



Revised Draft Water Resources Management Plan 2024

Section 3 – Demand Forecast



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Background and Introduction

Changes made between draft WRMP24 and revised draft WRMP24:

- The base year has been changed from 2019/20 to 2021/22 (AR22). At the time of producing forecasts AR22 was the most recent water balance available.
- Revised forecasts of population and properties have been produced. All forecasts of growth used in our plan have been updated with the latest local authority plan information. Rebased profiles of ONS18 national and subnational population projections have also been used.
- New forecasts of household demand, DYAA and DYCP, have been produced based on the updated growth profiles
- In line with the updated Water Resources Planning Guideline we have moved any potential savings associated with government-led interventions out of the baseline demand forecast. This results in changes to the “trend adjustment factor” in order to prevent double counting.
- Estimates of demand forecast to arise from development of data centres have been added to the NHH forecast.

3.1 We are responsible for the supply of wholesome water to more than 10 million customers in over 4 million properties. Over the past ten years the population we serve has been growing at an average rate of more than 100,000 people a year This means that we now need to supply water to more than 1 million people more people than a decade ago.

3.2 To ensure we can provide a safe and secure supply of water to all our customers, we produce forecasts of what the likely demand for water will be in the future.

3.3 ‘Demand’ is the term we use to describe the water that is supplied through our network to households, workplaces and schools; water taken illegally and legally unbilled; water used by industry; water used in maintaining the water network; and water that is lost through the distribution systems.

3.4 Demand forecasting is the method by which we estimate future demand for water. We use mathematical models which use information such as population and property projections, water use data and trends, and a range of other information to forecast how the components of demand for water are likely to vary over the next 80 years.

3.5 For the revised draft Water Resources Management Plan 2024 (rdWRMP24) we have produced multiple different forecasts of demand for use in investment modelling. We have adopted an adaptive planning approach, along with our neighbouring water companies in the Water Resources in the South East (WRSE) Group, which allows multiple different futures to be considered. These forecasts of demand are intended to understand the impact of both higher and lower growth on demand and produce an adaptive plan which provides a best value solution across these scenarios.

3.6 Over the planning period we face continued growth in demand. Upward pressures include:

- Population increase

- Climate change
 - Increasing commercial demand
- 3.7 These upward pressures are partially offset by downward pressures from:
- The improving efficiency of water fixtures and fittings such as toilets, dish washers, washing machines, etc.
 - Water efficient new housing resulting from design requirements of building regulations
 - Customers opting for a meter to better manage their consumption
 - Customers being more efficient in their use of water
- 3.8 For WRMP24, we continue using the methods identified from the UKWIR project “WRMP19 Methods – Household Consumption Forecasting”¹. Using these methods, we estimate an increase in household demand of more than 300 MI/d by 2050 and then marginal decreases after this to give an overall increase of approximately 290 MI/d by 2075.
- 3.9 Non-household water use is forecast to increase by approximately 60 MI/d over the planning period to 2050 and a total increase of 72 MI/d by 2075, although it should be noted there are differing trends across our six WRZs. Generally, increases in water use from service industries (e.g. offices, call centres) are being offset by reductions in demand from non-service industries (e.g. industrial sites, breweries).
- 3.10 The baseline demand forecast is the starting position for the future supply demand balance without any planned interventions from 2025. It includes demand reductions from the promotion of water efficiency, leakage reduction and metering activities assumed in price limits up to 2024-25, i.e. the demand management practices in place at the beginning of the new planning period.
- 3.11 Water taken unbilled, operational use and leakage are forecast to remain at current levels in the baseline forecast.
- 3.12 Overall, the total baseline demand forecast (before intervention) is expected to increase by more than 265 MI/d in the period of 2023-2050 and then marginally reducing to 262MI/d by 2075. This represents a significant challenge. As part of our plan, we have looked at strategies to reduce demand (Section 8) and show how different levels of demand management affect the cost and performance of future plans and strategy (Section 10). This is in accordance with the Water Resources Planning Guideline² (WRPG) which states that the plan should address government policy including reducing the demand for water.
- 3.13 The remainder of this section is structured as follows:
- An introduction to the concept of ‘demand’
 - Guiding principles and drivers of demand
 - Annual water balance – reporting the components of the water balance relevant to the base year, 2019-20

¹ UKWIR 2015 WRMP19 Methods – Household Consumption Forecasting 15/WR/02/9

² Water resources planning guideline Version 12 updated March 2023

- Demand forecasting – how we forecast demand to 2050 and then to 2100

What is 'demand'?

- 3.14 'Demand' is the term we use to describe the water that we use that is supplied through our network.
- 3.15 When reporting demand for water it is split into the following categories:
- Household Use - water used in the home and garden
 - Non-household Use - water used by businesses
 - Operational Use - water used maintaining the network
 - Water Taken Unbilled - water used without charge either legally (e.g., fire hydrant use), or illegally (e.g., usage in a property declared as void (empty))
 - Leakage - water lost from the distribution system
- 3.16 We calculate and report these components on an annual basis in a process known as the 'water balance'.
- 3.17 Demand forecasting is the method by which water companies estimate future demand for water. We use mathematical models which use information such as population and property projections, water use data and trends, and a range of other information to forecast how the components of demand for water are likely to vary over the next 80 years. We produce updated forecasts every five years, with an annual review in the intervening period. We follow industry guidelines supplemented with our own detailed analysis.

Guiding principles

- 3.18 The WRPG sets a clear framework for developing a demand forecast. We have followed the latest UKWIR guidance³ in developing our forecasts.
- 3.19 For the baseline forecasts it is assumed that beyond 2024-25 water efficiency activity delivered in AMP7 will continue to be maintained across the forecasting period. Our baseline assumptions are also that meters will only be fitted where customers request a meter and in new properties, and that there will be no additional leakage reduction, although activity to maintain leakage at current levels continues.
- 3.20 AMP7 activity includes the progressive household metering programme in London to 2025, where we will fit meters to properties including those that have not requested a meter. Our progressive metering programme assumes that after a one-year adjustment period the customer will be switched over to a measured tariff. This will deliver benefits through demand reduction and leakage detection and repair, as well as delivering long-term efficiencies for network maintenance in metered areas.

3.3 ³ UKWIR, WRMP19 Methods – Household Consumption Forecasting, 15/WR/02/9, 2015

- 3.21 Within the Thames Valley area (our WRZs other than London) we have brought forward our plans for progressive metering as part of the Green Economic Recovery programme⁴. We now plan to install 200,000 meters in our Thames Valley area in AMP7.
- 3.22 Once all the steps in the water resources planning process have been completed, a range of demand reduction options will be included in the demand forecast, such as further leakage reduction, progressive household metering and additional water efficiency measures (Section 8: Appraisal of demand options, Section 10: Programme appraisal and Section 11: Preferred programme). We call this final demand forecast the ‘Final Plan’ forecast to differentiate it from the ‘Baseline’ forecast described above.

Demand drivers

- 3.23 Demand for water varies due to several factors. One of the most important of these factors is the weather. In hot, dry weather, customers use additional water for activities such as garden watering or filling paddling pools. On the other hand, in cold weather, leakage will rise, because pipes can contract causing joints to break, resulting in leaks. The effect of weather on demand is shown in Figure 3-1. Extreme hot and extreme cold temperatures tend to increase demand (via increased household consumption and leakage respectively), while rainfall tends to dampen demand.

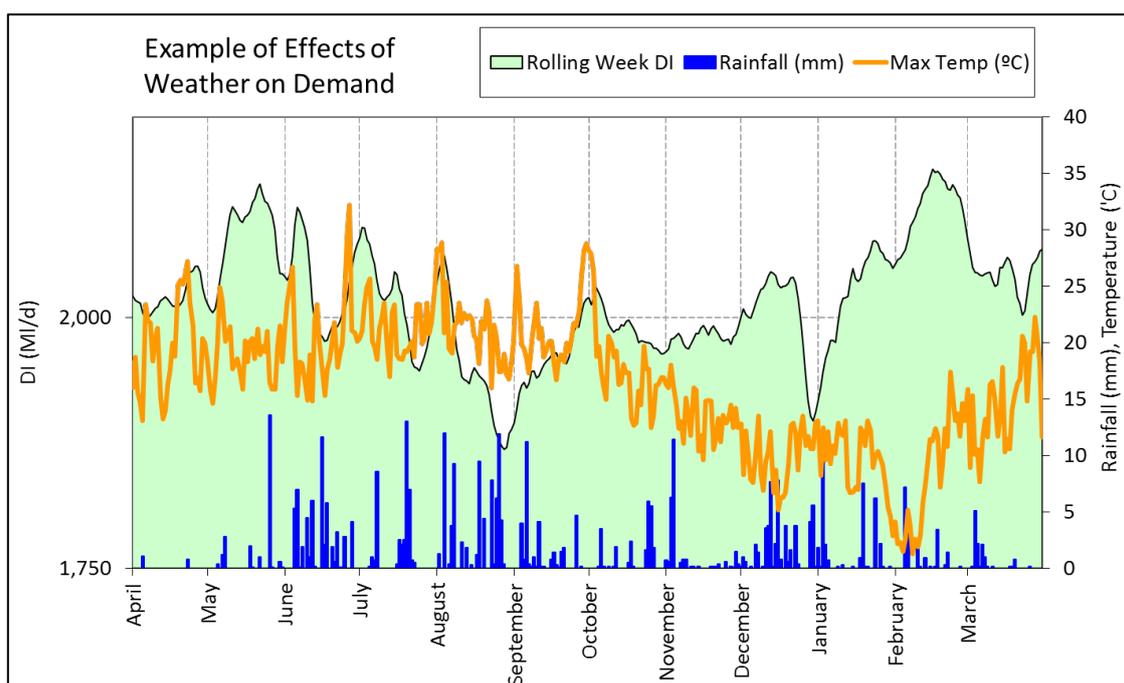


Figure 3-1: Effect of weather on demand (measured by Distribution Input)

- 3.24 Demand will change over time in response to a range of drivers which also change over the planning period. The main drivers, which are included within demand forecasting models, are:

⁴ [Green-economic-recovery-final-decisions.pdf \(ofwat.gov.uk\)](https://www.ofwat.gov.uk/green-economic-recovery-final-decisions.pdf)



- Population and property growth
- Effects of climate change
- Changes in non-household consumption, including industrial and commercial use
- Trends in household water use linked to behaviour and technological development of water using devices

3.25 Leakage is an important element of demand but in our baseline scenario leakage remains constant after 2025-26 as required by the WRPG, at the target level as set by Ofwat with their 2019 Final Determination, including reductions associated with the conditional allowance⁵ and Green Economic Recovery programmes.

- Demand drivers are discussed in more detail within the remaining sections of this document and in Appendix E: Populations and property projections, Appendix F: Household water demand modelling, Appendix G: Non-household water demand and Appendix H: Dry year and critical period forecasting

⁵ Thames Water final determination [PR19-final-determinations-Thames-Water-final-determination.pdf](https://www.ofwat.gov.uk/pr19-final-determinations-Thames-Water-final-determination.pdf) ([ofwat.gov.uk](https://www.ofwat.gov.uk))

Base Year Demand

The water balance

3.26 To understand how water is used across our supply area in a year, we use a water balance. An overview of the water balance is shown in Figure 3-2 below.

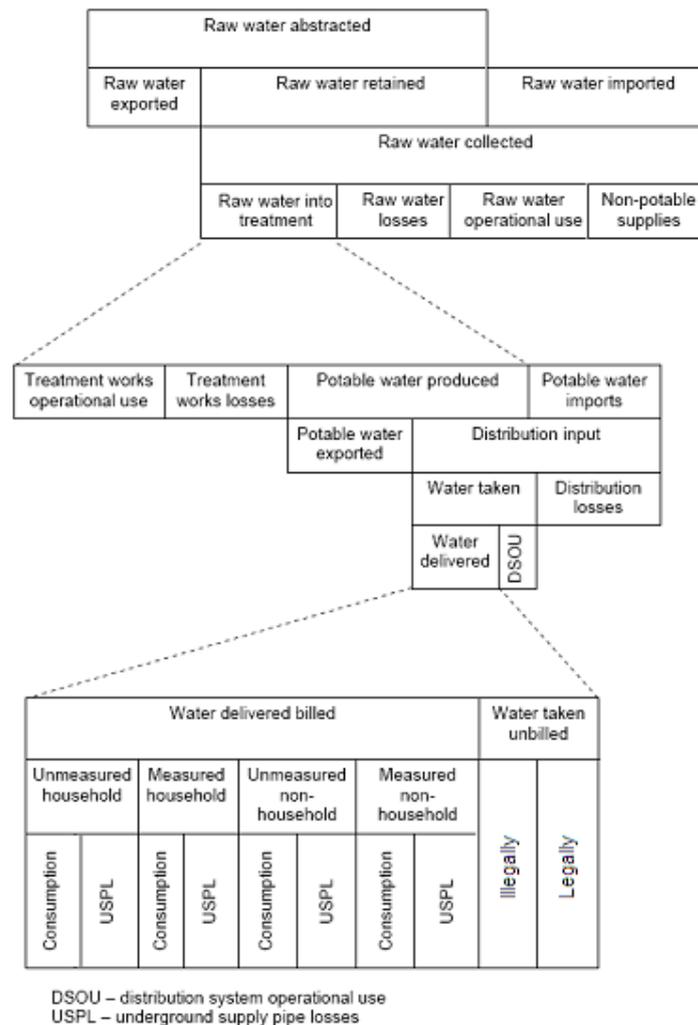


Figure 3-2: Overview of water balance

3.27 The water balance is split into components as shown in Figure 3-2. The sum of the household, non-household, leakage and minor component volumes should equal the distribution input volume. Not all of these volumes can be directly measured (e.g., unmeasured consumption) and so must be estimated. As some components are estimated, a mathematical method called maximum likelihood estimation (MLE) is used to reconcile the components with the distribution input.

Choice of base year and Covid-19 impacts

- 3.28 The base year of the demand forecast is 2021/22, this is the most recent reporting year available at the time of producing forecasts. While restrictions from Covid-19 pandemic remained in place until February 2022 the reporting year was not affected by the restrictive lock downs that had been experienced the previous year and therefore we opted to use this as the base year for our forecasts.
- 3.29 As the UK has now moved out of lockdown and returns to normality post Covid-19, household demand is showing reductions from the peaks seen at the start of the pandemic. What impacts will be seen in the long-term is unknown.

Base year properties

- 3.30 Company level property numbers by type (measured/unmeasured, household/non-household, void household/void non-household) are derived from our SPRING billing system. These include adjustments to the unmeasured and measured household and non-household figures for missing properties. They also take account of properties that have moved to a measured tariff due to optant metering as well as the addition of new properties to the count of measured households.
- 3.31 The number of properties of each type within each WRZ is then calculated using a database called Netbase. Netbase takes property information from SPRING and geo-references it, firstly to District Meter Areas (DMAs), a discrete area of the network where water supplied is metered, then to Flow Monitoring Zones (FMZs), discrete areas of the network where the water supplied is measured by a zonal meter, and finally to Water Resource Zones (WRZs). The proportions from this exercise are then used to apportion the property numbers from SPRING to each WRZ.
- 3.32 The base year property values are summarised in Table 3-1.

WRZ	Households (000s)			Non-households (000s)		
	Unmeasured	Measured	Void	Unmeasured	Measured	Void
London	1,471.180	1,437.080	107.272	28.173	113.223	26.846
SWOX	142.032	281.930	8.993	1.441	17.774	3.300
SWA	94.098	112.898	3.905	0.636	8.786	1.360
Kennet Valley	66.856	93.025	3.389	0.577	5.658	1.186
Guildford	27.467	34.213	1.392	0.322	2.756	0.484
Henley	6.420	14.210	0.432	0.082	0.698	0.128
Thames Water	1,808.053	1,973.355	125.384	31.231	148.894	33.305

Table 3-1: Base year properties (2021-22)

Base year population

- 3.33 The starting point for estimating base year population is the mid-2020 population estimates published by the Office for National Statistics (ONS). This data was then updated to the base year of 2021-22 using projections from expert consultants, Edge Analytics, and the Greater London Authority (GLA) for areas within London. Edge Analytics has worked with us to develop a more granular distribution of population for the



WRMP24. This has been done using census output areas giving a better occupancy distribution and population split across WRZs. Insight from this work has been incorporated in our plan.

- 3.34 Not all population is accounted for in official statistics. To take account of “hidden” population, for short-term migrants and second addresses we apply an additional allowance, based on a study by Edge Analytics⁶. This allowance totals an additional population of 665,170, the majority of which are within London.
- 3.35 Non-household population is population residing in communal establishments; based on the Ofwat eligibility criteria released in July 2016⁷.
- 3.36 The total household population is derived by subtracting the total non-household population from the total population. The 2022 Annual Return (AR22) estimated the population associated with communal establishments at 103,843. The unmeasured non-household population remains at zero.
- 3.37 The population split between measured and unmeasured households uses data obtained from occupancy questionnaires which were sent to 49,028 households, both unmeasured and measured, of which 11,482 were returned with valid data. All responses could be classified by property type, metering type, ethnicity and region enabling us to scale up responses according to the effective sampling rates of each category. We also adjusted for any occupancy bias in the responses by comparison with profiles of occupancy classes obtained from the Census 2011⁸ for regions covering our London and Thames Valley zones.
- 3.38 To update population splits between measured and unmeasured households this year we have used the movement in properties, reductions in unmeasured properties as customers opt for a meter, and increases in measured properties associated with optants, in addition to newly built properties⁹.
- 3.39 It is assumed that the occupancy of the additional measured properties is the same as the occupancy of the existing measured properties. This plan also considers the impact of population in bulk billed blocks of flats (subsidiary properties), taking account of the population in the measured/unmeasured household split rather than in non-household population. This should provide a more reflective view of the population distribution. The residual movement in population is assumed to be in the unmeasured population base. Base year populations are summarised in Table 3-2. As with any company, large changes in government statistics on population estimates would affect our plan.

WRZ	Population (000s)	
	Unmeasured	Measured
London	4,052.117	4,001.019
SWOX	371.527	686.222
SWA	264.187	280.359

⁶ Clandestine and Hidden Populations Edge Analytics February 2020

⁷ [Eligibility guidance on whether non-household customers in England and Wales are eligible to switch their retailer – Ofwat July 2016](#)

⁸ Census 2021 detailed statistics will not be available until at least summer 2023

⁹ All newly built properties are required to be fitted with a water meter. In our supply area these will be smart meters

WRZ	Population (000s)	
	Unmeasured	Measured
Kennet Valley	182.955	229.369
Guildford	74.616	87.836
Henley	16.272	34.061
Thames Water	4,961.675	5,318.867

Table 3-2: Base year household population (2019-20)

Household demand

3.40 Household demand is often described by the volume of water used per person each day and is called Per Capita Consumption (PCC). Unmeasured customer PCC is calculated from our Domestic Water Use Survey (DWUS); a panel of customers who have voluntarily had meters installed but are charged on an unmeasured basis. Measured customer PCC is calculated by totalling the volume recorded by all customer meters; allowances are then applied for supply pipe leakage, which is subtracted, and meter under-registration¹⁰, which is added. This total volume of water is then divided by the estimated total number of measured customers to give a measured customer PCC.

3.41 For 2021-22 the average, measured, and unmeasured PCC for each WRZ is shown in Table 3-3.

WRZ	Unmeasured PCC	Measured PCC	Average PCC	% Metered
London	164	125	144.3	47.66%
SWOX	167	133	145.0	65.12%
SWA	166	133	149.1	53.53%
Kennet Valley	157	129	141.6	56.98%
Guildford	166	128	145.5	54.24%
Henley	163	147	152.0	67.47%
Thames Water	164	127	144.6	50.51%

Table 3-3: Per capita consumption (2021-22) (l/person/d)

Non-household demand

3.42 Most non-household demand is measured. It is primarily water used by commercial, industrial and agricultural premises, though there is a small population whose consumption is included within the non-household category as they live in properties classified as 'mixed' (e.g. a flat above a shop).

3.43 Assessed non-household¹¹ usage is estimated using a matrix which looks at the size of the property supply and the number of full-time employees as well as the business type, calculating an estimated daily consumption. Unmeasured non-household usage is

¹⁰ Water meters on average under record volumes of water used and therefore a correction is applied to improve the accuracy of water used in measured properties

¹¹ Non-household properties where it is impractical to fit a meter

assigned by billing band type and number of billed units supplied by the Central Market Operating System (CMOS).

3.44 Non-household demand for 2021-22 was reported as shown in Table 3-4.

WRZ	Measured	Unmeasured
London	288.64	12.19
SWOX	53.39	0.69
SWA	14.35	0.29
Kennet Valley	12.26	0.24
Guildford	5.02	0.16
Henley	1.26	0.04
Thames Water	374.91	13.61

Table 3-4: Non-household consumption (2021-22) (MI/d)

Leakage

3.45 The reported leakage value for our AR22 was 595.80 MI/d, consistent with the guidance contained within the 2017 UKWIR report “Consistency of Reporting Performance Measures” (17/RG/04/5). As the WRMP is required to plan for a dry year scenario we use the DYAA uplifted leakage value of 605.86 M/d as the base year value.

3.46 Leakage is split into two categories:

- Distribution losses: these are leaks on our own infrastructure and make up approximately 72% of total leakage
- Supply pipe leakage: this is water leaking from customer supply pipes, which are the responsibility of customers, although we offer a free leakage repair service to household customers who meet eligibility criteria

3.47 Leakage for each WRZ, as reported within Appendix A of AR22, is shown in Table 3-5.

WRZ	Total Leakage (MI/d)
London	431.79
SWOX	68.75
SWA	44.40
Kennet Valley	27.67
Guildford	18.58
Henley	4.61
Thames Water	595.80

Table 3-5: Actual leakage (2021-22)

Minor components

3.48 Minor components include the demand taken from the distribution system for our operational use and any water which is taken but unbilled. Operational use includes water used by a company to maintain water quality standards in the distribution system such as mains flushing. Water taken unbilled includes public supplies for which no charge is made

(sewer flushing etc.), fire training and fire-fighting supplies; it also includes water taken illegally.

3.49 At the company level, minor components add up to 77 MI/d in the base year.

Summary for 2021-22

3.50 Figure 3-3 shows the breakdown of the total demand reported in the water balance for 2021-22 by component. Overall household water use accounts for 58%, leakage for just over 23% and non-household demand accounting for approximately 15% of total demand. The remaining 3% is accounted for by minor components, water taken unbilled and operational use.

3.51 This split of total demand and its sub-components forms the base position for the demand forecast.

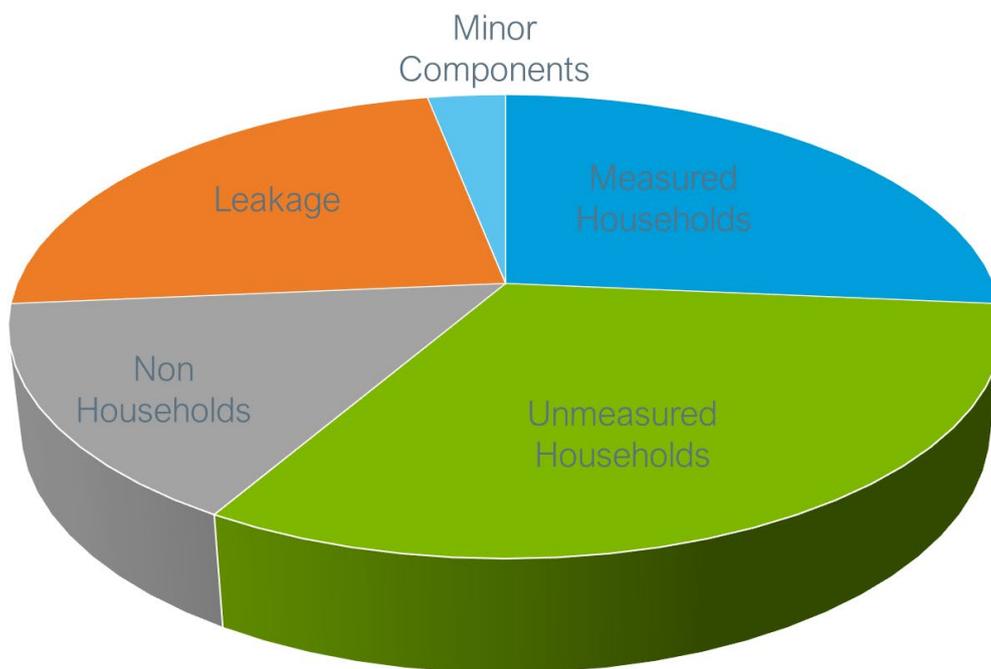


Figure 3-3: Sub-components of demand (2021-22)

Future demand – the demand forecast

Planning scenarios

3.52 Demand reported in the water balance reflects the conditions experienced in that year. It may have been, looking at the year as a whole, wet, dry, hot, cold or somewhere in the middle. From a planning perspective, we are interested in the demand that would be expected to be met up to the point that the system becomes stressed, as set out in our level of service. Therefore, we need a demand forecast which is reflective of that level of service. We use planning scenarios to recreate anticipated demand levels.

3.53 The planning scenarios we use are:

- Dry Year Annual Average (DYAA) scenario: this describes the average daily demand in a dry year (a period of low rainfall) where there are no constraints on demand
- Dry Year Critical Period (DYCP) scenario¹²: this describes the average daily demand over the critical period, which for some of our WRZs is during the peak week for water demand
- Normal Year Annual Average (NYAA) scenario: this describes the average daily demand in a normal year. We produce this forecast for investment planning purposes. It allows us to better model the utilisation and costs of operating potential future options

3.54 Table 3-6 summarises the scenarios constructed for each of our WRZs:

WRZ	Baseline		Final Plan	
	DYAA	DYCP	DYAA	DYCP
London	✓	✗	✓	✗
SWOX	✓	✓	✓	✓
SWA	✓	✓	✓	✓
Kennet Valley	✓	✓	✓	✓
Guildford	✓	✓	✓	✓
Henley	✓	✓	✓	✓

Table 3-6: Planning scenarios used in each of our WRZs

3.55 We do not report on DYCP demand for the London WRZ. This is because peak demands in London can be met through the relatively large volume of surface (raw) water storage (reservoirs) and treated water in the London Ring Main. The ability to meet peak demands is therefore not a resource availability issue at present but dictated by treatment and transmission capabilities.

3.56 All other zones could be driven by summer weather-related peak demands. Thus we calculate both the DYAA and the DYCP scenario in order to establish the planning scenario which drives the need for investment.

3.57 All scenarios are produced by factoring up or down the demand reported in the base year, the approach used is described below.

¹² The point where demand and supply are most closely matched

Peaking factors

- 3.58 Peaking factors are used to uplift or reduce out-turn demand in any year to the DYAA and DYCP planning scenarios.
- 3.59 As in previous WRMPs, the level of demand in all planning scenarios has been derived using analysis of the impact of a range of weather scenarios on demand using a long time-series of weather data. Models of how demand varies as a function of weather have been developed and calibrated using a number of years' worth of weather and demand data.
- 3.60 The model explains the weather dependent variability of both usage and leakage. Once trained, the models are given inputs of measured distribution input (DI) from the year of interest (here, 01/04/2021 – 31/03/2022) and weather conditions over the same period, in order to estimate the amount of demand attributable to the prevailing weather conditions. The difference between this year's modelled demand and that of the desired planning scenario is reported as the peaking factor. The "normal year" peaking factor is that which is required to match a 1 in 2 return period DI. The "dry year" peaking factor is the sum of uplift to 1 in 5 usage and 1 in 5 leakage (deemed to represent an approximately 1 in 10-year overall uplift).
- 3.61 The peaking factors, described below as uplift volumes, for each component, are shown in Table 3-7. These volumes are applied to the outturn demand volumes.

2021-22			
AR22 Dry and Normal Year Distribution Input Uplifts		Normal Year uplift (MI/d)	Dry Year uplift (MI/d)
London	AA	-23.99	19.71
	CP	N/A	N/A
SWOX	AA	-3.96	2.25
	CP	N/A	50.10
SWA	AA	-1.80	1.05
	CP	N/A	25.79
Kennet Valley	AA	-1.70	1.00
	CP	N/A	16.55
Guildford	AA	-0.65	0.42
	CP	N/A	12.65
Henley	AA	-0.34	0.15
	CP	N/A	4.88

Table 3-7: Distribution input uplift volumes (MI/d), 2021-22

- 3.62 These uplifts result in the overall demand, measured in terms of distribution input, shown in Table 3-8.

WRZ	DYAA (MI/d)	DYCP (MI/d)	NYAA (MI/d)
London	1975.50	1975.50	1931.80
SWOX	289.12	349.02	282.90
SWA	144.20	171.80	141.35
Kennet Valley	101.87	119.33	99.17
Guildford	49.40	63.94	48.33



WRZ	DYAA (Ml/d)	DYCP (Ml/d)	NYAA (Ml/d)
Henley	14.04	19.80	13.55
Thames Water	2574.13	2699.39	2517.11

Table 3-8: Overall demand (Distribution Input) post uplift, 2021-22

Covid-19 Impacts on Demand Forecasts

3.63 During lockdowns related to Covid-19 spikes in demand were observed and water use increased as a result of more people being at home for longer. Therefore we must consider how we evaluate the longer term impacts the epidemic may have on future demand.

3.64 Artesia consulting noted within their study “Understanding changes in household water consumption associated with Covid-19”¹³ that to understand how domestic water use patterns will change as a result of the Covid-19 pandemic will:

“require long-term monitoring with both qualitative and quantitative data to know whether the changes in dynamics reflected during this lockdown reflect only a temporary disruption, or represent a longer-term change to the patterns and rhythms of the everyday practices that underpin and influence domestic and garden water use.”

3.65 This leaves us in the position whereby we are unable with any confidence to predict a most likely outcome to include within our demand forecast.

3.66 Given this uncertainty we consider the most prudent way forward is to consider the potential for longer term impacts within target headroom and to not include any actual Covid-19 impacts within the demand forecast directly.

3.67 How we have allowed for this Covid-19 related uncertainty is discussed within Section 6.

13

[Understanding changes in domestic water consumption associated with COVID 19 in England and Wales](#)

Population and property forecasts

Introduction

- 3.68 Throughout this section, the term ‘forecast’ is used as a generic term to encompass both population projections (trend-based outcomes) and population forecasts (policy-based outcomes, e.g. housing-led forecasts).
- 3.69 Robust population and property forecasts are a key underpinning of the WRMP24 process. A sustained period of new housing growth, ageing population profiles and an uncertain future for international migration continue to be important considerations for industry planners. Given this, Thames Water and WRSE, updated our forecasts of growth in February 2023. This involved updates of local authority plans, where they had been updated, rebasing of ONS18 sub-national population projects and inclusion of the ONS 2020 interim national population projection, which has been published since our previous set of forecasts.
- 3.70 WRSE have continued to use industry experts, Edge Analytics, to produce growth forecasts for all the water companies within WRSE. WRSE have further undertaken an independent review¹⁴ of the Edge Analytics growth forecasting by a recognised expert in this field, Professor Adrian McDonald. This report confirmed that the work undertaken by Edge Analytics of a high quality and compliant with the WRPG.
- 3.71 The WRPG includes guidance on the key requirements for population, property and occupancy forecasts to support the WRMP24. In addition to this Ofwat has proposed common reference scenarios¹⁵ which includes guidance for which growth forecasts should be considered.
- 3.72 Both sets of guidance require water companies to use Local Authority plan (LAP) based forecasts and also consider Office of National Statistics (ONS) trend-based projections.
- 3.73 Section 6.3 of the WRPG states:
- “Your planned property and population forecasts, and resulting supply, must not constrain planned growth. For companies supplying customers in England you should base your forecast population and property figures on local plans published by the local council or unitary authority.”***
- 3.74 Therefore, our central forecasts use projections produced by the local authorities.
- 3.75 In addition to the LAP and ONS forecasts we have also produced maximum and minimum scenarios in the production of demand forecasts for use in adaptive planning scenarios.

¹⁴ Population and Property Forecasts Developed by Edge Analytics for WRSE for Resource Planning in PR24 An Assessment of Suitability Professor Adrian McDonald 2023

¹⁵ Ofwat April 2022 [PR24-and-beyond-Final-guidance-on-long-term-delivery-strategies_Pr24.pdf](#) (ofwat.gov.uk)

3.76 All forecasts have been produced for us by Edge Analytics Ltd who are experts in demographic analytics and scenario forecasting.

Regulatory Guidance

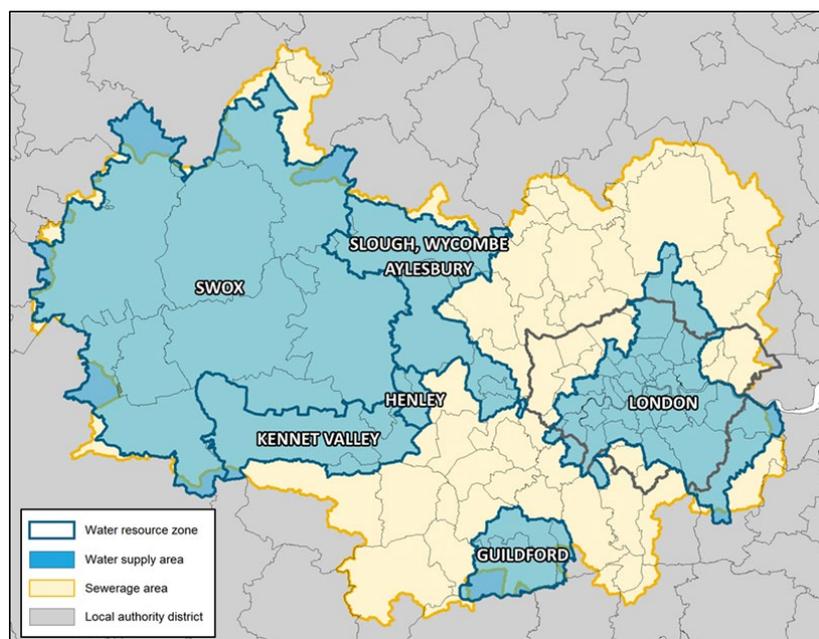
3.77 The WRPG provides a framework for water companies to follow when developing our WRMPs. The guidelines summarise the key requirements for population, property and occupancy forecasts that feed into WRMP evidence, emphasising the importance of using housing growth evidence from Local Plans.

3.78 Edge Analytics have, within their 2020 report¹⁶ (Section 1, Regulatory Guidance), described how they have ensured that the projections they have produced comply with the requirements of the Water Resources Planning Guideline. This report is published in full within Appendix E - Population and Property Projections. This is supplemented with an updated 2023 report¹⁷ which describes the work they have done to update the initial set of forecasts, within the same appendix.

Area definition

3.79 The Thames Water area in which it provides its water and sewerage services encompasses a total of 95 local authority areas (either in full or in part); a mix of London Boroughs, Unitary Authorities and non-metropolitan districts.

3.80 The six WRZs are covered by a sub-set of these local authority areas, as shown in Figure 3-4, again either in full or in part. This sub-set of local authority areas has provided the basis for the development of our WRMP24 population and property forecasts.



¹⁶ Population & Property Forecasts: Methodology & Outcomes Edge Analytics July 2020

¹⁷ WRSE Forecast Comparison – Edge Analytics June 2023

Figure 3-4: Area definition of Thames Water operational areas and local authorities

- 3.81 Population and property forecasts developed for each local authority area have been scaled to ensure consistency with the WRZ geography. This scaling process has been based upon the proportional distribution of properties, using digital map data and Geographical Information System (GIS) technology to ensure the most accurate process of estimation.
- 3.82 The development of growth forecasts to inform WRMP24 plans is underpinned by evidence on Local Plan housing growth for those Local Planning Authorities (LPA) that are within our WRZ geography.
- 3.83 Our consultants, Edge Analytics', have developed a database, Consilium, to enable the collection, processing, organisation and delivery of Local Plan evidence, for all LPAs across the UK (including National Parks and Development Corporations). Data is collected both at a macro level, providing Local Plan evidence for individual LPAs, and at micro level, providing site-specific housing growth locations.
- 3.84 For each LPA that falls within WRZ boundaries, Consilium provides a summary of all Local Plan housing evidence, presenting information on:
- Local Plan status
 - historical and planned housing growth trajectories (including LPA and MHCLG completion statistics)
 - housing need
 - housing requirements and targets
 - housing growth locations (site data)
- 3.85 The site data provides geocoded information on housing growth locations, the number of planned units and the likely phasing (timing) of development. This information is key to the configuration and calibration of the micro-level, 'bottom-up' forecasts.
- 3.86 The data sourced is from LPA published documentation/statistics or directly from Councils, if not readily available.

Local Authority Forecasts

- 3.87 Local authority forecasts can be described as "housing-led" in that they provide a housing driven perspective on future population growth. Under these scenarios, the population impact of a pre-determined trajectory of housing growth is considered.
- 3.88 The starting point for a housing-led scenario is a trend projection, which is modified year-on-year to ensure reconciliation between population change and the capacity of the housing stock. The relationship between housing growth and population change is determined by the changing age-structure of the population, projected household representative rates (occupancy), a vacancy rate, plus the changing size of the population not-in-households.
- 3.89 In a housing-led forecast, if the demographic trend does not match the capacity of the housing stock, then the trend is altered, through higher or lower migration. If the capacity of the housing stock exceeds the population growth trend, then additional growth through

migration will result. Likewise, if the capacity of the housing stock does not meet the requirements of the population growth trend, then growth is reduced through out-migration.

- 3.90 A key component of any housing-led scenario is the average ‘occupancy’ associated with the changing housing stock. The general ‘ageing’ of the UK population results in a reduction in average household size, with the older population typically having smaller household sizes compared to the younger population. Since the financial crash of 2007-08, a counter trend brought about by both financial constraints and a mismatch between demand and supply of new homes, has seen a reduction in the speed at which young adults are able to form new households, resulting in a dampening of the rate of occupancy reduction. These factors are considered in the housing-led scenario analysis.
- 3.91 The WRPG has mandated that water companies need to consider population and property forecasts derived from the Local Plans published by LPAs. Local Plan development encompasses a complex mix of processes, documents and data. Consilium collates evidence from all LPAs, enforcing a consistent classification on the derived data (Table 1), enabling the formulation of scenarios that consider housing need, housing requirement and planned delivery.
- 3.92 Local Plan evidence on future housing growth is typically formulated for a 10-15-year period, shorter than the 2025–2050 outlook required by the WRMP. Under each scenario, following the final year of plan data available, we assume that projected housing growth in non-London local authority areas returns to a long-term annual growth average by 2050.
- 3.93 The GLA includes its own housing-led outcome in its suite of scenarios¹⁸. Its scenario is based on data from the 2016 Strategic Housing Land Availability Assessment (SHLAA) providing housing growth totals, with phasing, for each London Borough. Beyond 2041, housing growth is aligned to the 2035– 2041 average.
- 3.94 The GLA Housing scenario adopts an alternative method for determining occupancy rates in the changing housing stock, setting upper and lower bounds for average household size in each local authority. Plus, whilst the housing-led approach is applied to each London Borough, the population projection for Greater London, in total, remains consistent with the GLA-18-Central scenario.
- 3.95 This scenario includes projections for London Boroughs only and is combined with the GLA-18-Central scenario for all other local authority areas when aggregated to WRZ geographies.

OxCam Arc Scenarios

- 3.96 The OxCam Arc covers 26 Local Authority Districts, extending between Oxford, Milton Keynes and Cambridge. It has been identified as an area of huge economic potential. To support the Arc’s economic growth potential, a requirement for up to one million new homes has been estimated to 2050, together with improvements to the transport

¹⁸ [Population and household projections – London Datastore](#)

infrastructure of the region. However, with the UK’s exit from the European Union and the unprecedented, short-term effects of the Covid-19 crisis, there is considerable uncertainty around the timing of infrastructure and housing delivery.

- 3.97 Councils within the Arc are already seeking to manage significant increases in the rate of house building to meet targets set out in current Local Plans. Achievement of one million homes by 2050 would present a further step-change in housing delivery requirements.
- 3.98 Further details on the development of OxCam Arc Scenario can be found in Appendix E - Population and Property Projections. A summary of the growth scenarios we have used in developing our forecasts can be seen in Figure 3-5.

Scenario	Scenario Variant Housing Distribution	
	New Settlements (a)	Expansion (b)
OxCam-1 (23k dpa)	Cherwell (20%), Aylesbury Vale (20%), Central Bedfordshire (40%), South Cambridgeshire (20%)	Milton Keynes (30%), Luton (15%), Bedford (15%), Oxford (10%), Cambridge (10%), Northampton (10%), Peterborough (10%)
OxCam-2 (30k dpa)		

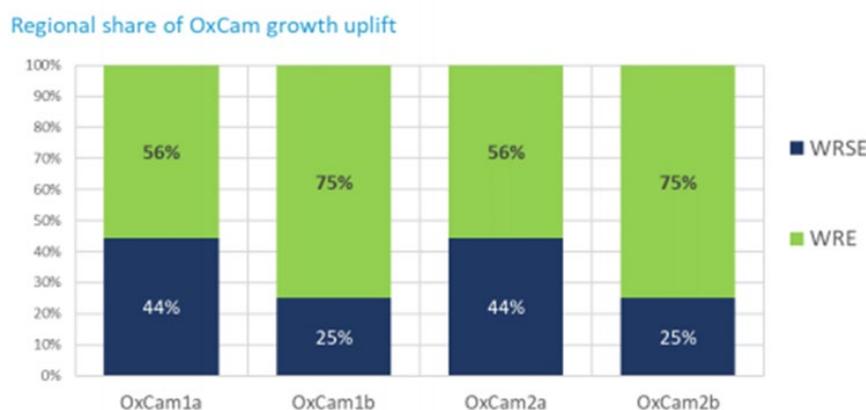


Figure 3-5: Oxcam Scenarios

Long-term Scenarios

- 3.99 For each of the scenarios presented in Table 3-9 a long-term growth outlook is considered, extending the scenario horizon to 2100. Growth scenarios for the 2050–2100 period are aligned to the ONS 2018-based National Population Projection (NPP), configuring a principal, low and high growth outcome.

Scenario	Description
Low ('-L')	The Low long-term scenario incorporates the mortality and fertility assumptions of the ONS 2018-based NPP Principal scenario, plus a Low net international migration assumption of +90k p.a. for the UK in total.

¹⁹ Due to modelling practicalities at a regional level the investment programme described in Section 11 extends to only 2075 however we will continue to discuss demand forecasts to 2100

Scenario	Description
High ('-H')	The High long-term scenario incorporates the mortality and fertility assumptions of the ONS 2018-based NPP Principal scenario, plus a High net international migration assumption of +290k p.a. for the UK in total.
Principal ('-P')	The Principal long-term scenario incorporates the mortality and fertility assumptions of the ONS 2018-based NPP Principal scenario, plus its Principal net international migration assumption of +190k p.a. for the UK in total.

Table 3-9: Long-term Growth Scenario Assumptions

- 3.100 The key determinants of growth rates under these scenarios are assumptions relating to fertility, mortality and international migration. In each of the three long-term outcomes, fertility and mortality rates trends are consistent with the NPP Principal scenario. For international migration, the Principal scenario is based on an assumption of +190k annual net growth through international migration, with the High and Low variants assuming +290k and +90k per year respectively.
- 3.101 Where data on site level housing developments is available, the housing-led forecasting approach is able to utilise both a combined 'top-down' and 'bottom-up' methodology. This means that micro-level forecasts of population change can be directly linked to the location of planned housing growth and the phasing over time of that growth.
- 3.102 A 'top-down' forecast is produced providing an indication of population and property growth for an aggregate area (local authority district). This is used as a constraint for a 'bottom-up' forecast which takes account of micro-level housing intelligence. The Consilium data provides information on the extent of new housing growth and its likely spatial and temporal distribution.
- 3.103 Since the 2020 delivery, there have been a number of important data releases (e.g., Census 2021 results, more up-to-date Local Plan Housing Growth information), which highlighted the need to revisit the forecasts and update them in light of this new information. In February 2023, WRSE commissioned Edge Analytics to produce updated population and property forecasts, taking account of the latest demographic and housing statistics
- 3.104 The outputs were produced for a 2021–2101 forecast period and for a sub-set of the 2020 scenarios:
- ONS-18-Rebased-P - ONS 2018-based Principal sub-national population projection (SNPP), using a five-year history (2013–2018) to derive local fertility & mortality assumptions and a long-term UK net international migration assumption of +190k. Unlike earlier rounds of SNPP, the 2018-based Principal projection uses a two-year history (2016–2018) of internal migration assumptions, following recent changes to the methodology used for its estimation, which have only covered the latest 2 years. This scenario has been rebased to the 2021 MYE. From 2050 to 2101, growth under this scenario is trended in line with the Principal (-P) 2018-based national population projection (NPP) from ONS.
 - ONS-18-Rebased-L - ONS 2018-based Principal SNPP using a five-year history (2013–2018) to derive local fertility & mortality assumptions and a long-term UK net international migration assumption of +190k. Unlike earlier rounds of SNPP, the 2018-based Principal projection uses a two-year history (2016–2018) of internal migration assumptions,

following recent changes to the methodology used for its estimation, which have only covered the latest 2 years. This scenario has been rebased to the 2021 MYE. From 2050 to 2101, growth under this scenario is trended in line with the Low migration (-L) variant of the ONS 2018-based NPP

- Housing-Plan-P - A Housing-led scenario, with population growth underpinned by each local authority's Local Plan housing growth trajectory. Following the final year of data, projected housing growth in non-London areas returns to the average of ONS-14 & ONS-16 long-term annual growth average by 2050. For London Boroughs, housing growth returns to the GLA Central scenario long-term annual average by 2050. From 2050 to 2101, growth under this scenario is trended in line with the Principal (-P) 2018-based NPP from ONS.
- Housing-Need-H - A Housing-led scenario, with population growth underpinned by the trajectory of housing growth associated with each local authority's Local Housing Need (LHN) or Objectively Assessed Housing Need (OAHN). Following the final year of data, projected housing growth in non-London areas returns to the average of ONS-14 & ONS-16 long-term annual growth average by 2050. For London Boroughs, housing growth returns to the GLA Central scenario long-term annual average by 2050. From 2050 to 2101, growth under this scenario is trended in line with the High migration (-H) variant of the ONS 2018-based NPP.
- OxCam-1a-P - 'New Settlement' 23k dpa scenario, with c.3.8k dpa above Housing-Plan distributed between Cherwell (20%), Aylesbury Vale (20%), Central Bedfordshire (40%), South Cambridgeshire (20%). From 2050 to 2101, growth under this scenario is trended in line with the Principal (-P) 2018-based NPP from ONS

3.105 A number of other methodological/data changes were required for the 2023 update.

- Coercion of historical demographic inputs (population, households, population not-in households, etc.) to a Census 2021 Output Area (OA21) geography
- Use of the Census/2021 MYE data to devise population by single year of age and sex constraints at OA21 level (not available from official releases)
- Modelling of population not-in-households data by age groups and sex from available partial Census 2021 data, aligning it with 2021 MYE
- Updating/estimating other model inputs, such as household, vacancy, and properties to an OA21 basis, utilising Census 2021 where available
- Rescaling Sub-National Population Projection (SNPP) trajectories to a 2021 MYE starting point and extending them to 2050
- Rescaling of household headship rates to a rebased Census 2021 value
- Reformulation of all models to accept the new Census/2021 MYE data
- 'Need' and 'Plan' housing trajectories updated between January – February 2023

3.106 These scenarios have been used to produce the growth forecasts that underpin the demand forecasts used in investment modelling. The population and property forecasts for each scenario and WRZ can be seen in Figure 3-6 and Figure 3-7.



Figure 3-6: WRZ Population Growth Scenarios

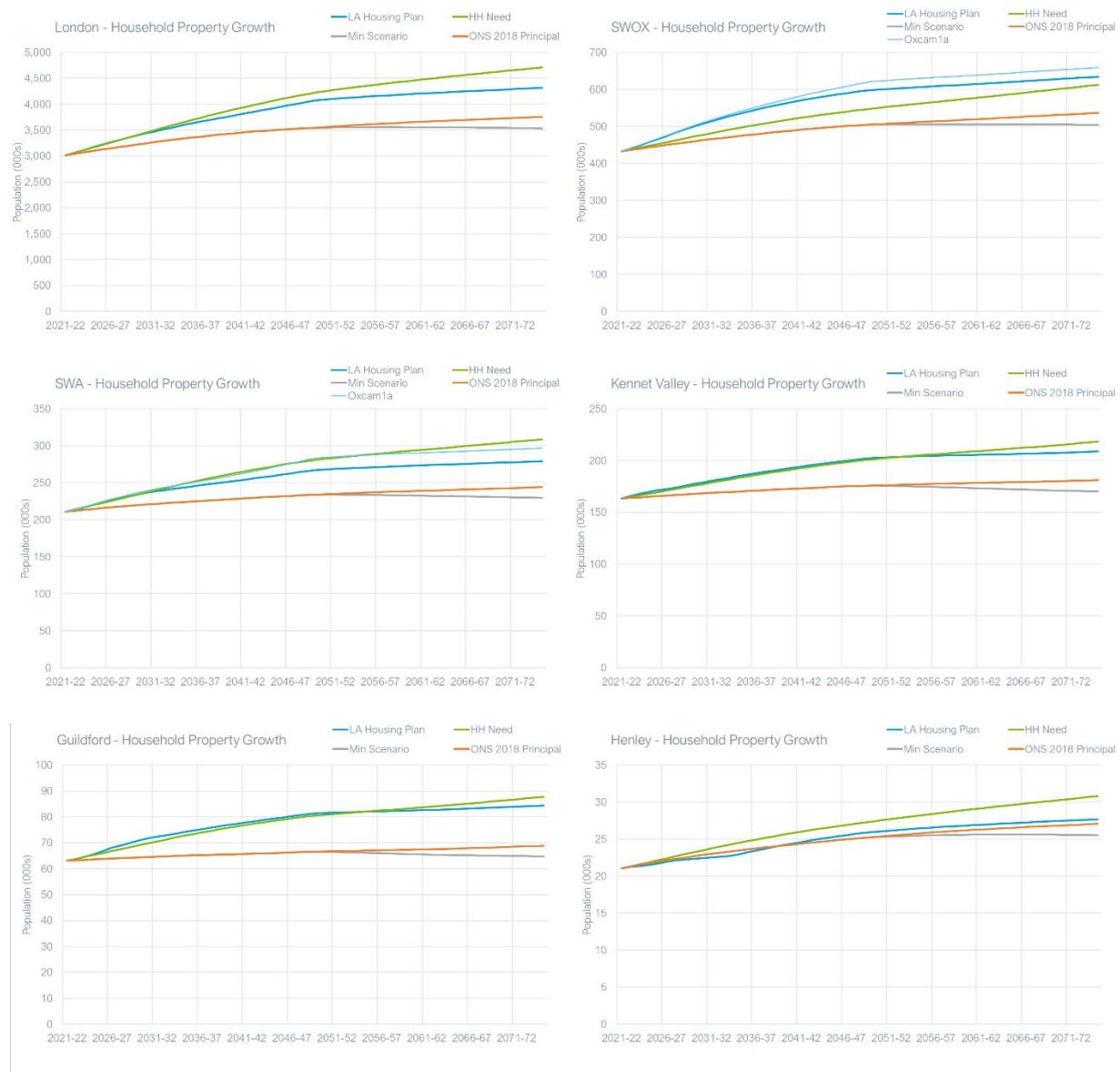


Figure 3-7: WRZ Property Growth Scenarios

- 3.107 The rate of population change is relatively high within the plan-based forecasts, consistent with higher housing growth in Local Plans while a significantly lower rate of growth is predicted by the ONS projections. Once the period covered by the local plans, typically 10 to 15 years, the growth slows within these forecasts as we revert to ONS based forecasts.
- 3.108 Incorporating the range of forecasts shown above into demand forecasts and investment modelling allows a robust consideration of multiple possible futures and ensures a resilient plan. For the rest of this section we focus on the local authority plan-based and the ONS-18 forecasts as these provide a good representation of upper and lower forecasts and focussing on two scenarios will remove the complexity of presenting five – nine different scenarios.
- 3.109 For the six WRZs in combination, the plan-based forecast estimates a population growth of 2.2 million (22%) for the 2020-2050 plan period and 3.6 million (35%) by 2100. The

ONS forecasts predict population growth of 1 million (10%) by 2050 and 2.2 million (22%) by 2100.

3.110 Household property growth is forecast to increase by 1.4 million properties (37%) by 2050 and 2.3 million properties (60%) by 2100 for the plan-based scenario. The ONS forecast predicts an increase of 0.9 million properties (22%) by 2050 and 1.7 million properties (44%) by 2100.

3.111 The forecast growth for population and properties, for both ONS and plan-based forecast, across the entire forecasting period can be seen in Figure 3-8 below.

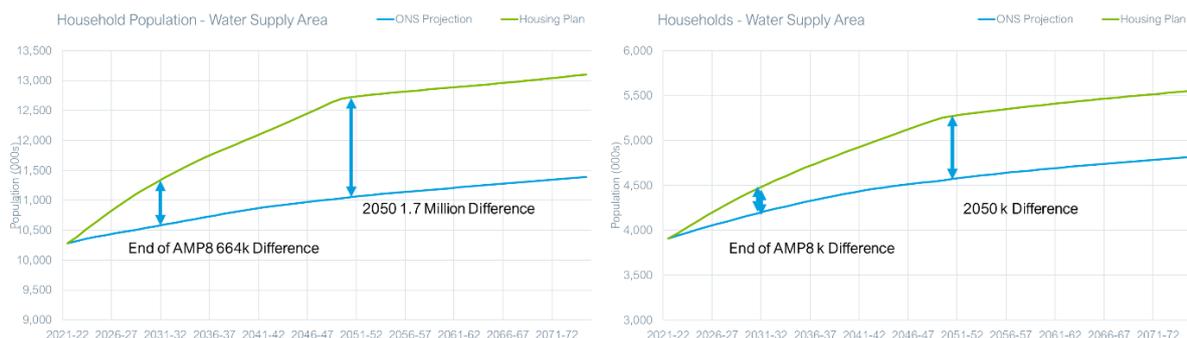


Figure 3-8: Difference in Population and households between ONS and Housing Plan Scenarios

3.112 The growth in both population varies by WRZ and the growth in each WRZ is presented in Table 3-10 and Table 3-11 below.

WRZ	Total Population	Plan-based Change in Population from Base Year				% Change in Population from Base Year to 2100
	2019-20	2024-25	2029-30	2049-50	2074-75	
London	8,053	8,323	8,734	9,928	10,251	27.29%
SWOX	1,058	1,111	1,202	1,377	1,426	34.84%
SWA	545	563	591	647	662	21.51%
Kennet Valley	412	427	441	489	497	20.54%
Guildford	162	168	179	198	203	24.68%
Henley	50	51	53	59	61	21.80%
Total	10,281	10,643	11,200	12,697	13,100	27.42%

Table 3-10: Housing Plan Based Property Summary

WRZ	Total Population	ONS Change in Population from Base Year				% Change in Population from Base Year to 2100
	2019-20	2024-25	2029-30	2049-50	2074-75 2099-2100	
London	8,053	8,140	8,259	8,663	8,951	11.15%
SWOX	1,058	1,073	1,094	1,158	1,203	13.70%
SWA	545	549	552	567	581	6.71%
Kennet Valley	412	414	415	423	430	4.37%
Guildford	162	163	163	164	167	2.93%



WRZ	Total Population	ONS Change in Population from Base Year				% Change in Population from Base Year to 2100
	2019-20	2024-25	2029-30	2049-50	2074-75 2099-2100	
Henley	50	51	53	56	58	15.71%
Total	10,281	10,389	10,536	11,031	11,391	10.80%

Table 3-11: ONS Based Population Summary

Measured and unmeasured property forecasts

- 3.113 Now that we have a total population and property forecast for each WRZ we look to disaggregate this to produce estimates for measured and unmeasured household properties, and measured, unmeasured and non-household populations for the baseline forecast.
- 3.114 The first stage in this process is to calculate the change in measured and unmeasured households each year which is done using simple arithmetic.
- 3.115 The increases in the total number of household properties each year is attributable to new households being built and, as all new household properties have a meter, these are added to the measured category.
- 3.116 The effects of metering are also accounted for. The total of optant and progressive meters are calculated for each year and this number is subtracted from the unmeasured household category and added to the measured household category.
- 3.117 These simple calculations allow us to produce household property forecasts segmented by their metering status.
- 3.118 The calculation of populations for metered and unmetered properties is more complex. Forecasts of population are not available for measured and unmeasured property types and therefore need to be calculated. An algorithm is used to forecast the changing occupancy for measured and unmeasured population as metering progresses. This algorithm is initiated by calculating the change in population expected from shifts in metering status and new build properties for both measured and unmeasured populations. These are then used with forecast population changes to reconcile the two calculations against total population on an annual basis.
- 3.119 The calculated occupancy can then be multiplied by the total number of households in each segment giving a total population value for each. Population totals for each segment and their associated occupancy are shown in Table 3-12. Forecasts of properties and population for each WRZ and each segment are used in the production of demand forecasts.



WRZ	Parameter		2019-20	2024-25	2029-30	2049-50	2074-75
London	Population (000s)	Measured	4,001.019	5,092.479	5,761.600	7,797.010	8,986.412
		Unmeasured	4,229.848	3,230.364	2,971.946	2,131.362	1,264.566
		Non-Household	52.322	52.638	55.656	76.595	97.200
	Properties (000s)	Measured	1,489.341	1,863.416	2,162.894	3,110.077	3,683.059
		Unmeasured	1,445.955	1,194.828	1,127.734	859.357	523.887
	Occupancy	Measured	2.69	2.73	2.66	2.51	2.44
		Unmeasured	2.93	2.70	2.64	2.48	2.41
		Overall	2.80	2.72	2.65	2.50	2.44
	SWOX	Population (000s)	Measured	656.972	963.909	1,061.204	1,261.479
Unmeasured			415.294	147.469	140.664	115.213	89.229
Non-Household			32.927	32.940	34.003	39.218	43.287
Properties (000s)		Measured	292.054	392.007	436.839	543.350	588.542
		Unmeasured	138.636	55.805	53.880	46.176	36.547
Occupancy		Measured	2.25	2.46	2.43	2.32	2.27
		Unmeasured	3.00	2.64	2.61	2.50	2.44
		Overall	2.49	2.48	2.45	2.34	2.28
SWA		Population (000s)	Measured	271.996	428.880	465.384	549.525
	Unmeasured		278.156	133.920	126.083	97.137	65.856
	Non-Household		5.412	5.442	5.898	7.966	9.869
	Properties (000s)	Measured	116.290	169.261	185.809	227.921	250.839
		Unmeasured	94.668	46.748	44.526	35.635	24.522
	Occupancy	Measured	2.34	2.53	2.50	2.41	2.38
		Unmeasured	2.94	2.86	2.83	2.73	2.69
		Overall	2.61	2.61	2.57	2.45	2.40



WRZ	Parameter		2019-20	2024-25	2029-30	2049-50	2074-75
Kennet Valley	Population (000s)	Measured	214.595	378.348	394.281	447.491	461.767
		Unmeasured	201.808	48.691	46.998	41.134	35.248
		Non-Household	6.876	6.918	7.196	8.639	9.780
	Properties (000s)	Measured	92.821	149.045	157.125	184.090	192.091
		Unmeasured	67.596	17.282	16.875	15.247	13.211
	Occupancy	Measured	2.31	2.54	2.51	2.43	2.40
		Unmeasured	2.99	2.82	2.79	2.70	2.67
		Overall	2.60	2.57	2.54	2.45	2.42
	Guildford	Population (000s)	Measured	83.649	133.909	146.975	171.902
Unmeasured			80.864	33.775	32.131	26.158	19.937
Non-Household			7.525	7.529	7.685	8.454	8.972
Properties (000s)		Measured	35.402	51.876	57.624	69.997	75.273
		Unmeasured	27.353	12.366	11.906	10.066	7.767
Occupancy		Measured	2.36	2.58	2.55	2.46	2.43
		Unmeasured	2.96	2.73	2.70	2.60	2.57
		Overall	2.62	2.61	2.58	2.47	2.44
Henley		Population (000s)	Measured	30.361	34.995	48.838	55.770
	Unmeasured		19.756	16.174	3.707	3.286	2.846
	Non-Household		0.308	0.300	0.363	0.657	0.935
	Properties (000s)	Measured	14.423	14.656	20.438	24.197	26.060
		Unmeasured	6.487	6.406	1.467	1.348	1.200
	Occupancy	Measured	2.10	2.39	2.39	2.30	2.24
		Unmeasured	3.05	2.52	2.53	2.44	2.37
		Overall	2.40	2.43	2.40	2.31	2.25

Table 3-12: Plan-based Growth Statistics



WRZ	Parameter		2019-20	2024-25	2029-30	2049-50	2074-75
London	Population (000s)	Measured	3,682.766	4,909.556	5,290.704	6,516.252	7,677.827
		Unmeasured	4,227.191	3,229.947	2,968.730	2,146.312	1,273.160
		Non-Household	52.322	52.397	54.562	70.628	87.527
	Properties (000s)	Measured	1,463.908	1,796.713	1,988.272	2,581.103	3,125.499
		Unmeasured	1,445.955	1,194.828	1,127.734	859.357	523.887
	Occupancy	Measured	2.52	2.73	2.66	2.52	2.46
		Unmeasured	2.92	2.70	2.63	2.50	2.43
		Overall	2.72	2.72	2.65	2.52	2.45
	SWOX	Population (000s)	Measured	635.075	926.486	954.672	1,043.422
Unmeasured			413.742	146.765	139.408	115.038	89.111
Non-Household			32.927	32.899	33.730	37.787	41.264
Properties (000s)		Measured	283.380	378.594	396.527	450.109	490.828
		Unmeasured	138.636	55.805	53.880	46.176	36.547
Occupancy		Measured	2.24	2.45	2.41	2.32	2.27
		Unmeasured	2.98	2.63	2.59	2.49	2.44
		Overall	2.49	2.47	2.43	2.33	2.28
SWA		Population (000s)	Measured	263.911	414.875	426.559	470.000
	Unmeasured		277.546	133.680	125.373	97.400	66.174
	Non-Household		5.412	5.411	5.740	7.294	8.881
	Properties (000s)	Measured	113.082	164.028	171.273	194.411	215.734
		Unmeasured	94.668	46.748	44.526	35.635	24.522
	Occupancy	Measured	2.33	2.53	2.49	2.42	2.39
		Unmeasured	2.93	2.86	2.82	2.73	2.70
		Overall	2.61	2.60	2.56	2.47	2.42



WRZ	Parameter		2019-20	2024-25	2029-30	2049-50	2074-75
Kennet Valley	Population (000s)	Measured	206.322	365.206	368.114	381.768	395.130
		Unmeasured	201.195	48.508	46.732	41.081	35.204
		Non-Household	6.876	6.892	7.120	8.282	9.262
	Properties (000s)	Measured	89.515	144.410	147.533	157.256	164.574
		Unmeasured	67.596	17.282	16.875	15.247	13.211
	Occupancy	Measured	2.30	2.53	2.50	2.43	2.40
		Unmeasured	2.98	2.81	2.77	2.69	2.66
		Overall	2.59	2.56	2.52	2.45	2.42
	Guildford	Population (000s)	Measured	77.429	128.901	130.709	137.118
Unmeasured			79.868	33.823	32.206	26.480	20.222
Non-Household			7.525	7.518	7.635	8.204	8.643
Properties (000s)		Measured	33.178	49.865	51.129	55.154	59.736
		Unmeasured	27.353	12.366	11.906	10.066	7.767
Occupancy		Measured	2.33	2.58	2.56	2.49	2.46
		Unmeasured	2.92	2.74	2.71	2.63	2.60
		Overall	2.60	2.61	2.58	2.51	2.48
Henley		Population (000s)	Measured	30.502	35.363	48.979	52.917
	Unmeasured		19.625	16.079	3.657	3.209	2.766
	Non-Household		0.308	0.295	0.344	0.566	0.805
	Properties (000s)	Measured	14.588	14.898	20.779	23.511	25.445
		Unmeasured	6.487	6.406	1.467	1.348	1.200
	Occupancy	Measured	2.09	2.37	2.36	2.25	2.18
		Unmeasured	3.03	2.51	2.49	2.38	2.31
		Overall	2.38	2.41	2.37	2.26	2.19

Table 3-13: ONS Growth Statistics

Household water use

Introduction

- 3.120 We forecast future household consumption in line with the methods set out by “WRMP19 Methods – Household Consumption Forecasting.
- 3.121 We use the same linear regression approach we used for the WRMP19. Details of the approach can be found in Appendix F Household Water Demand Forecasting.

Household Consumption Model

- 3.122 The model takes the form:

$$\mathbf{Consumption} = \alpha + \beta x_1 + \gamma x_2 + \delta x_3 + \eta x_4 + \nu x_5 + \varepsilon \quad \mathbf{Equation 1}$$

where:

- x_1 Number of adults
 x_2 Number of children
 x_3 South Asian Ethnic Group flagged property type flag; either Semi-detached, terraced, flats, flat block or detached
 x_4 Non-IBP flagged property type flag; either Semi-detached, terraced, flats or flat block
 x_5 Rateable value (RV)

and the coefficients:

- α Intercept
 β Number of adults
 γ Number of children
 δ Vector of coefficients for South Asian Ethnic Group property types; Semi-detached, terraced, flats, flat block and detached. The appropriate coefficient is used dependent on the value of x_3
 η Vector of coefficients for Non-IBP flagged property types ; Semi-detached, terraced, flats, flat block and detached. The appropriate coefficient is used dependent on the value of x_4
 ν Rateable value (RV)
 ε Error term

- 3.123 These parameters are the same for both the London and Thames Valley data sets.
- 3.124 The household consumption model residuals from previous years produce a significant trend in time series, indicating that some of the projected change in consumption is not accounted for by dynamic time series parameters within the model such as occupancy rates and meter penetration.
- 3.125 This observed un-modelled trend is thought to be driven by both technological efficiency of water using devices and behavioural changes.



- 3.126 Separate trends were derived for both London and Thames Valley data sets. The trend was observed over a ten-year period and is derived from model residuals. The trend was generally downward and stronger for winter; the year-round trend was applied to the initial forecast period to 2045 and also for a ten year initial period.
- 3.127 It is possible that the strong Thames Valley and weak London trends could switch because evidence²⁰ showed more efficient appliances are installed in Thames Valley, thus leaving a greater potential for consumption reduction in the London area.
- 3.128 Therefore, we have used a weighted average of the two observed trends for use in the demand forecasts. The trend is presented as a percentage which is used to factor the household demand. For the period of 2022 – 2040 we have flat lined this adjustment factor. This is due to requirements of the WRPG whereby any savings associated with government intervention, e.g. water labelling, should be included within options rather than the baseline. In our opinion the extrapolation of this trend-based method into the future represents some of anticipated savings that would be anticipated from Government led water savings initiatives and as such we have been careful not to double count these savings. The flatlining of the trend as shown in Figure 3-9 ensures we have not double counted these savings. More details on Government led initiatives and associated benefits are contained within Section 8 of our WRMP.

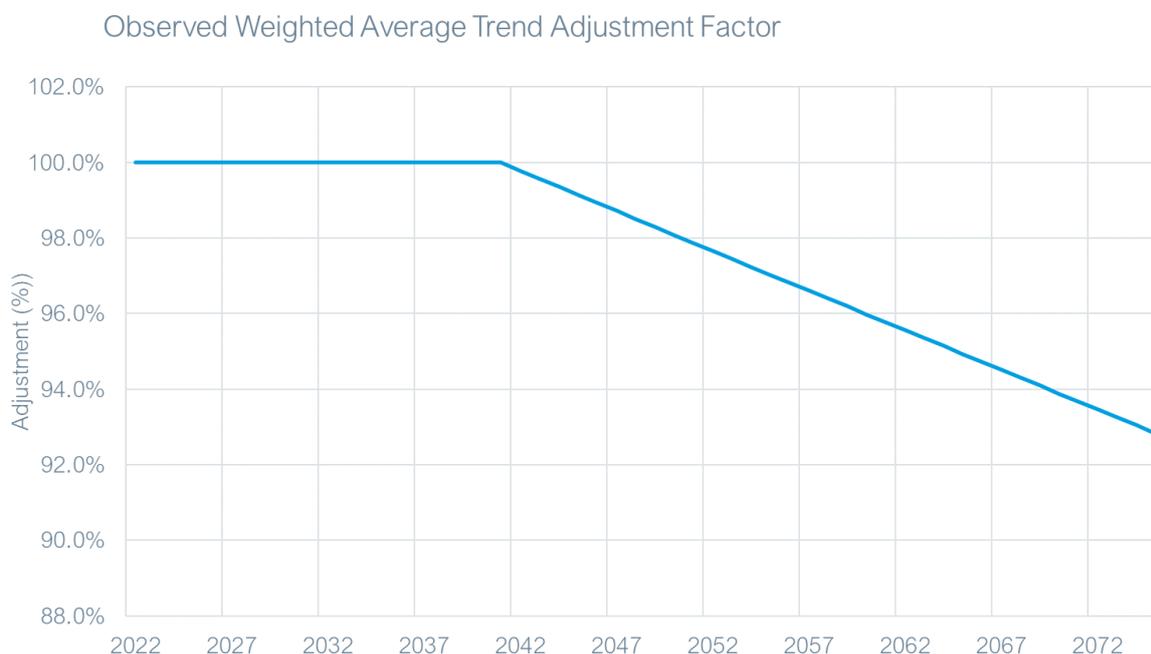


Figure 3-9: Household demand trend adjustment factor

²⁰ WRMP19 Household Consumption Forecast Final Report – Artesia Consulting 2017

Climate change

- 3.129 We commissioned the consultants HR Wallingford to carry out a study²¹ to estimate the likely impacts of climate change upon household demand. No climate change effects are assumed for other components of demand based on the findings of the UKWIR report on the impacts of climate change on demand²².
- 3.130 HR Wallingford undertook a statistical analysis of available data in order to derive empirical relationships that describe how weather and other factors affect household demand for water in our supply area.
- 3.131 We provided the following data sets:
- DWUS Unmeasured PCC by property type (2000-2010)
 - PCC by property type for testDWUS23 panel (2002-2004)
 - Demand data (distribution input – minimum night line, 1998 onwards)
 - Climate data (temperature, rainfall and sunshine hours, 1998 onwards)
- 3.132 Three climate variables were considered in the statistical analysis: temperature, rainfall and sunshine hours. However sunshine hours were removed as it was found to be highly correlated with temperature, and temperature provided a stronger and better understood climate change signal which would increase confidence in the model. For the DYAA model both rainfall and temperature were included. For the ADPW model only temperature was included as an explanatory variable, this was due to insufficient data as for most years there was no rainfall in the peak period.
- 3.133 To estimate the impacts of climate change, the full sample of 10,000 UKCP09 climate change projections for maximum temperature and rainfall in the Thames Valley basin in the 2030s; medium emissions scenario, was used. These scenarios provide climate change factors that are applied to the regression models.
- 3.134 The climate change factors are reported as the change between the baseline period (1961-1990) and the future period (2021-2050). As the baseline for the revised draft WRMP is 2016/17 a scaling factor was calculated:

$$\text{ScalingFactor} = \frac{2035 - \text{BaseYear}}{2035 - 1975} \quad \text{Equation 2}$$

- 3.135 As the base year is 2019-20 this results in a scaling factor of 0.4, i.e. 60% of the climate change between 1975 and 2035 has already been assumed to have occurred.
- 3.136 These factors were then used to provide estimates of PCC change due to climate change in the 2030s. The results of this gave 10,000 potential future PCC factors. The 10th, 50th and 90th percentiles of these factors were extracted to represent lower, mid and upper estimates of impact on PCC. The mid estimate was used in the demand forecasting

²¹ HR Wallingford (2012) EX6828 Thames Water Climate Change Impacts and Water Resource Planning. Thames Water Climate Change Impacts on Demand for the 2030s

²² UKWIR 2013 Impact of Climate Change on Water Demand 13/CL/04/12

²³ testDWUS – A temporary panel of unmeasured customers used to validate DWUS

models while the upper and lower estimates have been used in headroom modelling (see Section 5: Allowing for risk and uncertainty).

3.137 The climate change profiles for lower, mid and upper estimates are shown for the DYAA and DYCP scenarios in Figure 3-10 and Figure 3-11.

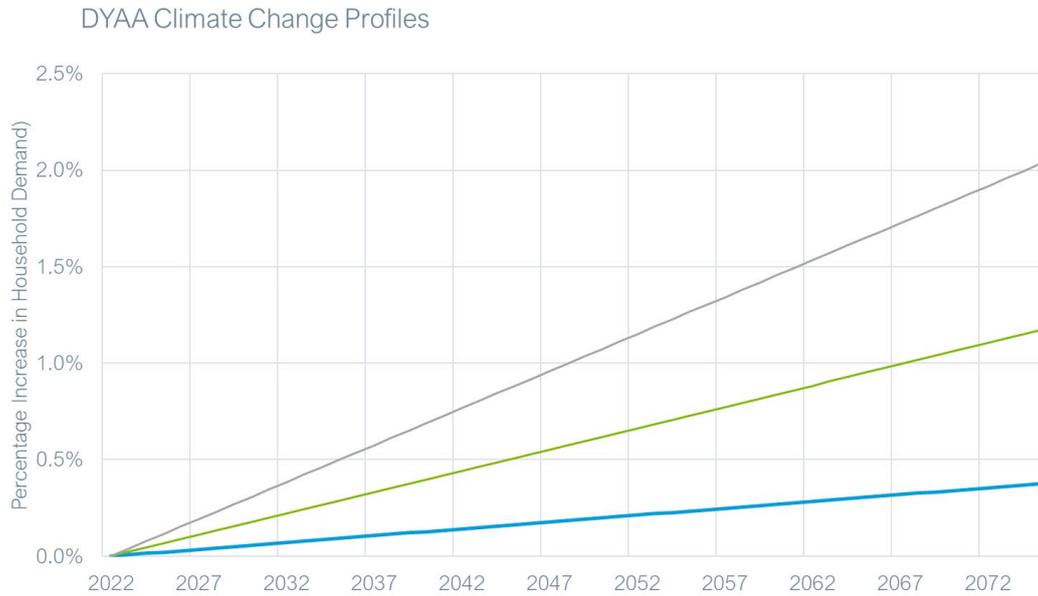


Figure 3-10: The impacts of climate change for the DYAA scenario

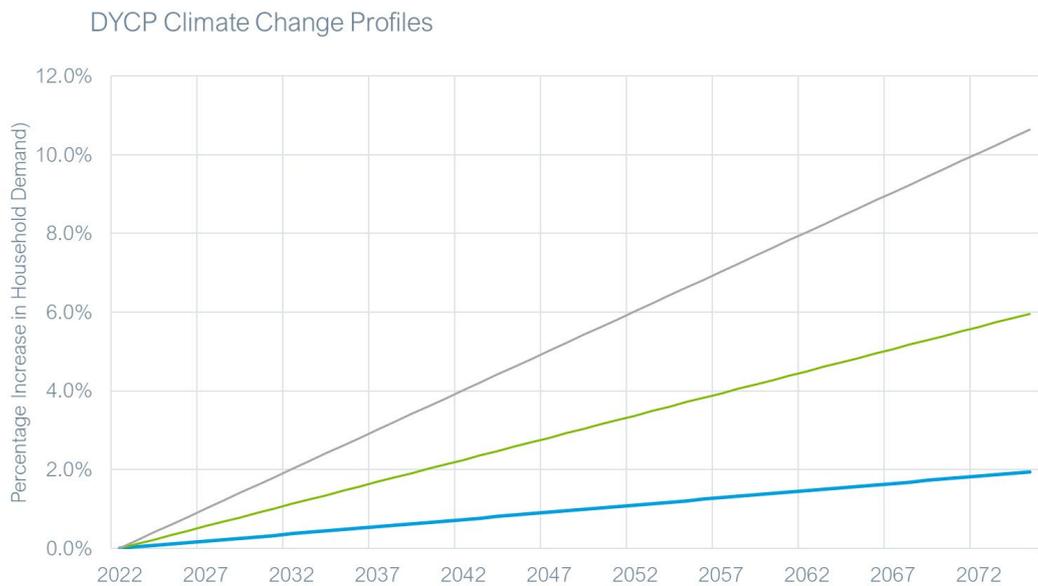


Figure 3-11: The impacts of climate change for the DYCP scenario

3.138 The volume impact of the central climate change profiles for DYAA is shown in Table 3-14 and Table 3-15 and for DYCP in Table 3-16 and Table 3-17.

Units Ml/d	2022	2025	2030	2050	2075
Henley	0.00	0.01	0.02	0.06	0.10
Guildford	0.00	0.03	0.06	0.18	0.32
Kennet Valley	0.00	0.06	0.13	0.43	0.76
London	0.00	1.32	2.77	9.41	17.01
SWA	0.00	0.09	0.19	0.61	1.11
SWOX	0.00	0.17	0.37	1.24	2.24

Table 3-14: Plan-based DYAA additional demand due to climate change

Units Ml/d	2022	2025	2030	2050	2075
Henley	0.00	0.01	0.02	0.05	0.10
Guildford	0.00	0.03	0.05	0.15	0.27
Kennet Valley	0.00	0.06	0.12	0.37	0.66
London	0.00	1.29	2.63	8.24	14.91
SWA	0.00	0.09	0.18	0.54	0.98
SWOX	0.00	0.17	0.34	1.06	1.93

Table 3-15: ONS DYAA additional demand due to climate change

Units Ml/d	2022	2025	2030	2050	2075
Henley	0.00	0.06	0.12	0.39	0.72
Guildford	0.00	0.19	0.39	1.25	2.23
Kennet Valley	0.00	0.46	0.91	2.92	5.21
SWA	0.00	0.64	1.30	4.15	7.47
SWOX	0.00	1.22	2.55	8.30	15.00

Table 3-16: Plan-based DYCP additional demand due to climate change

Units Ml/d	2022	2025	2030	2050	2075
Henley	0.00	0.06	0.12	0.38	0.70
Guildford	0.00	0.19	0.37	1.10	1.96
Kennet Valley	0.00	0.45	0.88	2.64	4.72
SWA	0.00	0.63	1.25	3.79	6.82
SWOX	0.00	1.20	2.40	7.41	13.40

Table 3-17: ONS DYCP additional demand due to climate change

Baseline Demand Management

- 3.139 Planned activity for AMP7 is shown in the Table 3-18 below. This sets out our planned activity from the 2019 Price Review and incorporates additional activity as part of the Green Economic Recovery Programme and the conditional allowance. Additional metering numbers are shown in Table 3-19 and additional leakage reduction from conditional allowance in Table 3-20. Values for Green Economic Recovery and conditional allowance are included within the table of AMP7 planned activity. The total demand reduction volumes are incorporated into our demand forecasts.
- 3.140 We continue to support our customers and encourage efficient use of water, through a range of water efficiency initiatives on households and businesses. Average household water use continues to be higher than forecast at WRMP19 with planned reductions lower than originally set out.
- 3.141 Our ability to expand our delivery field-based programmes and GreenRedeem household water efficiency incentive in line with WRMP projections was impacted significantly by Government’s Covid-19 restriction – resulting in a suspension of all in-home water efficiency and wastage fix activities.
- 3.142 Our ability to digitally / electronically engage with customers to promote water efficiency incentives was also impacted by updated Privacy and Electronic Communication Regulations ruling under data protection laws, requiring greater levels of customer consent.
- 3.143 We are now changing our in-home and in-business water efficiency visits to utilise smart meter data for improved targeting of delivery and engagement activities with customers however we do not expect to be able to achieve PCC targets as set out in WRMP19.

WRZ	Activity	2022-23	2023-24	2024-25	2025-26	2026-27
London	PMP Installs	92168	61680	77683		
	Dumb Meter Replacement	15250	6000	6000		
	Small Bulk Meter	0	0	0		
	Bulk Meter	137	0	0		
	Total Leakage Reduction (MI/d)	-32.76	44.43	49.14	18.20	7.8
	Total HH Usage Reduction (MI/d)	8.78	8.20	5.82	6.46	
	Total NHH Usage Reduction (MI/d)	1.38	1.38	1.38		
	Total Demand Reduction (MI/d)	-22.60	54.00	56.33	24.66	7.8
SWOX	PMP Installs	0	42470	42470		
	Bulk Installs	85	0	0		
	Total Leakage Reduction (MI/d)	-5.22	7.07	7.82	0.00	
	Total HH Usage Reduction (MI/d)	0.00	0.89	3.15	2.27	



WRZ	Activity	2022-23	2023-24	2024-25	2025-26	2026-27
	Total NHH Usage Reduction (MI/d)	0.63	0.63	0.63		
	Total Demand Reduction (MI/d)	-4.59	8.59	11.60		
Guildford	PMP Installs	0	7397	7397		
	Bulk Installs	15	0	0		
	Total Leakage Reduction (MI/d)	-1.41	1.91	2.11	0.00	
	Total HH Usage Reduction (MI/d)	0.00	0.15	0.55	0.39	
	Total NHH Usage Reduction (MI/d)	0.00	0.00	0.00		
	Total Demand Reduction (MI/d)	-1.41	2.07	2.66		
SWA	PMP Installs	0	18193	27864		
	Total Leakage Reduction (MI/d)	-3.37	4.57	5.05	0.00	
	Total HH Usage Reduction (MI/d)	0.00	0.38	1.55	1.49	
	Total NHH Usage Reduction (MI/d)	0.00	0.00	0.00		
	Total Demand Reduction (MI/d)	-3.37	4.95	6.61		
Henley	PMP Installs	0	0	4909		
	Total Leakage Reduction (MI/d)	-0.35	0.47	0.52	0.00	
	Total HH Usage Reduction (MI/d)	0.00	0.00	0.10	0.26	
	Total NHH Usage Reduction (MI/d)	0.00	0.00	0.00		
	Total Demand Reduction (MI/d)	-0.35	0.47	0.63		
Kennet Valley	PMP Installs	0	0	49302		
	Total Leakage Reduction (MI/d)	-2.10	2.85	3.15		
	Total HH Usage Reduction (MI/d)	0.00	0.00	1.03	2.63	
	Total NHH Usage Reduction (MI/d)	0.00	0.00	0.00		
	Total Demand Reduction (MI/d)	-2.10	2.85	4.18		

Table 3-18: Baseline Demand Management Activity (MI/d)

Region	Green Economic Recovery Meter Installs
Guildford	14,794
Henley	4,909
Kennet Valley	49,302



Region	Green Economic Recovery Meter Installs
Slough-Wycombe-Aylesbury (SWA)	46,057
Swindon-Oxford (SWOX)	84,940
Total	200,002

Table 3-19: Green Economic Recovery Additional Household Meter Installs

	2022-23	2023-24	2024-25	2025-26	2026-27
London Leakage Reduction	0.0	0.0	1.7	18.2	7.8

Table 3-20: Conditional Allowance Leakage Reduction

Household Demand forecasts

- 3.144 Using the information presented in the previous sections, household demand forecasts can now be produced for all WRZs. The charts in the sections below show total household demand in each WRZ for DYAA and ADPW where applicable. All zones show the same trend in that measured household demand increases both in absolute terms but also relative to the proportion of unmeasured household demand. This is due to two factors. The first is that all new properties are built with a meter installed and therefore drive an increase in measured demand. The second is the effect of metering (based on the AMP7 projections for the progressive metering programme, and thereafter the baseline optant and new households' forecasts to 2075).
- 3.145 This can be clearly seen in Figure 3-12 which shows total household demand for our whole water supply area for both ONS and plan-based forecasts of demand.

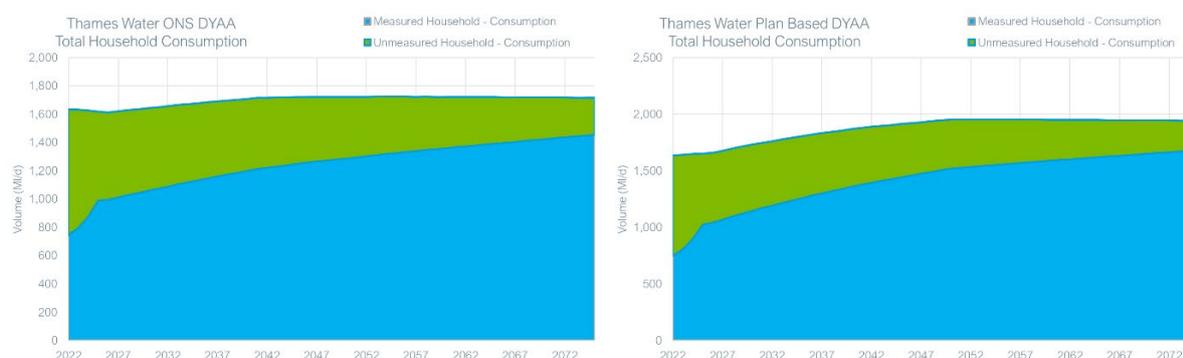


Figure 3-12: Thames Water Baseline Total Household Demand

- 3.146 The impact of both the London and Thames Valley progressive metering results in a sharp decline in unmeasured demand and a corresponding increase in measured household usage. The savings from metering and water efficiency activity within AMP7 offset the impacts of growth in both ONS and plan-based scenarios. Beyond AMP7 the effect of growth can be seen with household demand increasing in both scenarios but growing faster within the plan-based scenario due to higher growth. The plan-based scenario predicts an increase of 309 MI/d to 2050, followed by a reduction of 58 MI/d between 2050 and 2075, due to a combination of decreasing growth and continuing more efficient use of water as explained in paragraph 3.125. The ONS scenario predicts an increase of 81 MI/d from the start of AMP8 to 2050, and a reduction of 13 MI/d between 2050 and 2075, again due to reduced growth and more efficient water use.
- 3.147 The PCCs associated with these demands is shown in Figure 3-13 below.

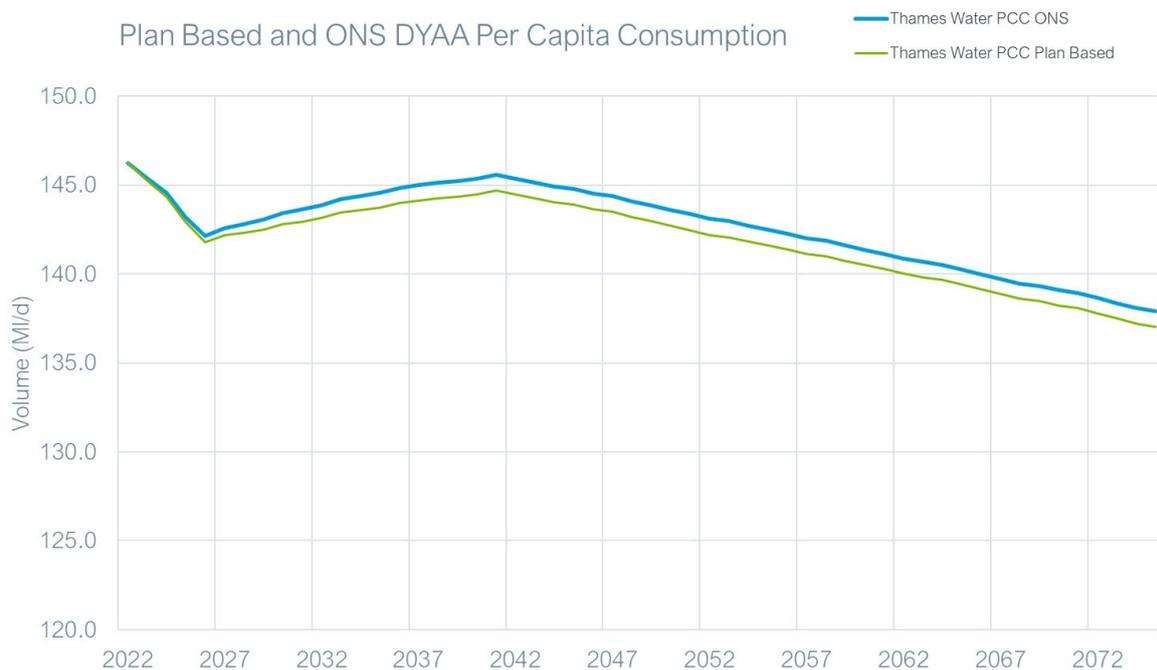


Figure 3-13: Thames Water Baseline Supply Area Per Capita Consumption

- 3.148 Minor variation in PCC is seen between the forecasts, as expected, as the volumetric differences are due to the amount of growth. Other factors within the model such as child/adult split, property types etc. remain consistent within the model so any differences are primarily due to changes in occupancy. This will affect the metered household segment more as this segment is growing and all new properties are metered.
- 3.149 The sharp decline in PCC in AMP7 is driven by the demand management programme incorporating metering and water efficiency, there is also a leakage reduction within the demand management programme for AMP7.
- 3.150 The initial increase in PCC from the start of AMP8 through to 2040 is due to the removal of the trend adjustment factor which is not include within the government led water efficiency option. The ongoing reduction in PCC over the forecast period beyond 2040 is due to ongoing changes in water using efficiency and behavioural changes, as outlined in the previous section.

London

- 3.151 For the DYAA plan-based growth scenario London is forecast to begin AMP8 with a total household demand of 1,201 MI/d, 56% of which is from customers on a measured tariff. This is forecast to increase to 1,430 MI/d by 2050 and to 1,417 MI/d by 2075, as shown in Figure 3-14.
- 3.152 The ONS 18 scenario gives a London demand of 1,166 MI/d at the start of AMP8. This is then forecast to increase to 1,252 MI/d by 2050 and to 1,242 MI/d by 2075, as shown in Figure 3-14.

3.153 PCC generally increases across all scenarios in the medium term (2025-2035) , due to the removal of the trend adjustment factor for the period through to 2040 so that it can be included within the Government Led water efficiency option, while a downward trend is seen in the longer term which is mainly due to the reintroduction of the household demand trend adjustment factor beyond 2040. A summary of PCC movements for measured and unmeasured customers for both plan based and ONS scenarios can be seen in Table 3-21 and Figure 3-15.

Component	Scenario	2025-26	2049-50	2074-75
Measured Household – PCC	ONS 18	127.45	136.02	134.30
Unmeasured Household – PCC	ONS 18	167.20	170.66	165.98
Measured Household – PCC	Plan Based	127.86	136.69	134.30
Unmeasured Household – PCC	Plan Based	167.19	171.01	166.31

Table 3-21: London Baseline PCC Summary



Figure 3-14: London Baseline DYAA Household Consumption

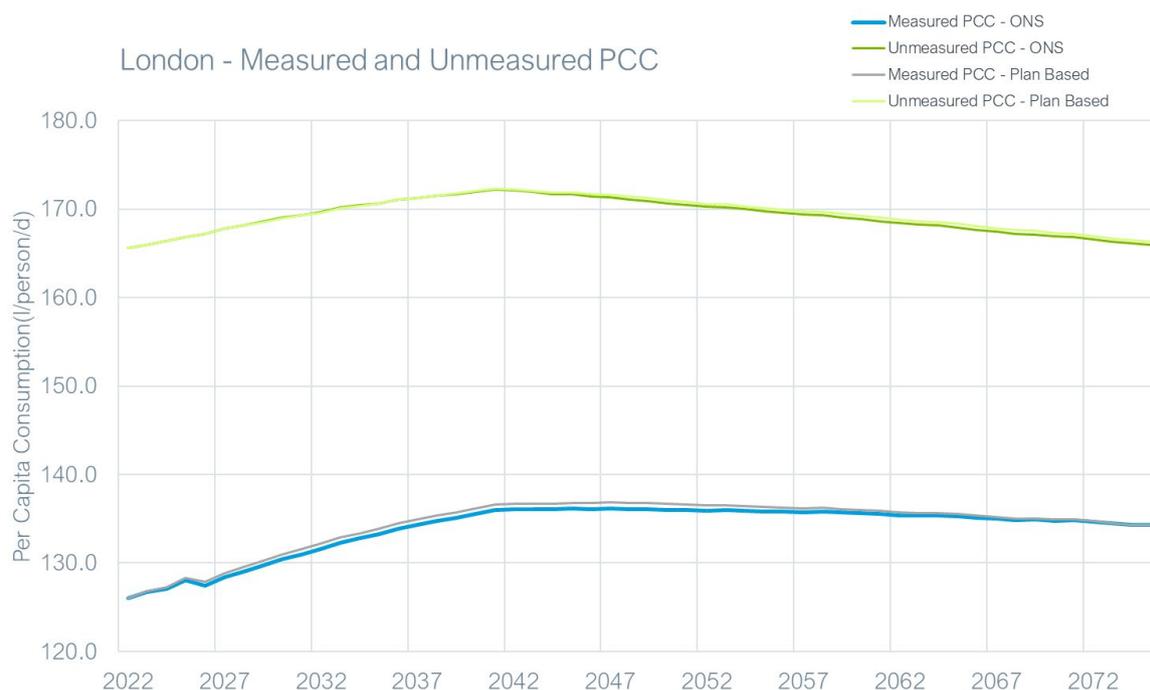


Figure 3-15: London Baseline Per Capita Consumption

SWOX

- 3.154 For the DYAA plan-based growth scenario SWOX is forecast to begin AMP8 with a total household demand of 156.2 MI/d. This is forecast to increase to 187.7 MI/d by 2050 and to 186.8 MI/d by 2075, as shown in Figure 3-16.
- 3.155 The DYAA ONS 18 scenario gives a SWOX household demand of 150.2 MI/d at the start of AMP8. This is then forecast to increase to 161.1 MI/d by 2050 and to 160.6 MI/d by 2075, as shown in Figure 3-16.
- 3.156 The DYCP plan-based growth scenario SWOX is forecast to begin AMP8 with a total household demand of 218.7 MI/d. This is forecast to increase to 254.1 MI/d by 2050 and to 257.5 MI/d by 2075, as shown in Figure 3-17.
- 3.157 The DYCP ONS 18 scenario gives a SWOX household demand of 212.7 MI/d at the start of AMP8. This is then forecast to increase to 226.9 MI/d by 2050 and to 230.0 MI/d by 2075, as shown in Figure 3-17.
- 3.158 PCC is flat at the beginning of AMP8 due to the progressive metering planned as part of the Green Economic Recovery activity. An increase is observed between AMP8 and 2040 due to the removal of the trend adjustment, as previously discussed, for both the plan based and ONS forecasts. Beyond 2040 PCC gradually declines due to the reintroduction of the trend adjustment factor.
- 3.159 A summary of PCC movements for measured and unmeasured customers for both plan based and ONS scenarios can be seen in Table 3-22 and Figure 3-18.



Component	Scenario	2025-26	2049-50	2074-75
Measured Household – PCC	ONS 18	134.63	135.52	130.90
Unmeasured Household – PCC	ONS 18	169.62	171.37	166.61
Measured Household – PCC	Plan Based	133.65	133.14	128.60
Unmeasured Household – PCC	Plan Based	169.29	171.29	166.54

Table 3-22: Baseline SWOX PCC Summary

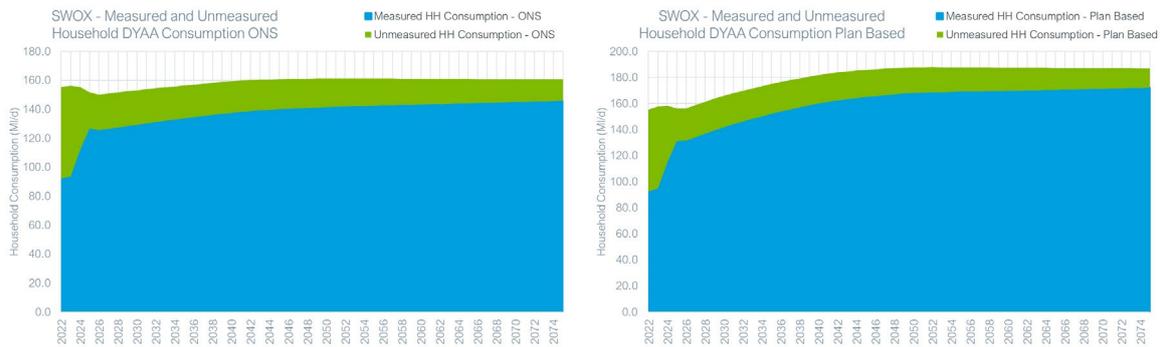


Figure 3-16: SWOX Baseline DYAA Household Consumption

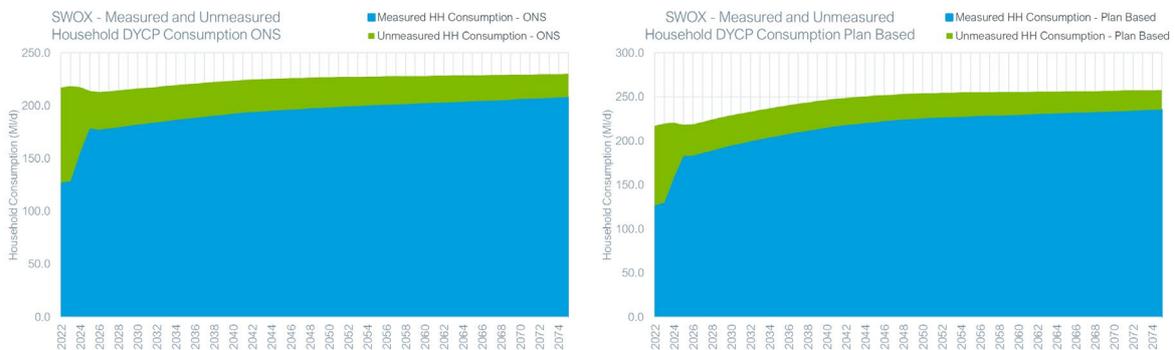


Figure 3-17: SWOX Baseline DYCP Household Consumption

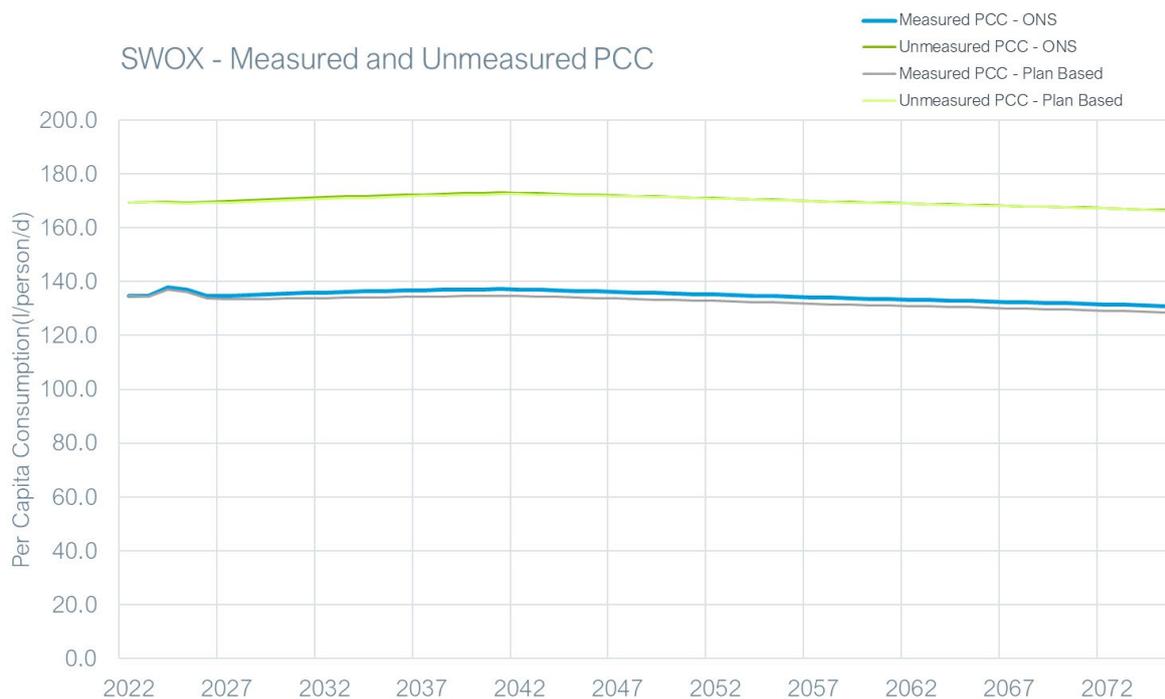


Figure 3-18: SWOX Baseline Per Capita Consumption

SWA

- 3.160 For the DYAA plan-based growth scenario SWA is forecast to begin AMP8 with a total household demand of 81.5 MI/d. This is forecast to increase to 93.4 MI/d by 2050 and to 92.2 MI/d by 2075, as shown in Figure 3-19.
- 3.161 The DYAA ONS 18 scenario gives a SWA demand of 78.9 MI/d at the start of AMP8. This is then forecast to increase to 82.6 MI/d by 2050 and to 81.6 MI/d by 2075, as shown in Figure 3-19.
- 3.162 For the DYCP plan-based growth scenario SWA is forecast to begin AMP8 with a total household demand of 113.4 MI/d. This is forecast to increase to 127.2 MI/d by 2050 and to 128.2 MI/d by 2075, as shown in Figure 3-20.
- 3.163 The DYCP ONS 18 scenario gives a SWA demand of 110.8 MI/d at the start of AMP8. This is then forecast to increase to 116.2 MI/d by 2050 and to 117.1 MI/d by 2075, as shown in Figure 3-20.
- 3.164 PCC is flat at the beginning of AMP8 due to the progressive metering planned as part of the Green Economic Recovery activity. An increase is observed between AMP8 and 2040 due to the removal of the trend adjustment, as previously discussed, for both the plan based and ONS forecasts. Beyond 2040 PCC gradually declines due to the reintroduction of the trend adjustment factor.
- 3.165 A summary of PCC movements for measured and unmeasured customers for both plan based and ONS scenarios can be seen in Table 3-23 and Figure 3-21.



Component	Scenario	2025-26	2049-50	2074-75
Measured Household – PCC	ONS 18	136.39	140.75	137.38
Unmeasured Household – PCC	ONS 18	166.64	169.24	164.54
Measured Household – PCC	Plan Based	136.00	139.96	136.54
Unmeasured Household – PCC	Plan Based	166.44	169.41	164.84

Table 3-23: SWA PCC Summary

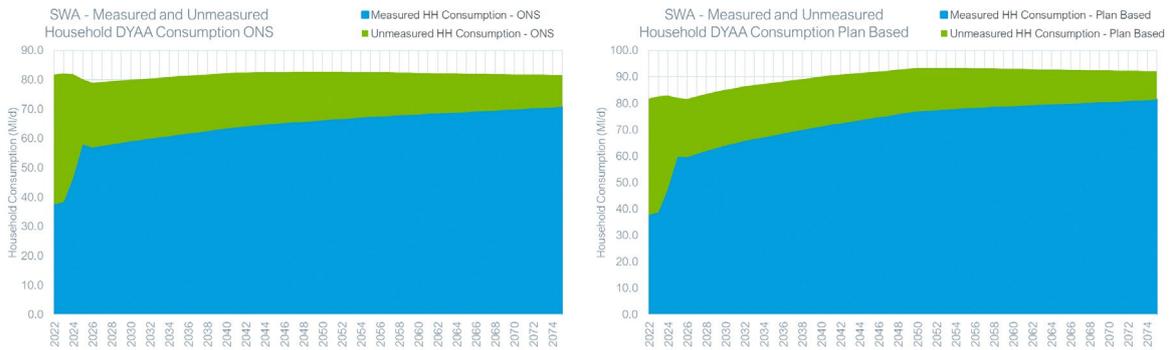


Figure 3-19: SWA Baseline DYAA Household Consumption

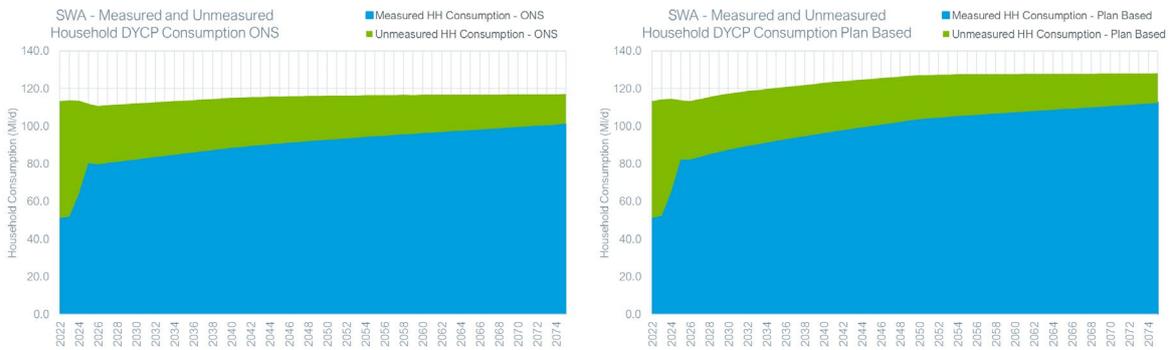


Figure 3-20: SWA Baseline DYCP Household Consumption

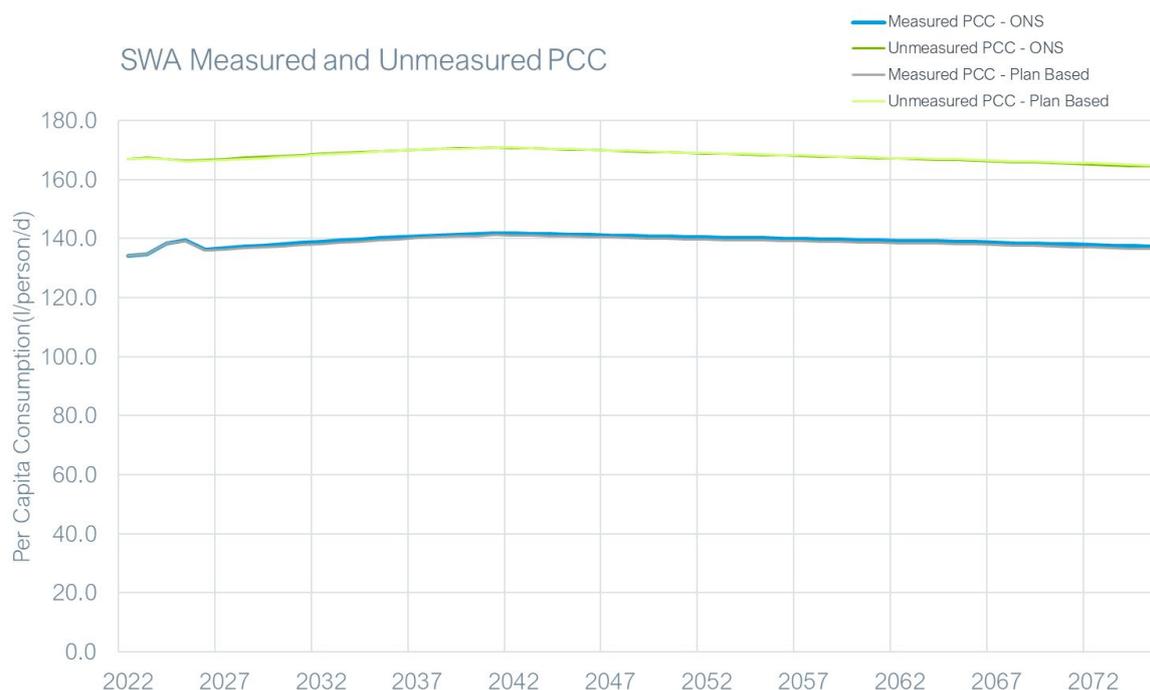


Figure 3-21: SWA Baseline Per Capita Consumption

Kennet Valley

- 3.166 For the DYAA plan-based growth scenario Kennet Valley is forecast to begin AMP8 with a total household demand of 56.6 MI/d. This is forecast to increase to 64.6 MI/d by 2050 and to 63.2 MI/d by 2075, as shown in Figure 3-22.
- 3.167 The DYAA ONS 18 scenario gives a Kennet Valley demand of 54.7 MI/d at the start of AMP8. This is then forecast to increase to 56.3 MI/d by 2050 and to 55.2 MI/d by 2075, as shown in Figure 3-22.
- 3.168 For the DYCP plan-based growth scenario Kennet Valley is forecast to begin AMP8 with a total household demand of 79.9 MI/d. This is forecast to increase to 89.3 MI/d by 2050 and to 89.4 MI/d by 2075, as shown in Figure 3-23.
- 3.169 The DYCP ONS 18 scenario gives a Kennet Valley demand of 78.0 MI/d at the start of AMP8. This is then forecast to increase to 80.8 MI/d by 2050 and to 80.9 MI/d by 2075, as shown in Figure 3-23.
- 3.170 PCC is flat at the beginning of AMP8 due to the progressive metering planned as part of the Green Economic Recovery activity. An increase is observed between AMP8 and 2040 due to the removal of the trend adjustment, as previously discussed, for both the plan based and ONS forecasts. Beyond 2040 PCC gradually declines due to the reintroduction of the trend adjustment factor.
- 3.171 A summary of PCC movements for measured and unmeasured customers for both plan based and ONS scenarios can be seen in Table 3-24 and Figure 3-24.



Component	Scenario	2025-26	2049-50	2074-75
Measured Household – PCC	ONS 18	128.81	130.44	125.87
Unmeasured Household – PCC	ONS 18	157.70	159.26	154.21
Measured Household – PCC	Plan Based	128.45	129.78	125.19
Unmeasured Household – PCC	Plan Based	157.46	159.19	154.14

Table 3-24: Kennet Valley Baseline PCC Summary

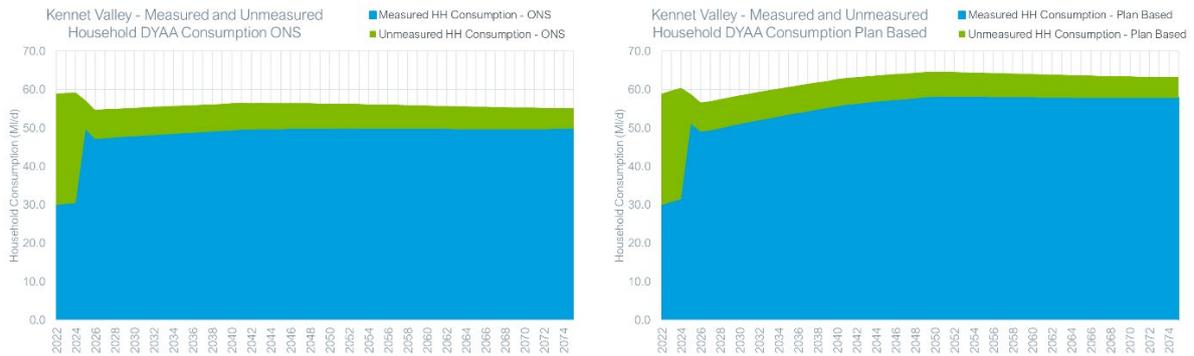


Figure 3-22: Kennet Valley Baseline DYAA Household Consumption

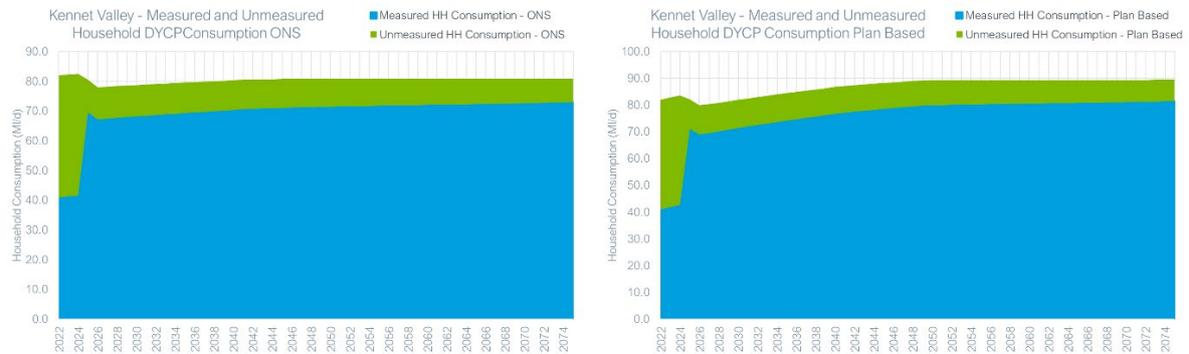


Figure 3-23: Kennet Valley Baseline DYCP Household Consumption

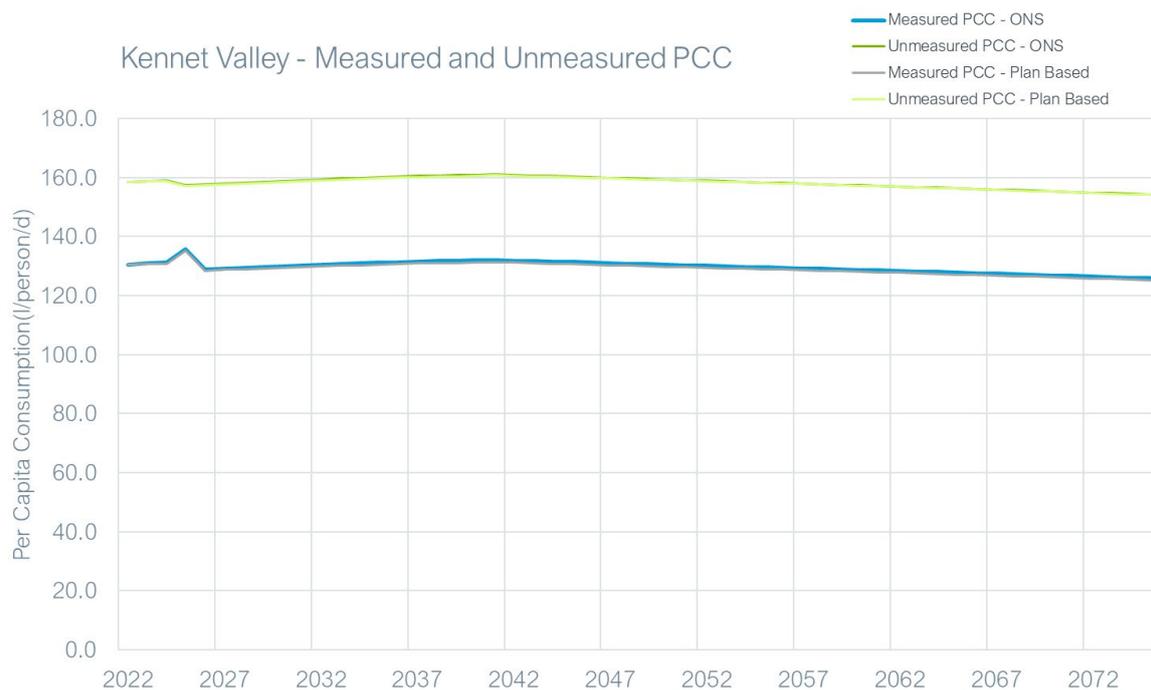


Figure 3-24: Kennet Valley Baseline Per Capita Consumption

Guildford

- 3.172 For the DYAA plan-based growth scenario Guildford is forecast to begin AMP8 with a total household demand of 23.9 MI/d. This is forecast to increase to 27.5 MI/d by 2050 and to 26.9 MI/d by 2075, as shown in Figure 3-25.
- 3.173 The DYAA ONS 18 scenario gives a Guildford demand of 22.9 MI/d at the start of AMP8. This is then forecast to increase to 23.0 MI/d by 2050 and to 22.5 MI/d by 2075, as shown in Figure 3-25.
- 3.174 For the DYCP plan-based growth scenario Guildford is forecast to begin AMP8 with a total household demand of 34.1 MI/d. This is forecast to increase to 38.3 MI/d by 2050 and to 38.4 MI/d by 2075, as shown in Figure 3-26.
- 3.175 The DYCP ONS 18 scenario gives a Guildford demand of 33.1 MI/d at the start of AMP8. This is then forecast to increase to 33.7 MI/d by 2050 and to 33.7 MI/d by 2075, as shown in Figure 3-26.
- 3.176 PCC is flat at the beginning of AMP8 due to the progressive metering planned as part of the Green Economic Recovery activity. An increase is observed between AMP8 and 2040 due to the removal of the trend adjustment, as previously discussed, for both the plan based and ONS forecasts. Beyond 2040 PCC gradually declines due to the reintroduction of the trend adjustment factor.
- 3.177 A summary of PCC movements for measured and unmeasured customers for both plan based and ONS scenarios can be seen in Table 3-24 and Figure 3-27.



Component	Scenario	2025-26	2049-50	2074-75
Measured Household – PCC	ONS 18	133.31	135.06	130.38
Unmeasured Household – PCC	ONS 18	168.89	169.55	163.73
Measured Household – PCC	Plan Based	133.16	134.28	129.46
Unmeasured Household – PCC	Plan Based	169.03	170.30	164.57

Table 3-25: Guildford Baseline PCC Summary

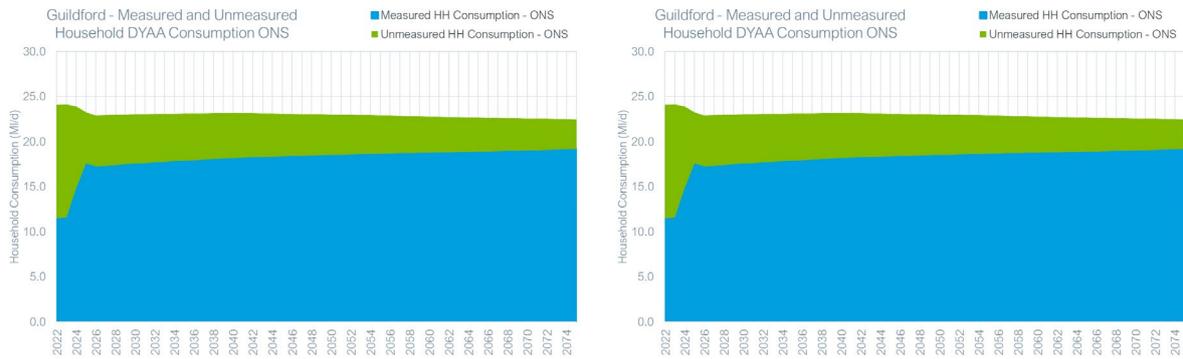


Figure 3-25: Guildford Baseline DYAA Household Consumption

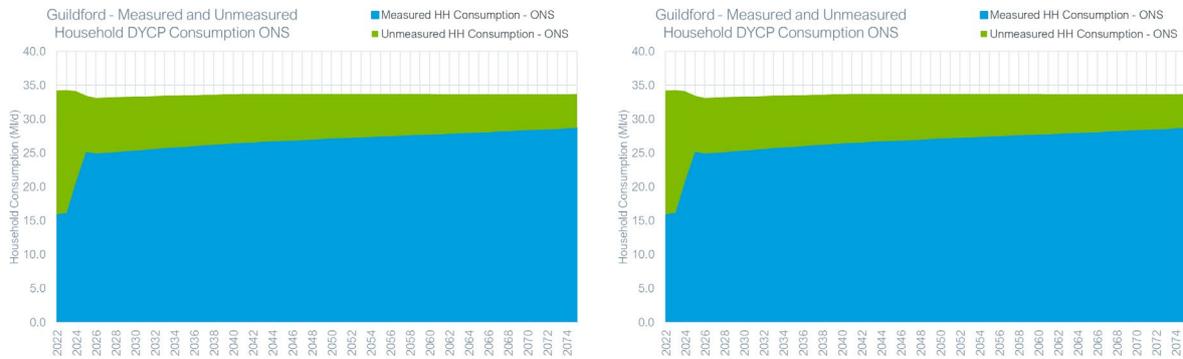


Figure 3-26: Guildford Baseline DYCP Household Consumption

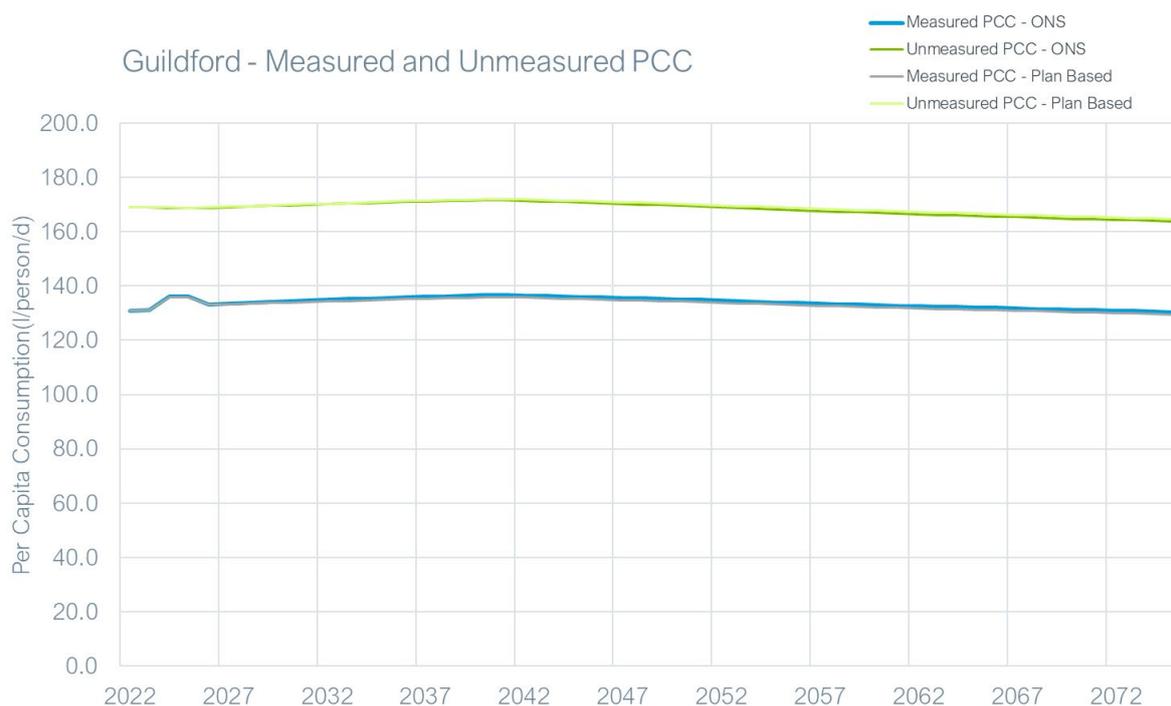


Figure 3-27: Guildford Baseline Per Capita Consumption

Henley

- 3.178 For the DYAA plan-based growth scenario Henley is forecast to begin AMP8 with a total household demand of 7.5 MI/d. This is forecast to increase to 8.7 MI/d by 2050 and to 8.7 MI/d by 2075, as shown in Figure 3-28.
- 3.179 The DYAA ONS 18 scenario gives a Henley demand of 7.6 MI/d at the start of AMP8. This is then forecast to increase to 8.3 MI/d by 2050 and to 8.4 MI/d by 2075, as shown in Figure 3-28.
- 3.180 For the DYCP plan-based growth scenario Henley is forecast to begin AMP8 with a total household demand of 10.7 MI/d. This is forecast to increase to 12.0 MI/d by 2050 and to 12.0 MI/d by 2075, as shown in Figure 3-29.
- 3.181 The DYCP ONS 18 scenario gives a Henley demand of 10.8 MI/d at the start of AMP8. This is then forecast to increase to 11.7 MI/d by 2050 and to 12.2 MI/d by 2075, as shown in Figure 3-29.
- 3.182 PCC is flat at the beginning of AMP8 due to the progressive metering planned as part of the Green Economic Recovery activity. An increase is observed between AMP8 and 2040 due to the removal of the trend adjustment, as previously discussed, for both the plan based and ONS forecasts. Beyond 2040 PCC gradually declines due to the reintroduction of the trend adjustment factor.
- 3.183 A summary of PCC movements for measured and unmeasured customers for both plan based and ONS scenarios can be seen in Table 3-26 and Figure 3-30.



Component	Scenario	2025-26	2049-50	2074-75
Measured Household – PCC	ONS 18	144.33	147.03	142.96
Unmeasured Household – PCC	ONS 18	166.90	170.74	166.71
Measured Household – PCC	Plan Based	133.16	134.28	129.46
Unmeasured Household – PCC	Plan Based	169.03	170.30	164.57

Table 3-26: Henley Baseline PCC Summary

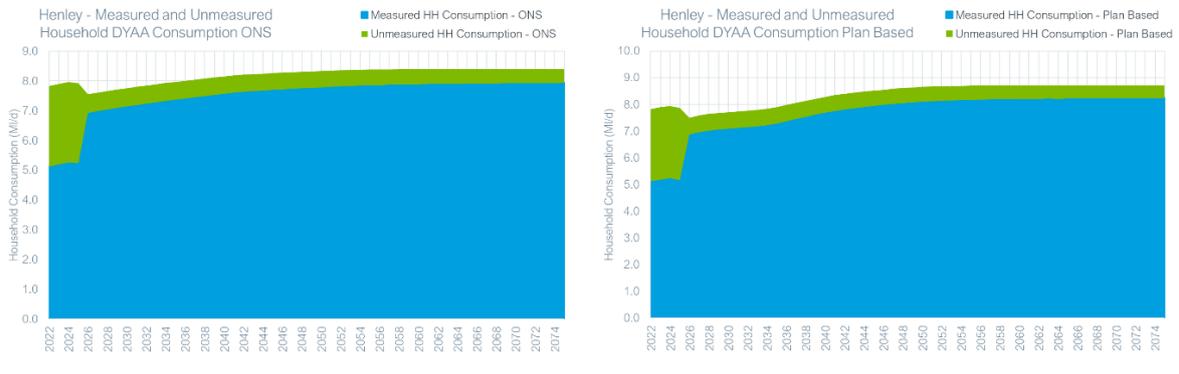


Figure 3-28: Henley Baseline DYAA Household Consumption



Figure 3-29: Henley Baseline DYCP Household Consumption

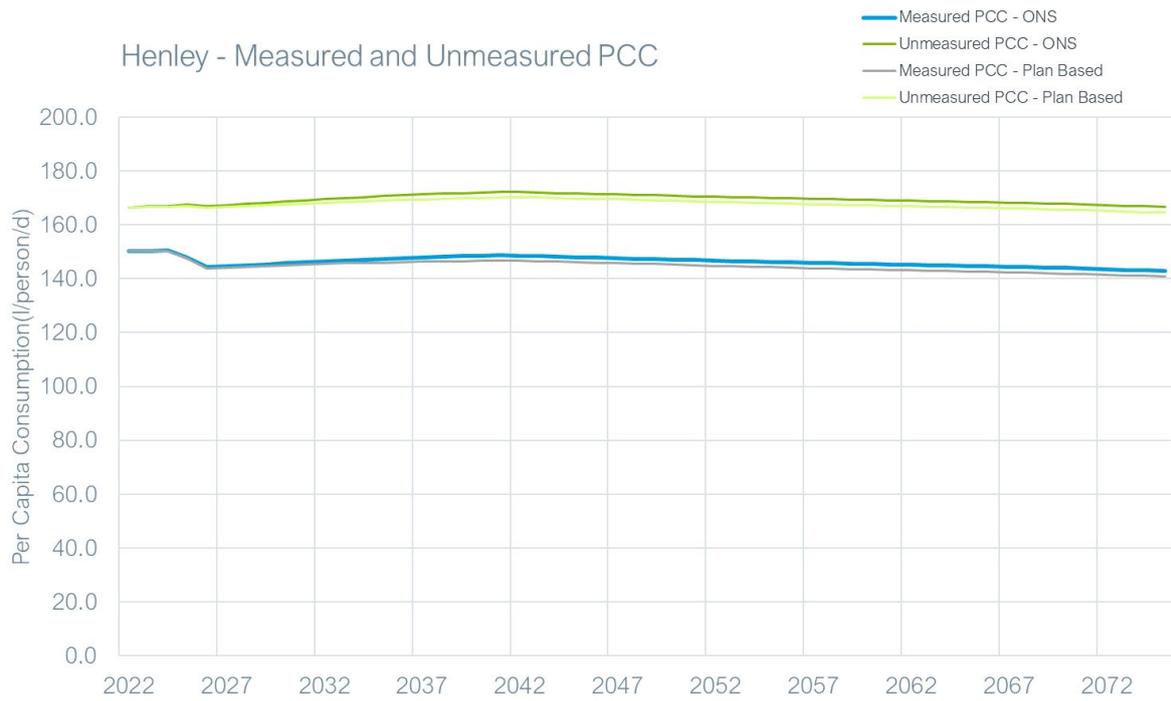


Figure 3-30: Henley Baseline Per Capita Consumption

Non-Household water use

Introduction

Regulatory requirements

- 3.184 Expectations and guidance for non-household demand forecasts are set out in Section 6.5 of the WRPG. Water companies are required to forecast the demand for water being used by non-household premises (such as businesses and industrial processes) and for the population living in communal establishments (for instance hospitals, prisons and educational establishments). Since the last non-household demand forecasts were developed, the non-household market has been opened for competition. The definition of non-households is in line with Ofwat's guidance.
- 3.185 For non-household (NHH) demand forecasts we are required to:
- Produce plan that contains an estimated demand forecast for non-households
 - Provide a description of how figures and assumptions in the forecast have been derived
 - Ensure that the plan makes use of the Market Operator Services Ltd (MOSL) system that stores retail company data as needed
 - Describe the makeup of non-household demand in different sectors either by using the service and non-service split (identifying the main sectors), or by using Standard Industrial Classification (SIC) categories published by the Office for National Statistics
 - Derive a baseline forecast which reflects non-household demand without any further intervention
- 3.186 As part of WRSE we participated in a group project to develop a new non-household demand forecasting model, development of the model was undertaken by Artesia Consulting.
- 3.187 Artesia used data from the Central Market Operating System (CMOS) operated by MOSL for the period 2017 to 2020 and Additional data from the pre-MOSL period was also used to develop longer term trends in historic non-household consumption data.
- 3.188 SIC codes were used to assign non household customers into the identified segments with AddressBase Classification datasets provided by WRSE companies used to augment and crosscheck the SIC classifications.

Voids and large users

- 3.189 Our consumption data was provided at property level which allowed Artesia to identify and exclude large users, which may have a significant impact on consumption at WRZ level and adversely affect the robustness of the model. Artesia used this to determine a consumption threshold value above which they could classify users as a large user. This threshold was set at 2%, i.e. if a single user consumes greater than 2% of the WRZ non-household consumption then this property would be flagged as a large user.

Population data

- 3.190 Population data from forecasts and Annual Returns, by year and WRZ, are imported and combined to create a joint population dataset. Populations for overlapping years (2019-20) for both historical and forecast data are compared to check data accuracy. For the baseline population local authority plan-based forecasts are used.
- 3.191 SIC groups or AddressBase classifications are mapped to industry grouping using various mapping files, we developed mapping files for SIC_1980, SIC_1992, SIC_2003, SIC_2007 and AddressBase. These were then used to group the properties' consumption into the industrial sectors shown in Table 3-27.

Industry grouping	SIC_2007 sections	Reference
Agriculture (and other weather dependent industries)	A	1
Non-service industries (excluding Agriculture)	B, C, D, E, F	2
Service industries – population driven	O, P, Q, R, S, T	3
Service industries – economy driven	G, H, I, J, K, L, M, N	4
Unclassified		5

Table 3-27: Industry Groupings

- 3.192 Table 3-28 shows the proportion of properties and the proportion of consumption for each company that falls into each of the industry groupings identified in Table 3-27.

Company	Industry grouping	Proportion of properties in group	Proportion of consumption in group
Thames Water	Agriculture	2%	3%
	Non-service	5%	7%
	Service – population	18%	27%
	Service – economy	29%	31%
	Unclassified ²⁴	46%	34%

Table 3-28: Proportions of consumption and properties by Industry grouping

- 3.193 Econometric data was provided by Oxford Economics (OE). This data is formatted into employment and gross value added (GVA) by SIC group and region. All WRSE companies currently use the “South East” region, with the only exception being Thames Water where the London WRZ uses the “London” OE region. Historic data was provided from 1991, and forecast data was provided to 2040.
- 3.194 A maximal theoretical dataset was created by creating all combinations of year (from OE, weather, consumption, and population datasets), WRZ (weather, consumption, and population) and SIC/industry groups (consumption), with all variables joined to these where available.
- 3.195 This is then aggregated to industry grouping level, with group-specific numerical variables summed (consumption, employment, GVA) and other numerical variables re-joined at

²⁴ Unclassified is used when we are unable to identify a specific industry for a non-household property

aggregated level (weather and population). Both the SIC and industry grouping aggregation datasets are output for use in subsequent modules.

Model build, testing and refinement for baseline forecasts

- 3.196 The non-household forecast modelling is carried out in line with best practice²⁵.
- 3.197 Choosing the right modelling process is a complex task that needs to take into consideration statistical model performances, but also many other variables that require the modeller's expert judgement (availability of variables, reliability of data, overfitting problems, and more).
- 3.198 The NHH forecast modelling process is divided in the following steps:
- Build the multi linear regression (MLR) model based on past aggregated consumption data, considering Oxford Economic variables and potentially other factors
 - Calibrate the model for the base year, in this case 2019-20, first by industry sector using the property consumption data, then by WRZ using the AR consumption
 - Apply the MLR model and the calibration to future explanatory variables to estimate future NHH consumption
- 3.199 The MLR modelling is done at company level but considering industry groups independently. Calibration is then performed at WRZ level.
- 3.200 MLR modelling aims at finding a linear relationship between the observed consumption and explanatory variables. At first, all available explanatory variables are considered. Subsequently, the model is refined choosing only the significant variables. The choice is based on:
- Model performances excluding the variables one by one
 - Interaction between variables
 - Logical inclusions/exclusions based on the relationship between the expected effect of each variable on consumption, and the estimated coefficients
 - Exclusion of outliers
- 3.201 The MLR model is based on MOSL data in the base year, which may not represent the total annual reported NHH Measured consumption. For this reason, the results of the model need to be calibrated against the Annual Report data for the base year, in this case 2019-20. This also helps account for differences between WRZ, not accounted for building the model at company level.
- 3.202 To ensure the proportion between different sectors is maintained, the calibration has been further refined:
- First, modelled consumption is calibrated against property consumption for each industry group and WRZ, deriving an additive factor
 - Then the total measured consumption is calibrated against AR data at WRZ, deriving a multiplicative factor

²⁵ Forecasting water demand components - Best practice manual. UKWIR, 97/WR/07/01. 1997.



- 3.203 The Artesia Consulting report for Thames Water specific results for each MLR model for each industry sector are included in Appendix G Non-Household Water Demand.
- 3.204 Final NHH baseline forecasts are obtained separately for the measured and the unmeasured component.
- 3.205 The model results are shown in Figure 3-31 to Figure 3-32. Over the planning period (2025), the Thames Water region total modelled non-household demand is predicted to increase by 38 MI/d with a range of -144 MI/d to +276 MI/d indicating a high level of uncertainty.

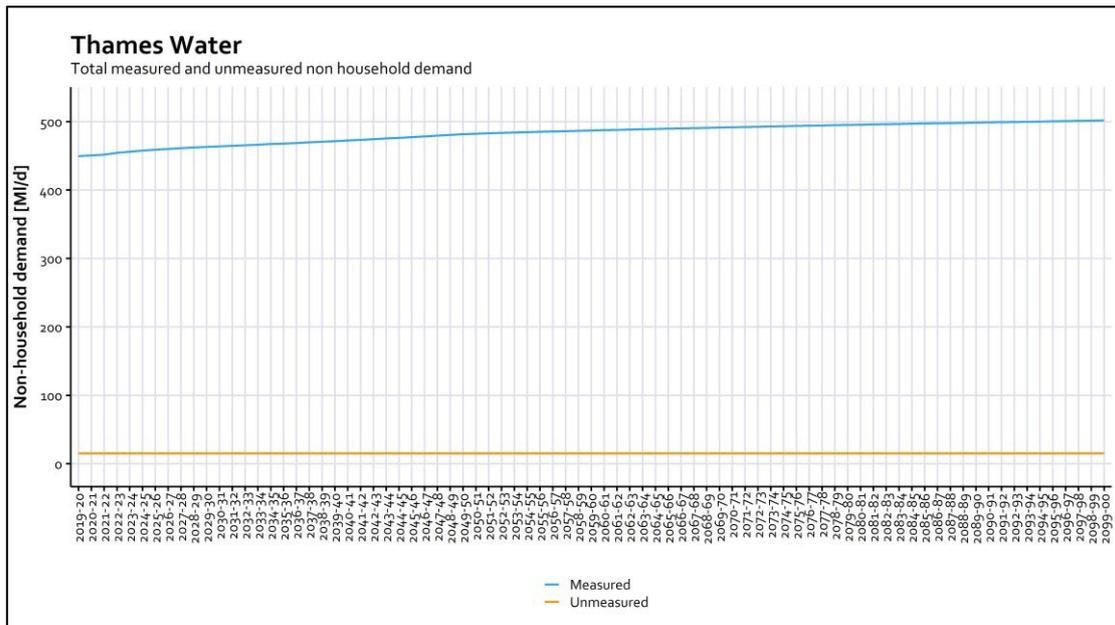


Figure 3-31: Thames Water measured and unmeasured non-household consumption

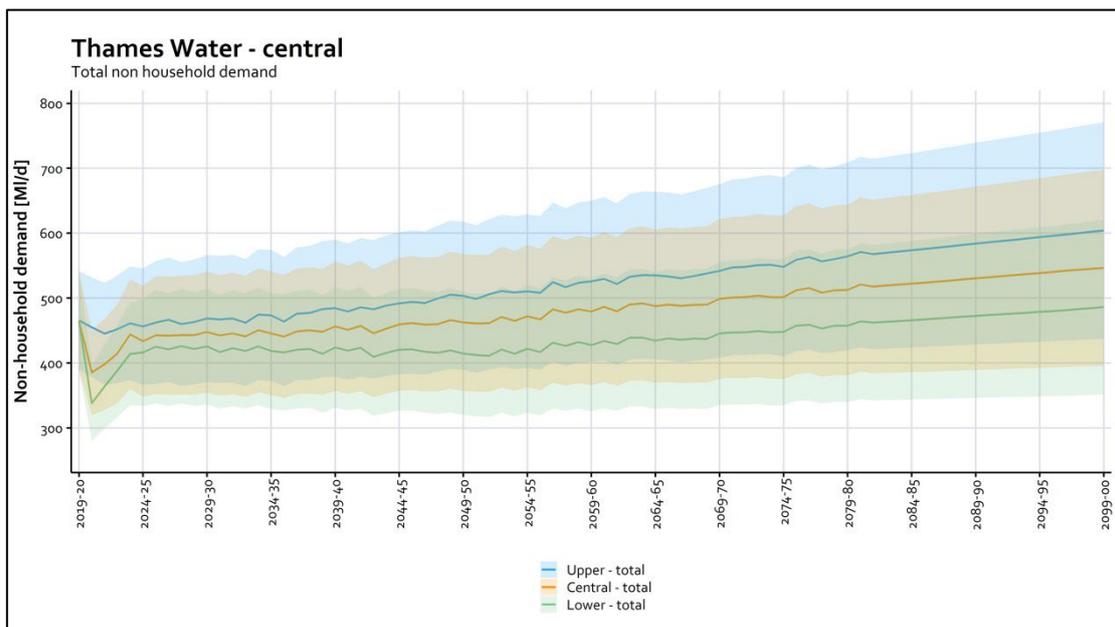


Figure 3-32: Thames Water region non-household consumption central, lower and upper scenarios

- 3.206 There is growth in the Thames Water region from the service sectors, with a small increase in agriculture, the non-service sector remains flat across the planning period.
- 3.207 About 27% of the demand in the Thames Water region falls into the unclassified group and this is held flat across the planning period. These are properties that could not be allocated into an industry sector because either the property has no industry code assigned to it or the industry code is incorrectly recorded and cannot be matched to a sector. Artesia attempted to model this unclassified sector, but because of the inconsistency in the data it was not possible to derive meaningful relationships or models, therefore the forecast for the unclassified sector is flat across the planning period.

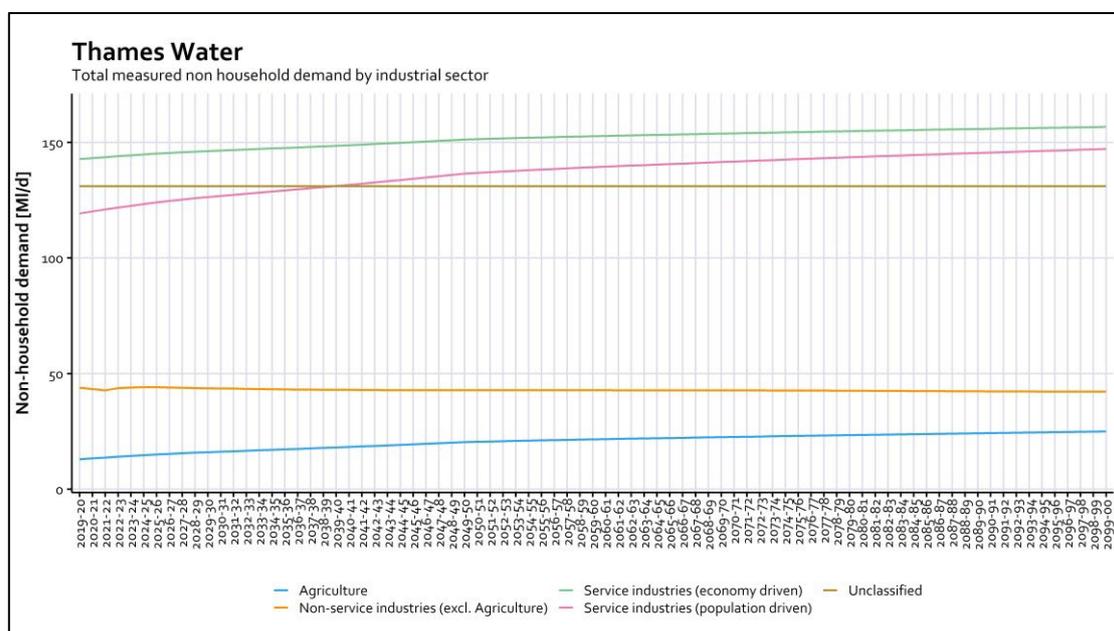


Figure 3-33: Modelled non-household by industrial Sector

Data Centres

- 3.208 Recently we have received enquiries regarding the planning of data centres within our water supply area. Data centres are a nascent industry and one that, based on the number of applications we are receiving, is growing quickly. Given that there is little historical record of data centres within our supply area we do not consider that linear regression methods used for our non-household forecast will capture likely future growth in this sector, as these methods are reliant on historical data and their correlation with explanatory variables.
- 3.209 We therefore commissioned Jacobs to undertake a study on potential future growth for this industry. The outcome from this study was that Jacobs produced high, medium and low scenarios for each water resource zone across AMP 8 and 9, shown in Figure 3-34.

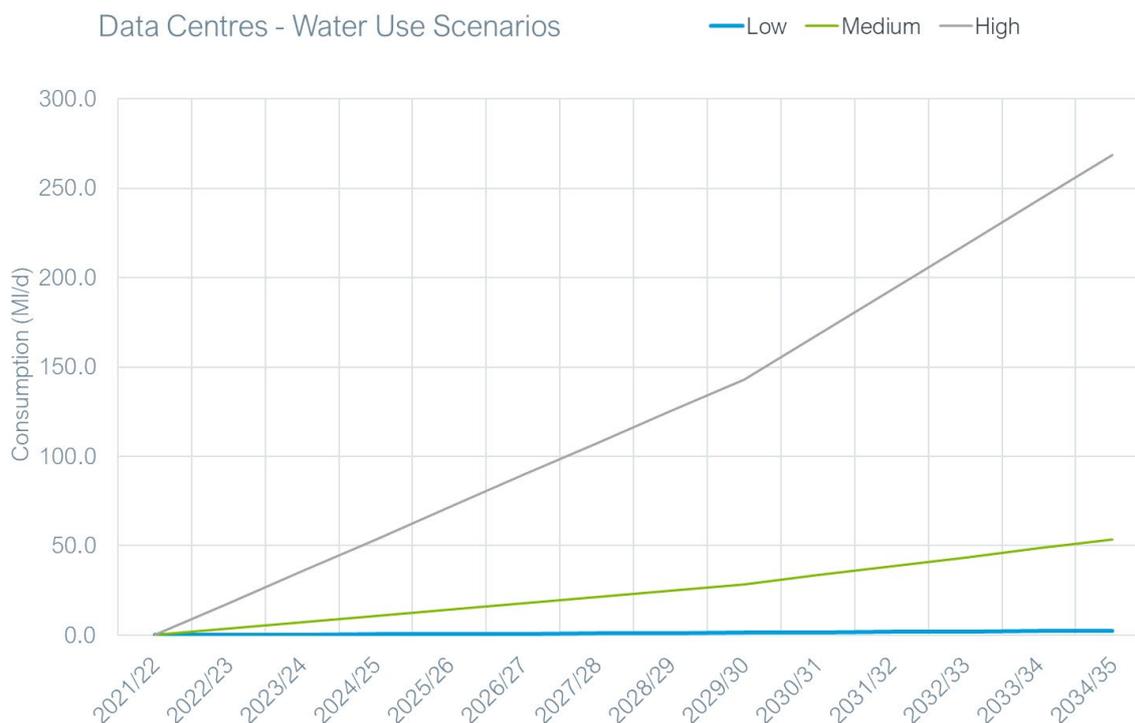


Figure 3-34: Jacob Data Centre Scenarios

- 3.210 The scenarios above show a wide range of potential futures in terms of water demand for data centres. However, we are under no obligation to supply water to non-household customers and therefore where we consider water use to be inefficient we can refuse to supply the customer and require that they improve their efficiency.
- 3.211 Given this we have decided to include the midpoint between the low and medium forecasts within our demand forecasts. We believe this gives a sufficient allowance to allow data centres to be operated within our supply area without risking investment on assets that may not be required.
- 3.212 The profile used within our demand forecasts is shown in Figure 3-35.



Profile of Data Centre Water Use Included In Demand Forecast

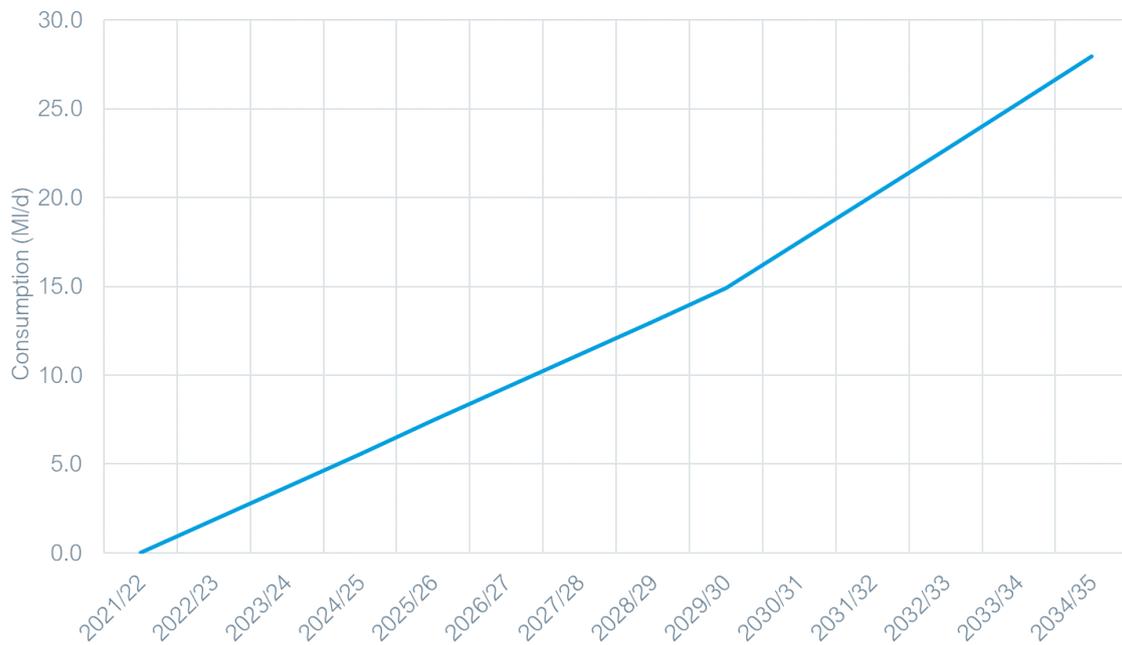


Figure 3-35: Data Centre Water Use Profile

3.213 Overall NHH demand shows increases across AMP8 and AMP9 due to the inclusion of data centres within the forecast. Beyond AMP9 profiles are generally flat, Henley is an exception to this as the Jacobs study did not identify data centre growth being likely to impact Henley. Overall the change in non-household demand looks dramatic in Henley, but is a decrease of less than 0.6 MI/d between the start of AMP8 and 2075. The decreases in Henley are due to forecast reduction in the service sector.



Figure 3-36: WRZ NHH Demand Totals

3.214 Figure 3-36 shows the forecast NHH consumption across all our WRZs for both measured and unmeasured categories.



Baseline leakage and minor components

- 3.215 Typically, we forecast leakage in the baseline demand forecast as flat across the forecast period however there is additional leakage within year 1 and 2 of AMP8 for London which reflects the conditional allowance for this activity, this was an allowance within the 2019 Price Review, and USPL savings from metering associated with GER.
- 3.216 We forecast minor components as unchanged over the planning period as there is no satisfactory method by which to forecast them.
- 3.217 The values for leakage, from year 2 of AMP8, and minor components across the planning period can be seen in Table 3-29.

WRZ	Leakage	DSOU	Water Taken Unbilled
Guildford	11.61	0.47	0.92
Henley	3.96	0.09	0.22
Kennet Valley	24.12	0.58	1.86
London	352.53	12.67	47.86
SWA	38.47	0.98	2.12
SWOX	60.76	2.39	6.93
Thames Water	491.46	17.18	59.91

Table 3-29: Leakage, operational usage and water taken unbilled

Summary of our baseline demand forecasts

3.218 The baseline plan based and ONS DYAA demand forecast for each WRZ and the DYCP forecast for Thames Valley zone are shown in Figure 3-37 and Figure 3-38 with summaries presented in Table 3-30, Table 3-31, Table 3-32, Table 3-33.

3.219 In the Plan-Based scenario a consistent picture can be seen across our WRZs where once new demand management activity ceases at the end of AMP7 demand for water quickly shows increases in the housing plan scenario. Most of this increase in demand is prior to 2050 which is the period for which local plans are in place. Once we move beyond the period of the local plans and revert to longer term ONS statistics the increase in water demand slows for the remainder of the forecast period.

3.220 The ONS scenario shows Slower growth and increases in water demand once AMP7 demand management activity is complete.

	2025-26	2049-50	2074-75
London	1930.37	2193.90	2193.38
SWOX	280.26	316.47	316.29
SWA	139.45	155.71	154.70
Kennet Valley	96.70	106.87	105.27
Guildford	47.51	53.11	52.29
Henley	12.99	13.60	13.70

Table 3-30: Summary of Total DYAA Demand (Plan Based Scenario)

	2025-26	2049-50	2074-75
London	1896.05	2016.27	2018.63
SWOX	274.26	289.90	290.10
SWA	136.86	144.97	144.12
Kennet Valley	94.77	98.59	97.19
Guildford	46.52	48.58	47.85
Henley	13.05	13.27	13.39

Table 3-31: Summary of Total DYAA Demand (ONS Scenario)

	2025-26	2049-50	2074-75
SWOX	340.67	380.75	384.84
SWA	167.32	185.55	186.70
Kennet Valley	114.35	125.93	125.84
Guildford	62.13	68.31	68.11
Henley	18.77	19.57	19.88

Table 3-32: Summary of Total DYCP Demand (Plan Based Scenario)

	2025-26	2049-50	2074-75
SWOX	334.64	353.50	357.32
SWA	164.72	174.55	175.58
Kennet Valley	112.41	117.44	117.35



	2025-26	2049-50	2074-75
Guildford	61.13	63.66	63.44
Henley	18.83	19.23	19.55

Table 3-33: Summary of Total DYCP Demand (ONS Scenario)



Figure 3-37: DYAA Distribution Input



Figure 3-38: DYCP Distribution Input

