensure sufficient levels of drought resilience are achieved during the 2025-2030 period.

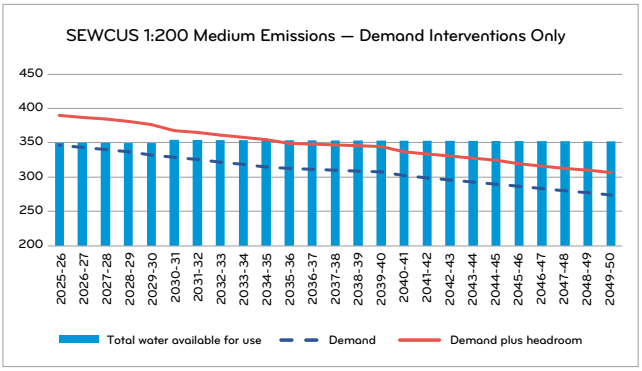

Figure 53 — SEWCUS S/D Balance; Demand Interventions Only

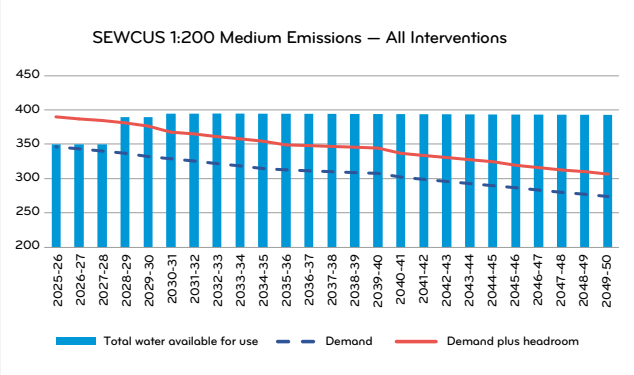

Figure 54 — SEWCUS 1 in 200 Final Plan S/D Balance

The preferred program 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 that the schemes with all interventions in place:

- Deliver enhanced resilience to drought, achieving 1 in 200-year resilience by end of AMP8 and 1 in 500 year resilience by end AMP9 under a medium climate emissions scenario
- Provides resilience against climate change, in line with Welsh Government and Natural Resources Wales guidance, when tested against a high emissions scenario (Figure 55)
- Delivers environmental benefit through reducing the demand for water (c 18 Ml/d reduction in an average year by 2030) thus contributing to achievement of SMNR aims
- Is efficient by making better use of existing resources rather than developing new resource, aligning with our customer preferences
- Enhances our SEWCUS network connectivity will provide wider supply resilience benefit during WTW outages events or major bursts on the network

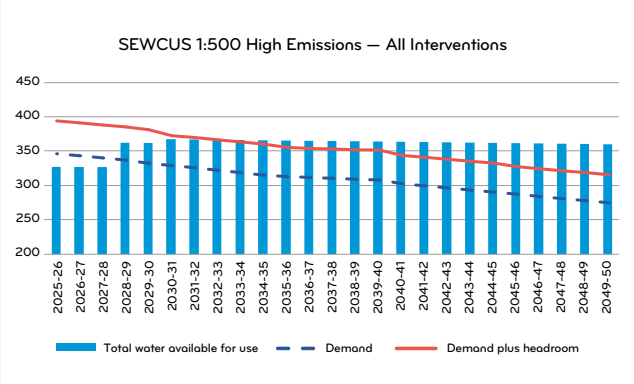

Figure 55 — SEWCUS 1 in 500 Final Plan S/D Balance

The results of testing our preferred plan for the SEWCUS zone against a number of alternative scenarios are provided in section 6.3.

6.2.2. TYWI GOWER

In our WRMP19 we reported a strong 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.

Against our 'Core' planning scenario of achieving drought resilience to a 1 in 200 year, the 'baseline' Tywi Gower supply against demand balance shows a deficit across the 25 year planning period to 2050 (Figure 56)

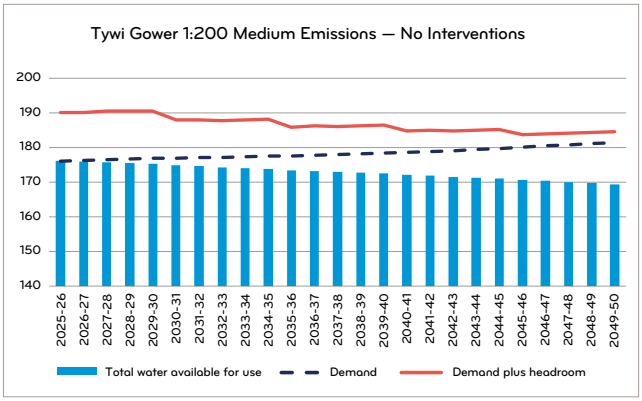

Figure 56 — Tywi Gower Baseline S/D Balance

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 that are 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:

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 our long-term leakage and metering plans reduce zonal demand over time, this is insufficient to provide zonal resilience during the AMP8 period as shown in Figure 57. It is the twin track approach of supply and demand side schemes, as shown in Figure 58, that is needed to ensure sufficient levels of drought resilience across the planning period, particularly when the effects of climate change are accounted for.

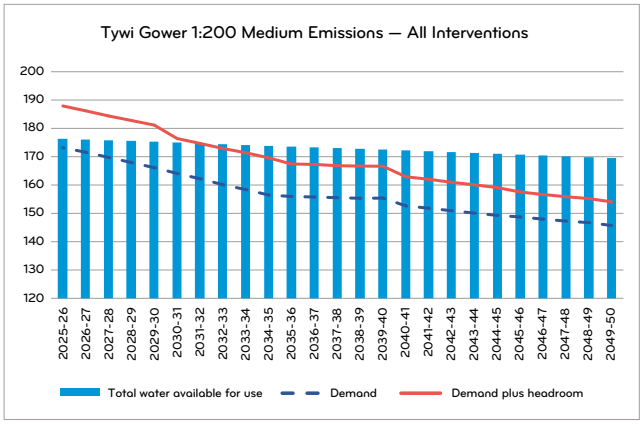

Figure 57 — Tywi Gower S/D Balance; Demand Interventions Only

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.

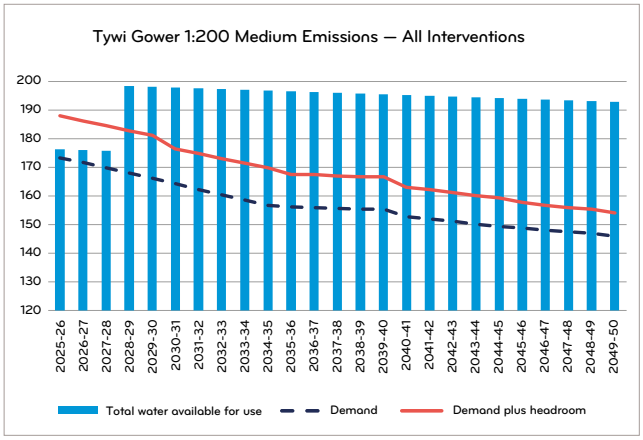

Figure 58 — Tywi Gower Final Plan S/D Balance

6.2.3. 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. With the inclusion of updated catchment hydrology through our new rainfall runoff models and the greater detail around our supply networks built into our Aquator models, the supply demand position now shows a marginal baseline supply demand deficit under a 1 in 200 year drought scenario (Figure 59).

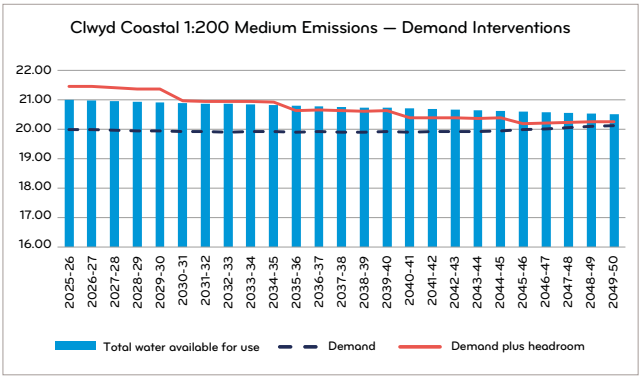

Figure 59 — Clwyd Coastal Baseline S/D Balance

The deficit is driven by the reduced supply capability we are reporting for this Plan compared to that presented in WRMP19. Recent dry weather experience has highlighted the limitations within our supply network and so we have incorporated this within our Aquator models and calculated our DO accordingly.

We commenced the longlisting of supply side options however, once the benefits of our demand management strategy is included, the analysis shows that this is just sufficient to meet our resilience target during AMP8 (Figure 60) and so and conclude this would be our preferred plan for the zone.

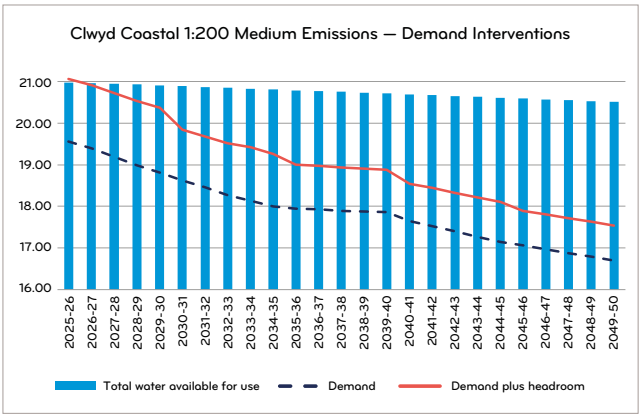

Figure 60 — Clwyd Coastal Final Plan S/D Balance

Our testing indicates that the demand management strategy will increase drought resilience against a 1 in 500 year extreme drought by 2029, under a medium emissions scenario. We have also tested this plan against an increased climate change impact pathway, customer usage behaviour and need for environmental improvement against climate change (Figure 61). We are including funding in AMP8 to undertake an investigation into the sustainability of our Llanerch groundwater source. These all present a risk dependent upon the level of impact in relation to the gradual benefits gained through zonal demand management. Given this risk a simple adaptive pathway is presented whereby we can make an updated decision at WRMP29 based on the updated evidence available.

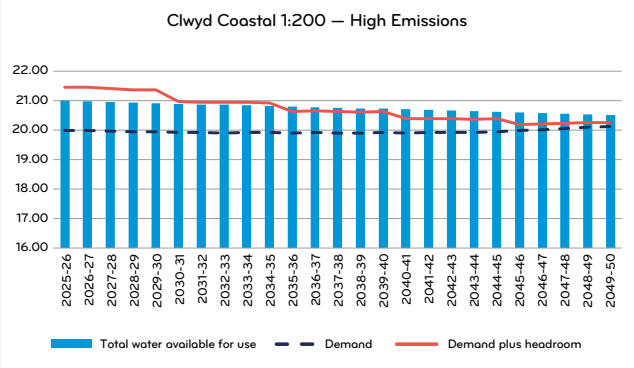

Figure 61 — Clwyd Coastal S/D Balance under reduced demand savings

We have identified few options to increase the deployable output of the zone with the only short-listed option to provide a transfer from the neighbouring Alwen Dee zone which has a net supply surplus against forecast demand. This scheme has been examined in parallel to enable the potential abandonment of the Trecastell WTW's.

As part of our PR24 submission we will include funding to deliver the necessary design work for this new network link. We would then review the need for this scheme as we progress through the AMP8 period based on the delivery of our demand management strategy, climate change evidence or environmental drivers that require reductions in the use of our existing water resources. This will determine the size and timing of any transfer if required.

6.2.4. 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.

We have reconfirmed for this Plan that the annual average position remains robust against worst historic and more severe drought events but that when tested under a critical period scenario, the position is less robust and shows a supply against demand shortfall (Figure 62). This is borne out by recent experience during the Summer where to meet customer demand, the output from our Strata Florida and Llechryd treatment works was supplemented by supplies brought in by road tankers from the Capel Dewi WTW system in the neighbouring Tywi Gower zone.

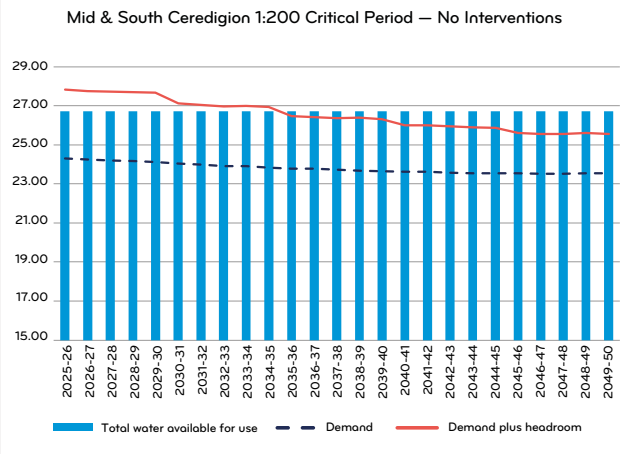

Figure 62 — Mid & South Ceredigion 1:200 S/D Balance

This confirms that our current peak supply capability is insufficient to meet peak demands, particularly in the light of the extreme high temperatures seen during July which pushed demands higher than ever experienced before and which are likely to be repeated more frequently as our climate warms. We have therefore appraised a limited range of supply side options for this zone. We have no options to bring disused sources of water back into supply and transfers from neighbouring zones are very expensive given the large distances involved. There is no ability to increase the capacity of Strata Florida WTW as the Teifi Pools resource which supplies this works gets drawn down to very low levels during severe drought events and so an increased demand would cause more frequent breaches of emergency storage and hence provide a lower LoS to our customers.

Our modelling confirms that raising the maximum output of our Llechryd WTW would provide us with the additional capacity needed to ensure we can adequately meet peak demands in the future. In discussions with NRW, we have re-confirmed that as published in the latest 'Abstraction Licensing Strategy' that additional water could be licensed for abstraction in the lower reaches of the Teifi.

Our preferred plan for the zone, therefore, is to deliver both our demand management strategy and the upgrade to Llechryd WTW. This programme of investment will ensure long term resilience against climate change and more extreme drought events through a reduction in demand whilst providing sufficient treatment capacity to meet peaks in demand, which are largely driven tourism and so our metering programme may have less of an impact on this.

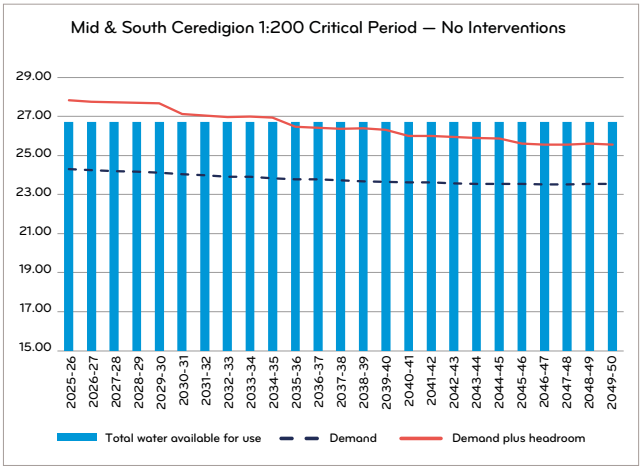

Figure 63 — Mid & South Ceredigion Final Plan 1:200 S/D Balance

6.2.5. PEMBROKESHIRE

In our WRMP19 we reported that with the proposed solution at Canaston Bridge 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 our Canaston Bridge station 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 this summer 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 64, these improvements to our supply capability, together with our planned reductions in demand, will deliver the required level of drought resilience for the zone.

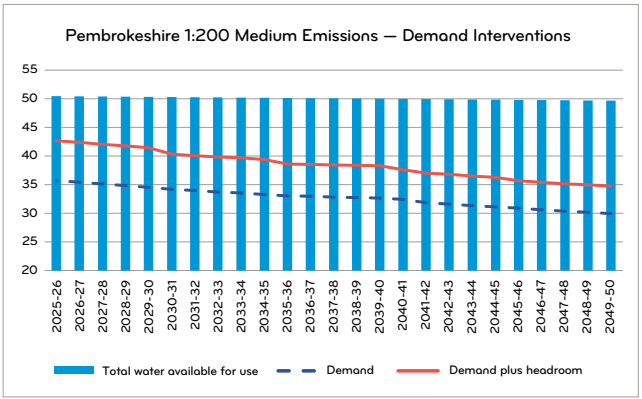

Figure 64 — Pembs 1 in 200 S/D Balance

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.

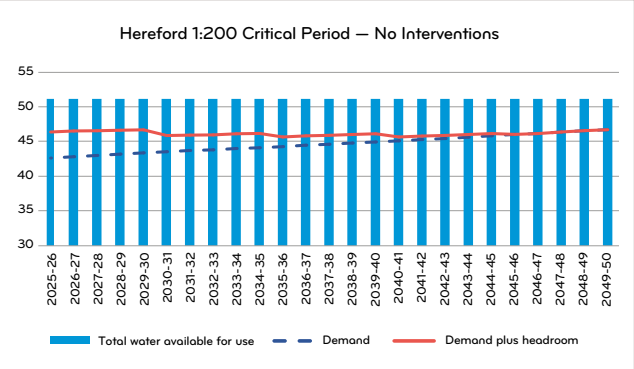

Figure 65 — Hereford Baseline S/D Balance

The critical period supply demand balance baseline shows a relatively tight position (Figure 65) though future demand savings from our strategy greatly improve this (Figure 66). 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 potentially reduces local river flows below environmental flow targets, 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 and so building this into our modelling, shows that we would fall into deficit during AMP8. We plan to complete additional confirmatory studies in AMP8 to better understand the ecological risks in the catchment and to confirm the scale of licence reduction that would be required.

Interrogation through system modelling indicates the cause of the shortfall to be a restriction in the amount of water that can be supplied from the Broomy Hill system to Leintwardine if the licence is restricted during summer months. There is connectivity between the two systems and during normal demand levels, if required then Broomy Hill can supply all of the Leintwardine demand area. However, during increased summer demands, a hydraulic limit is reached between Dinmore SRV and Bewdley Bank SRV – the key storage tanks between the two systems – and so we are planning to include investment in our PR24 submission for a network scheme that will overcome this restriction.

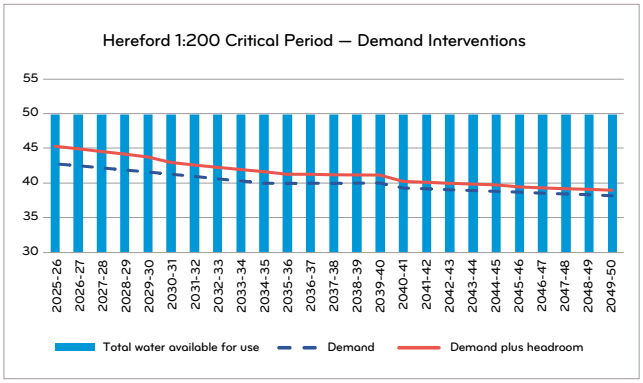

Figure 66 — Hereford Final Plan S/D Balance

6.3. RESULTS OF SCENARIO TESTING

The long-term impact of leakage and customer usage policies generates an increased water resource surplus which over time provides greater drought resilience and enhanced benefit to the environment as our take from the rivers and groundwaters is reduced. Our objective is to move to a 1 in 500 drought resilience position by 2040 to align us with the position being taken in England, ensuring that our customers receive at least an equal, if not better, LoS.

Assuming the full delivery of our preferred investment programme within the proposed timescales, we should achieve this higher resilience target across all zones by 2030. There are however three key risks that could impact the achievement of this: more severe climate change than our baseline 'medium emissions' scenario, higher demand level than anticipated by the combined effect of our demand reduction strategy and Welsh Government population estimates, and the imposition of sustainability reductions to our abstraction licences by Natural Resources Wales. Below, we have set out the potential impacts of these.

More severe climate change: Climate Change may follow a higher emission and warming pathway resulting in significantly less summer rainfall

For all zones we have tested our supply demand balance against the higher emissions scenario (RCP8.5) by accounting for reduced rainfall in our inflows, running this data through our Water Resources models, and calculating the impact on our Deployable Output. This analysis shows that our 1 in 500 year supply demand balance position would be achieved in all zones within AMP8, with the exception of SEWCUS which would not achieve this higher level of drought resilience until 2033 but still within our target of 2040. This scenario aligns with the WRW 'Compound High', which utilises the Ofwat common reference 'High' scenario as we have assumed AMR smart metering delivered by 2035, RCP8.5 emissions scenario and Welsh Government population data in our demand forecast.

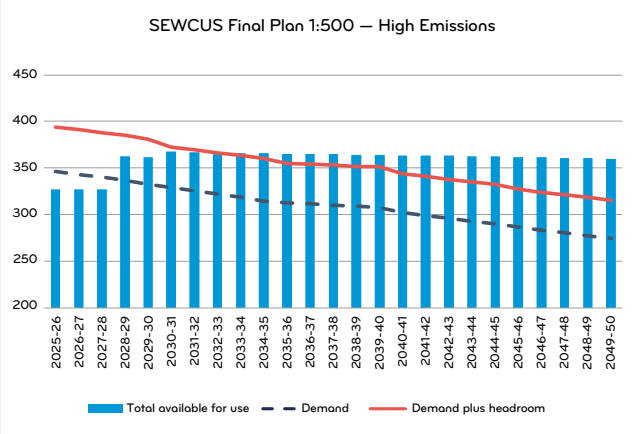

Figure 67 — SEWCUS S/D Balance 'High' scenario

Higher demand level: Customer behaviour and population may not change as assumed with PCC estimates and so demand remains higher than forecast

We have tested a scenario whereby we achieve our full leakage savings but only gain a 50% reduction in the assumed savings from customer behaviour. In this instance, SEWCUS does not achieve a 1 in 500 year level of resilience until 2033 under a medium emissions scenario (RCP6.0) and 2040 under a high emissions scenario (RCP8.5). The Tywi Gower zone is more resilient and still achieves this higher level of service by 2029 (Figure 68).

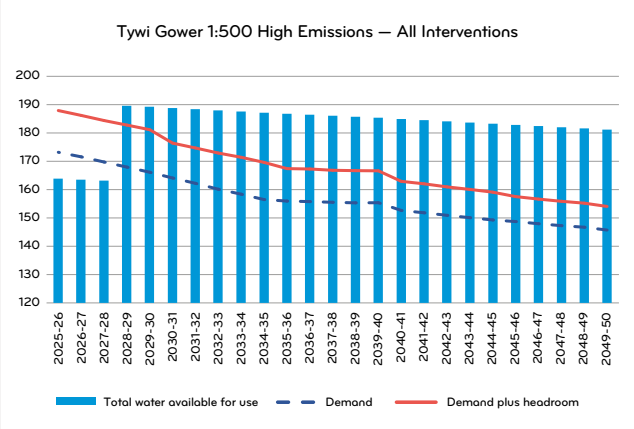

Figure 68 — Tywi S/D Balance 'High' scenario

Sustainability reductions to our licences: Our abstractions are proven to be environmentally unsustainable under a future climate change assessment and are reduced by NRW

We have not formally tested this as a scenario since NRW have not followed the EA's approach in providing any sustainability reductions that can be included within our DO modelling. This is however potentially one of the largest risks to achieving the higher level of drought resilience by 2040, based on the experience of water companies in the WRW region where the scale of reductions to DO ranges from around 10% - 20%.

In our SEWCUS zone for example, applying a similar scale could see a DO reduction of around 40-80 Ml/d and would require significant additional investment in AMP9 to return us to our desired level of drought resilience.

We are therefore proposing a series of investigations during AMP8 to better understand this risk and to be on the 'front foot' in working with NRW to resolve any long-term environmental concerns. Adopting an SMNR approach and seeking wider catchment-type solutions may negate some of the need for significant licence changes and consequent reductions in DO. Our WRMP29 will be the point at which we will have a better understanding of the need to deviate away from the preferred programme set out in this Plan and so we are not presenting any intermediate decision points and are confident that the 5 yearly planning cycle allows us to adapt to changing future conditions.

For completeness, we present below the results of testing the Tywi (Figure 69) and SEWCUS (Figure 70) preferred plan under a 'Low' climate change emissions scenario (RCP2.6). This confirms that the planned investment is still required as the overall impact of moving between these scenarios, is relatively minimal.

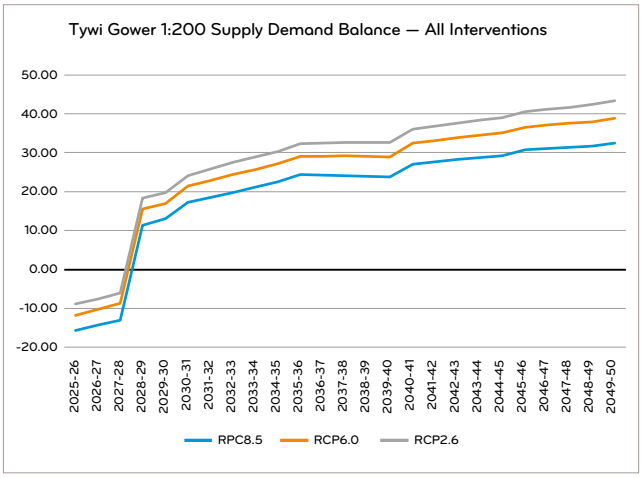

Figure 69 — Tywi 1:200 S/D Balance

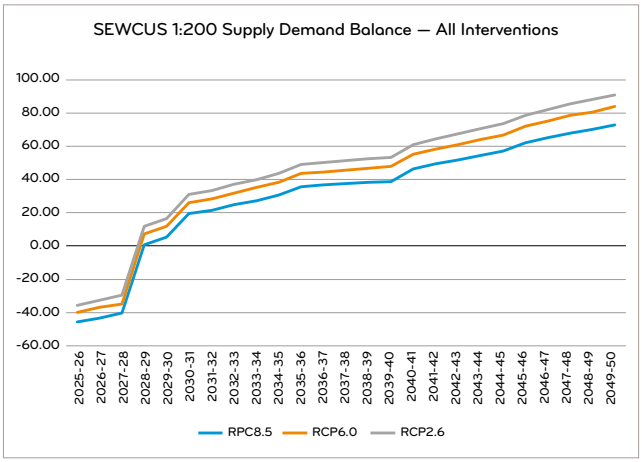

Figure 70 — SEWCUS 1:200 S/D Balance

We have also presented our Final Plan supply demand balance positions for 2030 (Figure 71) for each of our zones with scenarios assessing the impact of the high climate change scenario and the 50% demand management delivery scenario, for both the 1:200 and 1:500 drought resilience positions. This assessment shows that the only zone to fall into a supply demand deficit under this scenario testing is SEWCUS, which does not achieve a 1:500 Drought resilience at the demand forecast levels with the high climate change emissions pathway.

6.4. SUMMARY OF 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, Tywi Gower and Clwyd Coastal water resource zones there is a risk of not achieving target levels of water resource resilience. In the Mid and South Ceredigion zone investment is needed to ensure that there is sufficient water to meet peaks anticipated peaks in demand.

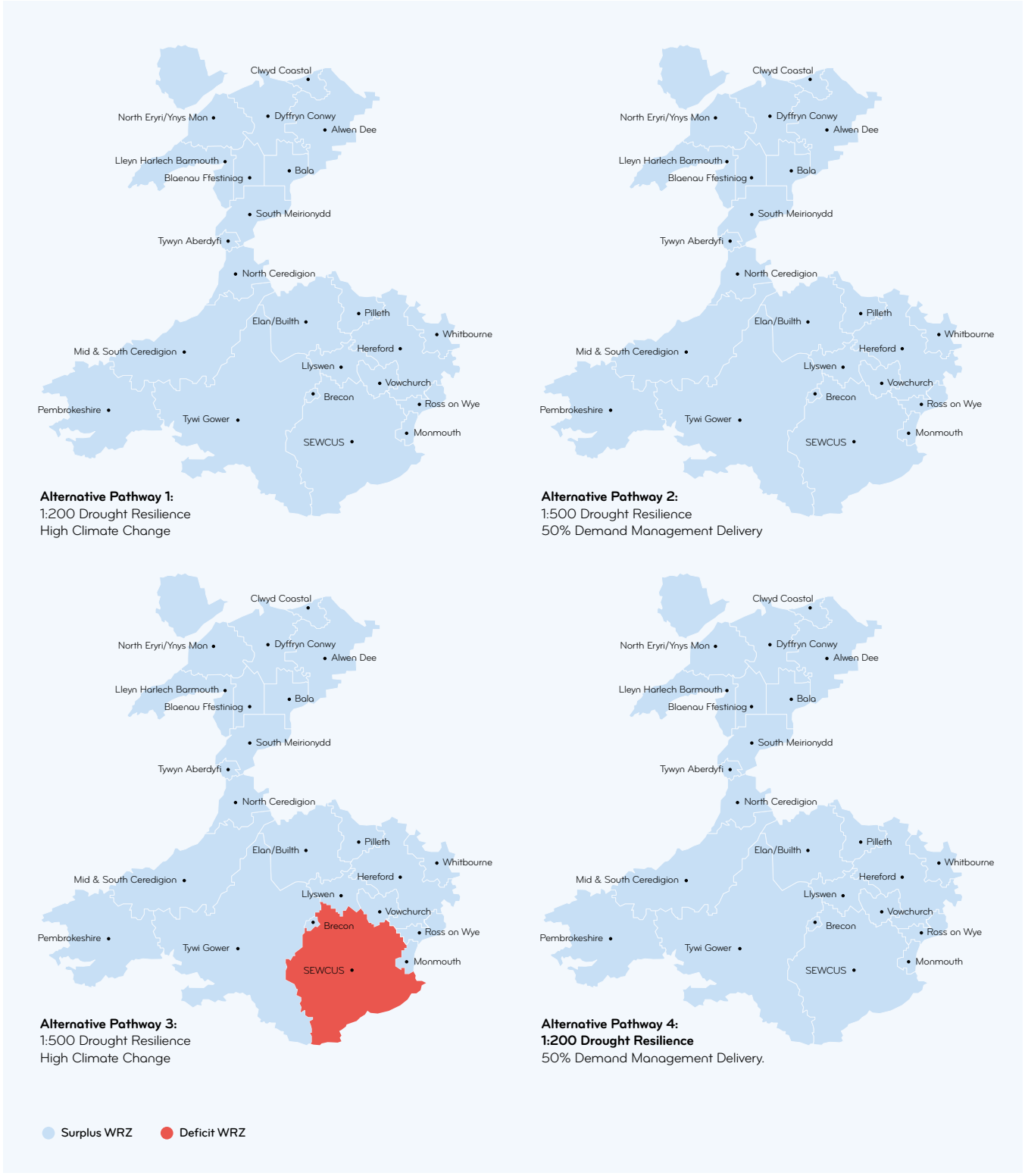

Figure 71 — Supply/demand position at 2030 (end AMP8) with WRMP24 interventions

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 through the use of 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 support our domestic customers in reducing their usage to 110l/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;
- Six network improvement schemes, two in the Tywi Gower, two in the SEWCUS and one in the Mid & South Ceredigion and one in the Herefordshire water resource zone that will balance the use of existing licenced sources;
- Increase the capacity of the Llechryd water treatment works in the Mid & South Ceredigion water resource zone;
- Deliver the design of a scheme to transfer water from the Alwen Dee to the Clwyd Coastal zone;
- Commitment to undertake joint investigations with NRW in AMP8, to assess the future sustainability of our abstraction licences under a changing climate.

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.

The Plan will reduce the demand for water by an average of 158Ml/d 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. The network improvements in the Herefordshire zone will enable the delivery of sustainability reductions at Leintwardine.

6.5. 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;
- Our drought triggers for implementing customer side measures to restrict demand are consistent between both Plans;
- 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 these 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**

6.6. 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 it is proposed to further investigate the scheme cost and environmental constraints to understand if this is better value than comparative schemes proposed for use by WRSE in the 2040s.

6.6.1. 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 agreed to look at 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 in order to provide c30 Ml/d will impact our drought resilience unless we can develop additional resource to replace it.

We have options to support the anticipated canal demands and will continue to work with CRT and NRW to find the best value solution. We will flag this additional water demand within our Final WRMP24 and work to the principle that our customers will not subsidise those of the Trust. Current tariff structures are not relevant to this supply which will need a new cost reflective contract to ensure value for our customers.

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

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