Draft Water Resources Management Plan 2024

Appendix C: Managing Uncertainty

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Appendix C: Managing Uncertainty

The Environment Agency, Natural Resources Wales and The Water Services Regulation Authority (Ofwat) have released Water Resources Planning Guidelines (WRPG; 2021, p. 69) which state that water companies should **"analyse the sources of uncertainty around the components of your supply-demand balance"** and that **"it is recommended… that you provide a headroom value which represents uncertainty"**.

The WRPG highlights three documents, which set out the different approaches:

- Risk Based Planning (UKWIR, 2016)
- Decision Making Process: Guidance (UKWIR, 2016)
- An Improved Methodology for Assessing Headroom (UKWIR, 2002)

In preparation for our 2024 dWRMP (dWRMP24) we applied the UKWIR problem characterisation approach to assess the size and complexity of the supply demand situation from 2025 to 2085. We have adopted a risk-based approach for assessing uncertainty based on the methodology outlined in 'An Improved Methodology for Assessing Headroom' (UKWIR, 2002). This is a change from our 2019 WRMP (WRMP19) which used 'A Practical Method for Converting Uncertainty into Headroom' (UKWIR, 1998) which was the previous guidance. Furthermore, in collaboration with Dŵr Cymru Welsh Water, South Staffs Water and Severn Trent Water we commissioned Atkins to review target headroom for the dWRMP24. The approach we have followed and our assumptions, are described in detail in the remainder of this chapter.

C1 Target headroom

Target headroom represents the minimum buffer that companies should plan to maintain between supply and demand for water in order to cater for current and future uncertainties. It is important for water companies to plan for an **"appropriate level of risk"** in their WRMPs as **"if target headroom is too large it may drive unnecessary expenditure"**, whereas **"if it is too small you may not be able to meet your planned level of service"** (WRPG, 2021, p. 69).

To derive the range of target headroom uncertainty for our dWRMP24 we have adopted a risk-based approach to assessing target headroom uncertainty, using Monte Carlo simulation. The approach taken combines the uncertainties around supply and demand to derive an overall probability of supply and demand being in balance.

We have included the following inputs, which are discussed in detail in section C2:

Supply uncertainty:

- S5: Groundwater sources at risk of gradual pollution
- S6: Accuracy of supply-side data
- S8: Uncertainty of the impact of climate change on supply

Demand uncertainty:

- D1: Accuracy of sub-component demand
- D2: Demand forecast variation
- D3: Uncertainty of the impact of climate change on demand
- D4: Uncertainty in the outcome from demand management measures

In accordance with the WRPG (2021) we have made no allowances for S1 (vulnerable surface water licences), S2 (vulnerable groundwater licences) and S3 (non-replacement of time-limited licences on current terms). The data inputs for the models are discussed in more detail in section C2.

In order to derive the level of target headroom that we plan to maintain, we first needed to assess the scale of uncertainties around the components for our projected supply/demand balance and decide on what is the appropriate level of risk to accept in the forecast period as per the WRPG (2021).

The biggest contributors to our overall supply/demand balance uncertainty are:

- Accuracy of supply-side data
- Demand uncertainty

A discussion of the target headroom profile or 'glidepath' we have chosen to adopt in the plan can be found in section C2.3.

C2 Target headroom modelling assumptions

Target headroom is intended to provide a buffer that allows for the unavoidable uncertainties involved in estimating future changes to the various components of the supply and demand balance. As previously discussed, the calculation of target headroom follows an established best practice approach, set out in the publication 'An improved methodology for assessing headroom' (UKWIR, 2002). The key components of the target headroom assessment as described in the UKWIR publication are as follows:

Supply-side components

S1 Vulnerable surface water licences
S2 Vulnerable groundwater licences
S3 Time-limited licences
S4 Bulk imports
S5 Gradual pollution of sources causing a reduction in abstraction
S6 Accuracy of supply-side data
S7 Not used
S8 Uncertainty of the impact of climate change on DO
S9 Uncertain output from new resource developments

Demand-side components

D1 Accuracy of sub-component data
D2 Demand forecast variation
D3 Uncertainty of the impact of climate change on demand
D4 Uncertainty in the outcome from demand management measures

We have assessed each component to estimate the likely range of uncertainty in each case. The range of uncertainty around each component follows the shape of a probability distribution from which such likelihoods are drawn. Since it is these distributions which are co-sampled to create the combined (cumulative) probability distributions from which an appropriate target headroom value is ultimately taken, we have taken care to ensure they suitably represent the uncertainty. We have also undertaken sensitivity tests on the assumptions we have made on the likely range of uncertainties, and on the shape of input distributions, so as to explore the consequences of our choices.

We reviewed the inputs to our target headroom model to ensure that we were not double counting any uncertainty. As described in Appendix C1 of our dWRMP, we made an allowance for supply-side data uncertainty, impacts of climate change, accuracy of sub-component demand, demand forecast variation, uncertainty of the impact of climate change on demand, and uncertainty in the outcome of demand management measures. We did not make an additional allowance for bulk imports as we had already made an allowance for uncertainty of supply-side data under the UKWIR publication 'An improved methodology for assessing headroom' component S6 (accuracy of supply-side data). More detail around our assumptions is provided in section C2.1.

C2.1 Supply-side

S1 and S2 – vulnerable surface and groundwater licences

The WRPG (2021) instruct water companies not to include any allowances in target headroom for uncertainty related to sustainability changes to permanent licences. The guidelines state that Natural Resources Wales or the Environment Agency will work with water companies to ensure that sustainability changes will not impact their security of supply, and so there is no need for a headroom allowance to be made. In accordance with the WRPG, we have made no allowances for S1 (vulnerable surface water licences) or S2 (vulnerable groundwater licences) issues in our target headroom assessment.

S3 issues – time-limited licences

The WRPG (2021) instruct water companies not to include any allowances in target headroom for uncertainty related to non-renewal of time-limited licences on current terms. The guidelines (p. 69) state that "**if there are risks to supply because your licences may not be renewed, you should address this uncertainty directly in your plan through investigations and planning alternative supplies as necessary**". One of our public water supply licences has a time-limited condition on part of the licence. This has recently been renewed until March 2034; thus time-limited licences make up a small proportion of our total licences. In WRMP19 we made no explicit allowance for this uncertainty in our headroom assessment and we are continuing this approach, which is aligned with the updated WRPG (2021).

S4 issues – bulk imports

Any significant bulk transfers are included within the modelled DO, and so any corresponding uncertainty is allowed for under S6 (accuracy of supply-side data) issues, with the exporting zone carrying the associated uncertainty. Consistent with our WRMP19, no explicit allowance has been made for S4 issues in our target headroom assessment.

S5 issues – gradual pollution of sources causing a reduction in abstraction

In our target headroom assessment we evaluated groundwater sources to determine their risk of gradual pollution, where worsening water quality may potentially affect the ability of the source to maintain the current or future forecast DO value.

The assessment involved evaluating whether there were water quality issues that could affect DO, and whether there was a relationship between these two variables. If there was no risk of DO being affected, or the source issue fulfilled one or more of the criteria below they were excluded from the headroom risk assessment:

- The source is no longer in use and is not contributing to DO;
- There is a capital delivery scheme already commenced that will deliver the potential lost DO; or
- The issue presented an outage risk rather than a loss of DO.

It has been assumed that the drinking water quality standard cannot be breached. Our analysis suggests that none of our abstractions are at risk from gradual pollution therefore this component was not included in the target headroom assessment.

S6 issues – accuracy of supply-side data

This component reflects the scale of uncertainty around our calculation of DO. The target headroom assessment of supply-side data uncertainty has considered groundwater and surface water issues separately. The updated groundwater DO assessment also included a review of the constraints on DO for each source. The assessment has sought to categorise the sources of uncertainty as follows:

S6-1 abstraction licence constraints

For our abstraction licence constrained groundwater sources we have assumed a triangular distribution with a mean error of 1%, with a maximum of 4% (i.e. a 4% reduction in DO) and a minimum of -2% (i.e. a 2% gain in DO).

S6-2 aquifer constraints

For groundwater sources where the constraint is considered to be the aquifer, uncertainty is assumed to be a maximum of +/-20%, following a normal distribution. The relatively high figure reflects the uncertainty in establishing the safe yield of groundwater sources.

S6-3 infrastructure constraints (e.g. pumping capacity & treatment capacity)

For sources constrained by infrastructure, uncertainty is assumed to be a maximum of +/-10%, and follow a normal distribution.

S6-4 source yield constraints (surface water deployable output)

No sources were identified as being source yield constrained.

In preparation for the dWRMP24 we have reviewed the constraints on each of our sources. This has resulted in changes to the total target headroom for water resource zones (WRZs) as in WRMP19 the UKWIR 1998 methodology was used. The changes are shown in section C2.3.2.

S7 issues – uncertainty of the impact of climate change on deployable output

As discussed in Appendix A, we have assessed the potential impacts of climate change across our region by applying the methodology recommended in the WRPG. Our DO modelling of the wide range of climate change impacted scenarios, using the UK Climate Projections 2018 (UKCP18) has shown us that this is an area of uncertainty in Wrexham which increases over time. This is reflected in the impact that this issue has on target headroom in section C2.3.2.

The methodology we have applied uses 2 probabilistic and 12 regional climate model (RCM) UKCP18 projections for our region. The median of the 12 RCMs has been used to represent our central estimate of DO impacts which is used in our Water Resources Planning tables as our reduction to baseline DO. To characterise climate change uncertainty, we have used triangular distributions around our central climate change estimate. The 10th and 90th ranked impacted scenarios from the 20 probabilistic UKCP18 projections were used to derive the minimum and maximum changes in DO respectively. At 2070 (the relationship is the same throughout the WRMP period but scaled), there is a larger gain in DO (7.6 Ml/d) than loss in DO (2.4 Ml/d) compared to the climate change central estimate (loss of 10.3 Ml/d). Thus, the skewed distribution resulted in a greater chance of climate change DO impacts being less severe than the central estimate rather than more severe than the central estimate. It should be noted that the climate change central estimate encompasses much of the potential uncertainty around climate change indicated by the probabilistic scenarios, hence why the uncertainty distribution is skewed so that uncertainty gains in DO are greater than uncertainty losses in DO. Using this skewed triangular distribution when selecting a 'glidepath' with a level of certainty greater than approximately 75% (which we have followed for all WRZs) prevents issues with the climate change component of target headroom providing a positive contribution, meaning that it would effectively reduce the total target headroom. Therefore, following assessment we decided that a triangular distribution was suitable for use with this climate change data in our target headroom modelling.

Within our target headroom model, we can include uncertainty around the central estimate of the climate change impact on supply as a series of triangular distributions. We parameterised these using a value of 0 as the most likely and the minimum and maximum from the probabilistic scenarios. The probability distributions for individual years were then derived using the scaling equations (which are described in Appendix A), which produced a range reflecting the increasing uncertainty around climate change as we move through the planning period. To ensure transparency regarding the climate change allowance in target headroom the relative contribution of the climate change component is compared to the other components. This is discussed in more detail in section C2.3.2.

C2.2 Demand side

C2.2.1 issues: accuracy of sub-component demand

Uncertainty in the number of new property connections

The WRPG 2021 instructs companies supplying customers in Wales to base property forecasts on local authority (LA) property projections published by the Welsh Government. In light of this, we are adopting the Welsh Government projection for Local Councils' in our area for the dWRMP24 central housing growth forecast.

We have assumed historic growth rates in our area are approximately two thirds of Welsh Government projections, based on historic growth trends for Severn Trent and set this as a lower bound for uncertainty. Therefore, there is headroom built into the central estimate of this component of the demand forecast. We will review this assumption between draft and final plan as we work to gather data-based evidence of growth levels in our area. For uncertainty analysis we have assumed a triangular distribution using the Welsh Government LA growth projections and estimates of historical growth in our area.

- Lower bound – historic average growth rate
- Upper/central assumption – Welsh Government LA projections

Uncertainty in population numbers

For estimates of future total population we have used ONS estimates and applied trends to our base year data. Population uncertainty is based on high and low ONS population projections, each of which are based on projections combining variants of births, deaths and migration for Wales and England.

C2.2.2 issues: demand forecast variation

Uncertainties in household consumption

We use data from Defra's Market Transformation Programme (MTP) to set uncertainty in household consumption. There is not a separate dataset available for micro-component trends for Wales, and with the market for Wales and England being common with respect to white goods, using the MTP is justifiable. The MTP produced predictions of water use for different water using appliances in 2030 for three different scenarios:

- Reference scenario (equivalent to the baseline scenario)
- Policy scenario (assuming more effective implementation and accelerated take-up of more sustainable products)
- Early best practice (EBP) which assumes a more positive impact than the policy scenario and an early take up of innovative water efficient products.

The reference scenario underpins the baseline forecast, with the policy and EBP scenarios used to define upper and lower ranges of household consumption.

Uncertainties in COVID-19 impact

At the start of the COVID-19 stay at home restrictions in March 2020, we could not have foreseen the impact on water consumption in homes, which when combined with the hot and dry weather resulted in some of the highest peaks in water demand that water companies have ever seen. In our area, we have seen an uplift in household demand as a consequence of the COVID-19 pandemic. Factors causing this increase include the health advice on hand washing, more people staying at home as we moved into the lockdown period, home schooling and home working along with periods of hot weather. Although household consumption has reduced from the highs of 2020 as customers returned to work, we continue to see high levels of consumption and have factored in short-term and long-term assumptions for the impacts of COVID-19.

For our central assumption for COVID-19 impact we have used outputs of analysis from industry collaborative research led by Artesia which estimated a 9% COVID-19 impact on household consumption in 2020 and forecast a reduction to 3% by 2025, after which we assume a continued 3% impact to reflect what a 'new normal' may look like. The Welsh Government is promoting working from home and hybrid working so we expect a longer term increased level of water use in homes. For uncertainty we have assumed 2% above and below the central projection. Long-term this gives a range of 0% to 4% in headroom.

Uncertainties in measured non-household water consumption

There are multiple and complex links between non-household demand and a wide range of factors, from international and national macroeconomic trends to local investment strategies and population growth. This complexity could present challenges for forecasting; in terms of what factors to consider and the range of scenarios needed to capture a suitable range of futures. Therefore, we have developed seven scenarios to reflect the impact from a broad range of drivers and pressures. The scenarios each result in a different mid-century non-household forecast. These scenarios help to take account of a range of uncertainties and risks and help identify opportunities for resilient responses. We chose to adopt this scenario approach because of the specific short-term impacts likely as a result of COVID-19 and Brexit, alongside other medium to long-term impacts associated with the other factors considered. The scenarios have been developed and assessed using a Drivers, Pressures, States, Impacts and Responses (DPSIR) framework to identify how the scenarios are related and their performance.

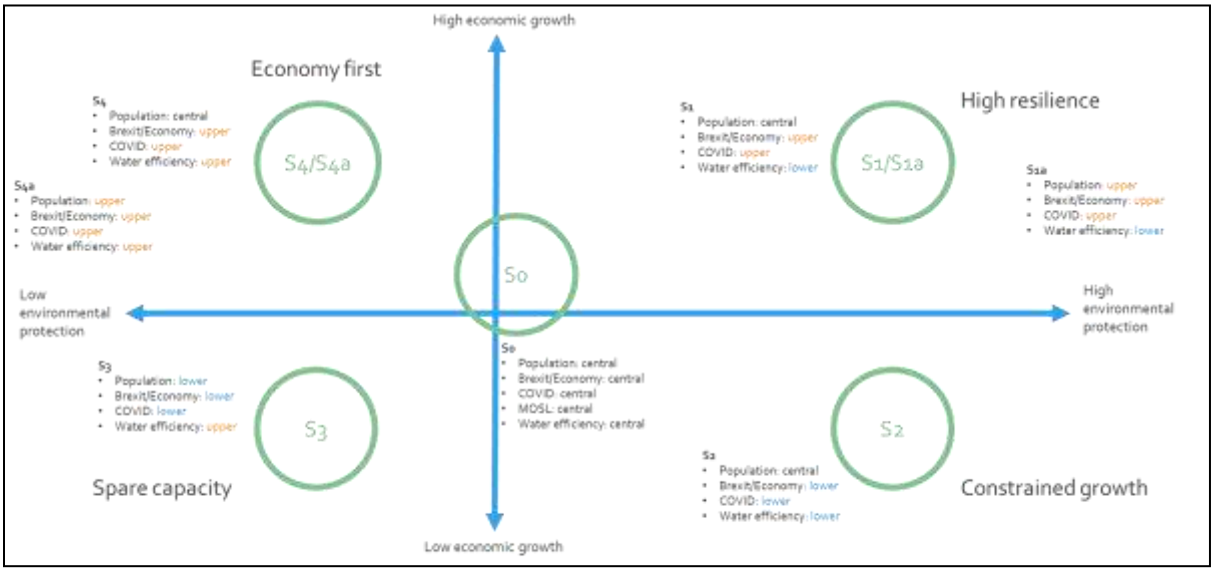

Figure C2.1: Positioning of seven Scenarios (S) based on environmental protection and economic growth representing an economy first, high resilience, spare capacity, or constrained growth future. N.B. MOSL is Market Operator Services Limited.

The scenarios take the current 'landscape' of non-household demand in summer 2020 as a starting point. They are characterised in terms of two of the main drivers of future water availability/consumption – economic growth and environmental protection. These form the axes in Figure C2.1 and help position the scenarios. Whilst other drivers could be used for the axes, this would not fundamentally impact the scenarios, which are designed to represent a range of plausible future 'states of the world'. There are seven different scenarios within five main headings, each is briefly described below numbered Scenario 0 to Scenario 4. We have used Scenario 2 and Scenario 4a to define the non-household consumption range uncertainty.

Scenario 0: Current landscape
Existing (summer 2020) non-household demand for water. This is suppressed (lower than usual) because of the COVID-19 pandemic.

Scenario 1: High resilience
Economic growth is partly driven and facilitated by technological change and innovation. This is matched by high environmental standards aimed at addressing increased water scarcity, leading to a greater focus on water efficiency, reuse and collaborative working. There are two variants (Scenario 1 and Scenario 1a) of this scenario using the central and upper population forecast.

Scenario 2: Constrained growth
Economic growth is heavily impacted by the COVID-19 pandemic and Brexit, as well as by the need to protect and enhance the environment, leading to legislative and regulatory policies that drive more efficient water use, and by the use of pricing and tariffs.

Scenario 3: Spare capacity
Economic growth is heavily impacted by the COVID-19 pandemic and Brexit, as well as by low levels of innovation and low population growth. Environmental protection is given a low priority and there is spare capacity in the provision of water services, with water efficiency and demand management measures deemed largely unnecessary.

Scenario 4: Economy first
Economic growth is prioritised, resulting in higher than average growth in both the service and non-service sectors. Water companies need to identify new potable and non-potable sources to maintain the supply demand balance. Collaboration, among water companies and between sectors, is limited, with a greater focus on competition. There are two variants of this scenario (Scenario 4 and Scenario 4a) using the central and upper population forecast. We have adopted Scenario 0 for our central forecast and Scenario 2 (low demand scenario) and Scenario 4 (high demand scenario) to account for the widest range of uncertainty in the long-term forecasts.

C2.2.3 issues: uncertainty impact of climate change on demand

No uncertainty has been attached to the best estimate of climate change impact on demand.

C2.2.4 issues: uncertainty of the outcome from demand management measures

There are inherent uncertainties within the water efficiency forecast as our assumptions regarding the impact of our activity on demand (of uptake by customers and demand reduction) are reliant on customer behaviour. Where we send devices to customers, we are reliant on the correct devices being ordered, actual installation of the device and devices then remaining installed.

For all water efficiency devices, we already assume that demand savings decay over time:

- as customers either dislike retrofit products or they are gradually removed as customers upgrade their kitchens and bathrooms over time, and
- we think we will have all but exhausted the customer base who are sufficiently engaged on water efficiency that they have requested free and subsidised water efficient products meaning the cost of promoting these products is likely to outweigh the benefit of supplying them.

We estimate the decay rate using the half-life from the Waterwise (2010) Evidence Base report and our own previous experience until we assume zero savings after 15 years. We estimate a +/-10% uncertainty range for savings from product related demand management measures.

C2.3 Target headroom profile

One of the most important elements of our dWRMP24 is the decision around how to deal with uncertainty in our long-term plan. Using the traditional Economic Balance of Supply and Demand (EBSD) approach, uncertainty is dealt with using target headroom. The amount of target headroom we include determines the scale of investment needed to maintain an adequate buffer between future supply and demand for water in order to accommodate the uncertainties outlined in the sections above.

C2.3.1 The target headroom profile

In the short term, the main uncertainty in our planning assumptions is around the accuracy and reliability of our source DO. Accuracy of supply data (S6) is constant over the period, with its absolute target headroom contribution affected by the 'glidepath'. The only increasing sources of longer-term uncertainty are around the trajectory of future demand for water (De) and the potential impacts of climate change (S8) in Wrexham.
In our zones we are adopting a target headroom profile that maintains a high degree of planning confidence across the full period. Our strategy is to maintain this high level of confidence through our leakage and demand management plans, and making best use of our existing sources of supply.

In our Wrexham zone, the longer-term uncertainty around the impacts of demand and climate change increase over time. Due to this, our chosen risk profile for this zone accepts a slightly higher level of risk from 2030 as it increases towards 2040 then remains constant onwards. We have adopted a target headroom risk profile that gives us high confidence in the short to medium term that we can meet our planned levels of service while accepting greater risk in the future.

In our Llandinam and Llanwrin zone, the longer-term uncertainty around the impact of demand increases over time. Due to this, our chosen risk profile for this zone accepts a slightly higher level of risk from 2030 onwards. We have adopted a target headroom risk profile that gives us high confidence in the short term that we can meet our planned levels of service while accepting slightly greater risk in the future.

Increasing risks in the future are consistent with advice as the five yearly update of our water resources management plan enable us to re-evaluate and plan for risk as better understanding of the uncertainty becomes available. Therefore, it would be inappropriate to plan to maintain a higher level of target headroom throughout the whole planning period as this could result in investment which proves to be unnecessary.

The target headroom profiles or 'glidepaths' used in our dWRMP24 are set out in Table C2.1. The target headroom percentile shown in the table represents the level of confidence we have of achieving our target level of service. Llanfyllin and Saltney zones are supplied by bulk imports, thus uncertainty lies with the exporting zone therefore we have not calculated target headroom for these zones.

Table C2.1: Target headroom profiles used in the dWRMP24. NA means not applicable.

Water Resource Zone	AMP8 2025-2029	AMP9 & AMP10 2030-2039	AMP11 onwards 2040-2085
Llandinam & Llanwrin	95%	90%	90%
Llanfylin	NA	NA	NA
Saltney	NA	NA	NA
Wrexham	95%	Transition 95% to 85% (in even target headroom steps)	85%

The 'glidepaths' that we have adopted are shown in Table C2.1. They all follow the 'glidepath' strategy of maintaining a 95% level of certainty in the initial AMP then reducing the level of certainty and accepting greater risk from the following AMP onwards. When the risk increases in 2030 the target headroom values decrease, potentially creating a step in the target headroom profile. We have reviewed the options for smoothing this transition of the 'glidepaths' as this results in greater consistency between consecutive years. The outcome of this review is that small step changes (<1 Ml/d) in the target headroom profile for Llandinam and Llanwrin will remain. For Wrexham which would have had a larger step (≥1 Ml/d) we have smoothed the target headroom values from 2030 to 2039 so that there is a gradual target headroom transition to the determined 'glidepath' certainty percentile of 85% in 2040.

We have opted for a low level of risk until 2029 as due to the relatively short timeframe we must plan to ensure that we can meet our levels of service. The 'glidepath' level of risk is higher from 2030 onwards as demand, and when applicable climate change uncertainty, typically increase over time. Our approach to managing long-term risk and uncertainty means that we avoid having to commit to potentially large-scale investment decisions in AMP8 that would be driven by very uncertain long-term scenarios. Our dWRMP delivers a high level of confidence for AMP8, but accepts an increasing amount of risk beyond that. The increasing risk will be managed by re-evaluating target headroom in subsequent WRMPs. Figure C2.2 illustrates how our target headroom profile compares with other potential profiles that could have been adopted to accommodate an even wider range of uncertainty ranging from 95% certainty to 80% certainty.

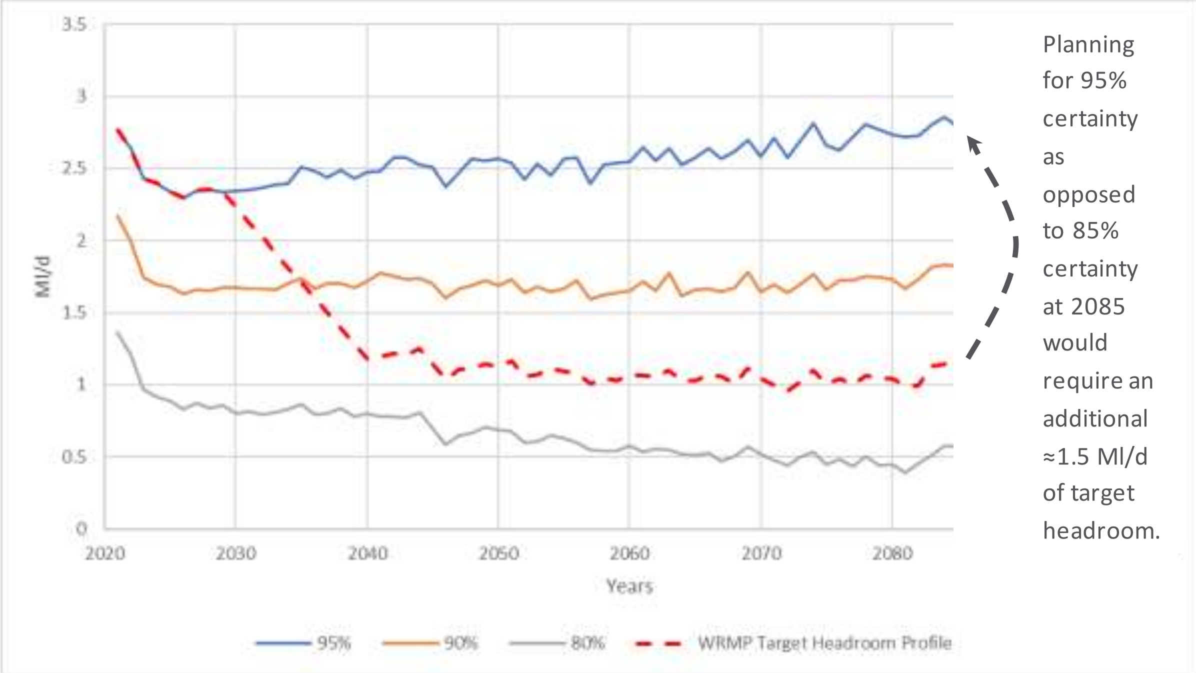

Figure C2.2: Planning for uncertainty – target headroom required to accommodate 80% certainty to 95% certainty with dWRMP24 target headroom profile for Wrexham WRZ .

Our strategy is based around delivering a target headroom that provides a 95% level of confidence that we will meet our target levels of service during AMP8. Over the 60 year horizon, our target headroom profile varies to reflect the fact that many of the medium to long term uncertainties can be managed over time. We believe this profile is appropriate given that:

- A proportion of the uncertainty in our AMP8 headroom assessment is related to our assessment of DO and the data that is available. It would not be appropriate to plan further significant capital investment to deliver the maximum level of confidence when the uncertainty around the supply/demand balance gap could be reduced by utilising improved data with further analysis.

- The growing long-term uncertainties can be managed over time through five yearly WRMP re-evaluation. The water resources planning process requires that WRMPs are reviewed and updated every five years, and we believe that the long-term planning risks can be managed and mitigated within this structured process. Therefore, we have adopted a target headroom profile that accepts an increasing amount of uncertainty over the 60 year period.

C2.3.2 Relative contributions of target headroom components

Figures C2.3 to C2.4 illustrate, for each of our WRZs, the relative contributions that the different target headroom components make to the overall target headroom requirement.

In the graphs the S6 issues (uncertainty around supply-side data) have been separated into the four categories discussed in section C2.1, where:

- S6-1 is uncertainty around licence constrained sources
- S6-2 is uncertainty around aquifer constrained sources
- S6-3 is uncertainty around infrastructure constrained sources
- S6-4 is uncertainty around surface water source yields.

As mentioned in section C2.1, in preparing for our dWRMP24 we have assessed the constraints on each of our sources of supply.

Our Llandinam and Llanwrin WRZ is supplied by groundwater sources, which our climate change assessment has shown will be resilient to future changes in climate. In this zone, the sources of uncertainty are limited to demand and S6-1 uncertainty (Figure C2.3). However, the overall target headroom in this zone is relatively small.

As discussed in Appendix A3.6, Wrexham is affected by the potential impacts of climate change. As can be seen in Figure C2.4, the relative contribution of uncertainty around climate change increases through the planning period but remains a relatively small target headroom component. Demand and S6-3 uncertainty comprise the majority of target headroom in Wrexham.

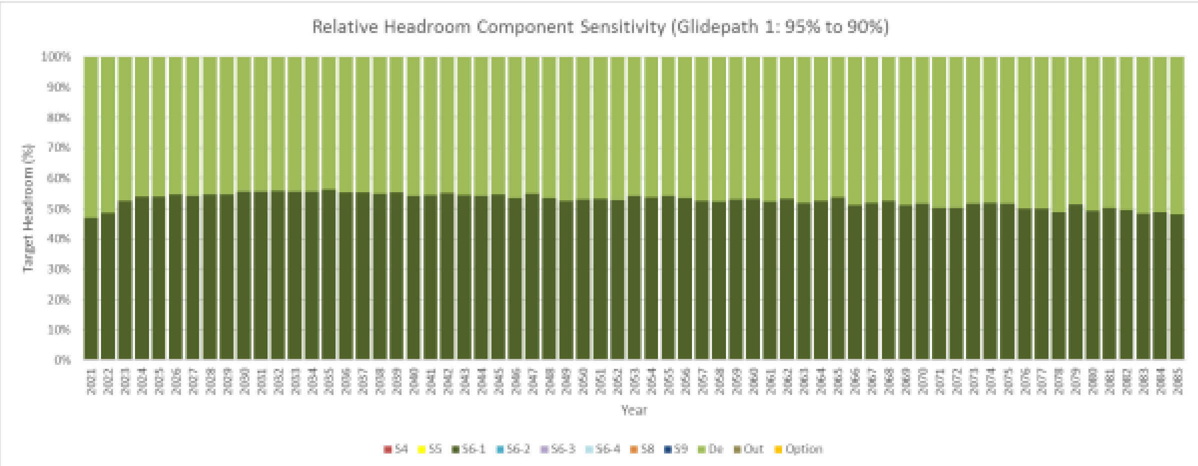

Figure C2.3: Components of target headroom for Llandinam and Llanwrin WRZ

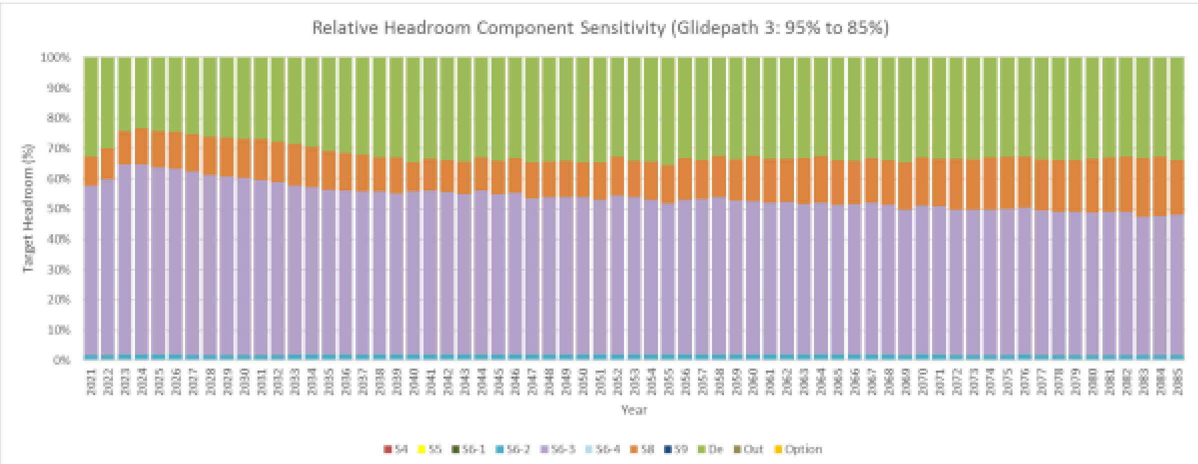

Figure C2.4: Components of target headroom for Wrexham WRZ

C3 Baseline supply/demand balance projections

The methodologies and assumptions behind our projections of our future supply capability, outage risks, demand for water across our region and headroom uncertainties are described in detail in Appendices A, B and C. The analysis of these issues comes together in our assessment of the overall balance of water supply and demand over the next 60 years. Below we discuss our assessment of the 'baseline' supply demand balance position from now until 2085.

The 'baseline' scenario demonstrates what the supply/demand outlook would be based on our projected changes to future demand and water available for use, but assuming no investment in new supplies and no further demand management activity and leakage reduction beyond our WRMP19 AMP7 investment. It depicts a scenario in which a dry year could occur in any year between now and 2085. Under that scenario we have assessed the demand for water we would expect to have to meet using the resources we could rely upon under those conditions, with the likely outage and headroom requirements taken into account. This scenario is used to test whether future investment will be required to maintain the balance of supply and demand and to ensure that we can meet our target levels of service.

The principal equation governing the calculation of the supply demand balance is:

Balance of Supply = Deployable Output – Exports + Imports – Outage – Headroom – Demand

Using this approach, the balance of supply is calculated for each year in the planning period (2025–2085). Both the headroom and outage requirements have been assessed on a probabilistic basis. The impact of this probabilistic assessment on the calculated supply demand balance is illustrated in Figure C3.1. Our analysis has been carried out over the 60 year planning period to derive the mean balance of supply in each year along with the range of uncertainty around the mean. The range of uncertainty has been plotted to show the probability that the supply and demand will be in surplus, in balance or in deficit.

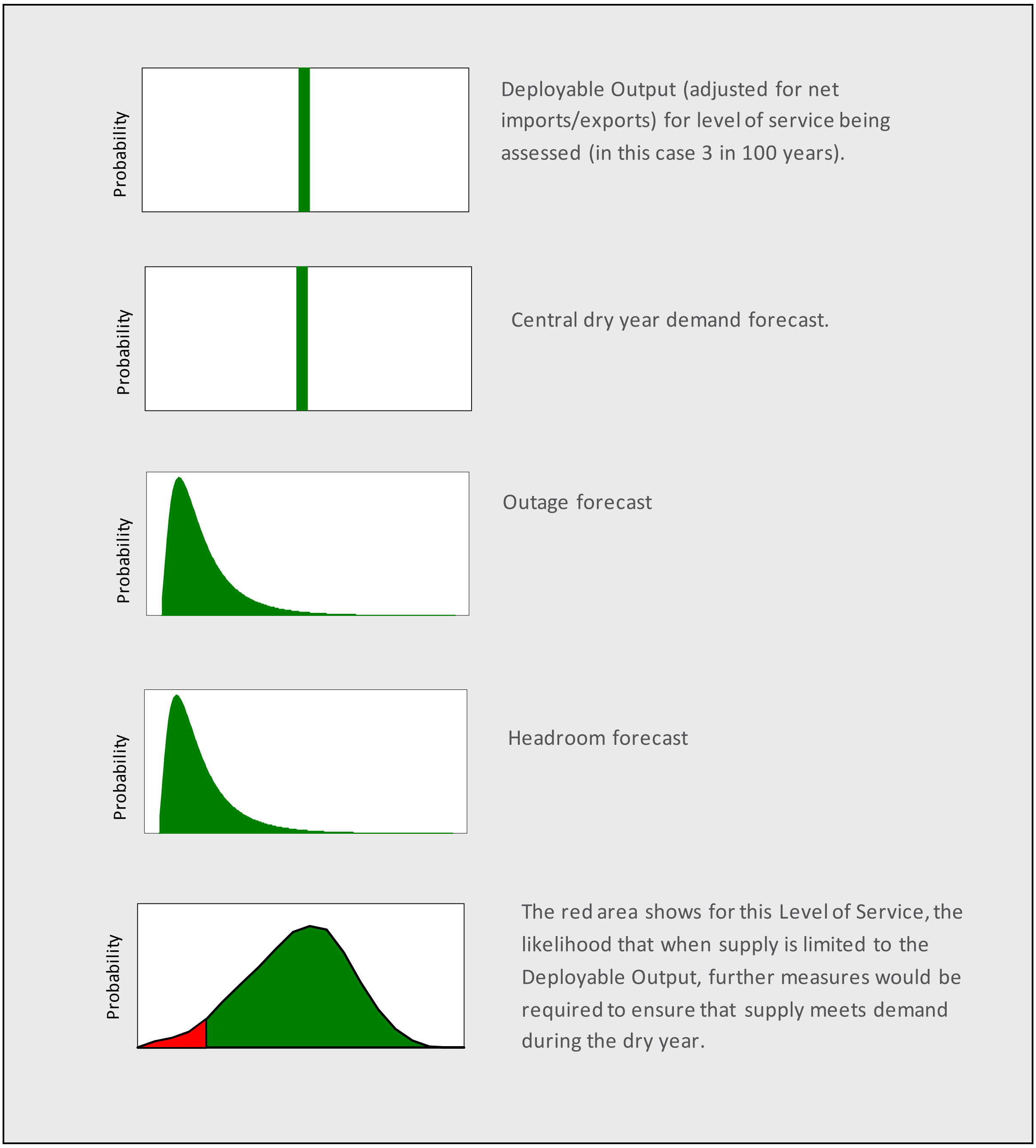

Figure C3.1: Calculating the balance of supply and demand in a WRZ

C3.1 Interpreting supply demand balance uncertainty

Figure C3.2 shows a typical result from the supply demand balance uncertainty analysis. The percentile ranges show the probability of supply meeting demand in future years given the uncertainties that have been assessed for each of the key planning components.

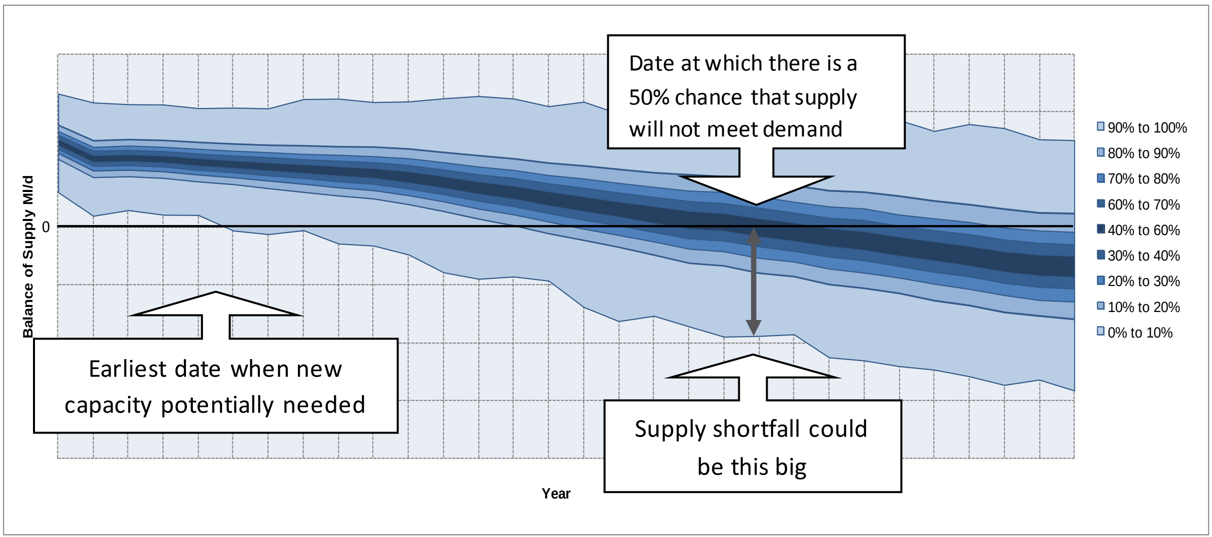

Figure C3.2: The supply demand balance with different levels of certainty/uncertainty. The exact temporal range and specific years of the x-axis below is not important but for reference it represents a period of approximately 30 years.

The example shown in Figure C3.2 shows a general trend of loss of DO over time combined with a growth in demand for water, resulting in a worsening supply/demand position. The percentile distribution about the mean projection increases through the planning period reflecting greater uncertainty going forward.

Generally, the supply demand balance graph can be used as the basis for investment planning for a resource zone. We make our investment decisions on the need for additional demand management measures (including leakage reduction, metering and water efficiency) and new water sources based on maintaining a give n level of certainty in the balance of supply.

The point at which the 0 percentile crosses the 0 Ml/d axis in Figure C3.2 shows the earliest point at which new sources or demand management measures could be required to ensure the level of service will be met, accounting for all identified uncertainty in the resource zone. The larger the risk the company is prepared to accept that supply may not meet demand; the longer it will be before these measures will need to be implemented.

The size of any supply/demand shortfall, and the scale of any resulting investment, is to some extent determined by the level of planning uncertainty that the company is prepared to accept. As explained in section C2.3.1, for our dWRMP24 we have adopted a target headroom requirement that reduces over time. The target headroom profile reflects the fact that medium to long term uncertainties can be managed over time, and so it would be inappropriate to plan to maintain a high level of target headroom throughout the whole planning period. Instead, we plan to accept a manageable degree of risk in our AMP8 supply demand balance and to accept an increasing level of risk in our longer-term planning horizon.

C3.2 Baseline supply demand balance results for individual WRZs

The results of our baseline supply demand balance assessment of Llandinam and Llanwrin, and Wrexham zones, are shown in Figures C3.3 and C3.4 respectively. Llanfyllin and Saltney zones are supplied by bulk imports, thus the bulk imports have been determined so that there is available headroom and thus a positive supply demand balance throughout the planning period for these zones.

The figures show that for the Llandinam and Llanwrin, and Wrexham zones, there is a high probability that there are sufficient supplies available to meet expected water demand from our customers. There is a comfortable surplus in Llandinam and Llanwrin, and in Wrexham supply only cannot meet demand potentially in the 0 to 10 percentile.

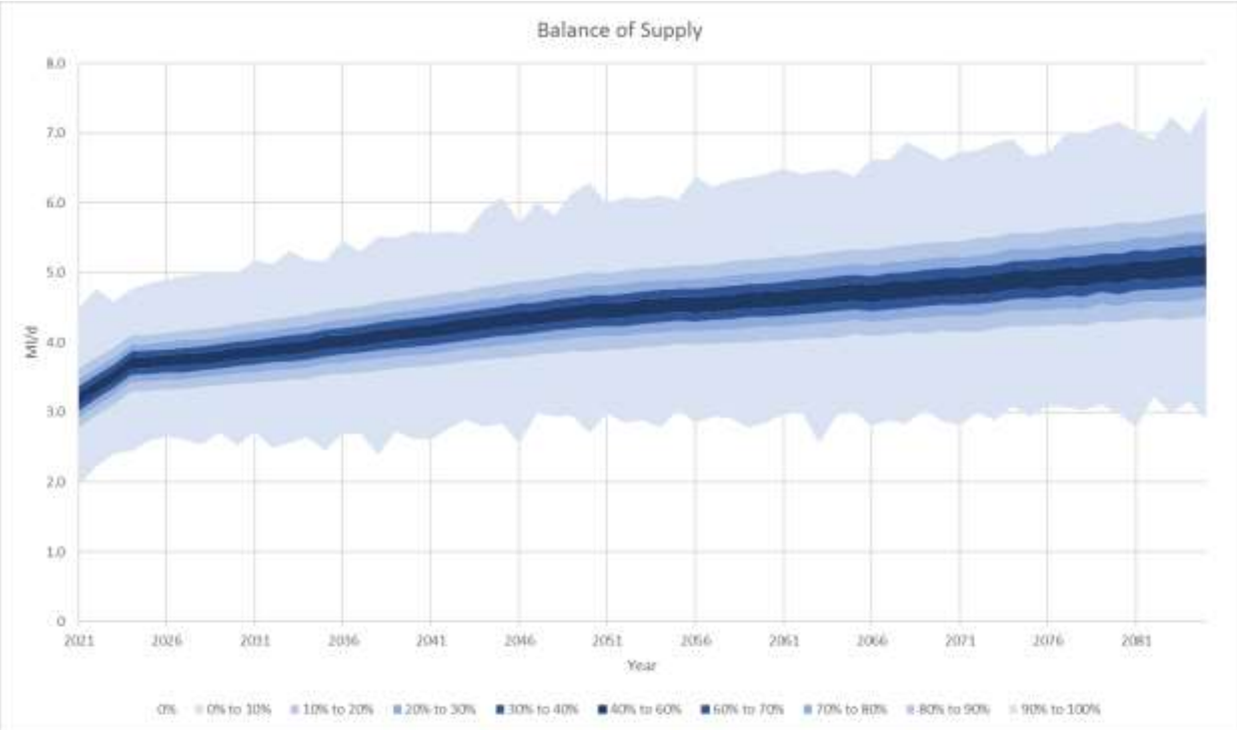

Figure C3.3: Balance of supply for Llandinam and Llanwrin WRZ

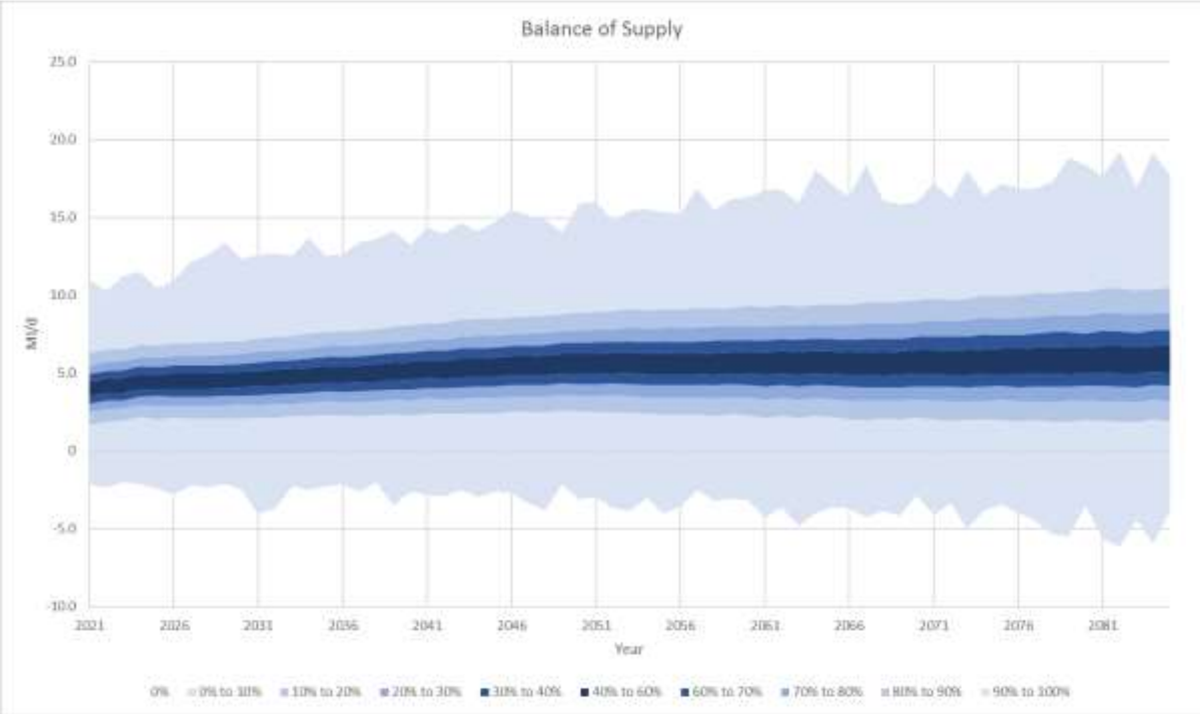

Figure C3.4: Balance of supply for Wrexham WRZ

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