WRMP24 Demand Forecast

Wessex Water

December 2024

Document revisions

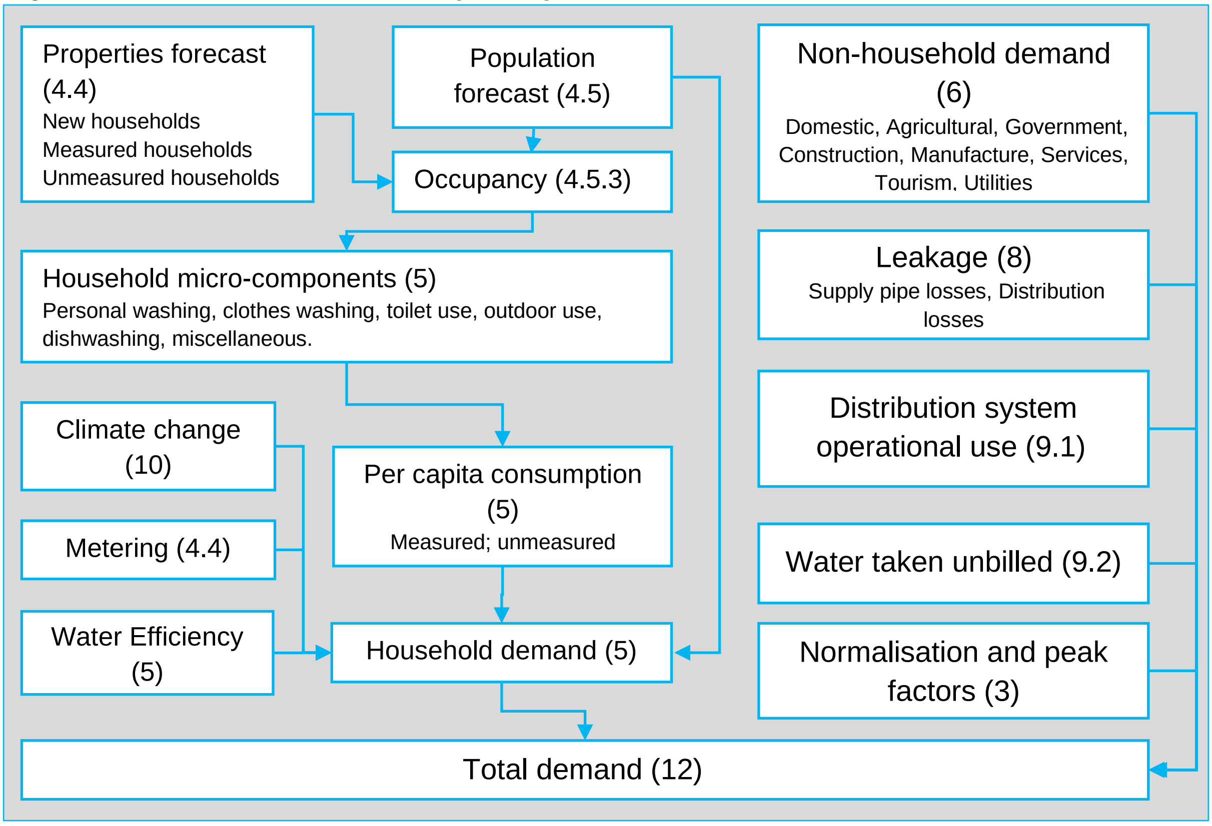
Major version number	Details	Lead contact	Date
1	Draft issued for comment	Chris Hutton	06/07/2021
2	Final version issued for dWRMP24	Chris Hutton	03/10/2022
3	Final published version	Chris Hutton	02/12/2024

Contents

1. Background and Demand Forecast Overview

This document outlines the development of our forecast of future water demands. An overall projection of the average volume of water we will need to put into our distribution network each day (known as 'Distribution Input', or DI) is built up from component forecasts of population, property, household water use patterns, commercial usage, leakage and other minor elements (Figure 1-1). The forecast takes account of projections made by Local Authorities of expected housebuilding rates in our area, the impact that increased metering and water efficient behaviours by our customers will have and an allowance is made for the possible impact that climate change may have on water usage. The approach taken in developing our demand forecast approach is consistent with our problem characterisation assessment and supply-demand balance situation.

Figure 1-1: Demand forecast development process



The demand forecast was developed following the Regulatory Water Resources Planning Guideline[1], and the following guidance:

- Water Resources Planning Guideline Supplementary Guidance – Leakage, External guidance: 18640, Published 22/09/2020
- UKWIR (2016) WRMP19 methods – household consumption forecasting
- UKWIR (2016) Population, household property and occupancy forecasting
- UKWIR (2006) Peak water demand forecasting methodology

[1] Environment Agency, Ofwat and Natural Resources Wales (2021) Water Resources Planning Guidance, Version 10 updated December 2021.

We have also used referred to and incorporated data from key high demand years and published reports in our demand assessments.

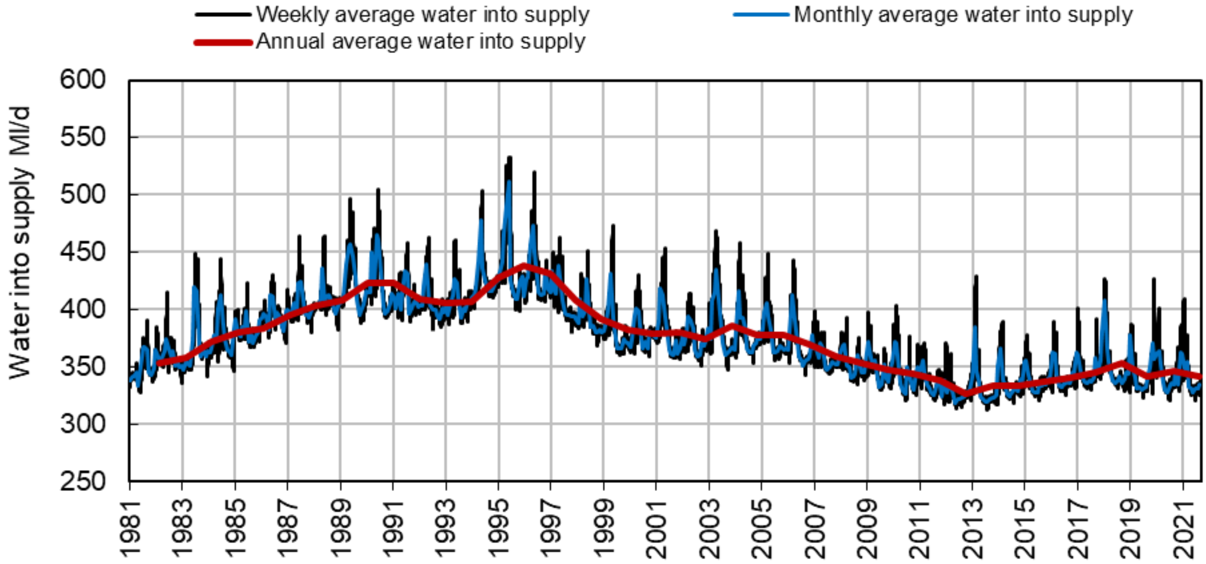
- the water industry project on ‘Water Demand Insights from 2018 (Artesia 2020)
- the collaborative research report “The impact of COVID-19 on water consumption during February to October 2020” (Artesia 2021)
- the joint study “Understanding changes in domestic water consumption associated with COVID-19 in England and Wales” (Artesia 2020)

In line with the Problem Characterisation a demand forecast has been generated for a Dry Year Annual Average (DYAA) and Dry Year Critical Period (DYCP). Where needed, for each component of demand a Low, Central and High forecast to support the assessment of uncertainty and scenario analysis has been made.

2. Historic and Baseline Demand

Until the mid-1990s the demand for water in the Wessex Water region was on a steadily rising trend (Figure 2-1). However, since then this trend has reversed – the demand for water and therefore the volume of water that we need to abstract from the environment fell up to 2013. Since 2013, demand has slowly risen again towards the peak demand year of 2018, before falling slightly over the last few years. Figure 2-1 shows weekly, monthly and annual average 'water into supply' (WIS) since 1981. It shows that since the mid 90's peak demands have fallen from approximately 525 Ml/d to around 425 Ml/d, and annual average demands have reduced from around 425 Ml/d to less than 350 Ml/d.

Figure 2-1 Weekly, monthly, and annual average water into supply (demand)

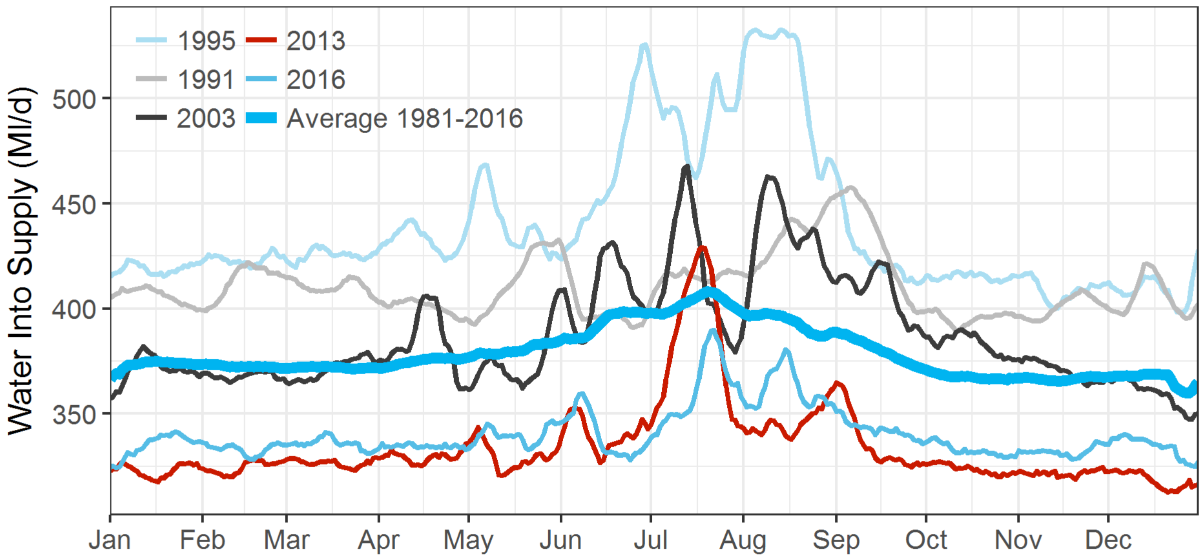


The reduction in the demand for water has occurred despite an overall increase in the population in our area, which has risen ~20% from 1.1 million in 1994/95 to over 1.3 million in 2021/22. The reduction in demand has occurred due to:

- Leakage reduction – we have reduced leakage from the network by half and are continuing to deliver our AMP7 PC target of a 12.8% leakage reduction by 2025 as a three year average.
- Customers switching to a metered supply – the proportion of metered households in our region has increased from less than 10% to over 70% today.
- The more efficient use of water in homes and businesses by our domestic and commercial customers.
- Reduced non-household (commercial) demands due to the closure of some large user industrial sites in the chemical and food and drink sectors and increased water efficiency.

Figure 2-2 shows the in-year variability in the demand for water for key historic drought years; during the summer the demand for water generally increases as our customers use more water in their gardens for plants and leisure, and also inside their homes for showering and clothes washing. Water use by businesses also increases in the summer months, particularly in areas popular for tourism and we also have a high proportion of agricultural volumes. Higher demands can also sometimes occur in the winter as a result of short-term increases in leakage related to freeze-thaw weather conditions; this effect is short-lived, notably in the winters of 2009/10 and 2010/11, and more recently during the beast from the east weather event in 2018.

Figure 2-2 Annual variability of water into supply for key historic years

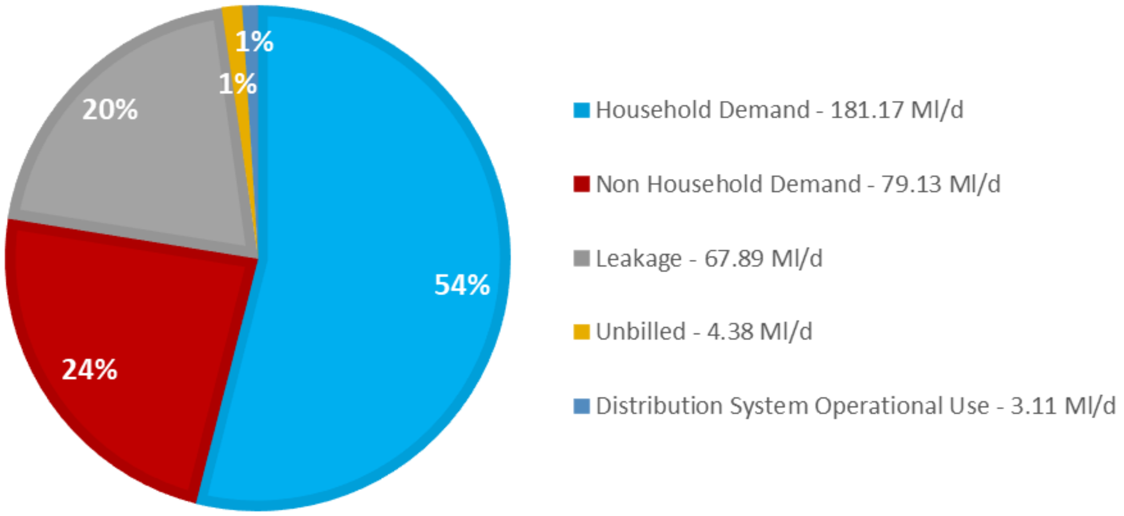


2019/20 is used as the base year for the demand forecast, from where we make a projection of future demands. For forecasting purposes, baseline demand is divided into 6 categories (Table 2-1); demand for each of these is categories forecast forwards to 2079/80. Total Demand (or Distribution Input) is summarised also in Figure 2-3. Household consumption is the main demand component and comprises 54% of Distribution Input. Measured consumption is the main component of household demand as nearly 70% of households are metered. Non-household demand accounts for 24% of water we supply, and leakage 20%. The minor components of water use for operational purposes and water that is taken unbilled make up the remaining 2% of demand.

Table 2-1 Base year 2019/20 (un-normalised) water balance components

Water Balance Component	Demand (Ml/d)	Demand (%)
Measured Non-Household Consumption	75.03	22.4%
Unmeasured Non-Household Consumption	4.10	1.2%
Measured Household Consumption	101.17	30%
Unmeasured Household Consumption	80.00	24%
Water Taken Unbilled	4.38	1.3%
Distribution System Operational Use	3.11	1%
Total Leakage	67.89	20.1%
Total Distribution Input (Demand)	**335.68**	-

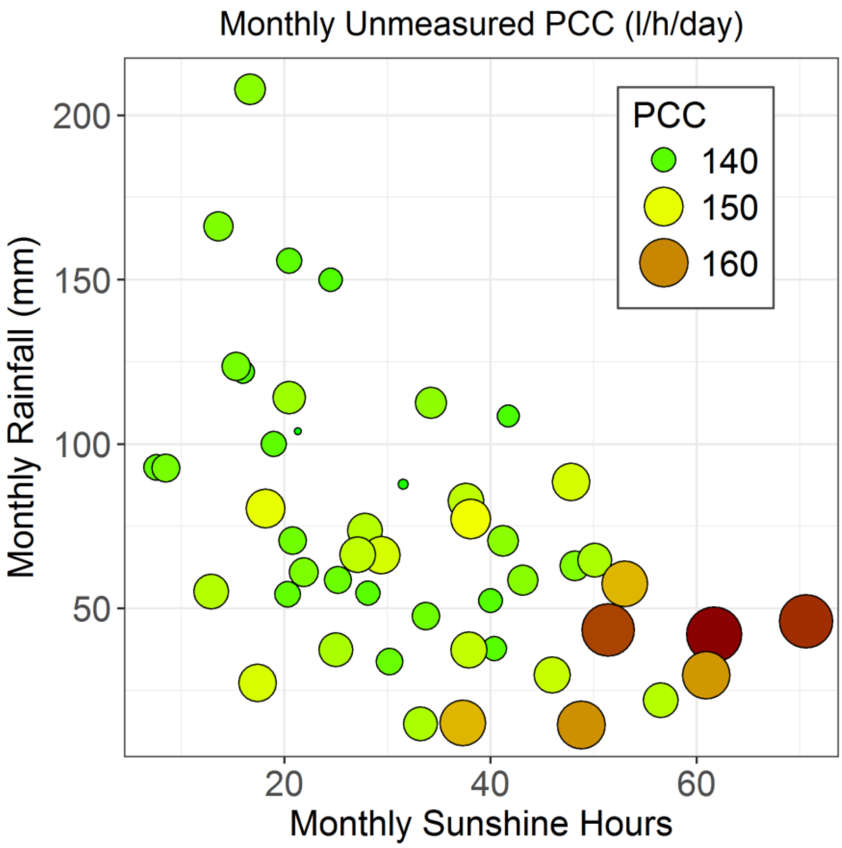
Figure 2-3: Segmentation of total water demand in the base year 2019/20 (post MLE numbers)



3. Baseline Normalisation and Peak Demand Factors

Demand varies season to season and year to year depending on the weather conditions. As shown in Figure 3-1, demand (as represented by unmeasured per capita consumption) is highest during drier periods with lower rainfall and also during sunnier (and typically warmer) periods.

Figure 3-1 Relationship between monthly per-capita consumption and key weather variables



Warmer, sunnier and drier periods tend to occur during the summer, leading to higher (peak) demands relative to average conditions (Figure 2-2). Increased water use at this time typically reflects increased garden usage for watering and leisure, and increased personal washing[2]. Depending on when in the year drier conditions occur can influence what water use behaviours are driving the peak – e.g. spring bedding planting or school holidays and leisure (paddling pool) use.

In addition to annual weather conditions overall demand is also influenced by long-term trends in water consumption (as can be seen by the differences in baseline demand in the years shown in Figure 2-2), relating to increased water efficiency, metering and long-term reductions in leakage.

[2] Tynemarch (2012), Wessex Water Tariff Trial Project Household Consumption Analysis (final report).

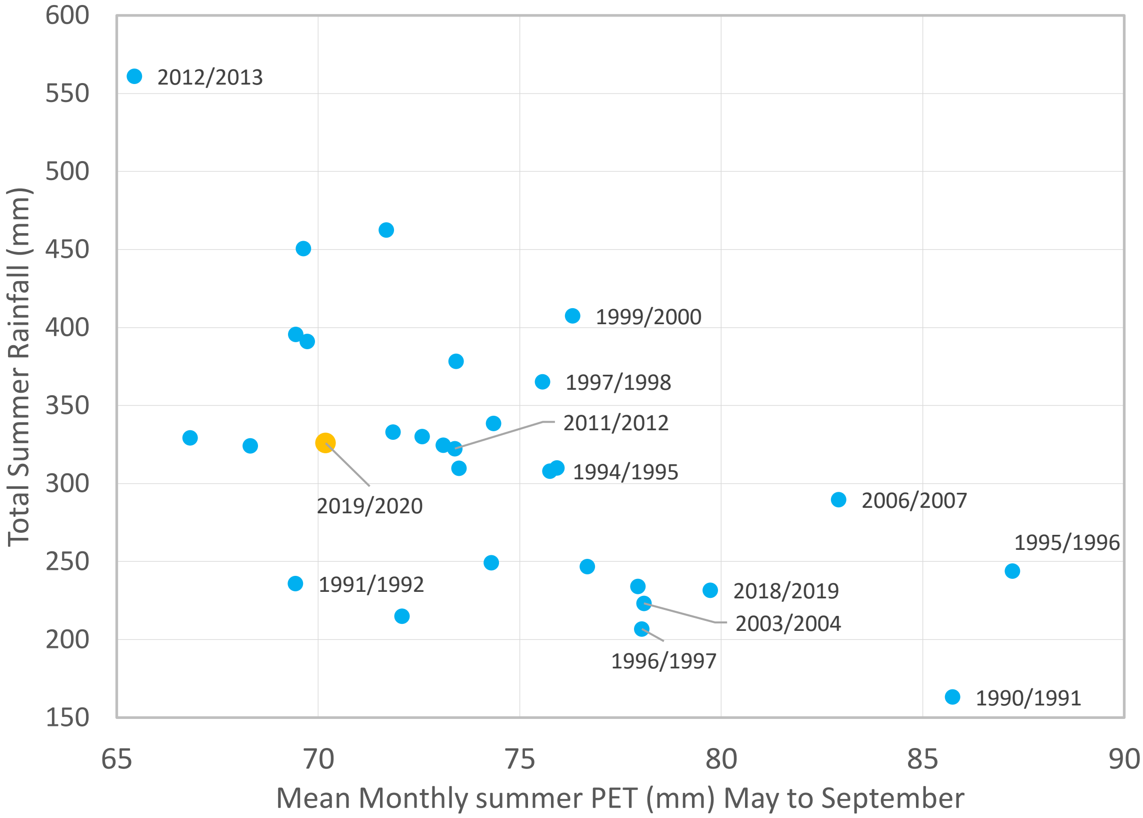
To calculate demand for our DYAA and DYCP planning scenarios, we evaluate how demand changes historically over time, and particularly during dry years in the historical record, which do not happen too often. It is necessary to isolate the effect of long-term trends from annual variability in weather conditions, to understand what demand would be today (reflecting current usage and leakage), under a low-rainfall year, and during a critical dry period.

To achieve this, we first normalise base-year demand to remove the influence of the weather that occurred during that year to derive the normal year annual average (NYAA) demand – e.g. the demand that would have occurred that year if there had been average weather conditions. Second, we uplift the normalised demand using **peak factors** to derive demand under dry weather conditions for the DYAA and DYCP planning scenarios.

3.1 Base year weather 2019/20

Figure 3-2 shows variability in summer weather across the past 30 years, with notable years highlighted, including the dry and hot summers of 1995/96, 1990/91 and 2018/19, and the wet summer of 2012/13. The base year 2019/20 had an average amount of total summer rainfall, but had lower amount of Potential Evapotranspiration (PET), as driven by solar energy and temperature. On that basis, it would be expected that demand in the base-year would be close to average, and perhaps slightly lower than average.

Figure 3-2 Variability in mean monthly Potential Evapotranspiration (PET) and total summer rainfall from 1990/91 to 2019/20, with the base year highlighted in yellow.



3.2 Overall Methodology

Of the water balance components, the demand components that we apply peak factors to are:

- Measured household consumption
- Unmeasured household consumption
- Measured non-household consumption
- Unmeasured non-household consumption

We do not apply normalisation or peak factors to minor water balance components such as run to waste and treatment works operational use, nor to leakage as they are not considered to be influenced by peak demands.

To separate out the influence of the weather and derive our normalisation and peak factors, ideally we need consistent long-term records of measured (unmeasured) household (non-household) consumption to capture both long-term trends on consumption as well as the influence of weather in each year, in particular capturing dry years and peak summer periods. We have a long-term record of our overall water into supply as shown in Figure 2-1, which shows inter-annual variability and peaks, notably in the dry years of 1995/96, and 2018/19. At a water balance component level, we have monthly billing data for measured customers, which is used to derive the annual reported consumption figures, as well as higher resolution sub-daily data from our Small Area Monitor (SAM)[3] for measured and unmeasured per household consumption and from the Consumption Monitor[4] for unmeasured household consumption.

Whilst the water into supply data provides a long-term consistent record, it does not do so at a water balance component level. On the other hand, whilst the SAM data and Consumption Monitor data provide higher resolution data at a water balance component level, these records are typically short, covering the last 3 or 4 years (as technology has evolved), so are not long-term to capture inter-annual variation in demand in response to hotter and drier weather.

To overcome the strengths and weaknesses of the different data sources available, base year normalisation and peak factors have been derived using a top-down bottom-up reconciliation approach. The approach is applied as follows:

1. For each bottom-up water balance component, calculate the normalisation factor and annual average and critical period peak factor for the base-year from available data.
2. Make an additional adjustment for the inclusion of Covid-19 impacts on demand from March 2020.
3. Calculate the top-down normalisation and peak-factors for distribution input data.

[3] The Small Area Monitor consists of 74 discrete representative areas of the Wessex Water supply system, containing ~13,000 properties. The monitor measures domestic water use during day and night to calculate legitimate HH night use allowances, and inform the Per Household Consumption (PHC) monitor.

[4] The Consumption Monitor consists of a sample of ~1000 unmeasured household properties with smart meters which is weighted by Acorn category and used to calculate unmeasured household consumption in the water balance.

4. Combine the bottom-up and top-down factors and adjust according to data quality to derive overall factors.
5. Include any uncertainty in the headroom assessment.

3.3 Data processing and factor estimation for water balance components

To calculate base year normalisation and peak factors, we have collated past analysis of peak factors undertaken primarily from Wessex Water's tariff trial project, which ran from 2008-2011[5]. Given more recent hot and dry weather, most notably in the summer of 2018, we have combined our previous peak factors with more recent analysis of different datasets.

3.3.1 Distribution Input

The long-term daily DI record from 1990/1991 until present day was used to calculate top-down normalisation and peak factors. To calculate the top-down normalisation and peak factors, the following approach was applied:

- The daily DI data (Figure 2-1) was normalised by fitting a loess function[6] to days in the winter months (excluding the Christmas period). The model was fitted to winter days on the assumption that demand during these months is not influenced by the weather, and therefore the fitted function captures long term trend changes in demand (Figure 3-3).
- The trend was removed using a multiplicative approach by dividing the daily demand profile by the fitted loess function.
- The normalised profile was then uplifted to the base year of 2019/20 by multiplying the normalised profile by the base year demand (Figure 3-4).
- From the resultant normalised time-series, peak factors were then obtained for annual average, peak week and peak month by dividing the normalised variables in each year by the normal year annual average demand – the mean of the annual averages in each year.

[5] Tynemarch (June 2012). Wessex Water Tariff Trial Project – dry year peak factors methodology (Final Report).
Tynemarch (October 2013). Dry Year household peak factors update.

[6] A locally fitted trend line

Figure 3-3 Distribution Input record and loess model fitted to winter values to remove long-term trend

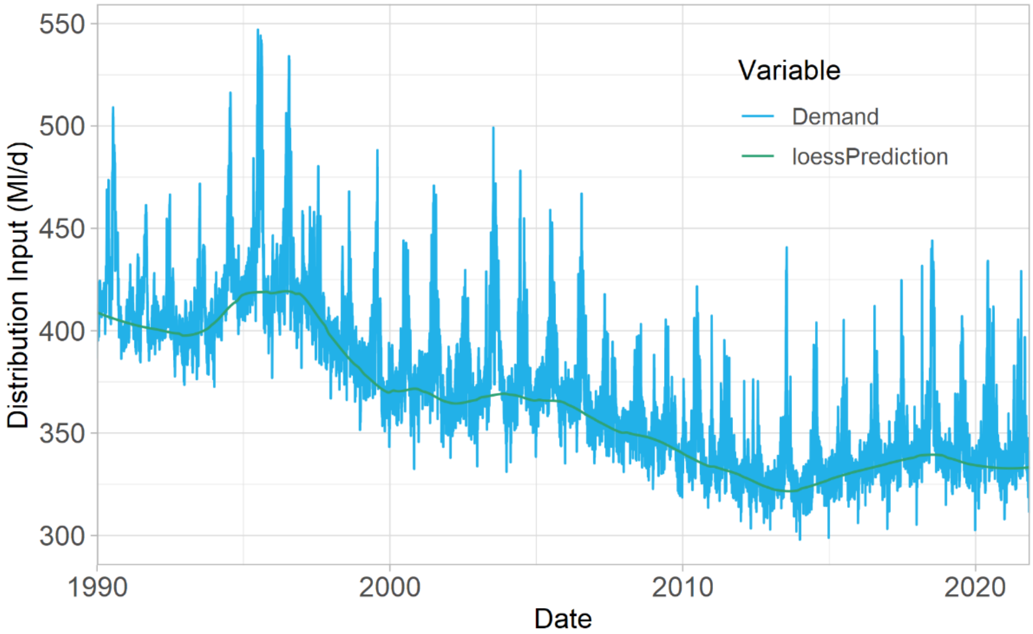
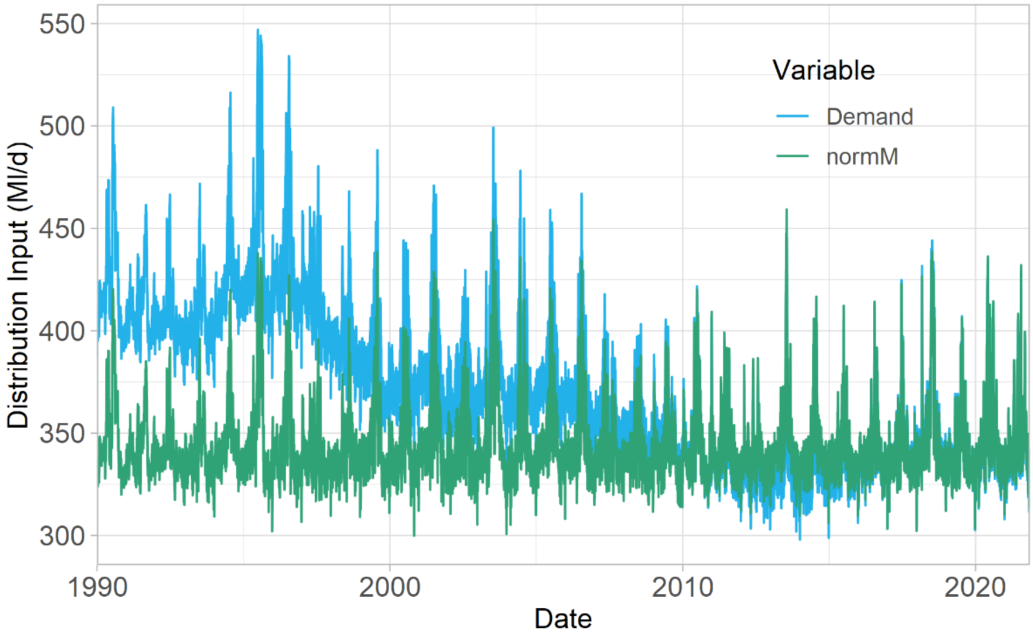


Figure 3-4 Distribution Input and normalised Distribution Input for the base year 2019/20



The ratio between the mean of the annual average DIs across the normalised DI record – e.g. the demand in 2019/20 if we had a normal weather year – and the actual Distribution Input for 2019/20 is 1.008. This result is consistent with the weather data in that the weather for 2019/20 was close to normal and slightly cooler (Figure 3-2), such that a small uplift to derive normal year annual average demand is reasonable.

The long-term record of daily data, which covers several key dry years over the 30-year record, allows us to explore the peak factors from normal year to dry year annual average and critical period. Figure 3-5 shows the inter-annual variability in peak factors for annual average, peak week and peak month, with peak factors for key dry years shown in Table 3-1.

Key dry years were 1995/96, 1990/91, 2003/04, 2013/14 and 2018/19. 2013/14 experienced the record peak week at 1.30 and associated high demand month in an otherwise average year. The annual average peak factors for other dry years vary between 1.017 and 1.21. Peak week factors for other dry years range between 1.21 and 1.24. Whilst peak week demands are seen more regularly in the historical record, only 1995/96 and 2018/19 had notable peak months, with peak factors of 1.21 and 1.20 respectively. For these years, the maximum monthly PET was similar and notably higher than the rest of the historical record (Figure 3-6). This demand pattern is shown in Figure 2-2, with a high demand month in August 1995.

Figure 3-5 Inter-annual variation in normalised distribution input peak factors

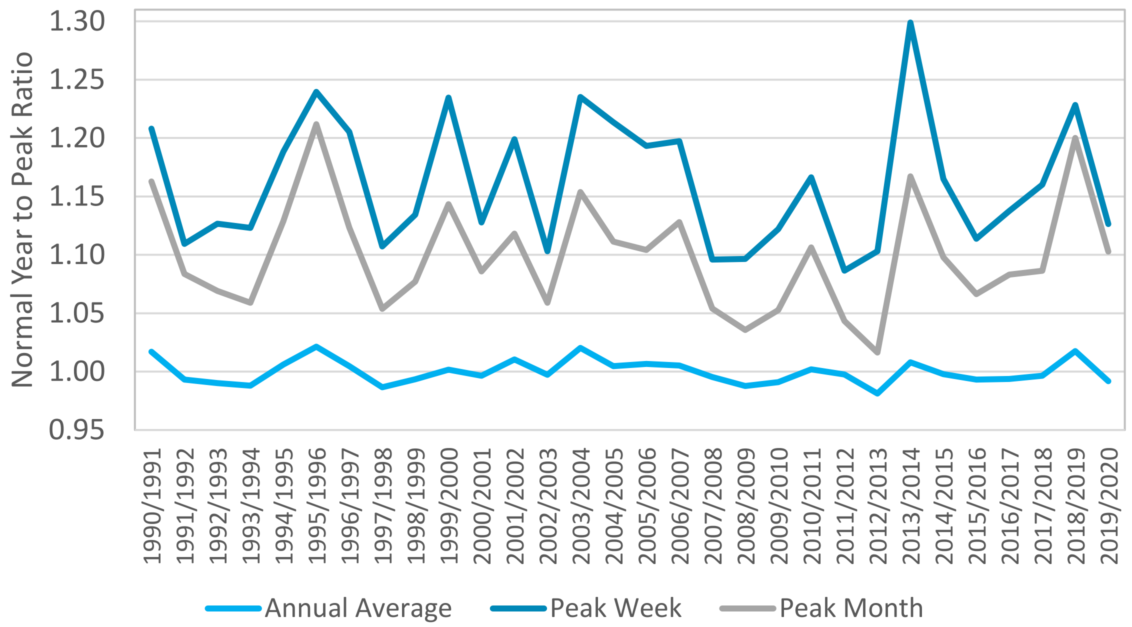


Figure 3-6 Variation in inter-annual Potential Evapotranspiration (PET) for the maximum month in each year and the average of summer months (June, July and August)

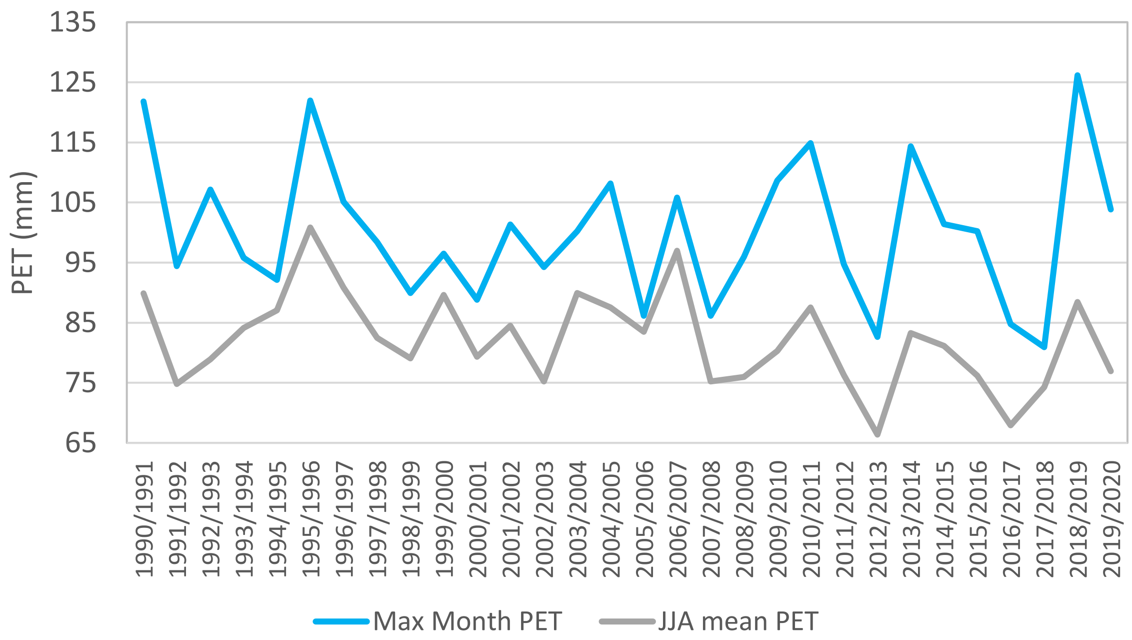


Table 3-1 Distribution Input peak factors derived from different key dry years

Year	NYAA to DYAA	NYAA to Peak Month	NYAA to Peak Week
1990/91	1.017	1.16	1.21
1995/96	1.021	1.21	1.24
2003/04	1.020	1.15	1.24
2013/14	1.008	1.17	1.30
2018/19	1.018	1.20	1.23

3.3.2 Household demand

Peak factors for measured and un-measured household demand have been derived from two main sources.

1. Analysis undertaken by Tynemarch in 2012 and 2013, based partly on the data collected for Wessex Water's tariff trial project[5].
2. 2022 analysis undertaken by Ovarro on annual out-turn data, consumption monitor and small area monitor data, covering the dry, hot summer of 2018/19[7].

The Tynemarch work in 2012/2013, in summary, derived peak factors for dry year annual average, using linear regression models that were constructed for measured and unmeasured PHC against a range of factors including weather variables, meter penetration and non-household demand from the mid 90's to 2006/07. To derive peak week factors, analysis of 1995/96 demand was undertaken, alongside analysis of July 2013, including the development of weather-demand models.

In summary, the 2022 analysis undertaken by Ovarro to derive peak factors:

- Developed trend-based models of the relationship between measured/unmeasured out-turn PHC to calculate base-year normalisation for 2019/20 and normal year to dry year annual average peak factors. Following changes to leakage reporting, water balance components have changed, and been updated for 2017/18. As a result, this means a break in the continuity of the long-term record for comparing inter-annual demand. Therefore, peak factors were derived by fitting models to the pre-leakage consistency reporting water balance components and taking the uplift from normal to dry year as the difference between the trend model and 2018/19 demand. The resulting peak factors are then applied to the post-leakage water balance components, which form the basis of dWRMP24 forecasting.
- Critical month and critical week peak factors were derived through analysis of Small Area Monitor (SAM) data[3], which looked at the ratio between peak week (and month) and annual average for 2018/19 to derive a peak week/peak year ratio. This is then combined with a peak year to normal year ratio to derive the normal year to peak week (month) factors.

Base year normalisation factors were only derived from the 2022 analysis for the base-year of 2019/20 and based on the trend model fitted to pre-leakage consistency out-turn data were 1.004 and 1.011 for measured and unmeasured PHC, respectively. These factors imply that actual consumption for 2019/20 is slightly lower but close to what would be

[7]Ovarro. Household demand forecast 2021-22. March 2022.

observed under an average or “normal” weather year for the base-year, which is consistent with the weather data (Figure 3-2).

Peak factors to uplift normal year demand from different data sources are shown in Table 3-2. The peak week factors between the different studies are very close for measured PHC and within a few percent for the unmeasured PHC, comparing a 48% uplift with a 50% uplift. Whilst the peak month factors are only available for the more recent 2022 analysis, they are as expected slightly lower than the peak week factors. The peak year factors for the more recent 2022 analysis are significantly lower than those derived from the 2012/13 work, implying there is a very small uplift for annual average demand.

Table 3-2 Summary of household peak factors for measured and unmeasured household consumption derived from different sources

Data	Component	NYAA to DYAA	NYAA to Peak Month	NYAA to Peak Week
2012/2013	Unmeasured PHC	1.065	NA	1.481
2022		1.028	1.468	1.506
2012/13	Measured PHC	1.041	NA	1.196
2022		1.008	1.173	1.193

3.3.3 Non-household demand

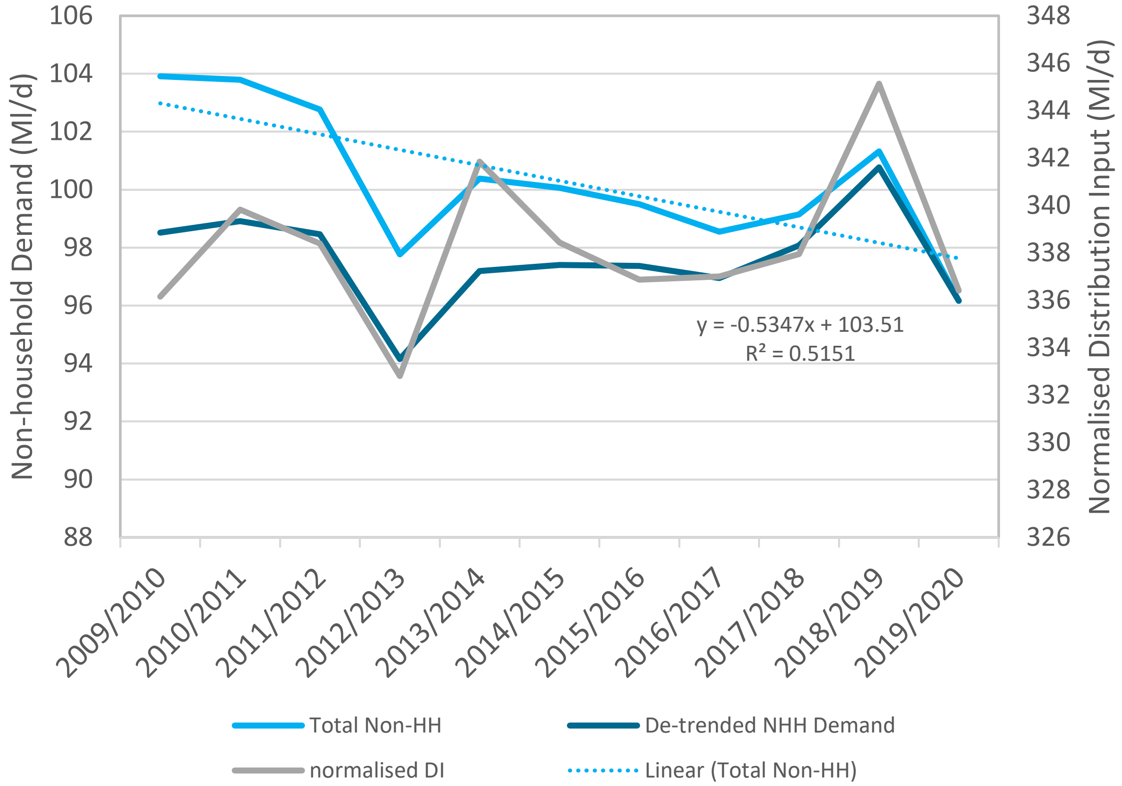
Non-household peak factors were produced for Wessex Water based on analysis undertaken by Tynemarch[5]. To derive a NYAA to DYAA peak factor, a trend-based model was fitted to historical annual non-household demand from 1995 to 2010, and concluded that a peak factor of 1.04 was appropriate.

To derive NYAA to DYCP peak factors, analysis was undertaken of monthly billed data from 2003 to 2010 (as weekly data was not available) and from 6-monthly billing data. Non-household water consumption has different levels of uplift depending on billing frequency; non-household customers that receive their bill on a monthly rather than 6-monthly basis exhibit flatter (lower) peak demands. This can be explained by the fact that non-households that are billed monthly tend not to include the type of businesses that have particularly seasonal demands such as farms and golf courses. Peak factors for measured non-households that are billed monthly were 1.161 for NYAA to peak month and 1.208 for NYAA to peak week, and for 6-monthly billing, uplifts were 1.217 and 1.345 for peak month and peak week, respectively.

Building on this previous work, we have re-analysed total annual non-household demand from annual return data to derive a normalisation factor for the base year and a dry year annual average peak factor. A linear model was fitted to the annual total non-household demand from 2009/10 to 2019/20 and used to remove the long-term trend (Figure 3-7)[8].

[8] Data prior to 2009/10 was excluded as large step changes in non-household demand meant it was difficult to fit a reliable trend model to normalise the data.

Figure 3-7 Outturn and normalised non-household demand plotted alongside the normalising trend model and for reference normalised distribution input



The normalised trend shows good consistency with the top-down normalised distribution input, with both datasets showing reduced demand in 2012/13 during the wet and cool summer, and high demands during the record hot summer of 2018/19 (see Figure 3-2). De-trended non-household demand has a strong positive linear relationship with mean monthly summer PET (R^2 = 0.78) and a strong negative relationship with total summer rainfall (R^2 = 0.54).

Demand for 2019/20 is lower than predicted from the trend model, with a normalisation uplift factor of 1.015 to convert demand from the base year annual average to a normal year annual average baseline demand. This is consistent with the weather for 2019/20. From this analysis we have also derived a NYAA to DYAA peak factor based on the record hot, dry summer that occurred in 2018/19 which is 1.032. Table 3-3 summarises the non-household peak factor analysis from different data sources; the more recent analysis produces a peak factor derived from 2018/19 summer period as lower than previous analysis, however the previous analysis did not include any particularly large summer peak periods and is based largely on reported years of maximum peak in 2003 and 2004 over a period of non-household demand with a strong downward trend.

Table 3-3 Summary of non-household peak factors

Data	Component	NYAA to DYAA	NYAA to Peak Month	NYAA to Peak Week
2011 analysis	Monthly Billed	1.040	1.161	1.208
2011 analysis	6-Monthly Billed	1.040	1.217	1.345
2021 analysis	Total Non-HH	1.032	NA	NA

3.4 Base Year Normalisation impacts due to covid impact

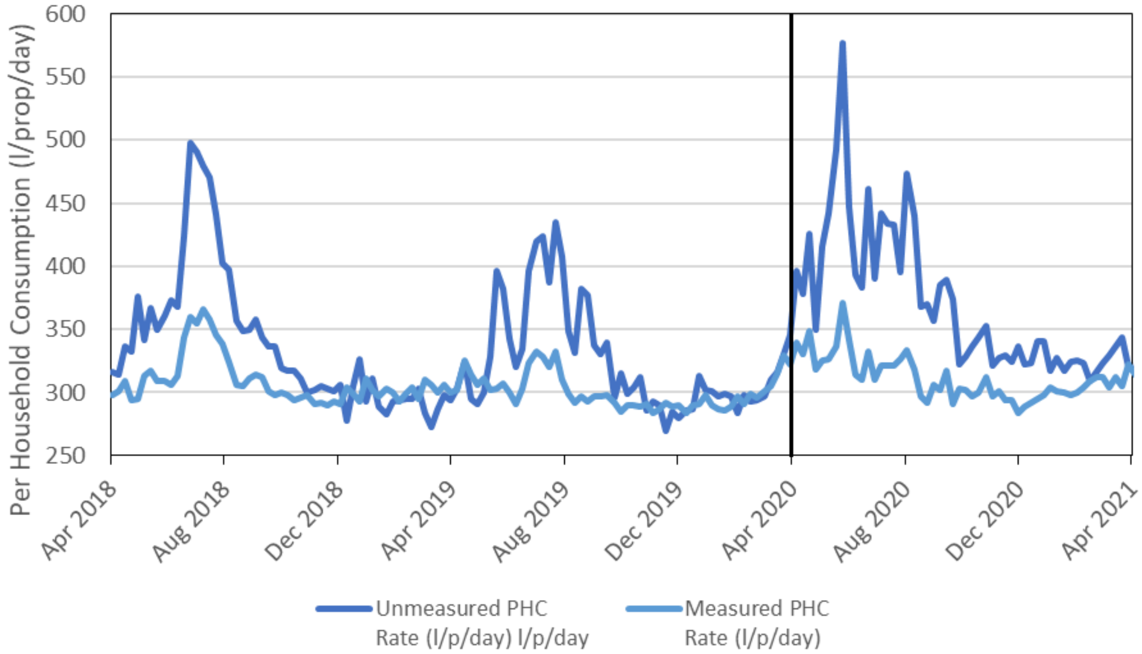
The base year for the water balance was chosen as 2019/20 to avoid the main impact of the Covid-19 pandemic on water balance components. However, the early onset of the pandemic started in February 2020, with initial measures taken by government in February into early March, with initial business closures from mid-March, and the first lock-down starting from 23/03/2020. Overall the impact of covid led to a +2.18% change in DI from January 2020 to October 2020[9].

In addition to the baseline normalisation due to the impact of the weather on the base-year, an additional adjustment has been made to water balance components in March due to the impact of the pandemic.

3.4.1 Household Demand

We reviewed Per Household Consumption (PHC) demand changes from the Small Area Monitor data, which show the increase in PHC associated with the pandemic (as compared to high demand peaks in the hot summer of 2018; Figure 3-8). The increase in household demand started in March 2020 at the end of the 2019/20 base year.

Figure 3-8 Per Household Consumption Variation from the Small Area Monitor Data for 2018/19 to 2020/21



To normalise for this influence on base-year demand, we assumed the rising trend in demand over this period was because of the pandemic and calculated the additional demand as all demand above 300 l/prop/day for both measured and unmeasured PHC. This additional demand was summed and divided by the total demand for 2019/20, to give a

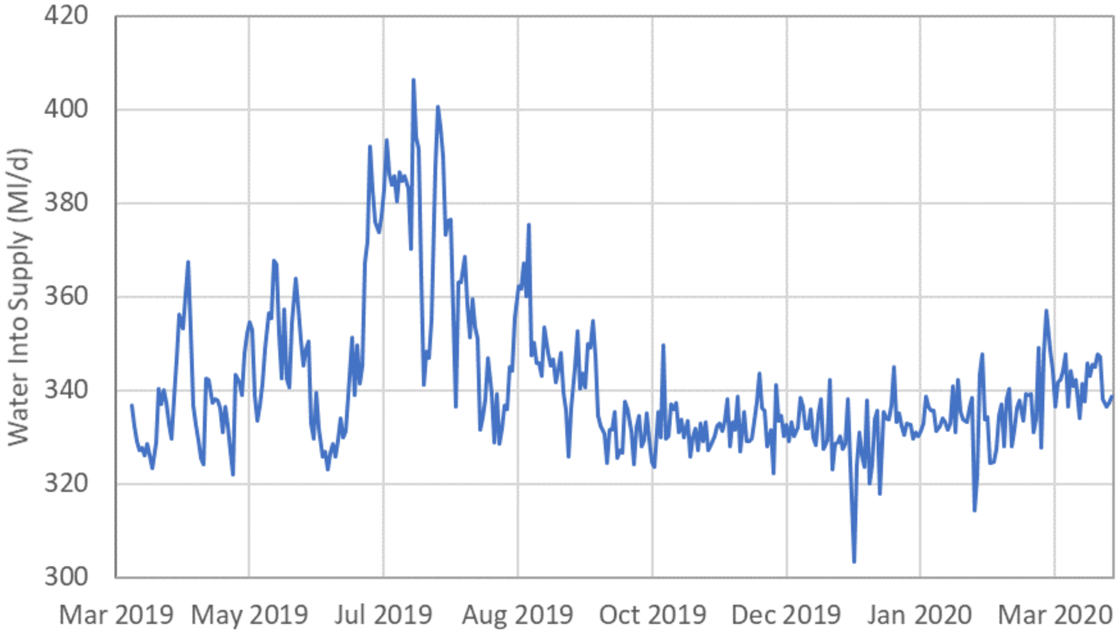
[9] Artesia (2021) The impact of Covid-19 on water consumption during February to October 2020 – Final Report.

normalisation reduction in PHC of -0.36% for measured household consumption and -0.50 for unmeasured household consumption.

3.4.2 Distribution Input

Distribution Input also increased over March 2020, consistent with the increase in household demand (Figure 3-9). The same approach as applied to household demand was also applied to remove the impact of the pandemic on distribution input; a base demand of 332Ml/d was assumed and all additional demand above this for March 2020 was calculated and used to calculate a -0.24% reduction in baseline demand.

Figure 3-9 Water Into Supply Variation over the 2019/20 base year



3.4.3 Non-Household Demand

Whereas household demand increased during the pandemic period (Figure 3-8), non-household demand reduced considerably during March 2020, as business closed (Figure 3-10). To adjust for the impact of the pandemic the same approach was applied as with household demand and non-household demand, using a baseline demand 29,700 m^3/d, resulting in a baseline demand change in non-household demand of +0.23%.

Figure 3-10 Variation in Logged Non-Household Demand during the base year 2019/20

3.5 Overall Base Year Normalisation

Combining the different factors for adjusting the base year demand, the overall reconciliation adjustment to go from base-year data, post-MLE leakage adjustment, to NYAA base year demand for 2019/20 is summarised in Table 3-4. First an ajustment is made to go from base year data for each component to NYAA, based on the values derived above. As described, the adjustment factors for all Consumption components are all small and possitive, consistent with the base year being slightly wetter/colder than average (Figure 3-2).

Table 3-4 Base Year Normalisation of Water Balance Components*

Base Year Data 2019/20		Base year to NYAA		Covid Adjustment to NYAA		Reconciliation Adjustment	
Water Balance Component	Post-MLE data (Ml/d)	Base to NYAA Factor (-)	NYAA (Ml/d)	Covid Adjustment (%)	NYAA (Ml/d)	Adjustment (Ml/d)	NYAA (Ml/d)
Meas. Non-HH Con.	75.03	1.015	76.17	0.23%	76.35	0.008	76.35
Umeas. Non-HH Con.	4.10	1.015	4.16	0.23%	4.17	0.000	4.17
Meas. HH Con.	101.17	1.004	101.57	-0.36%	101.21	0.010	101.22
Unmeas. HH Con.	80.00	1.011	80.88	-0.50%	80.48	0.008	80.49
Water Taken Unbilled	4.38	NA	4.38	NA	4.38	NA	4.38
DSOU	3.11	NA	3.11	NA	3.11	NA	3.11
Total Leakage	67.89	NA	67.89	NA	67.89	NA	67.89
DI (bottom-up)	335.68	NA	338.171	NA	337.58	NA	337.61
DI (top-down)	335.68	1.008	338.442	-0.24%	337.63	-0.020	337.61
Error (Ml/d)			-0.27		-0.05		0.00
Error (%)			-0.08%		- 0.01%		0.00%

*HH = Household; Con.= consumption; Meas. = Measured; Unmeas = Unmeasured; DSOU = Distribution System Operational Use; DI = Distribution Input.

The covid related adjustment to demand in March 2020 (Section 3.4) adjusts non-household demand possitively, and household demand and overall distribution input negatively. The resultant supply demand balance difference between the top-down adjustments to distribution input and bottom-up components is small, at 0.05 Ml/d, or 0.01%. As a result, small downward adjustments to DI and upwards adjustment to consumption water balance components are made to derive the overall NYAA distribution input of 337.61 Ml/d.

3.6 DYAA Peak Factor Calculation

The chosen peak factors for the base-year adjustment are shown in Table 3-5 for consumption components and distribution input. A peak factor for distribution input of 1.02 was chosen based on the spread in the data for key dry years (Table 3-1). For household and non-household consumption components, the peak factor values from the latest 2022 analysis were used for the initial adjustment. The result was a top-down distribution input estimate of 1.15 Ml/d or 0.33% higher than the bottom-up estimation. The household consumption factors were lower than those obtained from previous analysis, and so these bottom-up demand components were adjustment upwards to match the top-down distribution input.

Table 3-5 Peak Factor Adjustment from NYAA and DYAA*

Base Year Data 2019/20		NYAA to DYAA Adjustment		Reconciliation Adjustment	
Water Balance Component	NYAA (Ml/d)	NYAA to DYAA Factor (-)	DYAA (Ml/d)	Adjustment (Ml/d)	DYAA (Ml/d)
Meas. Non-HH Con.	76.35	1.032	78.80	0.000	78.80
Umeas. Non-HH Con.	4.17	1.032	4.31	0.000	4.31
Meas. HH Con.	101.22	1.008	102.01	0.632	102.65
Unmeas. HH Con.	80.49	1.028	82.73	0.513	83.25
Water Taken Unbilled	4.38	NA	4.38	NA	4.38
DSOU	3.11	NA	3.11	NA	3.11
Total Leakage	67.89	NA	67.89	NA	67.89
DI (bottom-up)	337.61	NA	343.24	NA	344.38
DI (top-down)	337.61	1.02	344.38	0.000	344.38
Error (Ml/d)			-1.15		0.00
Error (%)			-0.33%		0.00%

*HH = Household; Con.= consumption; Meas. = Measured; Unmeas = Unmeasured; DSOU = Distribution System Operational Use; DI = Distribution Input.

3.7 DYCP Peak Month Factor Calculation

The chosen peak factors for the base-year adjustment are shown in Table 3-6 for consumption components and DI. A peak factor for DI of 1.21 was chosen based on the spread in the data for key dry years, with particular emphasis on the fact that only 1995 and 2018 had significant peak months that we would expect under a 1 in 500 drought (Table 3-1). For non-household consumption components, the peak factor values from the 2011 analysis were chosen, and a weighted average of monthly and 6 monthly billed valued used for the measured non-HH consumption peak factor, and the 6-monthly billed value used for the unmeasured non-HH consumption. For household demand the latest calculated peak factors derived from 2018 analysis were used. The result was a bottom-up distribution input estimate of 0.63 Ml/d or 0.15% higher than the top-down estimation. An equal increase in distribution input, and bottom-up adjustment was made to derive the overall dry year critical month demand of 407.81 Ml/d.

Table 3-6 Peak Factor Adjustment From NYAA to DYCP*

Base Year Data 2019/20		NYAA to DYCP Adjustment		Reconcilliation Adjustment	
Water Balance Component	NYAA (Ml/d)	NYAA to DYAA Factor (-)	DYCP	Adjustment (Ml/d)	DYCP (Ml/d)
Meas. Non-HH Con.	78.80	1.189	90.78	-0.086	90.70
Umeas. Non-HH Con.	4.31	1.217	5.08	-0.005	5.07
Meas. HH Con.	102.01	1.173	118.73	-0.113	118.61
Unmeas. HH Con.	82.73	1.468	118.16	-0.112	118.04
Water Taken Unbilled	4.38	NA	4.38	NA	4.38
DSOU	3.11	NA	3.11	NA	3.11
Total Leakage	67.89	NA	67.89	NA	67.89
DI (bottom-up)	343.24	NA	408.12	NA	407.81
DI (top-down)	344.38	1.21	407.50	0.315	407.81
Error (Ml/d)			0.63		-0.01
Error (%)			0.15%		0.00%

*HH = Household; Con.= consumption; Meas. = Measured; Unmeas = Unmeasured; DSOU = Distribution System Operational Use; DI = Distribution Input.

3.8 Final Peak Factors

Based on the reconciliation process set out in the above sections, the final overall peak factors to go from baseline to normal year, and from NYAA to DYAA and DYCP, are shown in Table 3-7.

Table 3-7 Final normalisation and peak factors for water balance components

Water Balance Component	Base Year to NYAA	NYAA to DYAA	NYAA to DYCP
Measured Non-Household Consumption	1.018	1.032	1.188
Unmeasured Non-Household Consumption	1.018	1.032	1.216
Measured Household Consumption	1.000	1.014	1.172
Unmeasured Household Consumption	1.006	1.034	1.467
Distribution Input	1.006	1.020	1.208

3.9 Base Year Demand Uncertainty

Demand estimation under a severe drought is uncertain, given that demands under such droughts have not been observed recently under current baseline conditions. The process followed above, making the most of the top-down and bottom-up datasets available and their relative strengths and weaknesses helps to reduce this uncertainty.

To represent remaining residual uncertainties, a component of demand uncertainty associated with DYAA and DYCP scenarios is included in the headroom analysis. Demand uncertainty has been represented with triangular distributions. To inform the shape of these distributions, the distribution of peak demands for annual average and critical period were reviewed for key dry years of 1990/91, 1995/96, 2003/04, 2013/14 and 2018/19. We also generated some worse peak values by substituting in alternative peak months/weeks into otherwise dry years to generate some worst-case scenarios (e.g. assuming the peak month of 1995/96, a single season drought, occurred in 1990/91, a predominantly dry winter but with no peak summer demand; or that the peak week of 2013/14 occurred in the peak month of 2018/19). The resultant distributions for demand uncertainty are shown in Table 3-8. The variance in annual average demand for key dry years is low, with higher variance for the critical period scenario. The upper bound for the critical period scenario is based on assuming the peak week for 2013 occurred in the peak month of summer of 2018.

Table 3-8 Distributions of uncertainty in baseline demand included in headroom assessment.

Component	Base Year Value (Ml/d)	Lower Bound (Ml/d)	Mode (Ml/d)	Upper Bound (Ml/d)
DYAA	344.38	-0.21	0.50	1.41
DYCP	407.81	0	8.03	12.36

3.10 Comparison of Peak Factors with 2022 Summer

As of September 2022 (after the production of the peak factors for this plan) this year has been the UK's warmest on record, with the mean summer temperature equalling that of 2018, and the driest year since 1976[10]. The Environment Agency declared a drought status for much of the UK, but this did not extend to the Wessex region until 30 August 2022[11]. From the 8th-14th August, we saw a peak week distribution input of 413.4 Ml/d and the peak day demand reaching 422.9 Ml/d on 11th August 2022, and a peak month from mid-July to mid-August of 392.5Ml/d. These values compare to our peak month forecast in the WRMP (DYCP) for 2022-23 of 401.96Ml/d.

[10] Joint hottest summer on record for England - Met Office
[11] All of England's South West region now in drought - GOV.UK (www.gov.uk)

4. Properties, Population and Occupancy Forecast

We have developed forecasts of the growth in properties, population, and occupancy following section 6.3 of the Water Resources Planning Guideline (2021)[12] and the UKWIR supporting guidance[13].

In overview, we have based our household property and population forecasts on local plans published by local councils and unitary authorities that overlap with our supply area, and also applied trend-based forecasts derived from the Office for National Statistics (ONS) to compare against local authority (LA) derived trajectories. We have also used these trend-based forecasts to extend our forecasts beyond the period covered by local plans - which typically finish only 12 years into the planning period - up to the 2080 planning horizon.

Based on the uncertainty range of ONS forecasts, LA trajectories and uncertainty bounds produced following supporting UKWIR guidance, low, central and high household population and property forecasts have been produced to account for future uncertainty, and feed into the decision-making process.

4.1 Data Sources

We have collated data to inform the properties and population forecasts from four primary sources:

1. Local Authority Data
2. Internal system and billing data on base-year properties information
3. Office for National Statistics
4. UKWIR guidance

4.1.1 Local Authority Data

Our water supply system is currently covered by 12 Local Authorities (Table 4-1). Since 2019 three new Local Authorities have been formed, amalgamating some of the previous 17 Local Authorities covering the supply area:

- Dorset – merging East Dorset, North Dorset, West Dorset, Purbeck and Weymouth and Portland;
- Bournemouth, Christchurch and Poole - merging Bournemouth, Christchurch and Poole
- Somerset West and Taunton – merging Taunton Deane and West Somerset

Of the current, post-2019 LA areas, Wiltshire is the largest LA containing ~30% of supply households in the Wessex Water area, followed by the recently amalgamated Dorset LA with ~23%. 5 of the 12 LAs are on the fringes of our supply area, collectively contain fewer than 200 household properties combined.

Not all new Local Authorities have adopted and developed new plans, and some of the latest ONS trend-based forecasts are based on the pre-2019 LA areas. The local plans for each

[12] Environment Agency (2021) Water Resources Planning Guideline, Version 9: For publishing
[13] UKWIR (2016) Population, Household Property and Occupancy Forecasting (15/WR/02/8)

authority cover the first part of our planning period, but the end date of these plans varies from 2025/26 up to 2032/33, leaving between 13 and 19 years to be forecast by alternative, trend-based methods.

Local Authority data on planned housing development is obtained internally at Wessex Water as part of the Developer Services team, and mapped in our internal Geographical Information System (GIS) system. This information provides detail on the specific locations of, in particular, near-term planned developments, and the status of those developments from the initial planning applications, and is more detailed than obtained by a proportional allocation of the total LA housing trajectory, allowing us to better understand specific hotspots of planned and potential growth.

To supplement the information obtained on individual developments, housing requirements for each LA were obtained through review of local plans and core strategies. Housing completion rates to-date, alongside revised housing trajectories, were obtained from LA websites and updates/reviews of housing completions against plan requirements, which are required annually by The National Planning Policy Framework[14].

In August 2021, we also wrote to each LA to request the latest updates to their housing trajectories, and information on potential revisions to their local plan to support the development of our property forecast. The letter sent to each LA, including the information requested, can be found in Annex A. Of the 12 LAs covering our supply area we received responses from 8 LAs covering ~91% of supply area households: Dorset, Somerset West and Taunton, Test Valley, Mendip, Bath and North East Somerset, South Somerset, Wiltshire and Sedgemoor.

Table 4-1: Local authority (LA) within our supply region and the latest LA Plan

Local Authority/Council (pre 2019)	Post 2019 Local Authority	Plan status (August 2017)	Plan period	% of supply households
Bath & North East Somerset Council	Bath & North East Somerset Council	Adopted 2014	2011 - 2029	7.8%
East Dorset District Council	Dorset	Adopted 2014	2013 - 2028	0.9%
Mendip District Council	Mendip District Council	Adopted 2014	2006 - 2029	<0.1%
New Forest District Council	New Forest District Council	Adopted 2010	2006 – 2026	<0.1%
North Devon District Council	North Devon District Council	Adopted 2019	-	<0.1%
North Dorset District Council	Dorset	Adopted 2016	2011 – 2031	5.1%
Poole, Borough Of	Bournemouth, Christchurch and Poole Council.	Adopted 2018	2013 – 2033	9%
Purbeck District Council	Purbeck District Council	Adopted 2012	2006/07 – 2026/27	3.7%
Sedgemoor District Council	Sedgemoor District Council	Adopted 2019	2011 – 2032	5.8%

[14] DCLG (2012) National Planning Policy Framework

South Somerset District Council	South Somerset District Council	Adopted 2015	2006 – 2028	12.7%
Taunton Deane Borough Council	Somerset West and Taunton	Adopted 2012	2009 – 2028	8.7%
Test Valley Borough Council	Test Valley Borough Council	Adopted 2016	2011 – 2029	<0.1%
West Dorset District Council	Dorset	Adopted 2015	2011 – 2031	7.7%
West Somerset District Council	Somerset West and Taunton	Adopted 2016	2013 – 2033	2.8%
Weymouth and Portland Borough Council	Weymouth and Portland Borough Council	Adopted 2015	2011 – 2031	5.4%
Wiltshire Council	Wiltshire Council	Adopted 2015	2006 – 2026	30.3%

4.1.2 Internal System and Billing Data

To understand base-year properties in the supply area, and inform the percentage allocation of property forecasts at the LA geography to the Wessex Water supply area, we obtained information from our internal billing system on the number of household and non-household properties in each LA area. We also collated postal address point data from the GIS team by LA area. These data were obtained for both pre- and post- 2019 changes in LA areas.

4.1.3 Office for National Statistics Data

The latest forecasts of population and properties were obtained from the Office for National Statistics[15] (ONS) and used to inform the trend-based forecasts:

- 2018-based household (and household population) projections for local authorities and higher administrative areas (published June 2020)
- 2018-based sub-national population projections for local authorities and higher administrative areas (published March 2020)
- Mid-year population estimates for June 2020 (published June 2021).

The ONS, as updated in a press release on June 2021[16], determined not to publish 2020-based projections. The next set of projections will be 2021-based, and published in 2023.

For the population and household projections, data were obtained for the 5 projection scenarios available:

1. Principle projection – the main population projection produced by the ONS
2. High International Migration
3. Low International Migration
4. Alternative Internal Migration
5. 10-year migration variant

[15] Home - Office for National Statistics (ons.gov.uk) – last accessed 09/2021
[16] National population projections, subnational population projections and household projections for England – future plans - Office for National Statistics – last accessed 09/2021

4.2 UKWIR Guidance- Forecast Uncertainty

The EA WRMP guidance requires us to use the UKWIR (2015) WRMP19 Method – population, household property, and occupancy forecasting guidance manual (15/WR/02/8) in producing our forecast. In the guidance, look-up tables for percentage forecast uncertainty at different percentiles is provided to account for the inherent uncertainties in assumptions about future fertility, mortality and migration rates in cohort-component models used to derive the trend-based ONS forecasts. These uncertainty bounds are based on a post-hoc assessment of the accuracy of projections.

4.3 Base year Properties, Population and Occupancy

Base year population and property data determines household and non-household occupancy, which in turn impacts upon overall demand. These figures are produced for both measured and unmeasured households/non-households separately as it is on the basis of this demand disaggregation that our demand forecast is structured. Table 4-2 summarises the base year population and property data for each demand disaggregation[17].

Table 4-2 Base-year properties and population supplied (as per water 2020/21)

Property type	Properties	Population	Occupancy
Measured households	392,636	824,257	2.10
Unmeasured households	174,545	492,223	2.82
Total households billed water	567,181	1,316,480	2.32
Measured non-households	40,991	22,263	0.54
Unmeasured non-households	3,149	18,184	5.77
Total non-households billed water	44,140	40,447	0.92
Void properties	14,120	NA	

4.3.1 Base-year Properties

Our base year property figures for 2020/21 are derived from our billing system property records.

Void properties are properties that are connected to our supply system but are not charged for water services as they are not occupied. The number of void properties is derived from our billing records following a standard reconciliation process. The total number of void properties varies slightly from year to year; the average for the period 2007/08 to 2017/18 was 14,211, which is comparable to the total outturn data for 2020/21 (14,120) – it is reasonable therefore to keep the number of voids constant throughout the planning period. A small number of ‘properties’ chargeable only for fixed standpipe, trough or sprinkler charges are excluded from the billed property numbers on the basis that they are not premises receiving water for domestic purposes.

[17] Note: whilst water balance components are forecast from 2019/20, the year used for forecasting prior to the main impact of covid, out-turn property and population figures for 2019/20 and 2020/21 are used, which means for properties and population, 2020/21 is the effective “base-year”.

4.3.2 *Base-year Population*

Our total resident connected population (includes households and non households) in 2020/21 is 1,368,197 people. This was calculated as follows:

- The starting point for the 2020/21 data is the Office of National Statistics' (ONS) mid-year population estimate, which is the most recent Local Authority level data, typically published in June of each year, but 1 year behind.
- The Local Authority populations are apportioned according to the percentage of properties in Wessex Water's company area, based on GIS analysis.
- A downward adjustment is made for properties within our water supply area that are not connected to our supply system (i.e. private supplies), which represents 8,800 people. This is a long standing, consistent number.
- A downward adjustment is also made for inset appointments (properties in our company area that are served by another water undertaker). In the base year, the only inset appointment within our supply area is with Scottish & Southern at Old Sarum and Brewery Square (~2500 people).
- An upward adjustment was made to account for population growth in the 15-months since mid-2019 to the middle of reporting year.
- Finally, an upward adjustment of 15,882 people was made to account for clandestine and hidden populations within our region, following a study undertaken by Edge Analytics[18]. The study was commissioned to estimate the sub-populations within our region that are not captured as 'usual residents' by official ONS statistics, but nonetheless contribute to the water-using population (e.g. irregular migrants; short term residents; second address residents; visitors to friends and relatives).
- The split of measured and unmeasured population (household and non household) is then adjusted based on the number of meter optants, change of occupier, new connections (October to September of each reporting year) and population growth since the last update.

Our base-year population is then sub-divided, as shown in Table 4-2. Our population split has been informed through triangulation of several sources of information following a bespoke customer occupancy survey conducted in June 2017 (see box below).

2017 Household occupancy survey

From May to June 2017, we conducted an online household occupancy survey to understand how our total household population is divided between measured and unmeasured households. The survey was promoted to our customers through social media channels, and we received a total of 2,300 respondents. The survey was designed with specific questions to allow us to understand the representativeness of the respondents compared to our total population. Continual review of this information during the survey period helped us to target social media advertising to achieve as representative a sample as possible and allowed us to assess and account for bias when interpreting the results.

[18] Edge Analytics (2016) Wessex Water: Clandestine & Hidden Populations

The survey results were used alongside other sources of occupancy information we collect through billing, customer research and water efficiency work, was used to derive our base-year occupancy estimates.

4.4 Accounting for New Appointments and Variations (NAVs)

NAV sites are areas within our supply region that receive a bulk import of water from us, but from this point, the NAV company is responsible for providing water and/or sewage services to its customers in its geographic region. The water we export is therefore accounted for in the same way as a bulk export we provide to other water companies, but it is necessary to deduct the NAV properties and population forecast from our company forecasts.

Although development on most of these sites is yet to be completed and therefore the bulk supply has not commenced, demand volume has been calculated based on average household consumption and building rate projections, as outlined in Section 8 of the Supply forecast technical appendix. The number of properties is forecasted from the build rates provided to us by the NAV companies, adjusted and linearised where necessary to account for any delays in their progress reflected by actual September 2024 property numbers. The adjustments made are outlined for each company in Table 4-3. Population forecasts have been calculated using the properties projection and the company average occupancy figure.

Table 4-3: Adjustments made to NAV site build rate forecasts.

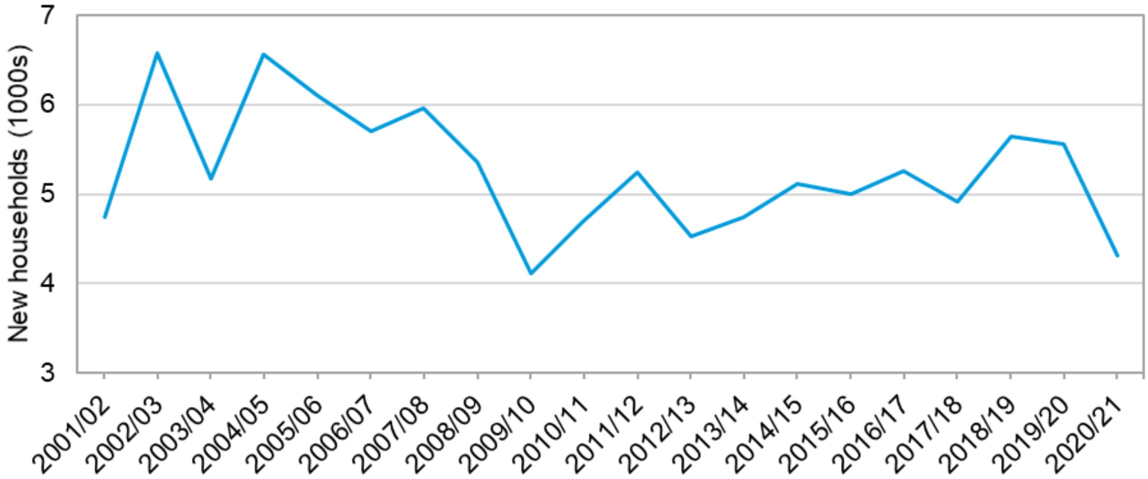
NAV company	Adjustments made to property build rates
Leep Sites	We have kept the build rate provided to us. This is already set at a linear rate which seems achievable.
Independent Water Networks Ltd (IWNL)	We have adjusted the 2022-23 and 2023-24 number of properties to reflect the actual number of properties connected as of September 2024 and either linearised the remaining properties left to build up to the site completion date or adjusted as per comments received from IWNL. In addition, to account for the period in between properties being built and the start of actual water consumption (connecting the property and customers moving in), all build rates have been moved on a year.
Icosa Water	Similarly to IWNL, the actual number as of September 2024 has been applied to 2022-23 and 2023-24 and then we have used the revised build out rate provided by Icosa Water which extends to 2040 due to a backlog in construction due to Covid and delays with planning permission.
ESP Water	We have kept the build rate provided to us by ESP Water as this seems achievable.

4.5 Household Properties Forecast

4.5.1 Observed property growth

House building rates are an important factor in the development of a water demand forecast. Figure 4-1 shows the number of new households in our region that have connected to our supply system each year since 2001/02. The average number of new households per year through this period is 5,225. Throughout much of the 2000s our region experienced a higher property growth rate of around 5,700 new properties each year. This rate fell in 2009/10 to just above 4,000 properties per year, following the economic slowdown. Since 2009/10 there has been slow overall growth in new household connections, with an average since 2011/12 of ~5,000 new properties per year. New properties in 2020/21 saw a decline from this recent average, reflecting the impact of the Covid-19 pandemic on building rates.

Figure 4-1 Observed annual rates of new household connections



4.5.2 Forecast property growth

We have developed forecasts of the growth in household properties and population following Section 4.2 of the Water Resources Planning Guideline (2017) and the UKWIR (2016) guidance manual[19]. In overview, we have undertaken a range of forecasts to aid in calculating the uncertainty in property growth to establish a Low, Central and High forecast.

To convert plan and trend-based housing trajectories and forecasts for each LA to a water resource zone level trajectory, we followed the UKWIR (2016) methodology, and used our base-year billing system data and GIS to calculate the proportion of households in each LA for the base-year. These percentages were then used to assign the proportion of household growth in each LA to the water resources zone. To extend the trend-based properties forecast from 2043 to the end of the planning period (2079-80) we applied the average trend from the last 10 years of the forecast.

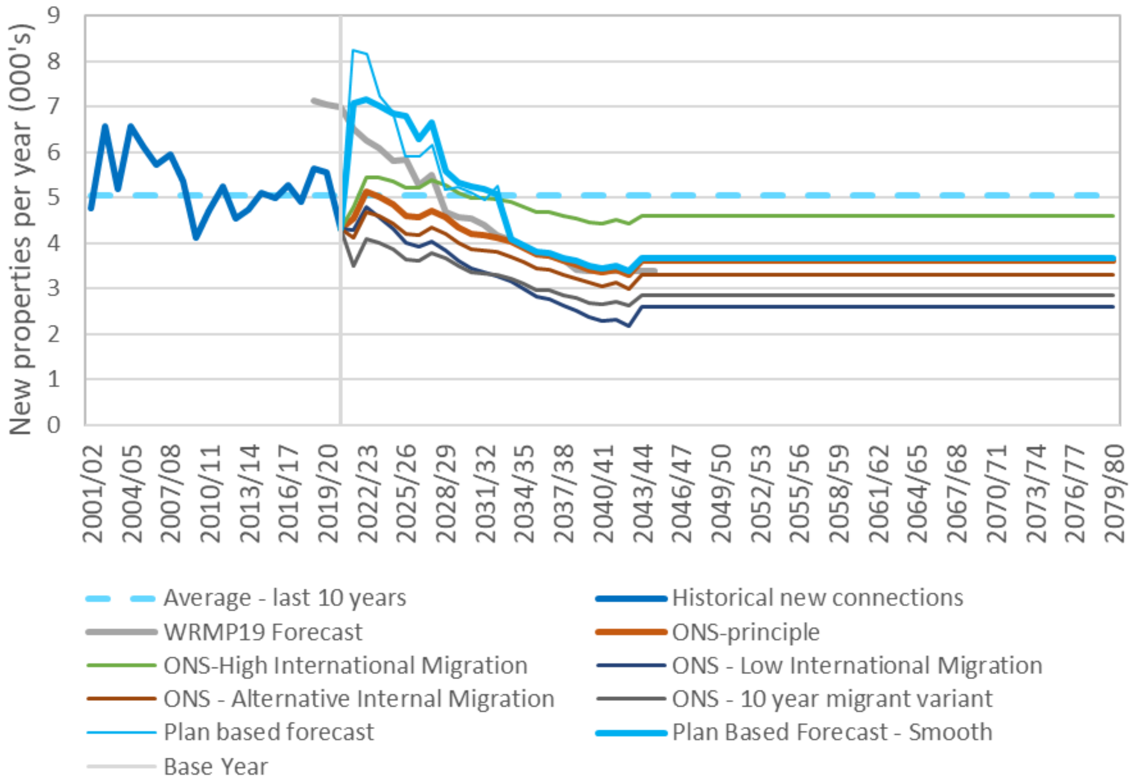
Based on the approach detailed in Section 4.5.2, Figure 4-2 shows forecasts of new households per year in the Wessex Water region based on LA data and the range of trend-based from the ONS, in comparison to the average actual number of new connections in recent years (dashed blue line), and the WRMP19 properties forecast. The LA plan-based forecasts are significantly higher than recent observed or other trend-based projections, as is the WRMP19 forecast which was also based on local authority data.

Local Authorities are required by the NPPF to review annually their delivery against housing requirements and identify a supply of specific deliverable sites sufficient to provide five

[19] UKWIR (2016) Population, household property and occupancy forecasting guidance manual.

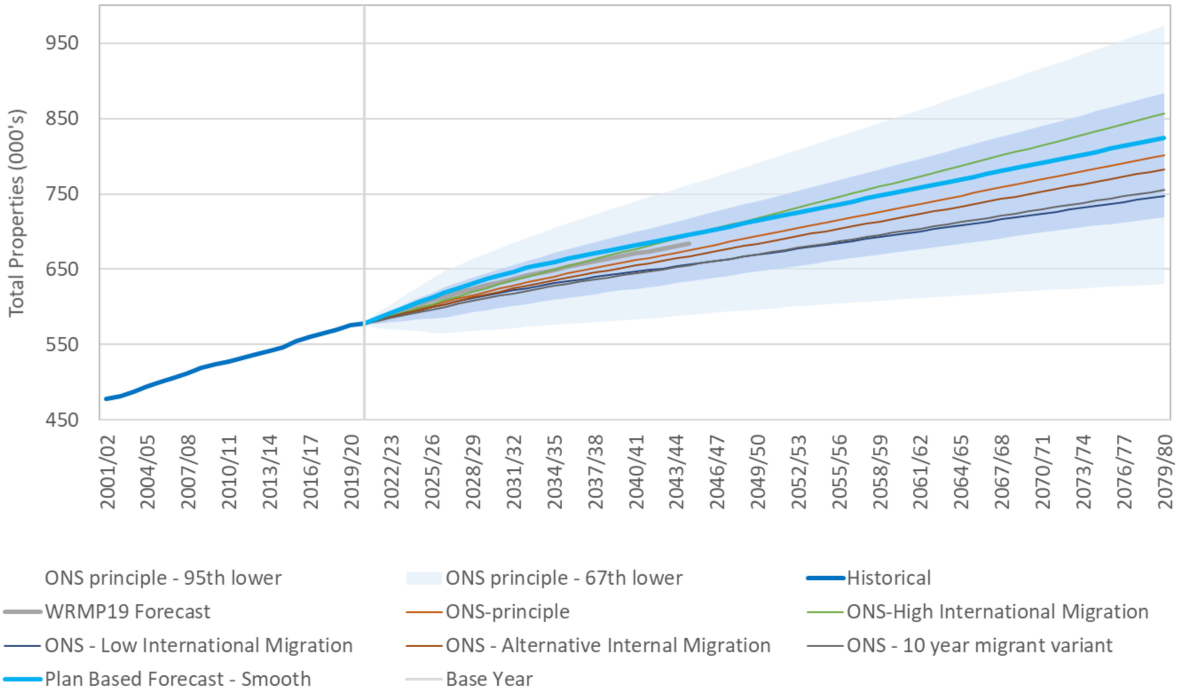
years' worth of housing against their housing requirements. In addition, to ensure choice and competition for land an additional 5% buffer is required, brought forwards from later in the full plan period. Where there has been persistent under delivery, this buffer should be increased to 20%. The combined LA trajectory is higher than the recent observed and ONS forecasts in part reflecting this under-delivery. As a result, and given that the LA trajectories are designed to provide a buffer for under-delivery, as opposed to being expected to be delivered, we have produced a smoothed LA forecast that does not constrain growth forecast in the local plans, but has a more realistic delivery profile, without significant front loading.

Figure 4-2: Range of forecast households per year compared to past completion rates



Total property growth is presented in Figure 4-3 over the planning period. This is presented alongside the ONS principle forecast at the 67 and 96th percentiles (using UKWIR derived uncertainty bounds) The range of total properties ranges from 755,000 to 856,000 properties by 2079/80. The high early delivery of the plan based smoothed forecast moves closer to the central estimate over time, as the central ONS forecast replaces earlier LA-derived property growth.

Figure 4-3: Total property growth over the planning period for each scenario



4.5.3 *Selected property forecast*

It is important that our water resources management plan accounts for the housebuilding projections produced by each LA. We have a statutory duty to provide water for new development and we plan to accommodate the growth plans set out by local and national government for our area. The combined plan based LA housing trajectory, however, forecasts an increase in household building rates to significantly rise above recent actual levels, and sits close to the upper 66th percentile range in the short term. As described earlier in this section, this uplift is in part a result of the annual delivery reviews that have identified under-delivery in recent years – notable uncertainty is therefore associated with this trajectory relating to whether such an uplift will be achieved in the short term particularly given the current economic situation. High inflation, labour market uncertainty associated with Brexit and a weak pound increasing construction costs may all act to moderate any significant increase in house building.

We believe that owing to the uncertainties described above, the plan based LA housing trajectory does not represent an appropriate central estimate of new housing connections that is appropriate for to use in the development of developing our central demand forecast. We have therefore taken the following approach to selecting a Low, Central and High forecast:

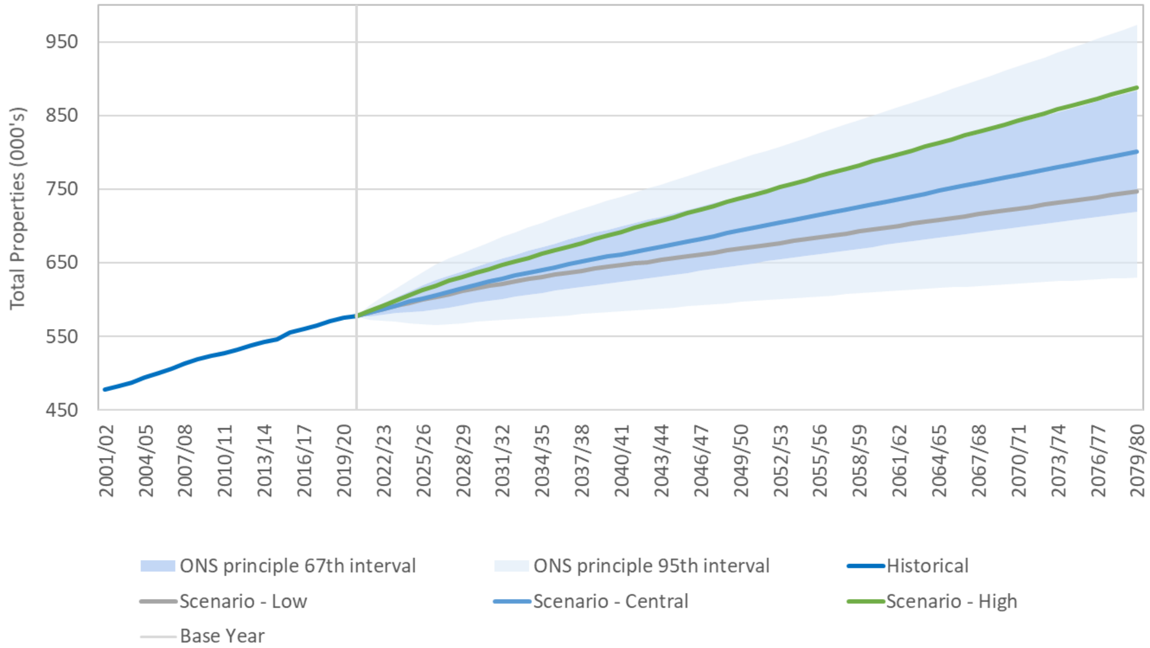
- **Low Forecast -** the ONS Low international migration scenario has been selected as this forms one of the lowest forecasts and therefore appropriate for a low forecast scenario.
- **Central Forecast:** as detailed above the LA projections are significantly higher than recent actual and ONS trend based forecasts which may reflect house building has been below forecast for a number of years. As a result, the ONS Principal trend based forecast has been selected as the central forecast.

- **High Forecast:** the forecast was generated via combining two datasets which include the smooth LA plan-based forecast in the short term and historical long term average of new properties in the long term (which falls closely to the 67th percentile)

The Central and High forecasts are consistent with the scenarios required for Ofwat's PR24 and beyond: final guidance on long-term delivery strategies.

The total properties for each of the scenarios is detailed in Figure 4-4. Based on the Central forecast (which is the ONS Principle forecast) total properties are forecast to increase by 28% from 577,716 in 2020/21 to 801,730 thousand in 2079/80.

Figure 4-4: Total property forecasts for the Low, Central and High forecast



Baseline household property type forecast

As per Section 3.3, baseline properties are split into measured and unmeasured households. Figure 4-5 presents the proportion of each property type for the baseline central forecast scenario. The change in total properties is because of new property growth over the planning scenario. The change in properties from unmeasured to measured includes the actual and forecast change of occupier policy up to 2024/25, consistent with our current WRMP19 options. From 2025/26 onwards, the meter optant model forecasts those properties opting for a meter using our meter optant model[20], and consistent with the guidance, includes no additional metering policy or promotion of optant metering for the baseline forecast.

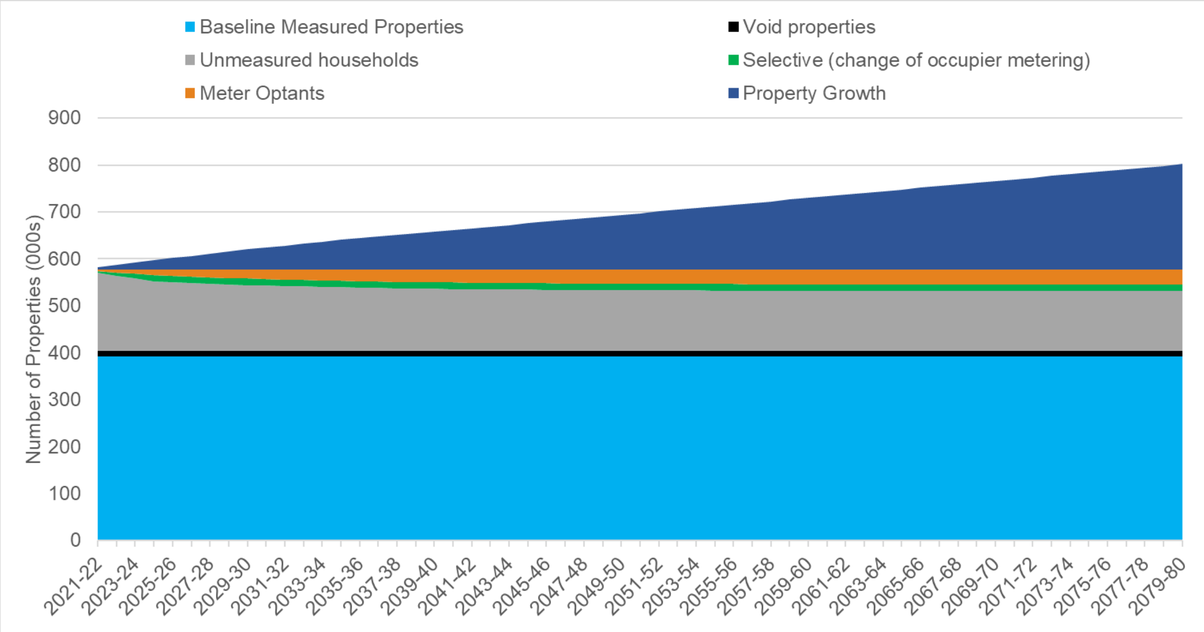
Metering policies are included as water resources options in the options appraisal (please see Options Appraisal Technical Report). For the baseline scenario, by 2024/25 74.5% of

[20] The meter optant model is part of our demand forecast model, and forecasts properties opting for a meter in each year based on bill cost for measured and unmeasured customers, and the proportion of properties remaining. The model is calibrated to the last 24 years of data.

households will be metered and by 2079/80 83.8% of properties will be metered (percentages exclude void properties).

There are a small proportion of unmeasured properties which have a meter installed but are billed unmeasured charges. These meters do not influence water delivered to measured properties. These numbers are reported in the Annual Performance Review table 4R.

Figure 4-5: Household property numbers by type (baseline)



We are required to report the number of domestic properties with a meter installed that are not charged by reference to volume. These properties fall into three categories:

- Voids – properties with a meter installed but not billed – we reported 9,000 void properties for the year 2021/22 and have a commitment to keep this to less than 2% of properties, and forecast 6,400 properties each year to the end of the planning period.
- There are a small number of properties within the unmeasured household property counts which have a water meter. These properties are charged based on the rateable value of their property and not the volume of water used. These properties reflect customers which were previously on a measured charge (but were able to revert back to unmeasured charges via the current money back guarantee policy for meter optants) and/or those which are on the unmeasured consumption monitor survey (which is used for our water balance estimation of unmeasured household consumption). We have reported this number via the Annual Performance Review since 2020/21 via Table 4R, Line 19. In 2021-22 the number of unmeasured properties was reported as 3,856 households. This number is not expected to change significantly in the future with the PR24 forecast of 4,320 properties from 2025/26 to 2030/31.

4.6 Household Population Forecast

4.6.1 Household population approach

As with the household properties forecast, our population forecast has been developed using the UKWIR (2016) guidance manual[21]. We have developed a number of different forecasts, based on local plan information and trend-based forecasts from national datasets for household population and non-household population. Household population was forecasted following a range of approaches which align with the scenarios for the property forecasts (Section 4.5.2).

This includes:

- A plan based forecast based on the relevant LA derived trajectories in our supply areas. These typically cover the period up to 2033/34. Section 5.2.1 details the LA's relevant to our supply area.
- A range of ONS trend-based forecasts which run up to 2043/44 and include:
    - A Principle trend-based forecast from the ONS which typically extends beyond the LA forecast
    - A high International Migration forecast
    - A low International Migration forecast
    - An alternative Internal Migration forecast
    - A 10-year migration variant forecast

Figure 4-6 shows the outputs of the five population growth forecasts between 2021/22 and 2079/80 that correspond to the property growth forecasts shown in Section 4.5.3. For all ONS forecasts the associated population growth assumptions were applied. For the LA based forecasts, the population growth was derived by applying the occupancy rate from the ONS Principle forecast multiplied by the number of LA forecasted properties. All outputs show higher growth rates in the early planning period which all drop and level off towards 2079/80. The plan-based forecast is the key outlier which has a much higher rate than all other forecasts. Figure 4-7 presents these growth rates as total household population forecasts. The total range between the lowest and highest forecast is 1,445,000 to 1,720,000.

[21] UKWIR (2016) Population, household property and occupancy forecasting guidance

Figure 4-6: Household population forecast growth rates

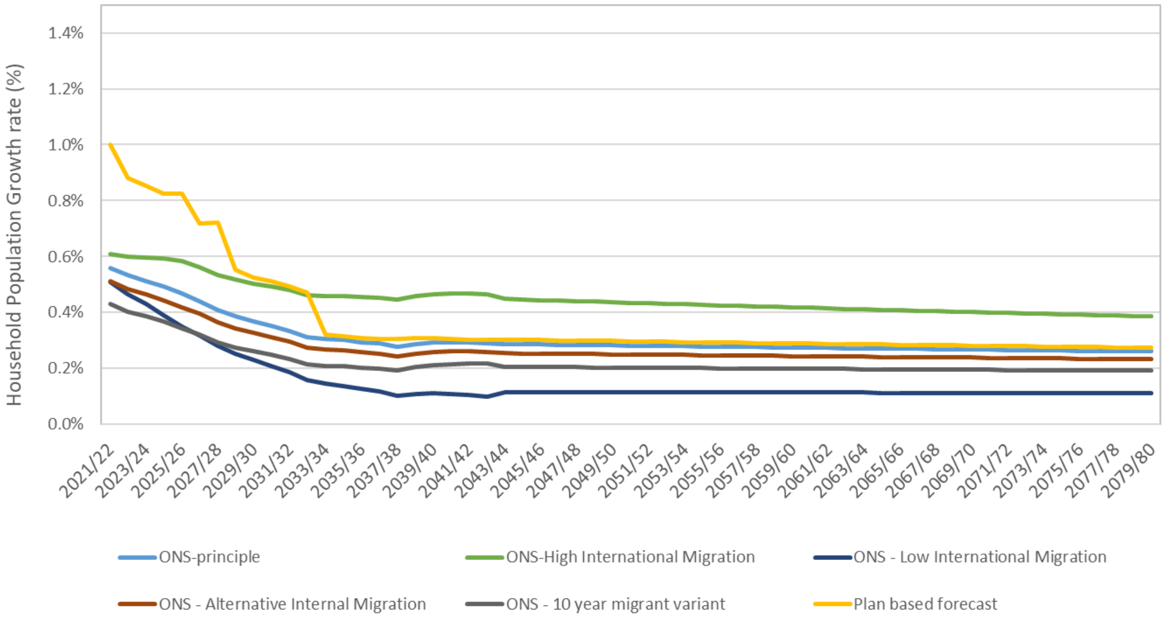
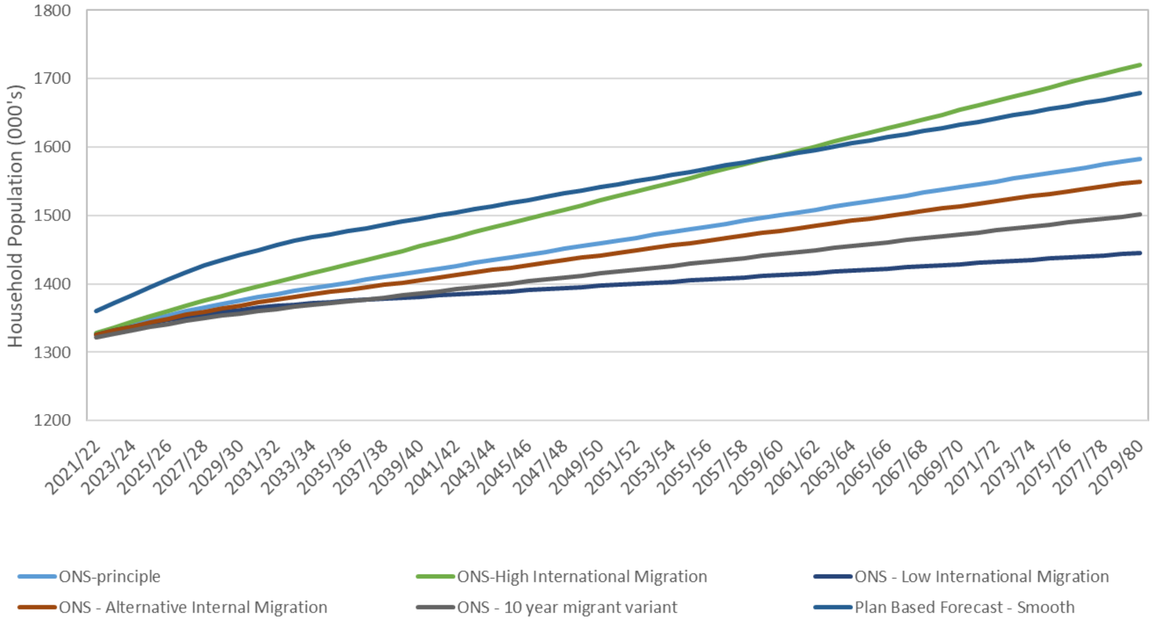


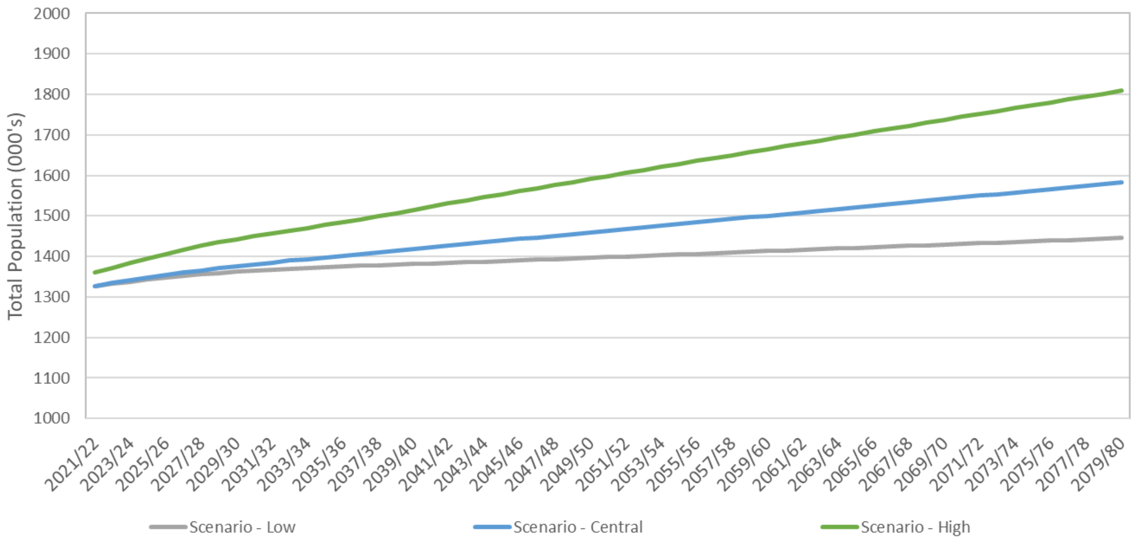
Figure 4-7: Household population growth forecasts



4.6.2 Selected population forecast

For WRMP24 we have selected three population growth scenarios for the Low, Central and High scenario which are shown in Figure 4-8. These selected scenarios are as per the properties to ensure the two datasets align (see Section 4.5.3)

Figure 4-8: Selected Low, Central and High population scenarios



4.6.3 *Occupancy changes*

Figure 4-9 shows the changes in the population split between measured and unmeasured household population. The majority of the growth is within the measured population due to new population growth[22]. Additional measured growth occurs due to change of occupier and meter optants between 2021/22 and 2024/25 which moves population from unmeasured to measured (post 2024/25 there is no additional metering in the baseline). The figure is based on the Central population forecast.

Figure 4-9: Household population forecast by customer type (baseline)

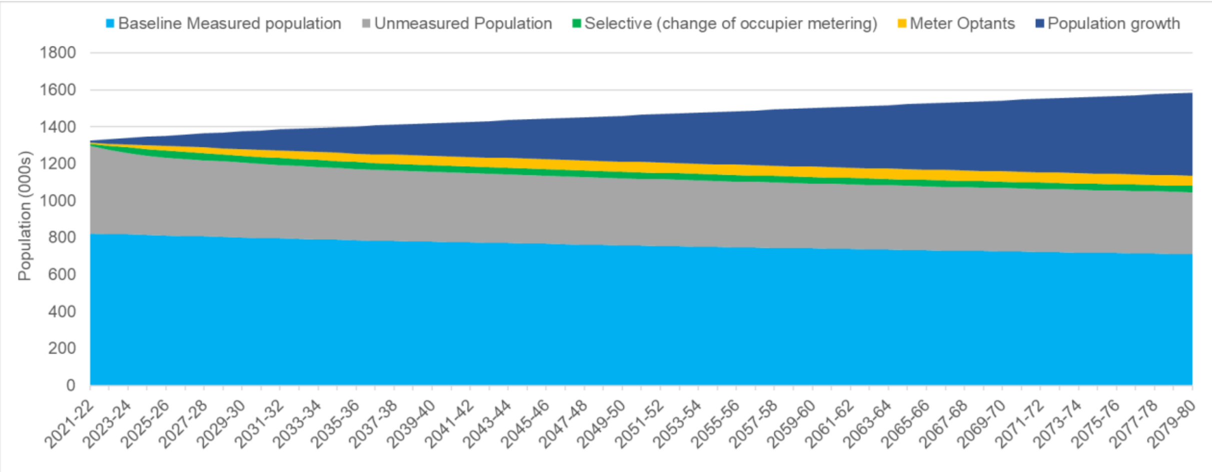
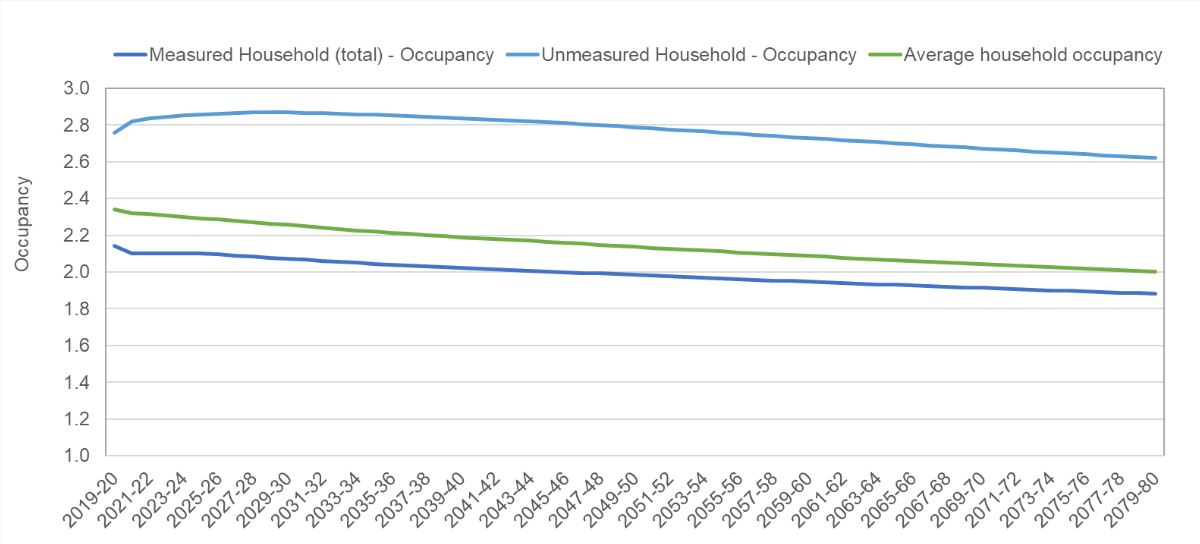


Figure 4-10 presents changes in total, measured and unmeasured occupancy over the planning period which shows a gradual reduction over time, indicating population growth is slower than forecast property growth. Between 2019/20 and 2020/21 there was a drop in measured occupancy which results in a higher increase in measured households and a lower growth in the measured population. This also resulting in increasing the unmeasured occupancy.

[22] Population growth associated with new household properties is metered

Figure 4-10: Measured and Unmeasured household occupancy



4.7 Non-household Properties Forecast

The average net annual percentage change in the number of non-households over the last 10 years is -0.23%. This rate is taken as a constant over the planning period and used to forecast the total number of non-household properties in the supply area. From 2019/20 to 2079/80 the **total number of non-household properties** is forecast to decline by 14% from 44, 976 to 38,590 properties.

The number of unmeasured non-household properties that switch to becoming measured non-household properties is forecast by analysing the historical percentage change over the past 10 years. On average 4.78% of unmeasured non-household customers opt for a metered supply every year. It is assumed that 4.78% of unmeasured non-household properties will opt each year over the planning period. Based on this switching rate, the number of **unmeasured non-household properties** is forecast to decline through the planning period from 3,229 properties to 175 by 2079/80.

Reflecting the net change in total non-household properties and those switching from unmeasured, the total number of **measured non-household properties** is forecast to decline from 41, 747 to 38,414 by 2079/80.

4.8 Non-household population forecast

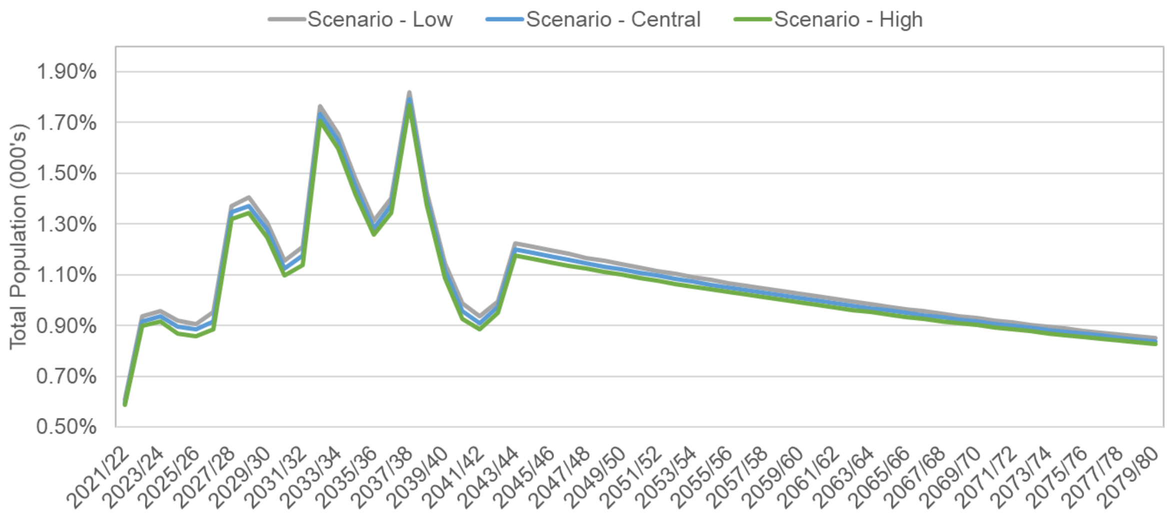
For WRMP19 a baseline population assessment was undertaken which split the population between household and NHH, where NHH population is the difference between connected population and household population. This baseline has been carried forward to WRMP24.

The future growth rate for NHH is based on NHH growth rates as per the ONS forecasts. As per the properties and household population forecasts a range of ONS forecasts were reviewed. Each of the scenarios had little variation between scenarios indicating lower uncertainty in NHH forecasts. The ONS Low and High international migration are the Low and High forecasts, with the Central Forecast being the ONS Principle central forecast. The overall forecasts are shown in Figure 4-11.

The measured non-household population is forecast through the planning period by adding the in-year non-household optant and selectively metered population (number of properties multiplied by the assumed occupancy rate) to the previous year's non-household measured population. It rises through the planning period from ~22,000 people in the base year to 62,000 people in 2079/80.

Unmeasured non-household population is the balancing population – i.e. total population less population accounted for in any other category. It falls through the planning period from ~18,000 people in the base year to 13,000 people in 2079/80

Figure 4-11: Low, Central and High NHH growth rates

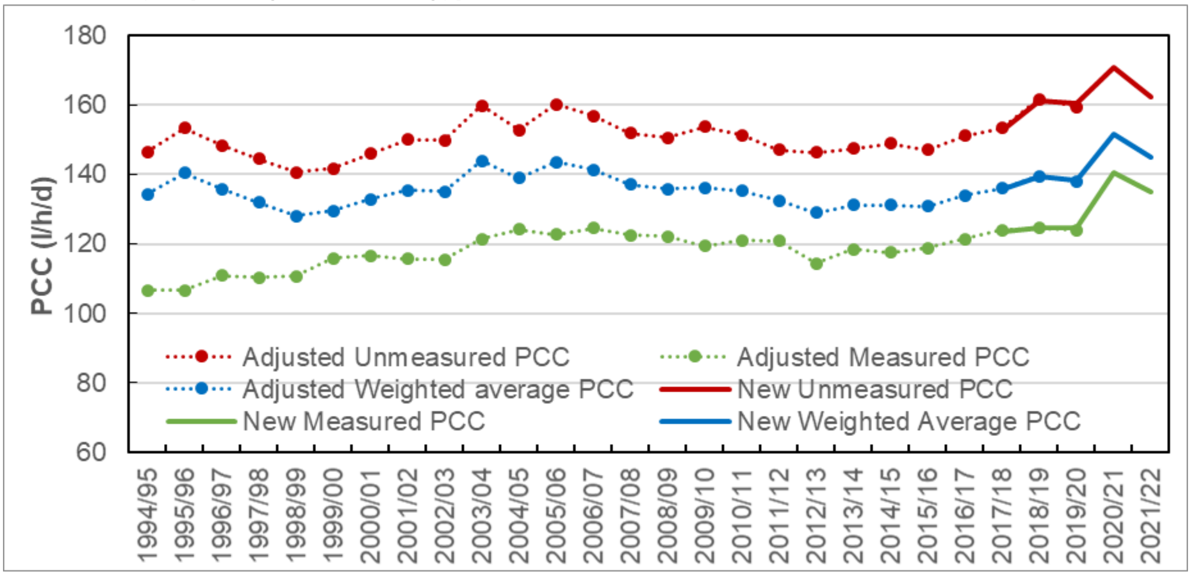


5. Household Water Consumption

In parallel to determining the size of the population and the number of households we expect to supply in our region, we need to also consider how much water on average each person will require (per capita consumption) and how these demands may change into the future.

Weighted average per capita water consumption in the Wessex Water region in the base year 2019/20 was 138 litres per head per day. It was 160 litres/head/day for unmeasured customers and 125 litres/head/day for measured customers. Figure 5-1 shows the trend in average PCC for the weighted average, measured and unmeasured households since 1994/95. The years pre-2017/18 have been back-calculated using a simple adjustment factor to enable the long-term trend to be observed, in comparison to post 2017/18 data which has been derived using a modified industry wide reporting methodology. The trend illustrates that there has been an upwards trend in PCC since around 2012/13 with a notable spike upwards in 19/20 and 2020/21 linked to the Covid-19 pandemic. In these later years people were mandated by government to stay at home for periods of 'lockdown'; whilst household demand has declined in 2021/22 "post-pandemic" there has been a societal shift towards continued homeworking for some people and its associated increase in water use at home.

Figure 5-1: Weighted average, measured and unmeasured per capita consumption since 1994/95 (NB: years pre-2017/18 have been adjusted for comparison with the later years and consistency reporting methodology)



It is reasonable to expect an underlying increase in PCC in unmeasured households as each year several thousand unmeasured households (typically with lower-than-average unmeasured water use) opt to have a meter installed thereby increasing the average PCC of the remaining unmeasured households.

We might also expect that measured households would exhibit an underlying downward trend in PCC as each year ~5,000 thousand new homes are built (Section 4.5.1) that are increasingly water efficient and measured customers are also more likely to take up water efficient behaviours and devices as they stand to financially benefit from reducing their water use. This trend may be diluted somewhat by the addition of newly metered households resulting from our change of occupier metering programme as these households will have a broader range of water use characteristics.

The three-year average PCC for the industry was 145 litres/head/day for Apr 2018-Mar 2021[23] the Wessex Water three year average for the same period was a little below this at 143 litres/head/day.

5.1 Unmeasured per capita consumption – base year

Unmeasured PCC values are calculated annually from our domestic unmeasured consumption monitor which was set up over 20 years ago to provide an estimate of water use by households that pay for water services on an unmeasured basis. The metering technology used for households on the monitor has evolved over this time. The monitor design, data collection and analysis methods follow the UKWIR best practice guidance[24] (1999) and UKWIR Future Estimation of Unmeasured Household Consumption (2017)[25].

Key features of the monitor are listed below:

- Households are selected to be representative of our region's mix of property types, socio-economic (ACORN[26]) categories, household occupancy, council tax bands and geographic locations.
- The monitor includes approximately 1,000 households and when customers leave the monitor (i.e. they opt to become a standard measured customer) additional households are recruited to maintain the sample size.
- Households have a meter and data logger that captures water consumption data at 15 or 30 minute intervals. Data is automatically transferred to our systems using mobile technology.
- Consumption data is reviewed monthly and where supply pipe leaks are suspected the property is excluded from the analysis for that month, so that true consumption is not overestimated and our leakage team investigate and fix where appropriate.
- PCC is calculated on a per property basis by dividing the overall monthly household consumption by the household occupancy. Occupancy data for each household is collected when they sign-up and is reviewed at least every two years. An occupancy survey of all households on the monitor was completed in 2017.
- To ensure that the households on the monitor, and therefore the derived PCC, are representative of our wider customer base, monthly PCCs are weighted by household size to reflect the overall composition of households in the Wessex Water area.

[23] https://discoverwater.co.uk/amount-we-use
[24] UKWIR (1999). Best practise for unmeasured per capita consumption monitors
[25] UKWIR (2017). Future Estimation of Unmeasured Household Consumption 17/WR/01/16
[26] ACORN is a geodemographic information system categorising UK postcodes into various types based on census data and other information. The population is divided into 5 categories from Wealthy Achievers to Hard Pressed.

5.2 Measured per capita consumption – base year

Measured normalised per capita consumption in the base year (125 l/h/d) is calculated based on the normalised water delivered to measured household divided by the measured household base year population.

5.3 Forecasting per capita consumption

5.3.1 Existing measured and unmeasured household per capita consumption – micro-component modelling

The micro-component approach to forecasting domestic water demand is a ‘bottom up’ way of understanding customer water use. Individual components of water use at home are considered in terms of devices and behaviours and how these might change in the future. Modelling undertaken for this Plan has been developed with reference to the household consumption forecasting approaches outlined by the 2012 UKWIR report [27] and the 2016 UKWIR guidance manual[28].

The approach involves the following key elements:

- Segmentation of customer water use by measured and unmeasured customer types
- Subdivision of household water consumption into different activities or ‘components’
- Estimation of ownership of the device or participation in the activity, frequency of use amongst the applicable proportion, and volume of water used each time
- Inclusion of a residual miscellaneous use component
- Projection of water consumption by component based on changes in ownership, frequency and volume over the 25 years of the planning period.

As a member of the West Country Water Resources Group we took our existing Excel-based micro-component model and commissioned consultants Ovarro to develop it further. Individual models were developed for each resource zone in the west country that had the same structure but allowed for individual company area input assumptions for scenario analysis.

Micro-component modelling is underpinned by a wide range of detailed data and assumptions on how water is used at home such as how often toilets are flushed a day; what is the average volume per flush; how long people spend in the shower and how the average volume per washing machine cycle will change over the next 25 years.

The model input assumptions on appliance ownership, frequency and volume were developed from a range of data sources, the majority being specific to our company area collected during our water efficiency engagement programmes:

- ~22,000 Home Check water efficiency visit records of appliances and usage behaviours recorded by Wessex Water technicians between 2016 and 2019
- >11,000 GetWaterFit water use survey records self-reported by customers between 2020 and 2021

[27] UKWIR (2012) A good practice manual and roadmap for household consumption forecasting, Tynemarch and Blue Marble (CU02)

[28] UKWIR (2016) WRMP19 Methods – household consumption forecasting

- Published industry research, notably the 2018 Energy Saving Trust (EST) report on water labelling options[29] that collated previous evidence.

The starting point for forecasting by micro-components is defining the base year split of water use into components. Figure 5-2 and Figure 5-3 show how water is used by measured and unmeasured domestic customers in the base year. The charts show that the majority of water use occurs in the bathroom; for toilet flushing bathing and showering. For measured and unmeasured customers, showering forms the biggest component of household water use amounting to nearly 40% of use and toilet flushing accounts for around 20% of use.

The other components are smaller, with clothes washing and dishwashing forming 9% and 14% of use in measured households, and 8% and 13% in unmeasured households. The ‘other miscellaneous use’ category (9-7%) includes water used for cleaning, drinking and wastage through plumbing losses arising from dripping taps and leaky toilets.

Figure 5-2: Measured customer base year water use by micro-components (litres, %)

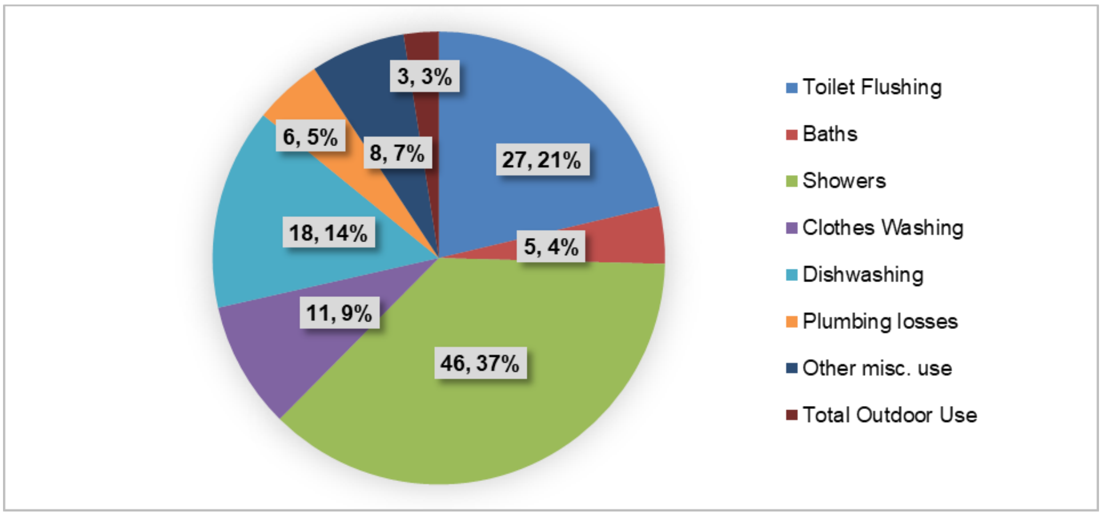
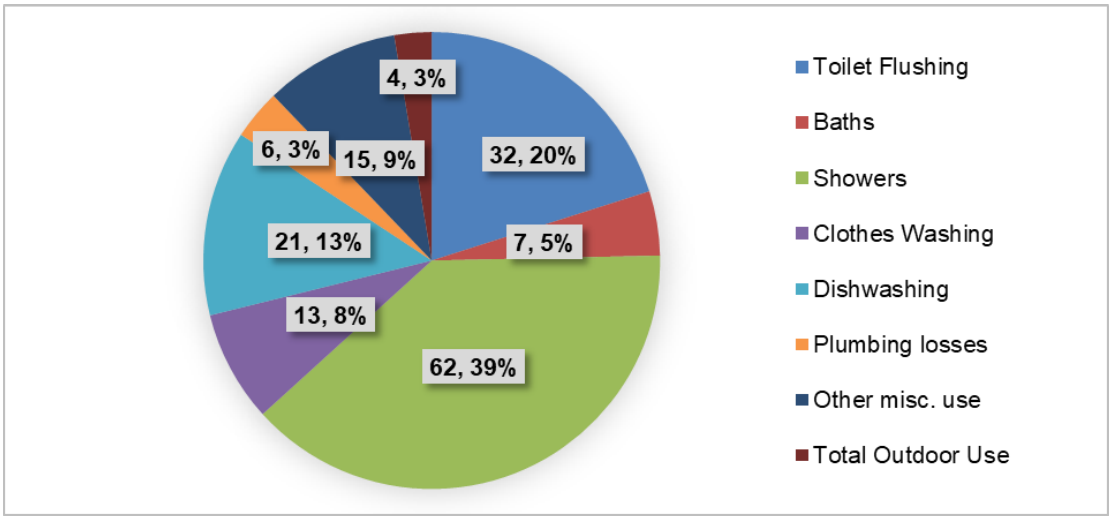


Figure 5-3: Unmeasured customer base year water use by micro-components in litres



[29] Energy Saving Trust – Independent review of the costs and benefits of water labelling options in the UK: EXTENSION PROJECT: Technical Report – FINAL. https://waterwise.org.uk/wp-content/uploads/2019/10/WEStrategy001-EXT_TechnicalReport_2.4.pdf

To forecast the change in water use through the planning period factors are applied in the micro-component model to either grow or decline ownership of appliances, frequency of use and the volume of water used. To account for uncertainty around the projections some of the elements in the model were varied on the basis of low, central and high factor assumptions. Some assumptions remained static through the planning period such as ownership and frequency of toilet flushing. A summary of the factors used in the model is provided below.

Table 5-7: Summary of micro-component changes during the planning period

Assumption	Scenario	Customer segment*	Current 2020-25	First 5 years 2025-30	Years 6-10 2030-35	Years 11-25 2035-50	Years 26-50 2050-80
Change in flushing volume	Low	uM & M	↓↓↓	↓↓↓	↓↓↓	↓↓↓	↓↓↓
	Central	uM & M	↓	↓	↓	↓	↓
	High	uM & M	→	→	→	→	→
Change in shower flow rate	Low	uM & M	↓	↓	↓	→	→
	Central	uM & M	→	→	→	→	→
	High	uM & M	↑	↑	↑	→	→
Change in shower duration	Low	uM & M	↓	↓	↓	→	→
	Central	uM & M	→	→	→	→	→
	High	uM & M	↑↑↑	↑↑↑	→	→	→
Change in shower frequency	Low	uM & M	↓	↓	→	→	→
	Central	uM & M	→	→	→	→	→
	High	uM & M	↑↑↑	↑↑↑	→	→	→
Change in bath ownership	Low	uM & M	↓	↓	↓	→	→
	Central	uM & M	→	→	→	→	→
	High	uM & M	→	→	→	→	→
Change in bath frequency	Low	uM & M	↓↓	↓↓	↓	→	→
	Central	uM & M	→	→	→	→	→
	High	uM	↑↑↑	↑↑	→	→	→
		M	↑	↑	→	→	→
Change in washing machine volume	Low	uM & M	↓↓↓	↓↓↓	↓↓↓	↓↓↓	↓
	Central	uM & M	↓	↓	↓	↓	↓
	High	uM & M	→	→	→	→	→
Change in dishwashing ownership$	Low	uM & M	↑↑↑	↑↑↑	↑↑↑	↑↑↑	↑↑↑
	Central	uM & M	↑↑	↑↑	↑↑	↑↑	↑↑
	High	uM & M	↑	↑	↑	↑	↑
Change in dishwasher volume	Low	uM & M	↓↓↓	↓↓↓	↓↓↓	↓↓↓	↓
	Central	uM & M	↓	↓	↓	↓	↓
	High	uM & M	→	→	→	→	→

Assumption	Scenario	Customer segment*	Current 2020-25	First 5 years 2025-30	Years 6-10 2030-35	Years 11-25 2035-50	Years 26-50 2050-80
Change in miscellaneous internal use	Low	uM	↓↓	↓↓	↓	↓	↓
		M	↓↓↓	↓↓↓	↓	↓	↓
	Central	uM & M	→	→	→	→	→
	High	uM & M	↑↑↑	↑↑↑	↑	↑	↑
Change in plumbing losses	Low	uM	↓↓	↓↓	↓	↓	↓
		M	↓↓↓	↓↓↓	↓	↓	↓
	Central	uM & M	→	→	→	→	→
	High	uM & M	↑↑↑	↑↑↑	↑	↑	↑
Change in garden watering ownership	Low	uM & M	→	→	→	→	→
	Central	uM & M	→	→	→	→	→
	High	uM & M	↑↑	↑↑	↑	↑	→
Change in garden watering frequency	Low	uM & M	↓↓	↓↓	↓↓	↓	→
	Central	uM & M	→	→	→	→	→
	High	uM & M	→	→	→	→	→
Change in garden watering volume	Low	uM & M	↓↓	↓↓	↓↓	↓	→
	Central	uM & M	→	→	→	→	→
	High	uM	↑↑↑	↑↑	↑	↑	→
		M	↑	↑	↑	↑	→
Change in miscellaneous external use	Low	uM & M	↓↓	↓↓	↓	↓	↓
	Central	uM & M	→	→	→	→	→
	High	uM	↑↑	↑↑	↑↑	↑	↑
		M	↑	↑	↑	↑	↑

*uM = Unmeasured; M= metered

Key: → = no change
↑ or ↓ = factor between +0.01% and +0.25% or -0.01% and -0.25%
↑↑ or ↓↓ = factor between +0.26% and +0.50% or -0.26% and -0.50%
↑↑↑ or ↓↓↓ = factor over +0.50% or -0.50%
$The key above is not applied for dishwasher ownership where ↑ = 0.5%, ↑↑ = 1% and ↑↑↑ = 2% to maximum ownership rates.

The key trends in water use by micro component are described below and the cumulative effect of the changes on overall PCC for existing metered and unmeasured customers are shown in Figure 5-4.

Toilets

The volume of water used for toilet flushing is assumed to fall steadily throughout the central scenario as older toilets are progressively replaced with more efficient versions. For the low case it is assumed the switch to more efficient models occurs more rapidly and for the high scenario it is assumed that flush volumes remain broadly constant throughout the planning period.

Personal washing - showering

Water use for showering is anticipated to remain stable in the central scenario. Showering behaviours are subject to a diverse range attitudes and habits that are stimulated by issues such as the growing significance of showering as a daily wellbeing combined with behaviours in more recent times to reduce energy use though reducing hot water use sparked by the cost-of-living crisis. To account for this uncertainty our high and low models assume increasing and decreasing volumes and durations respectively for the next that the 10-15 years of the planning period.

Clothes washing

The volume of water used by washing machines per load are assumed to continue to decline as manufacturers continue to develop ever more efficient models and older less efficient models are progressively replaced. The low scenario considers bigger efficiency gains while the high scenario assumes washing machine models get no more efficient than they are today to account for a range of future possibilities.

Dishwashing

All three scenarios – low, central and high – assume that dishwasher ownership will increase steadily through the planning period which is consistent with historical market trends[30]. The volume of water used per dishwasher cycle is assumed to become more efficient in a similar manner to washing machines in the central scenario. The low scenario assumes bigger reductions in water volume than the central case and the high scenario assumes dishwashers get no more efficient than they are today to account for a range of future possibilities.

Miscellaneous internal use

The central case assumes that miscellaneous internal use and plumbing losses remain stable through the planning period. To account for the potential impact of increased water efficiency and action on plumbing losses as a result of the cost-of-living crisis in the near term the low scenario applies negative factors with the larger reductions in metered households to reflect their greater motivation for action.

External garden use

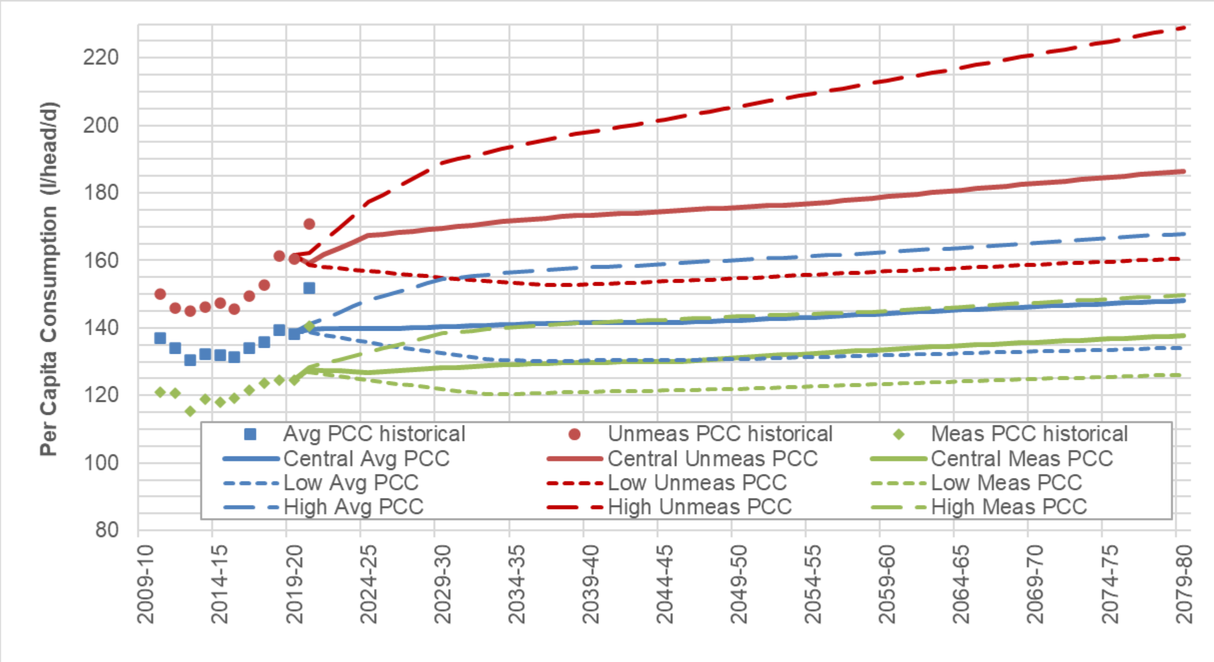
The central case for garden watering and miscellaneous outdoor use is that these remain stable through the planning period. To account for the uncertainty in possible futures relating to gardening habits the low and high scenarios assume modest change factors. The impacts of climate change on this element of demand is not accounted for here, that is handled elsewhere in the forecast.

[30] https://www.statista.com/statistics/289151/household-dishwashing-in-the-uk/

Overall low, central and high micro-component trends for existing customers

Figure 5-4 shows that the central case scenario forecasts that the central case average PCC is projected to experience modest growth from the base year of around 1% by 2030, 3% by 2050 and 7% by 2080. Existing metered and unmeasured customer PCCs are forecast to experience similar growth of 5% and 3% by 2030, 9% and 5% by 2050 and 15% and 10% by 2080. The trajectory of these trends compares well to the recent historical PCC data also shown on the graph.

Figure 5-4: Normal year PCC low, central and high scenario trends for existing customers



To incorporate the low, central and high forecasts into the demand forecasting model, the forecast percentage changes in consumption under each scenario are incorporated into the normal year annual average demand forecast, prior to uplift to DYAA and DYCP scenarios.

5.4 New properties per capita consumption

New property PCC at the start of the planning period is assumed to be in line with the requirements of the Building Regulations at 125 l/h/d[31].

5.5 Overall per capita consumption forecast – final plan

The overall cumulative effect of the micro component trends combined with population and property growth and options impacting on household demand (metering and water efficiency) determine the final plan micro component projections and overall PCC forecasts – which are illustrated in Figure 5-5 and
Figure 5-6.

[31] Part G of the Building Regulations came into force in April 2010. It specifies a whole building standard of 125 litres per person per day for domestic buildings. This comprises internal water use of 120 litres per person per day, plus an allowance of 5 litres per person per day for outdoor water use (Communities and Local Government, 2009)

Figure 5-5: Micro components of final plan DYAA metered demand alongside overall weighted average PCC

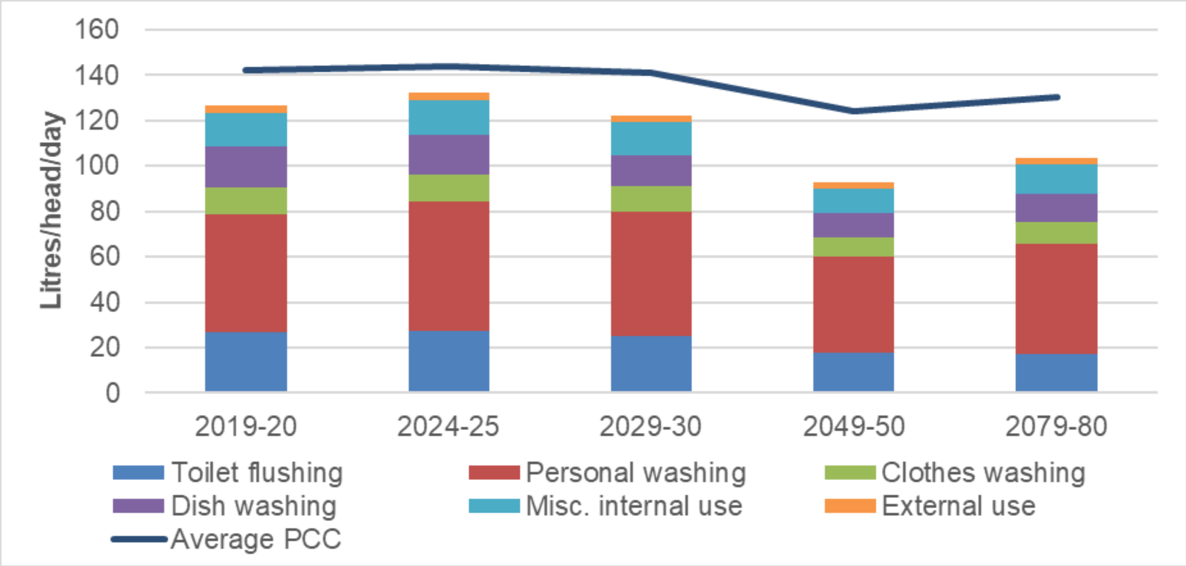
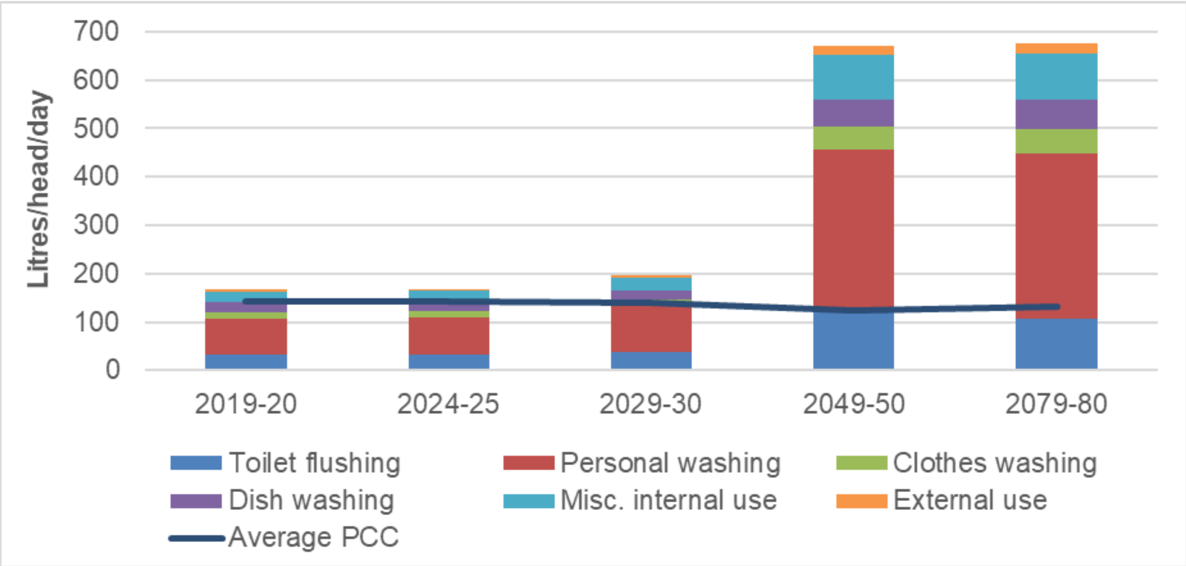


Figure 5-6: Micro components of final plan DYAA unmeasured demand alongside overall weighted average PCC



The very high unmeasured PCCs towards the end of the planning period are indicative that 80% of household properties will be metered by 2049-50 and so this high PCC in the remaining small cohort is not significantly influencing average PCC as shown on the chart.

Final plan average PCC is forecast to fall by 12% to 124 litres/head/day by 2050. The early part of the plan will see PCC remain broadly stable, falling by around 1% from the base year to 2029-30 (140.8 l/h/d) – this modest change represents a halting of the current increasing trajectory in average PCC that has occurred since around 2012-13, even excluding the impact of the pandemic.

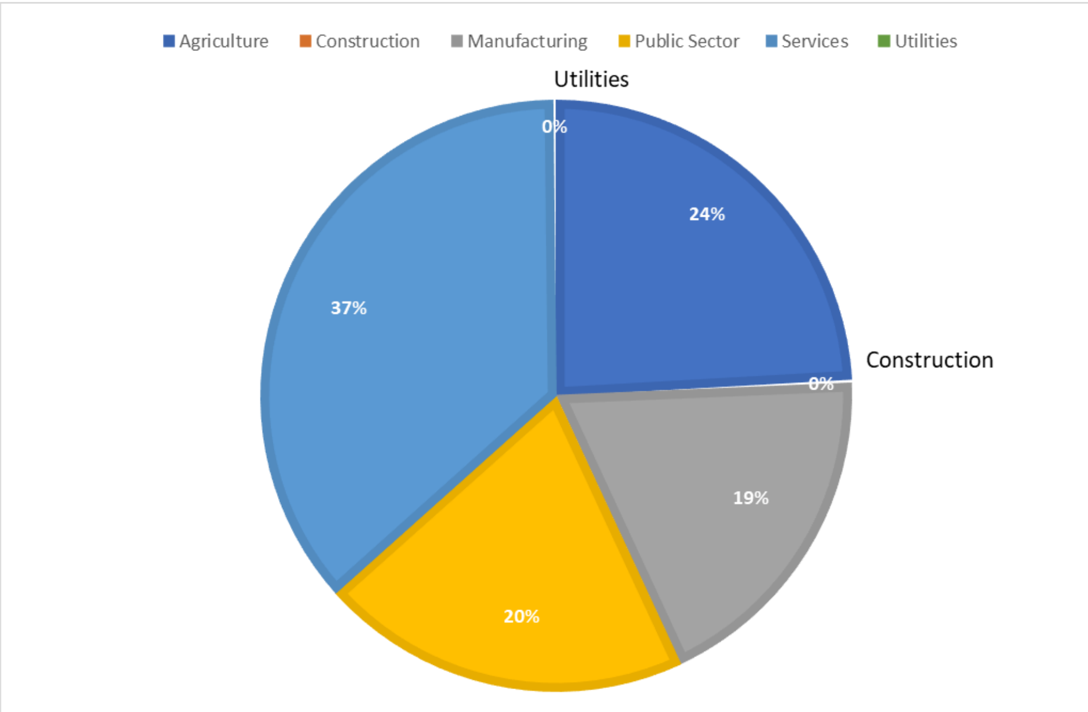
6. Non-Household Water Consumption

Non household (NHH) demand makes up a significant contribution to our overall demand, of which the majority is from measured NHH with a small proportion being unmeasured. This following section details the approach undertaken for WRMP24 to forecast total NHH demand. The sections are split into Measured and Unmeasured NHH demand.

Until 2019/20 NHH demand had remained relatively flat in recent years but in 2019/20 and 2020/21 NHH demand decreased significantly, which is largely attributed to the Covid-19 pandemic, where a large proportion of NHH sectors had to close down due to National lockdown restrictions. In 2021-22 NHH demand has recovered but has not returned to pre 2019/20 levels. It is expected NHH demand is unlikely to return to pre Covid-19 levels due to behavioural changes, such as a higher proportion of the population working from home and therefore their water demand during working hours moving to household demand. In contrast, emerging issues such as world food security may result in a higher proportion of food being grown in the UK, or with changing climate the growth of different more water intensive crops, which could result in an increase in water use within the sector. In summary, due to the above there is a high level of uncertainty in NHH demand which has been reflected in the approach undertaken. The following sections detail the approach in forecasting NHH demand.

Our NHH demand is made up of the following key sectors (see Figure 6-1), which is dominated by Services, followed by Agriculture and Public sector.

Figure 6-1: Key NHH sector types for Wessex Water and percentage of total non-household water used



In April 2017, Ofwat required a change to how water services are sold to non-household customers. Non-household customers are now able to choose their retailer with Wessex Water remaining the wholesaler for water services. When the market opened, the retailer became responsible for managing the accounts of non-household customers. We followed relevant guidance from Ofwat[32] in determining customer/property types that we have considered as non-household, and whether non-household customers were eligible to switch their retailer. We were required to undertake an external review of the data for upload to the market systems, and also of the broad approach taken to eligibility. Shepherd and Wetherburn undertook this audit review, and Wessex Water (like all companies) had to pass this review to enter its data to the market.

6.1 Measured Non-Household Consumption

6.1.1 Base year Measured NHH

Base year Measured NHH forecast is based on outturn data for 2019/20 which is pre the significant influence of Covid-19 on demand, which is 75.03 Ml/d. The outturn figure was adjusted to a NYAA as per the base year normalisations in Section 3.

6.1.2 WRMP24 Measured NHH Forecasts

Our forecast for measured NHH consumption was undertaken by Experian who undertook econometric analysis to identify the historical relationship between non-household water demand and a range of explanatory factors such as industrial output, employment and efficiency of water use. The results of this statistical analysis were combined with Experian forecasts of output and employment by industry to provide NHH demand forecasts disaggregated by broad sectors for the NHH demand. Further information on the approach can be found within the technical report[33]. The approach undertaken was in collaboration with Bristol Water and South West Water as part of regional plan development.

Wessex Water records of NHH consumption were used for the forecast due to the availability of historical data which supports the generation of the models. In the future with future development of the MOSL data records this could be used to support future forecasts as per the road map for retailer involvement in water resources planning[34]. In the baseline scenario no options for water efficiency have been considered as these have been considered in the Options Appraisal.

Experian have undertaken a Low, Central and High forecast for each key NHH sector. A trend-based forecast has also been undertaken by Experian, however, these have not been considered as the trends are largely driven by historic reductions in demand which would not

[32] Water Supply licensing – guidance on eligibility (latest revision Feb 2015 – published by OFWAT); "Supplementary Guidance on whether non-household customers in England and Wales are eligible to switch their retailer (latest revision July 2016 – published by OFWAT); Response to OFWAT consultation on guidance to eligibility" (latest revision August 2015 – published by OFWAT).
[33] Experian. Non-household water demand forecasts: Wessex Water. June 2022
[34] RWG- Water Efficiency Sub Group: WRMP24: guidance for retailer involvement in water resources planning

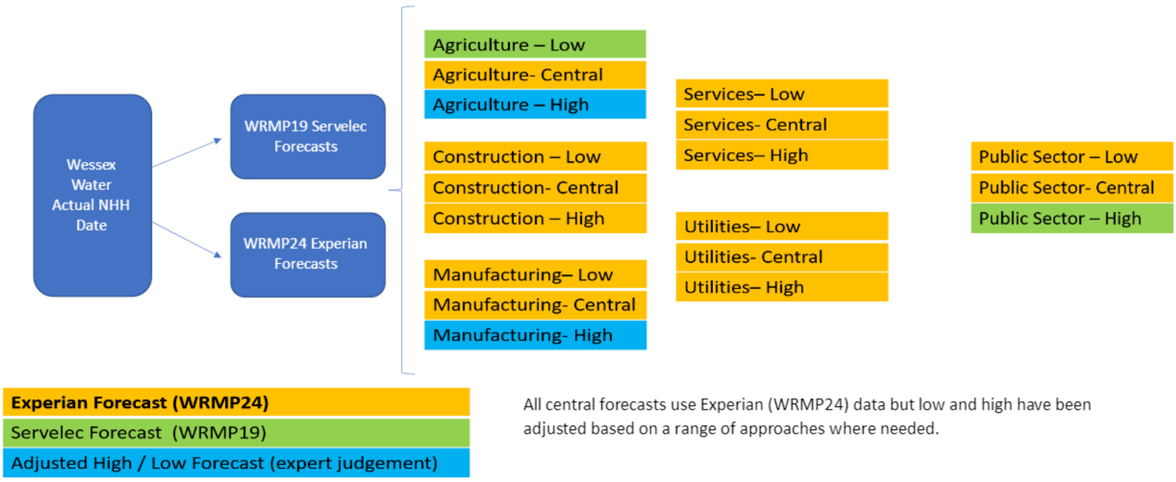
be expected to continue indefinitely. To support the assessments a comparison against WRMP19 forecasts which were undertaken by Servelec has been included given the increased NHH demand uncertainty due to Covid-19.

The forecasts are NYAA which are then uplifted to DYAA and DYCP accordingly in the supply demand model.

6.1.3 Data Selection

For each sector a Low, Central and High NHH demand forecast has been selected per sector type. The sum of the sectors is the total forecast for each scenario. As default, the Experian forecast has been used. The following sub sections detail where the Experian forecast has been replaced (to account for the increased uncertainty as detailed above), alongside the justification. Figure 6-2 details the selected Low, Central and High forecast for each of the NHH categories.

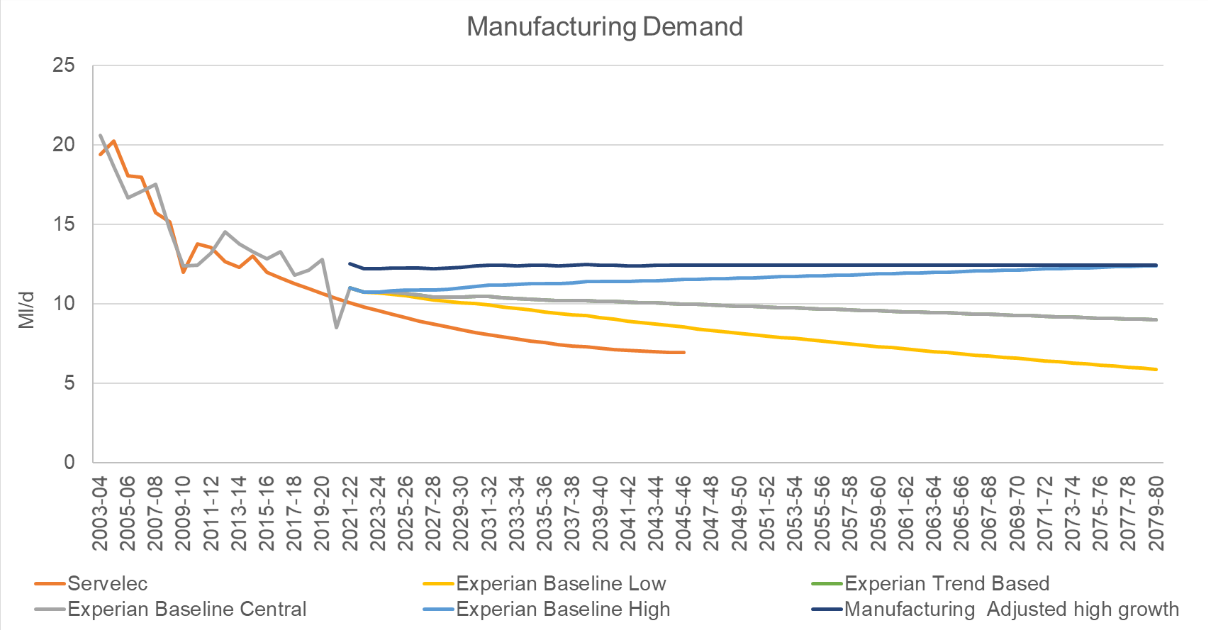
Figure 6-2: Measured NHH data inputs for WRMP24



<u>Manufacturing</u>

Manufacturing demand has reduced following the Covid-19 pandemic and has not recovered to pre pandemic levels. As a result, the demand forecast is uncertain. To account for this the High forecast has been increased to a level seen pre Covid-19 pandemic which then re-joins the Experian High forecast in 2079/80 (Figure 6-3).

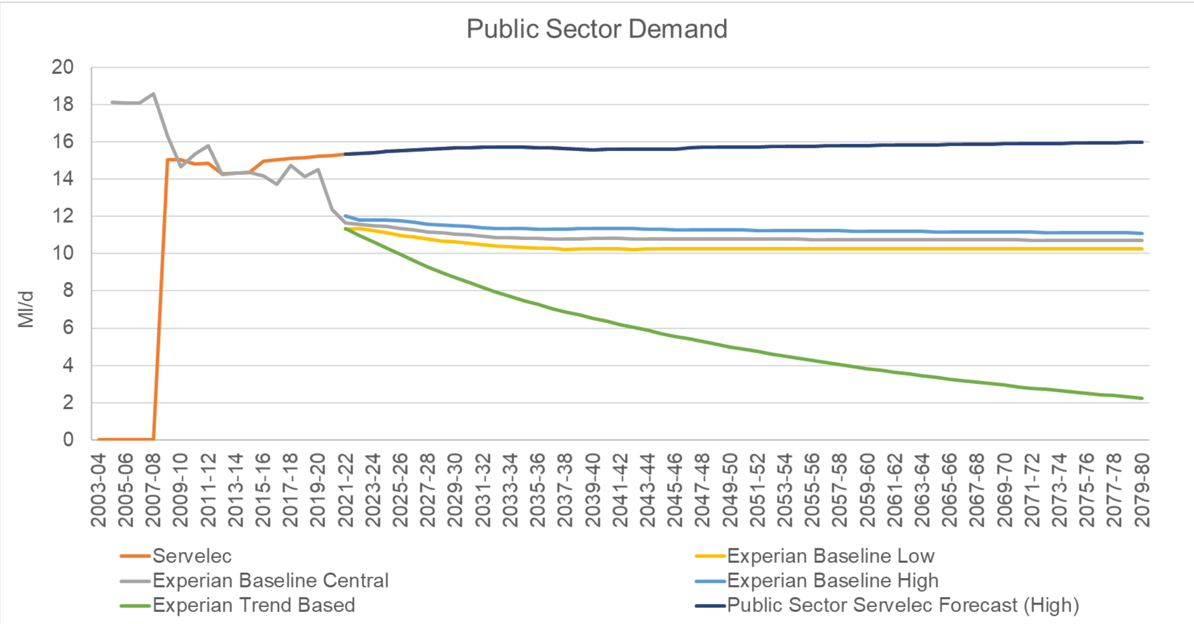
Figure 6-3: Forecast Manufacturing demand for WRMP24



Public Sector

Public sector forecast has suffered a drop in consumption following the Covid-19 pandemic and the Experian forecast does not indicate consumption returning to pre Covid-19 levels. As a result, the High forecast has been generated using the WRMP19 Central forecast from Servelec, which has been forecast out to 2080 (Figure 6-4) to account for the risk that public sector demand may fully recover.

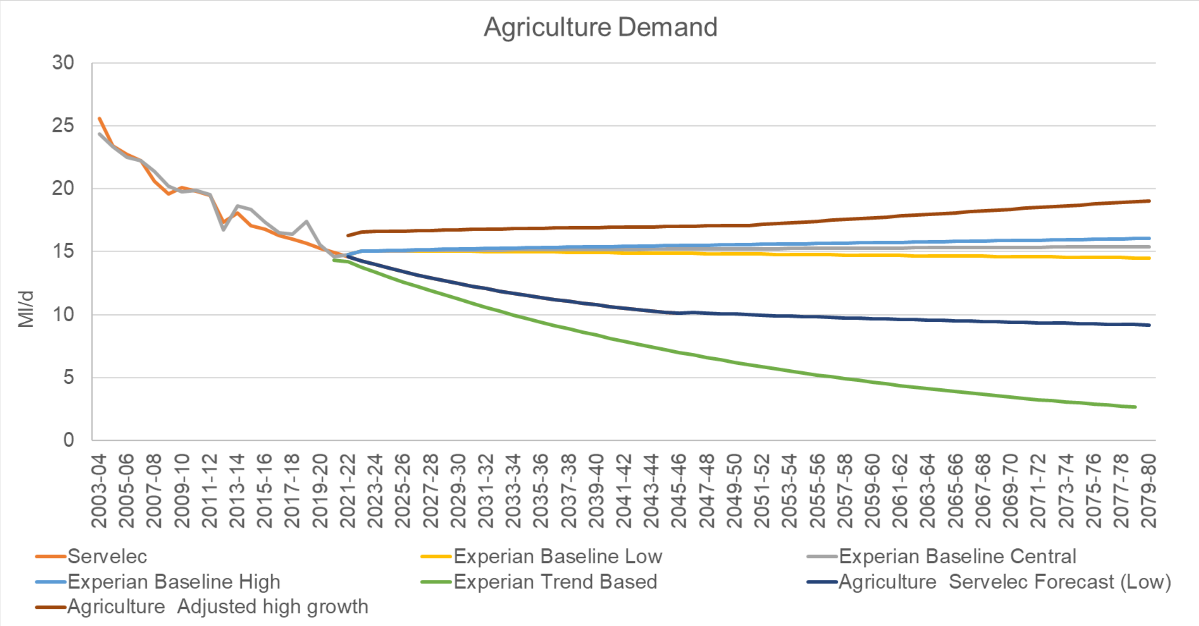
Figure 6-4: Public Sector Demand forecasts



Agriculture

Agriculture High forecast was increased to account for future uncertainty in agricultural demand from issues such as global food shortages which may increase UK agricultural production. The Low Experian forecast had little range from the Central so the Servelec WRMP19 central estimate was used for the Low forecast (Figure 6-5).

Figure 6-5: Agricultural Demand Forecasts



6.1.4 NHH demand estimates to overall demand

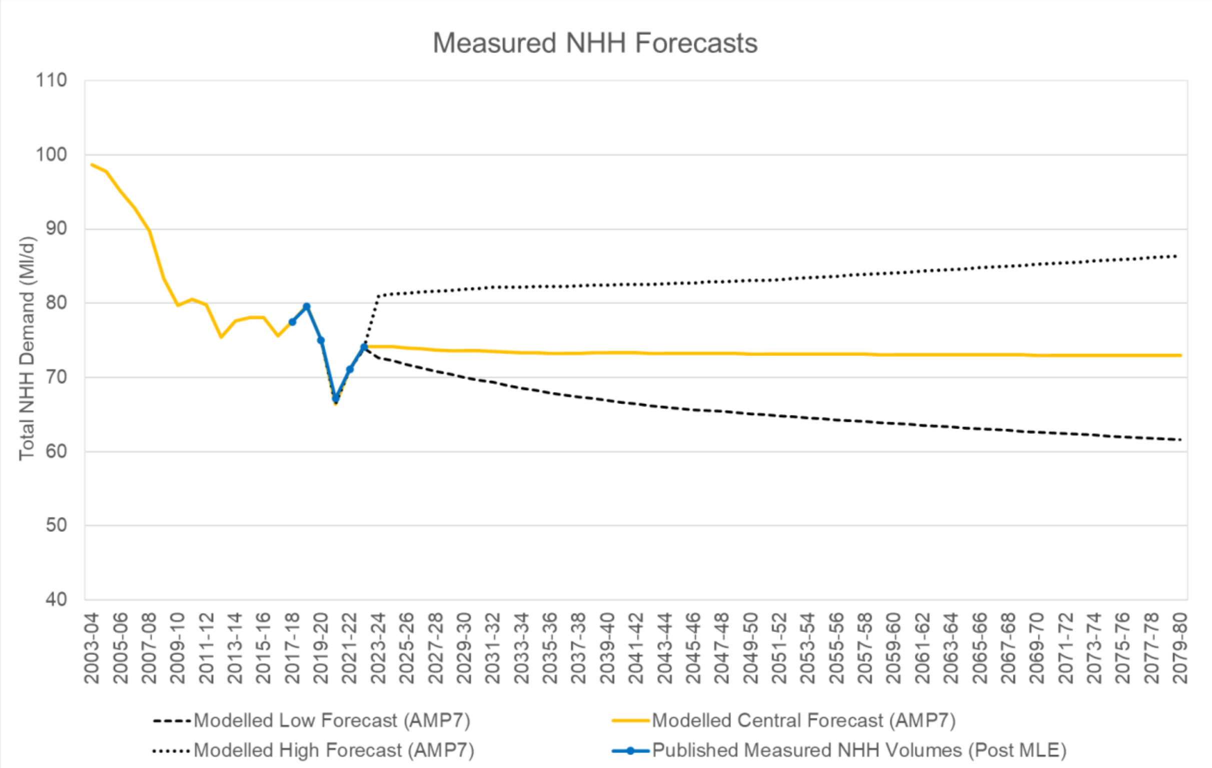
Section 7.1 details how the Low, Central and High measured NHH forecast were undertaken. These forecasts were then adjusted to account for meter under registration and other water balance adjustments. This results in each yearly forecast being increased by 6.2 Ml/d which is based on the average difference between the annual measured volumes per year and the post Maximum Likelihood Estimation (MLE) Measured NHH volume used in the water balance between 2017/18 and 2021/22. This was applied to all forecasted volumes over the planning period. The final adjustment was to align the 2019/20 forecast to the base year (2019/20) post MLE volume which resulted in the forecasted volumes being increased by a further 1.03 Ml/d.

6.1.5 Overall Measured NHH demand

Based on the approach undertaken in Section 6.1.3 and 6.1.4 the overall Low, Central and High forecasts have been generated which is presented in Figure 6-6. The forecasts have been compared against observed measured NHH volumes (post MLE). These forecasts form the basis of the measured NHH demand model inputs.

Since the publication of the draft plan, we have updated our overall measured NHH demand forecasts to account for additional observed measured NHH volumes (post MLE) in 2022/23.

Figure 6-6: Overall Low, Central and High Measured NHH forecasts



6.2 Unmeasured Non-Household Consumption

6.2.1 Base year Unmeasured NHH

Unmeasured NHH demand represents a small proportion of total demand. For the 2019/20 base year the volume was 4.1 Ml/d in comparison to 75.03 Ml/d for measured NHH. The approach to calculating unmeasured NHH is consistent with the annual water balance where an average per property allowance is generated which is then aggregated over the number of unmeasured NHH per reporting year. This approach has been developed since WRMP19 and is now Green status of on the Ofwat leakage consistency guidelines. The allowance per property is based on equivalent measured NHH types (i.e. commercial, public sector)

6.2.2 WRMP24 Unmeasured NHH Forecasts

Unmeasured NHH forecasts are based on two key factors which include the base year volume of 4.1 Ml/d which was divided by the number of unmeasured NHH in 2019/20. This equates to a per property allowance of 0.00127 Ml/d per property. This per property allowance remains consistent over the planning period. The per property allowance is then multiplied over the number of forecasted unmeasured NHH (as per Section 4). Due to the small overall volumes, a proportional approach has been undertaken. Overall volumes are forecast to go from around 2.5 M/d in 2024/25 to 0.2 Ml/d in 2079/80 as a result in the drop the number of unmeasured NHH.

7. Covid-19 influence on demand

The baseline demand forecast has forecast demand from 2019/20 which is the first year prior to the (main) impact of covid on water balance components. This base year was chosen for water balance components to remove the impact of the pandemic on the base water balance numbers for future forecasting on the basis that the pandemic, and lockdown restrictions, would not have an ongoing impact on water demand associated with lockdown periods.

However, adjustments need to be made to our baseline forecast to capture long term changes in water balance components as a result of covid which is most notably a change in hybrid office and home working. An ONS report[35] summarises:

- In spring 2022, when guidance to work from home because of the pandemic was no longer in place in Great Britain (announced February 2022), 38% of working adults reporting having worked from home at some point over the past seven days.
- In February 2022, of those workers who worked from home because of the pandemic, over 40% reported they plan to mostly work from home and sometimes at the usual place of work, with around ~25% reporting splitting time evenly between the usual place of work and home
- In addition to these changes, this may include more people living remotely, either in second homes, or relocating into or out of the Wessex Water region.

The best data we have "post-covid" was data from the most recent reporting year of 2021/22. However, as noted above the announcement of the removal of all covid restrictions did not occur until February 2021, until the end of the reporting year, which makes it difficult based on current data to split out the impacts of the pandemic and associated restrictions from any long-term changes in demand.

Any adjustments made have to consider and keep consistent adjustments to both household and non-household components. They will also need to consider that other changes will have occurred over the time period associated with broader economic and social changes, like Brexit and the now emerging cost of living crisis, which may all influence demand; pressure on household finances may lead to reductions in water use, both because of cost, but also because of the links between water use and energy use – the main driver of current inflation. In addition, there are changes to the measured and unmeasured customer base through new households and household metering.

We have analysed the following monthly data from 2021/22, and compared this to equivalent data from the years prior to the pandemic (2017/18, 2018/19 and 2019/20):

- Forecast and outturn water delivered measured households compared to in-month billed measured household volumes.
- Forecast and outturn water delivered unmeasured households compared to the unmeasured monthly consumption monitor.

For the in-month data (that is out-turn and therefore includes the potential impact of the pandemic), the average for 2021/22 and the winter average was calculated as the winter

[35] Is hybrid working here to stay? - Office for National Statistics (ons.gov.uk).

period is less likely to include any inter-annual variation in the weather, and the winter from 2021/22 is the most “post-covid” data to make a meaningful comparison (Table 7-1).

As the datasets being compared are slightly different, and as we are interested in the differences between trends in the datasets, the datasets were normalised, and then an adjustment was made to match the base year data (either 2018/19 or 2017/18) across datasets. The residual percentage difference between datasets was then compared for 2021/22 to identify any potential long-term changes in post-covid demand (e.g. the difference between the monthly data with covid impacts, as compared to out-turn and forecast water balance components that do not include any covid impacts). The outputs are summarised in Table 7-1.

Table 7-1: Consumption uplifts between forecast and 2021/22

Variable	Measured HH	Unmeasured HH
Winter 2021/22	1.14%	-0.09%
Total 2021/22	3.25%	0.84%

A selected 2% adjustment upwards for measured and 0.5% for unmeasured gives an uplift of about 2.25Ml/d normal year, as conservative adjustments. This may help to explain the drop in public sector demand (Section 6). This needs to be traded off with the non-household forecast, which has, given the inputs of economic predictors, reproduced demand reasonably well within the pandemic period (see Section 6).

8. Leakage

8.1 Historical leakage

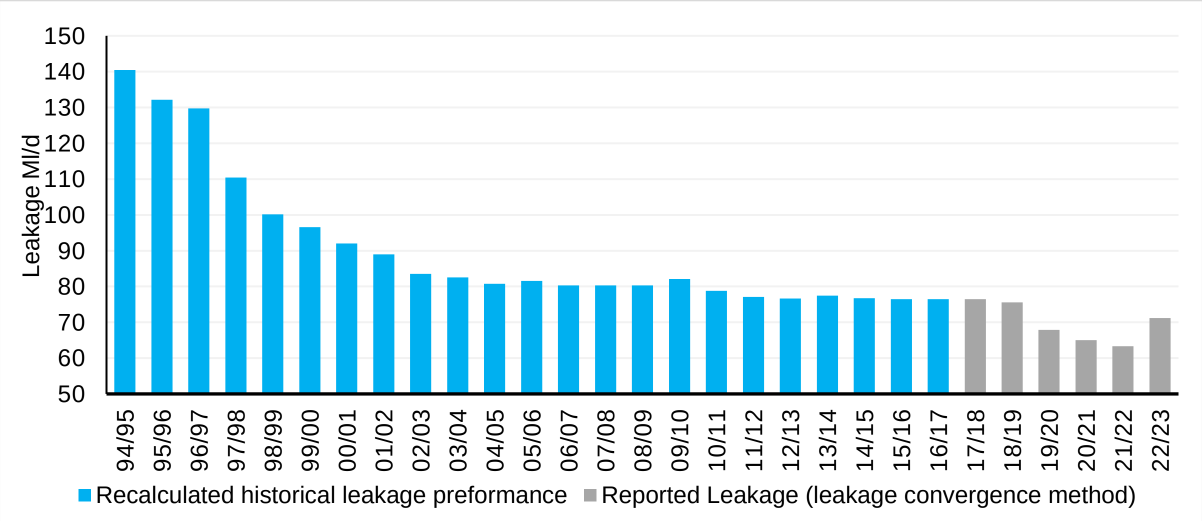
Since the mid-1990s we have halved the amount of water that leaks from our network. We managed to continue the downward trend in leakage despite our network growing each year by approximately 30 km of new water mains, around 6,000 new property connections.

Figure 8-1 presents the long-term leakage trends since 1995. From 2017/18 to 2021/22 the numbers are actual reported leakage figures as per the updated leakage consistency guidelines[36] which each water company needs to follow, replacing the approach followed previously (up to the end of AMP6 in 2019/20). These number were restated in the Ofwat Annual Performance Review in 2020/21 and 2021/22.

The leakage convergence method was used in WRMP19, however as detailed above we have since restated our leakage convergence figures based on achieving Green status on most leakage consistency method components. Therefore, the numbers are not comparable to those published in WRMP19.

The leakage figures from 1999/00 to 2016/17 have been back calculated based on the difference between the leakage figures between the old method (i.e. those reported up to 2019/20 for AMP6) and the new method for leakage consistency (i.e. 2017/18 onwards) and therefore should only be considered indicative of leakage trends.

Figure 8-1: Leakage reduction since 1995



8.2 Baseline leakage forecast

Our baseline leakage forecast assumes a continuation of current leakage strategies to achieve our current performance commitment target of a 12.8% leakage reduction as a

36 Reporting guidance - leakage - Ofwat

three-year average from the 2017/18 to 2019/20 baseline. We are well on track to meet this target and have over performed on the reductions in year 1 and 2 of AMP7, for example we have reduced leakage by 10.8% at the end of 2021/22 in comparison to 3.9% for our PC target (Table 8-1).

As a result of strong leakage reductions between 2018/19 and 2021/22, leakage could theoretically rise slightly, and we would still meet the end of AMP PC target. Therefore, the profile from 2022/23 to 2024/25 is based on meeting the end of AMP target of 12.8% which equates to an end of 2024/25 performance of 63.8 Ml/d.

As per the guidance[37], we assume in the baseline between 2025/26 and 2079/80 that leakage remains at the 2024/25 level. We have accounted for the change in supply pipe losses due to increased meter penetration and new connections and therefore the difference is applied to distribution losses.

Table 8-1: Actual and forecast AMP7 leakage performance and PC targets

	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
In year outturn Ml/d	76.5	75.6	67.9	65.1	63.3	64.0	63.8	63.8
In year reductions Ml/d		-0.9	-7.7	-2.8	-1.8	0.7	-0.2	0.0
Three-year average Ml/d			73.3	69.5	65.4	64.1	63.7	63.9
Three-year average reductions (PC Target) %				5.2	10.8	12.6	13.1	12.8
PC Target %				1.6	3.9	6.9	9.9	12.8

8.2.1 Customer Supply Pipes

Our approach for fixing customer supply pipes is detailed on our website[38]. We typically fix customer supply pipes for free and apply a rebate. Full details and conditions are provided on our website.

8.3 Leakage reduction scenarios

As per the EA guidance[37] regulators are expecting ambitious leakage reductions in WRMP24 which has been accounted for in our options appraisal, which includes expectations of leakage being 50% lower than 2017. Please refer to the Options Appraisal and Decision-Making technical report for further information on options to reduce leakage beyond the baseline.

[37] Water resources planning guideline supplementary guidance – Leakage. 2022. Ref: 18640
[38] Free leak repair service | Wessex Water

9. Minor Demand Elements

The following section details the minor elements of demand which make up the water balance.

9.1 Distribution System Operational Use

Distribution system operational use (DSOU) is the intentional use of water in the operation and maintenance of our supply network. Water is used for a variety of purposes often related to meeting statutory obligations relating to water quality, such as mains flushing, laying and commissioning; service reservoir cleaning and commissioning; sampling and sewage treatment works processes.

DSOU typically represents a small component of demand (approximately 1-2%). Estimates for annual regulatory reporting are made on the basis of records of reported occurrences and/or estimates of occurrences and assumptions regarding the volume of water used per occurrence. The method used is consistent with the leakage convergence methodology.

Over the last 15 years we have seen DSOU fall from 6.5 Ml/d in 2002/03 to 3.11 Ml/d in 2019/20. For the base year DSOU is 3.11 Ml/d and the number is consistent over the planning period. It would be reasonable to assume that this volume may increase through the planning period in-line with population growth; however, it is likely that this would be offset by increased operational efficiencies.

9.2 Other Water Use (billed and unbilled)

Other water use is the volume of water used legally (i.e. fire authorities, standpipes) and illegally (i.e. void properties, illegal standpipe use). Our current estimate is calculated as per the Ofwat leakage guidelines and is assessed on a comparable basis each year. The estimate for WRMP24 is based on the water balance year of 2019/20 which was 4.38 Ml/d. The number is not expected to increase significantly over the planning period. The UKWIR/NRA (1997) report[39] Forecasting Components of Water Demand (1997) suggests that given the small size and difficulty of measuring these components, it is reasonable to assume that the existing volume continues to apply over the planning period.

[39] UKWIR/NRA (1997). Forecasting components of water demand.

10. Impact of climate change on demand

All of the top ten warmest years for the UK, in the record since 1884, have occurred since 2002. The hot, dry summer experienced in 2018 was the equal warmest summer for the UK along with 2006, 2003 and 1976. Future warming predicts that by the mid-century these hot summers could become even more common, and close to 50% more likely[40]. Whilst the impact of climate change on water consumption is uncertain[41], the relationship between weather and demand (Figure 3-1), and in particular increased personal washing and garden water use in warmer drier periods, suggests water consumption patterns may alter with climate.

In 2013 UKWIR published a study on the *impact of climate change on water demand*[42], which examined the relationships between water use and weather variations for five case studies – including overall household consumption, micro-component consumption patterns and non-household consumption. Of particular interest for our forecasts were the household water consumption case studies that were developed from household monitor data-sets obtained from Severn Trent Water and Thames Water. The weather demand relationships were combined with climate projection data from UKCP09 to develop a set of regionally based look-up tables to estimate the future impacts of climate change on household demand. A range of percentiles were produced for each year between 2012 and 2040 to reflect the uncertainty associated with the climate change projections.

Table 10-1 summarises the outputs from the study for a selection of years through the planning period. Taking the 50th percentile as a central estimate of the impact of climate change suggests that demand will increase by 0.68 % and 0.99% up to 2040 as a result of climate change depending on whether the Severn Trent Water or the Thames Water model is used.

Table 10-1: Estimates of climate change impacts on domestic demand (% change relative to base year) for south-west England. Reproduced from UKWIR (2013)

	2011/12	2014/15	2019/20	2024/25	2029/30	2034/35	2039/40
Severn Trent Water model							
P10	0.00	0.04	0.11	0.18	0.24	0.31	0.38
P50	0.00	0.11	0.28	0.46	0.63	0.81	0.99
P90	0.00	0.18	0.47	0.77	1.06	1.35	1.65
Thames Water model							
P10	0.00	0.02	0.05	0.10	0.14	0.17	0.21
P50	0.00	0.07	0.17	0.32	0.44	0.56	0.68
P90	0.00	0.13	0.31	0.58	0.80	1.03	1.25

[40] Met Office UK Climate Projections: Headline Findings, July 2021: ukcp18_headline_findings_v3.pdf (metoffice.gov.uk).
[41] Water resources planning guidelines
[42] UKWIR (2013). Impact of climate change on water demand. CL/04.

The two models suggest broadly similar impacts.

WRMP24 planning guidelines states that in most cases the expected impact of climate change on demand is likely to be no more than 1% over the planning period, and should not be more than 3%, unless an exception can be demonstrated[43]. To account for climate change impact on household demand, we have assumed a maximum 1% impact on demand over the planning period up to 2079/80. We have also accounted for uncertainty in climate change impact on demand in headroom analysis (See the Decision-making Technical Appendix).

A 1% increase in consumption by the end of the planning period to 2079-80 under our central planning scenario results in a 2.34Ml/d uplift in NYAA consumption, a 2.39Ml/d uplift in DYAA consumption and a 2.91Ml/d uplift in DYAA consumption.

In accordance with the UKWIR 2013 study[42], given the relative paucity of evidence on the impact of climate change on non-household demand, we have made no adjustments for the impact of climate change on non-household demand.

The Uncertainty and baseline Supply Demand Balance and Decision-Making report describes that our preferred options for the final planning scenario include leakage reduction, increased optional metering, and water efficiency activities. The impact of climate change on the metering and water efficiency options are inherently accounted for in the percentage uplift that we apply to household demand.

[43] Water Resources Planning Guideline – December 2021

11. Non-Connected demand

The WCRG group commissioned a study[44] into potential additional demand from private supplies, agriculture and mining in drought conditions. This additional demand growth could occur during a drought or via a gradual long term growth where successive droughts results in customers switching to a Wessex Water supply.

Within the demand forecast, no demand allowance has been made for NHH demand which is not connected to our supply network due to having their own private supplies. This is partly because of the time delay in connecting a customer to the supply network which could take 2-5 months depending on the scale of the work and if road closures are needed, therefore there is considerable uncertainty if this additional demand would arise during a drought. There would also be an additional delay if considerable customers applied to connect into the network at once. Our pre consultation with Ofwat highlighted that the focus should remain on connected public water supply. As per the NHH, no allowance has been made for non-connected households.

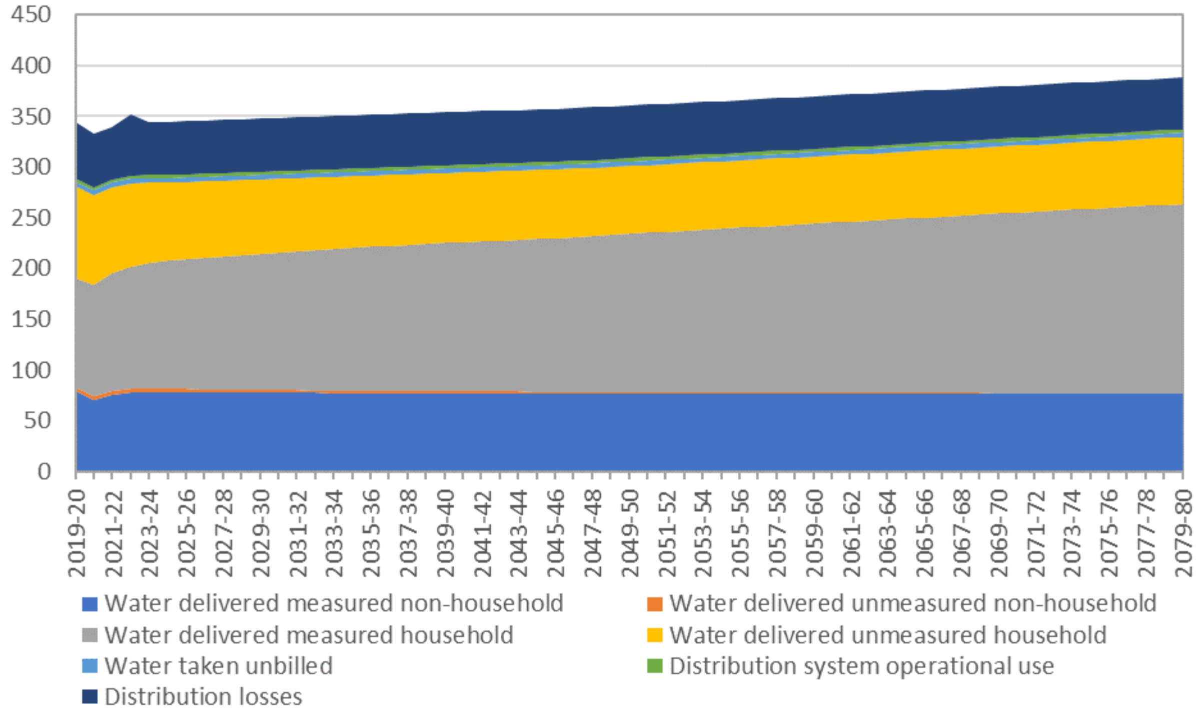
In terms of long-term growth in non-connected demand our scenario analysis of potential futures has considered a range of growth factors for households and non-household demand growth and therefore to avoid double counting of additional non connected demand this study has not been considered further. The report highlighted significant uncertainty in the volumes which may arise. It is recommended a national study assessing the non-connected demands for water.

[44] ARUP. West Country Water Resources Assessment of Water Demand in Private Water Supply, Agriculture (Livestock) and Mining sub sectors to inform the Regional Plan Final Report. June 2022.

12. Demand Forecast Summary

The overall demand forecast as detailed in the preceding section is summarised in Figure 12-1, for our preferred "most likely" planning scenario - the figures for the forecast can be found in our planning tables. Overall demand is forecast to remain relatively stable with a rise of 43 Ml/d from 2024-25 to 2079-80. The main change driving this overall rise is an increase in measured household consumption, above and beyond a rise that would be expected as a result of unmeasured properties switching, but resulting from changing overall forecast consumption trends.

Figure 12-1: Total annual average demand forecast over the planning period



13. Demand Forecast Assumptions

To comply with Section 37A(3)(d) of the Defra Direction, a water company must include the assumptions it has made as part of the supply and demand forecasts contained in the WRMP in respect of… (ii) household demand in its area, including in relation to population and housing numbers, except where it does not supply, and will continue not to supply, water to domestic premises; and (iii) non-household demand in its area, except where it does not supply, and will continue to not supply, water to non-domestic premises or to an acquiring licensee.

This section explicitly states those assumptions.

In respect of sub-clause (ii) assumptions in relation to household demand in its area, including in relation to population and housing numbers, Section 4.4 and Section 4.5 provide the methodological details of the household property and population forecasts. The key assumptions are:

- That the Office for National Statistics (ONS) properties forecast data under a range of growth scenarios, alongside the properties data contained within the local authority plans provides appropriate data sources, as per the UKWIR (2016) guidance manual, to appropriately forecast the range of potential future changes in local property growth within the Wessex Water supply area.
- We have assumed that the ONS Principal trend-based forecast provides the best central planning forecast for our main central planning scenario, given it is more consistent with historical long term average trends
- We have also assumed that the LA plan-based forecast in the short term, trending to the historical long-term average, provides an appropriate upper bound to our forecasts. This is based on the assumption that the forecasts from LAs to derive the time-series of build rates is based on a housing land supply statement, that is often front loaded to help meet local plan objectively assessed needs that have been under-delivered, and hence is about providing an appropriate amount of land to ensure building rates are met, as opposed to the actual number of properties that are built in a given year. We have therefore assumed that smoothing this trajectory, whilst also ensuring we deliver the total properties against the objectively assessed needs, is appropriate.
- To derive our forecast numbers for population growth rate we have assumed a methodology whereby we derive a percentage growth rate from each of the available forecasts and apply this to our base-year population number.
- In our base-year number we use a hidden and clandestine population adjustment based on a study undertaken in 2016, and we have implicitly assumed that this study is valid for the hidden and clandestine population today.
- We have netted off our total properties forecast in the supply area the forecast property growth for NAV areas, based on liaison with the NAV companies operating in our supply area, and assuming our standard new properties per property consumption, removed this demand from exports, as per the WRMP guidance updated in 2023.

Our forecast of non-household demand assumes:

- That an individual sector-based approach to forecasting, combined together to derive an overall non-household demand forecast, is an appropriate approach to forecast non-household demand.
- That multi-linear econometric regression models based on historical changes in demand volume (past trends), and various explanatory variables are an appropriate way to forecast future demand.
- That the uncertainty in the forecast can be adequately understood through a comparison of the range of different forecasts produced in previous studies to derive low, central and high forecasts.

Annex A. Local Authority Letter

Wessex Water
YTL GROUP

18th August 2021

Dear Sir/Madam,

Request for information: Local Plan housing and population projections

We are currently preparing our Water Resources Management Plan, which describes how we will balance our customers' demand for water with available supplies over the next 25 years. A key input to this plan is a forecast of population and housing growth so we can forecast future water demand. We are required by our regulators – the Environment Agency - to base this forecast on the Local Plans published by the local councils or unitary authorities that intersect our supply area.

I am writing to request information on the status of the Local Plan for your local authority, and the most recent housing trajectory and population forecasts made since the plan was adopted. I would be very grateful if you could respond to the questions below by 22nd September 2021. Please respond to chris.hutton@wessexwater.co.uk and wrmpconsultation@wessexwater.co.uk.

- What is the current status of your Local plan/core strategy (e.g. submitted/adopted)?
- Could you please provide the following information:
    - the total time-horizon of the plan (e.g. 2015-2035)?
    - The total assessed housing need to be built over this horizon?
    - The number of properties built to date, and the date of this assessment?
    - The remaining number of properties to be built from this date to meet the overall need?
    - The projected new households in each year of the planning horizon, and how this has been profiled to account for under/over-delivery against the need?
    - The population forecast and occupancy rates that fed into the identification of required housing need, and the basis of this information (e.g. ONS data) and modifications made based on local assumption (e.g. specific migration rates)?
- Local authorities in England are now required to use local housing need calculations to inform their local plans. Can you provide the local housing need calculations and how this assessment differs from current adopted local plans?
- Has work begun in developing new forecasts for the next local plan/core strategy? If so, are these significantly different from the current plan trajectories?
- Could you also inform us whether in the current adopted plan or plan under development, there are any particular locations of significant planned development?

Kind Regards

Christopher Hutton