Water Resources Management Plan

Appendix C –Target Headroom and the Supply-Demand Balance

Water Resource Strategy team
September 2019

RHAGOROL O'R TAP
WONDERFUL ON TAP

HAFREN DYFRDWY
severn dee

APPENDIX C – Target Headroom and the Supply-Demand Balance

C1. The headroom modelling approach

C1.1 Wrexham WRZ

While we have endeavoured to use the most up-to-date technology, methods and data available to produce our supply and demand forecasts, there is always an element of uncertainty in all forecasts. As part of the development of our WRMP19 we have therefore analysed and quantified the variability and uncertainty that are built into the dry year annual average scenarios.

As agreed with NRW and EA, we have used the UKWIR methodology *A Practical Method for Converting Uncertainty into Headroom (1998)* to do this. Although a newer headroom methodology was published by UKWIR in 2002, we feel that the relative simplicity of our supply system and small number of water resource zones is more suited to the original methodology.

'Target headroom' is defined as *"the minimum buffer that a prudent water company should allow between supply (including raw water imports and excluding raw water exports) and demand to cater for specified uncertainties (except for those due to outages) in the overall supply-demand balance. Introducing this buffer into the overall supply-demand balance will help to ensure that the water company's chosen level of service can be achieved".* This methodology calculates the target headroom on a WRZ basis. This can then be compared to the 'available headroom' to determine the final supply-demand balance.

The 'available headroom' in a WRZ is equal to the difference between water available for use (WAFU) and demand at specified points in time. If the available headroom is greater than or equal to target headroom, then the desired level of service should be achieved. However, if our available headroom were to fall below the target headroom, we would face the risk of failing to meet our chosen level of service.

The methodology we are using to determine our target headroom was designed to identify the principal uncertainties in the supply-demand balance and convert these into headroom. The calculation is based on assigning a score to each source of uncertainty and then converting the total score for each WRZ to target headroom.

The sources of uncertainty have been grouped under eleven headings – eight are supply related and three are demand related.

Supply Factors	Demand Factors
Vulnerable Surface Water Licences	Accuracy of Sub-Component Data
Vulnerable Groundwater Licences	Demand Forecast Variation
Time Limited Licences	Uncertainty of Climate Change on Demand
Bulk Transfers	
Gradual Pollution Causing a Reduction in Abstraction	
Accuracy of Supply-side data	

Single Source Dominance and Critical Periods Uncertainty of Climate Change on Yield	

Table C1.1 - Target headroom calculation factors

The methodology works through each of the factors, assigning an appropriate headroom score which is directly related to the degree of uncertainty and the impact it may have on the supply-demand balance for the WRZ under assessment. The scores are aggregated for each WRZ and then transformed by means of a conversion chart into a value for target headroom.

	Present Day → Planning Horizon						
	2016/17						2044/45
Water Available for Use (Ml/d)	49.75						48.79
Target Headroom (%)	4.50 Of which 0% CC						5.00 Of which 0.45% CC
Target Headroom (Ml/d)	2.24 Of which 0 CC						2.44 Of which 0.22 CC
Available Headroom (Ml/d)	7.12						10.37

Table C1.2 - Wrexham WRZ target headroom results

The results of the headroom assessment, combined with the supply and demand forecasts provide us with our 'supply-demand balance', details of which are set out in the next section.

Components

As explained above, the methodology considers a number of components to make up the headroom score. The explanation of our calculations for some of the key components is set out below. In addition, we have included justification for those components that were not included in the uncertainty calculation, resulting in 0 scores.

S1 and S2 – licensing vulnerabilities

In their Water Resources Planning Guidelines (2016), NRW and EA instruct water companies not to include any allowances in target headroom for uncertainty related to sustainability changes to permanent licences. The guidelines state that they will work with water companies to ensure that sustainability changes will not impact on security of supply, and so there is no need for a headroom allowance to be made.

In accordance with the planning guidelines therefore, we have made no allowances for S1 (vulnerable surface water licences) or S2 (vulnerable groundwater licences) issues in our target headroom assessment. All sustainability changes are dealt with outside of target headroom, as part of the supply demand balance calculation. We have no vulnerable surface water licences within our supply area.

S3 Issues – time limited licences

Although the NRW and EA's Water Resource Planning Guidelines now allow companies to make an allowance for uncertainty around non-renewal of time limited licences we have made no explicit allowance for it in our headroom assessment. We currently have one time limited licence which expired in March 2018. When we carried out this assessment for the dWRMP, we had applied to renew the licence and assumed renewal for the purposes of the SDB, as advised by NRW. The licence has since been renewed until March 2027 and we have therefore made no uncertainty allowance for time limited licences in the headroom calculation.

S4 Issues - uncertainties relating to bulk transfers

Any significant bulk transfers are included within the modelled deployable output, and so any corresponding uncertainty is allowed for under S6 (accuracy of supply side data) issues. Consistent with Dee Valley Water's WRMP14, no explicit allowance has been made for S4 issues in our headroom assessment.

S5 – Gradual pollution causing a reduction in abstraction

None of our abstractions have been identified as being at risk from gradual pollution.

S6 – Accuracy of supply side data

NRW provided a historical time series of cutbacks for the River Dee (1927 to 2015) which were fed into the Aquator model for initial DO assessment and we therefore have fairly high confidence in this data. However, our reservoir catchments are ungauged and there was therefore no gauged flow data that could be used as reservoir inflows in Aquator. Overall, therefore, we feel sufficiency of supply side data is average.

S7 – Single Source Dominance and critical periods

Due to over 85% of our water coming from the River Dee, it meets the criteria for single source dominance.

S8 – Uncertainty of climate change on yield

NRW tested 100 scenarios and used the six median scenarios to generate climate change versions of the abstraction tables from the Dee General Directions. We used these six scenarios to inform the climate change deployable output (DO) modelling.

As described in appendix A2.1.6 monthly climate change factors monthly climate change factors, provided by NRW, were applied to the baseline inflows used in our Aquator model. This created a perturbed time series of flows for each of the six climate change scenarios, and similarly, new time series for the NRW imposed cutbacks were created for each scenario.

The net abstraction volume for DVW was reduced by 1.61 Ml/d based on this assessment. As the Chester zone (which is now part of Severn Trent's supply area) is 100% consumptive the

most efficient way to apply the reduction was at the Dee Chester abstraction point. The cutback levels remained the same as they were in the baseline run, as did the maximum allowable abstraction. For Wrexham WRZ, this meant that the safe yield allocation, stage 1 and stage 2 cutbacks DO was 41.50 Ml/d.

The average DO of the Wrexham WRZ across the six scenarios was 50.7Ml/d compared to a baseline DO of 51.2Ml/d, implying a median climate change impact on DO of 0.5Ml/d (0.53 Ml/d in the peak month of July). We used this median impact to inform the reduction in baseline DO reported in the water resources planning tables for Wrexham WRZ.

The target headroom assessment used for our draft WRMP included an allowance for climate change based on the median climate impacts in the Wrexham WRZ. We have reassessed target headroom using assumed "wet" (CC075) and "dry" (CC015) projections to provide a range of uncertainty. Under these scenarios the maximum reduction in baseline deployable output is 0.7Ml/d (-1.3%), whilst the minimum reduction is 0.3Ml/d (-0.6%). The headroom score is the same for all 3 scenario because the impacts are less than 15% which is the threshold for the next step on the scoring matrix. We will be carrying out further modelling to test the impacts of the more extreme 5th and 75th percentile climate change projections to ascertain whether this changes the headroom score and will report on the outcome via the annual review process.

D1 – Accuracy of sub-component data

Our baseline demand forecasts assume a continuation of current rates of optional metering of unmeasured households - this is 3.2% of unmeasured household properties opting for a meter each year. For demand headroom analysis, a triangular distribution has been assumed around the central rate with upper and lower parameters set as follows:

- Lower bound – 2.85% of unmeasured customers opt per annum
- Upper bound – 3.55'% of unmeasured customers opt per annum

The 2019 EA WRMP guidelines explicitly instruct water companies to account for the local council projections of household growth for supply capacity planning purposes. In light of this, we are adopting Local Council projection of growth from AMP7 onwards for the WRMP19 central housing growth forecast. We have prepared the new property forecast using the Welsh Governments Local Authority Households Projections data set published March 2017 and local authority data sets for English councils.

However, the local authority forecasts represent a stepped increase in new households over current. For uncertainty analysis we have assumed a triangular distribution using the LPA growth projections and historically observed growth in our region:

- Upper/central assumption - LPA projections
- Lower bound – Historic average growth rate

For estimates of future total population we have used trends from the latest Welsh Government Local Authority population projections and applied these to our base year data.

Population uncertainty is based on high and low population projections for Welsh Government Local Authorities, which are based on projections combining variants of births, deaths and migration for Wales.

D2 – Demand Forecast Variation

Two scenarios based on micro-component trends are added to account for variations within the future predicted rate of change in consumption:

- Sustainable development - in this most extreme efficiency scenario, we have assumed that water saving is driven by both technological advancements and attitudinal changes. Sophisticated filtration technology would allow recirculation of shower water saving both energy and water. Waste water and washing functions are fulfilled by greywater recycling, aided by hydrophobic frictionless surfaces. Bathing is pretty much obsolete.
- Market trend - this scenario assumes that the projected trend in micro-components does not continue beyond 2022. This would require a situation such as Brexit where UK building regulations may be de-coupled from current standards and the logical decline in flush volumes is curtailed. The observed upward trend in showering continues to increase.

For measured non-household water consumption, we have based uncertainty bounds on a high and low economic growth scenario forecast, relative to the central estimate. Plausible economic scenarios were constructed to provide a range of possible outcomes. These involved variations in the macro assumptions to create alternative water demand forecasts as explain below.

The high scenario envisages that the UK economy will quickly recover after a modest initial post-referendum dip. This assumes that the rapid formation of the new government reassures investors and leads to good early progress on negotiating new trade arrangements with the EU, perhaps similar to the existing EEA member status for the UK but including a provision for some emergency brakes on migration. It also assumes promising initial discussions with other major trading partners such as the US, China and the Commonwealth countries, although actual deals would take longer to agree.

In the medium to long-term, the UK economy will slowly return to long-term growth rates of 2.5 per cent projected by the Office for Budget Responsibilities[1] (OBR) which was produced prior to the EU referendum and represents a more optimistic outlook for the UK's long-term growth path. The inflation pressure has soon subsided following the recovery of the value of Sterling, stronger economic fundamentals allow the Bank of England to raise interest rates at a faster pace than the central scenario.

The low scenario assumes that negotiation with the EU has proved difficult, raising concerns for a possible 'hard-Brexit' and the UK perhaps relying on WTO rules to trade with the EU.

[1] The assumptions are set out in the OBR's fiscal sustainability report June 2015. http://budgetresponsibility.org.uk/fsr/fiscal-sustainability-report-june-2015/

This has led to a further fall of the value of Sterling, which in turn leads to a further increase in inflation coupled with the loss of consumer and business confidence which undermine both consumer spending and business investment. In this case, the UK could enter a period of recession for the next 12-24 months and permanently lower the nation's growth potential. The Bank of England keeps the interest rates low in support of economic growth despite a period of higher inflation, the pace of interest rates rises is likely to be slow and gradual. The UK economy finally emerges from the recession stabilising at a below trend growth trajectory until the end of the forecast period.

D3 – Uncertainty of Climate Change on demand

We used the UKWIR (2013) Impact of Climate Change on Water Demand methodology, as required by the EA/NRW guidance, to determine the likely impact of climate change on our demand forecast. Reference data used was the Severn Trent Household Relationship - Annual Average, 50th percentile scaling factor. This results in a less than 1% increase in demand over the planning period.

C1.2 Llandinam & Llanwrin WRZ

To derive the range of target headroom uncertainty for our fWRMP19 we have adopted a risk-based approach to assessing 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:

- Supply uncertainty:
    - S6: Accuracy of supply side data
- Demand uncertainty, based on the demand forecast:
    - D1: Accuracy of sub-component demand
    - D2: Demand forecast variation
    - D3: Uncertainty of the impact of climate change on demand

S1 to S5 issues

In accordance with the EA's WRPG (2016) we have made no allowances for S1 (vulnerable surface water licences) and S2 (vulnerable groundwater licences). Although the Environment Agency's Water Resource Planning Guidelines now allow companies to make an allowance for uncertainty around non-renewal of time limited licences we have made no explicit allowance for it in our headroom assessment as none of the sources within this zone are currently time limited.

There are no bulk imports into the Lllandinam and Llanwrin zone so no allowance for S4 (bulk transfers) has been made.

None of the groundwater sources in this zone are deemed to be at risk of gradual pollution. We have therefore made no allowance for S5 (sources at risk of gradual pollution).

S6 issues – uncertainties in supply-side data

This component reflects the scale of uncertainty around our calculation of deployable output. The updated groundwater deployable output assessment included a review of the constraints on deployable output for each source. The sources in the Llandinam and Llanwrin zone are abstraction or infrastructure constrained. An allowance for uncertainty has therefore been made as follows:

Abstraction licence constraints

We have assumed a triangular distribution with a mean error of 1%, with a maximum of 4% (i.e. a 4% reduction in deployable output) and a minimum of -2% (i.e. a 2% gain in deployable output).

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.

S8 issues – uncertainty of the impact of climate change on source outputs

As described in appendix A1.2.6 our assessment has shown that the Llandinam and Llanwrin WRZ has a low vulnerability to climate change due to it's proximity to Clywedog Reservoir. Releases from Clywedog reservoir are likely to be sufficient to support the river gravels in the upper reaches of the River Severn (the source of the Llandinam abstraction). Modelling of the water resource zones located at the top of the river Severn has shown they have no or minimal change in DO under 20 climate change scenarios. We have made no allowance for climate change uncertainty within our target headroom assessment.

D1 issues – accuracy of sub-component demand

Uncertainty in the number of meter optants

Table C2.3 below shows the past rate of uptake of the free meter option from 2005/06 to 2014/15. The table shows that the rate of uptake has fluctuated over recent years in response to factors such as changes in average unmeasured bills and the economic climate.

	2005/06	2006/07	2007/08	2008/09	2009/10
Unmeasured household properties opting for a meter each year	1.45%	1.75%	1.53%	2.09%	1.98%
	2010/11	2011/12	2012/13	2013/14	2014/15
Unmeasured household properties opting for a meter each year	1.58%	1.63%	1.85%	2.16%	1.89%
Average rate of opting 2005 - 2015	1.79%				

Table C1.2 - Rate of metering from 2005/06 to 2012/13

For the fWRMP19 our central forecast is for baseline free meter optants (FrOpts) to continue at the observed average rate of 1.79% p.a. (average of AMP4 and AMP5 (2005/06 to 2014/15)).

For demand headroom analysis, a triangular distribution has been assumed around the central rate with upper and lower parameters set as follows

- Lower bound – 1.45% of unmeasured customers opt per annum, based on 2005/06 rate of metering.
- Upper bound – 2.16'% of unmeasured customers opt per annum, based on 2013/14 rate of metering.

Uncertainty in the number of new property connections

The 2019 EA WRMP guidelines explicitly instruct water companies to account for the local council projections of household growth for supply capacity planning purposes. In light of this, we are adopting Local Council projection of growth from AMP7 onwards for the WRMP19 central housing growth forecast.

However, the local authority forecasts for our region represent a stepped increase in new households over historic and current observed numbers. For uncertainty analysis we have assumed a triangular distribution using the LPA growth projections and historically observed growth in our region.

- Upper/central assumption- LPA projections
- Lower bound – Historic average observed growth rate (1997 to 2016)

Uncertainty in population numbers

For population projections we have used the latest Government projections for England and Wales. These are taken from the 2014 base sub-national population projections for England from the Office of National Statistics (ONS) and from Welsh Assembly Government based local authority population projections for Wales. The annual percentage rates of change for local authorities are applied to the base year population estimates at postcode level and then aggregated up to Water Resource Zone level. This gives the underlying change in population due to births, deaths and migration in the Severn Trent region.

Population uncertainty is based on high and low population projections, each of which are based on projections combining variants of births, deaths and migration for England and Wales.

D2 issues – demand forecast variation

Uncertainties in household demand

Two scenarios based on micro-component trends are added to account for variations within the future predicted rate of change in consumption:

- Sustainable development - in this most extreme efficiency scenario, we have assumed that water saving is driven by both technological advancements and attitudinal changes. Sophisticated filtration technology would allow recirculation of shower water saving both energy and water. Waste water and washing functions are fulfilled by greywater recycling, aided by hydrophobic frictionless surfaces. Bathing is pretty much obsolete.

- Market trend - this scenario assumes that the projected trend in micro-components does not continue beyond 2022. This would require a situation such as Brexit where UK building regulations may be de-coupled from current standards and the logical decline in flush volumes is curtailed. The observed upward trend in showering continues to increase.

Uncertainties in measured non-household water consumption

For measured non-household water consumption, we have based uncertainty bounds on a high and low economic growth scenario forecast for our region, relative to the central estimate. Plausible economic scenarios were constructed to provide a range of possible outcomes. These involved variations in the macro assumptions to create alternative water demand forecasts as explained below.

High economic growth scenario

The high scenario envisages that the UK economy will quickly recover after a modest initial post-referendum dip. This assumes that the rapid formation of the new government reassures investors and leads to good early progress on negotiating new trade arrangements with the EU, perhaps similar to the existing EEA member status for the UK but including a provision for some emergency brakes on migration. It also assumes promising initial discussions with other major trading partners such as the US, China and the Commonwealth countries, although actual deals would take longer to agree.

In the medium to long-term, the UK economy will slowly return to long-term growth rates of 2.5 per cent projected by the Office for Budget Responsibilities[2] (OBR) which was produced prior to the EU referendum and represents a more optimistic outlook for the UK's long-term growth path. The inflation pressure has soon subsided following the recovery of the value of Sterling, stronger economic fundamentals allow the Bank of England to raise interest rates at a faster pace than the central scenario.

Low economic growth scenario

The low scenario assumes that negotiation with the EU has proved difficult, raising concerns for a possible 'hard-Brexit' and the UK perhaps relying on WTO rules to trade with the EU. This has led to a further fall of the value of Sterling, which in turn leads to a further

[2] The assumptions are set out in the OBR's fiscal sustainability report June 2015. http://budgetresponsibility.org.uk/fsr/fiscal-sustainability-report-june-2015/

increase in inflation coupled with the loss of consumer and business confidence which undermine both consumer spending and business investment. In this case, the UK could enter a period of recession for the next 12-24 months and permanently lower the nation's growth potential. The Bank of England keeps the interest rates low in support of economic growth despite a period of higher inflation, the pace of interest rates rises is likely to be slow and gradual. The UK economy finally emerges from the recession stabilising at a below trend growth trajectory until the end of the forecast period.

D3 issues – uncertainty impact of climate change on demand

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

D4 issues – uncertainty of the outcome from demand management measures

No uncertainty has been attached to demand management measures.

The target headroom profile

In the short term, the main uncertainty in our planning assumptions is around the accuracy and reliability of our source deployable output rather than any major external factors. We have adopted 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.

Water Resource Zone	AMP7 2020-2025	AMP8 2025-2030	AMP9 2030-2035	AMP10 2035-2040	AMP10 2040-2045
Llandinam & Llanwrin	95%	90%	90%	90%	90%

Table C1.3 - Target headroom profiles used in the fWRMP19

C2. Supply-Demand Balance

To calculate the supply-demand balance, we take the water that is available to supply and subtract our required demand and headroom to give the balance. Our assessment of the dry year annual average supply-demand balance indicates that there will be adequate resources to meet water needs in all of our WRZs through to 2044/45. The balance for each WRZ is shown in Figure C2.1 below.

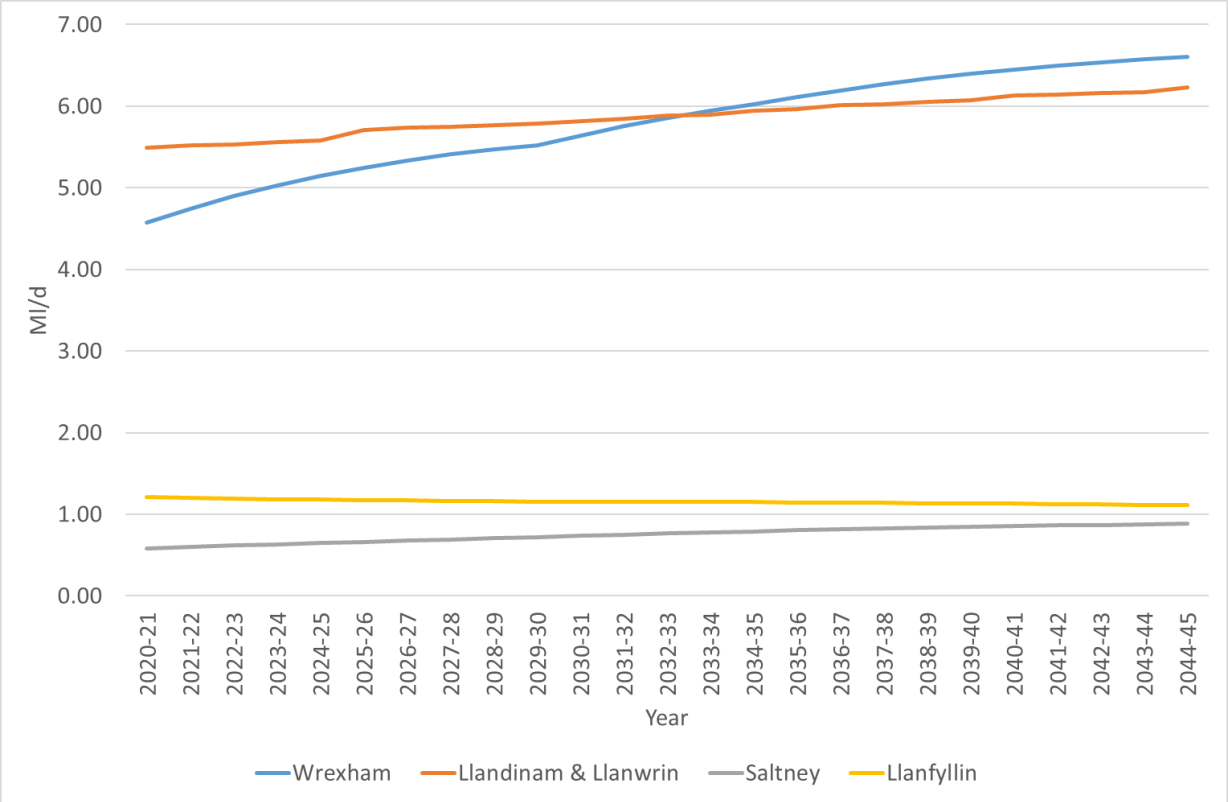

Figure C2.1 - Supply-Demand balance for Wrexham, Llandinam & Llanwrin, Saltney and Llanfyllin WRZs

Figures C2.2 to C2.5 show the results of the headroom analysis for each of the WRZs. As can be seen, the available headroom never crosses the target headroom, indicating that there is no deficit throughout the planning horizon and therefore we do not need to develop any new supply options or invest in any significant demand management options at this time.

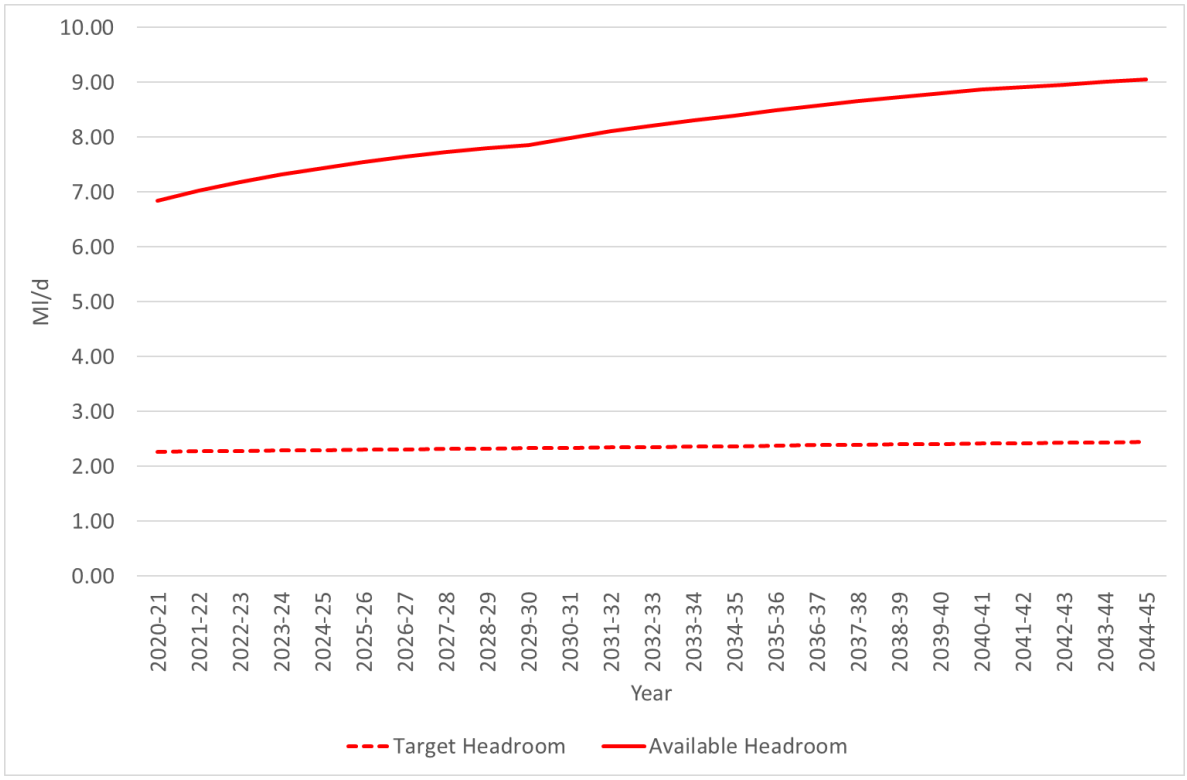

Figure C2.2 - Wrexham WRZ headroom profile for WRMP19

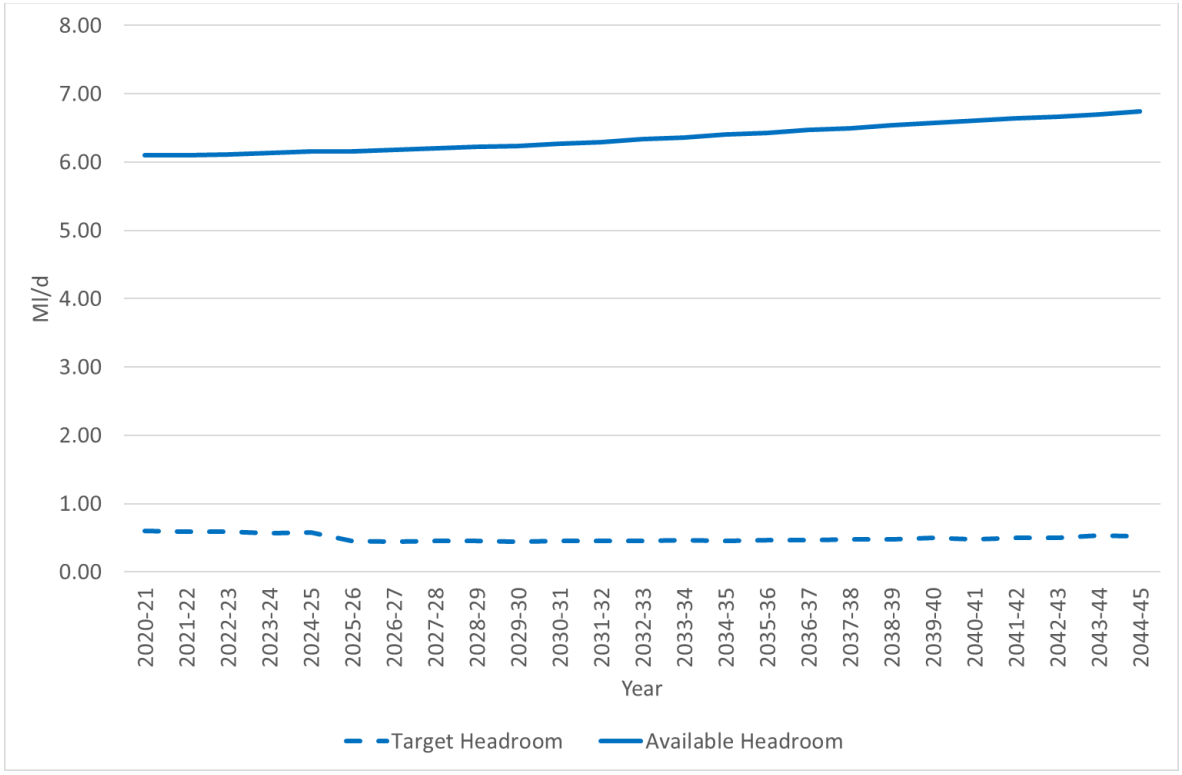

Figure C2.3 – Llandinam & Llanwrin WRZ headroom profile for WRMP19

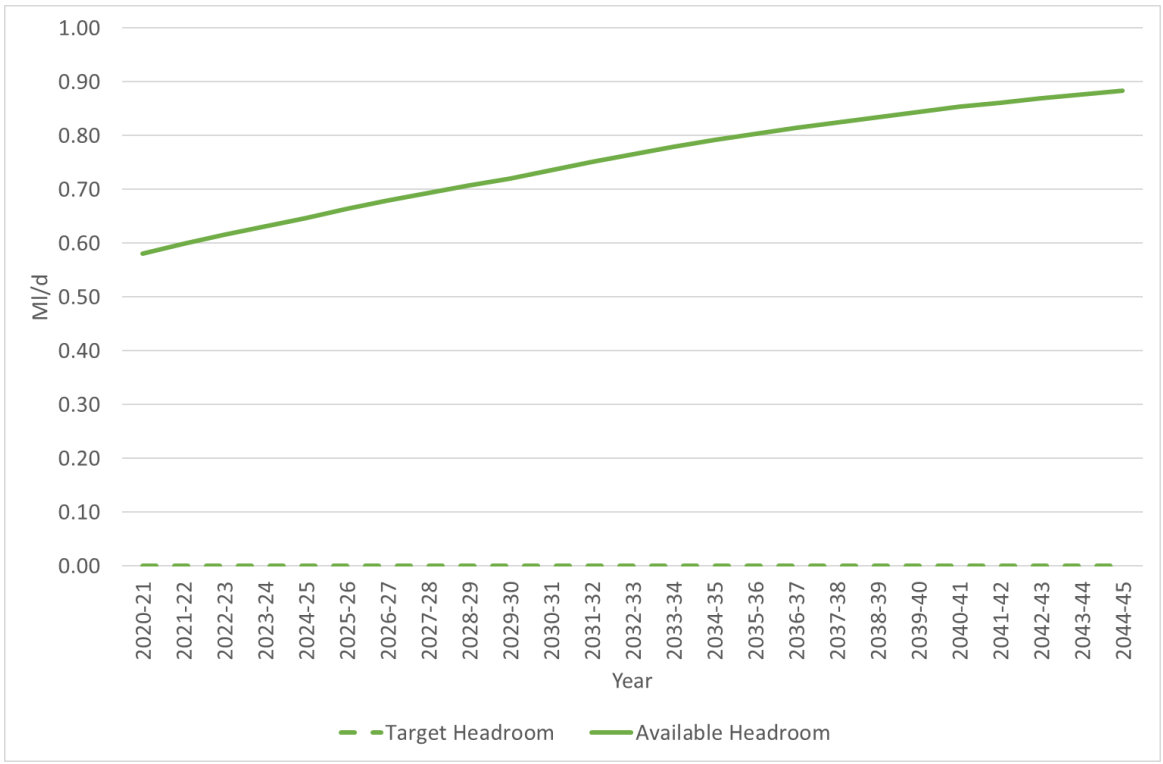

Figure C2.4 – Saltney WRZ headroom profile for WRMP19

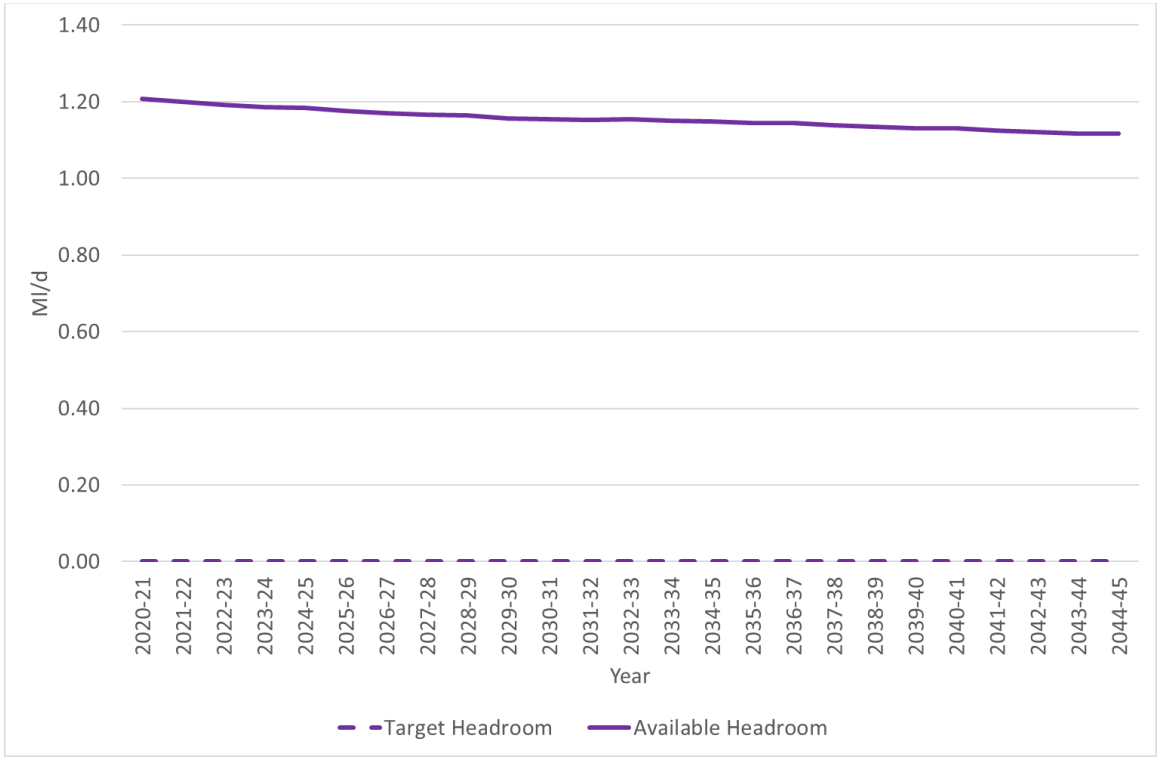

Figure C2.5 – Llanfyllin WRZ headroom profile for WRMP19