Water Resources Management Plan 2024

Section 3 – Demand Forecast

Table of Contents

Figures

Tables

Background and Introduction

This section describes how we calculate current and forecast future demand for water. This is one of the foundations of our plan as it provides the information that enables us to define the supply-demand balance we need to manage in the future.

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 Water Resources Management Plan 2024 (WRMP24) 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 299 Ml/d by 2050 and then marginal decreases after this to give an overall increase of approximately 283 Ml/d by 2075.

3.9 Non-household water use is forecast to increase by approximately 50 Ml/d over the planning period to 2050 and a total increase of 63 Ml/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 (WTU), distribution system operational use (DSOU) and leakage are forecast to remain at current levels in the baseline forecast (excluding marginal changes to WTU resulting from NAV forecasts).

3.12 Overall, the total baseline demand forecast (before intervention) is expected to increase by 270 Ml/d in the period of 2023-2050 and then marginally reducing to 266Ml/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 Guideline[2] (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, 2023-24
- 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 (DSOU) - water used maintaining the network

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

[2] Water resources planning guideline Version 12 updated March 2023

- Water Taken Unbilled (WTU) - 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 guidance[3] 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.

3.21 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

3.22 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

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

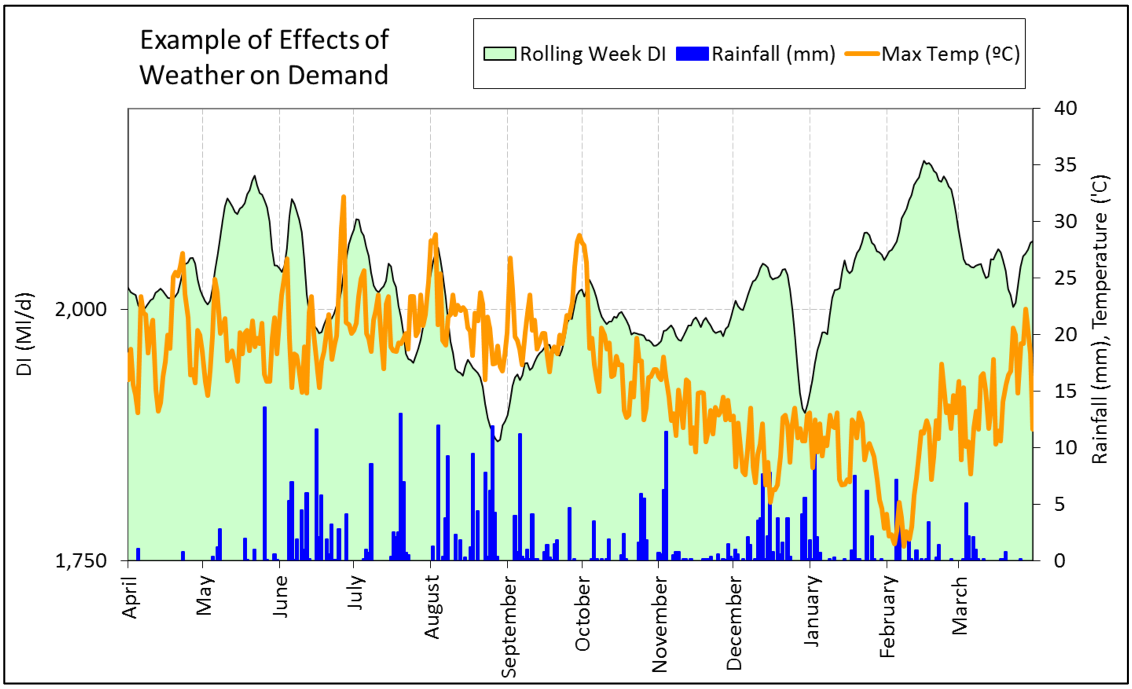

Figure 3-1: Effect of weather on demand (measured by Distribution Input)

3.23 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:

- 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

3.24 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 allowance[4] programme.

- 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

[4] Thames Water final determination PR19-final-determinations-Thames-Water-final-determination.pdf (ofwat.gov.uk)

Base Year Demand

The water balance

3.25 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.

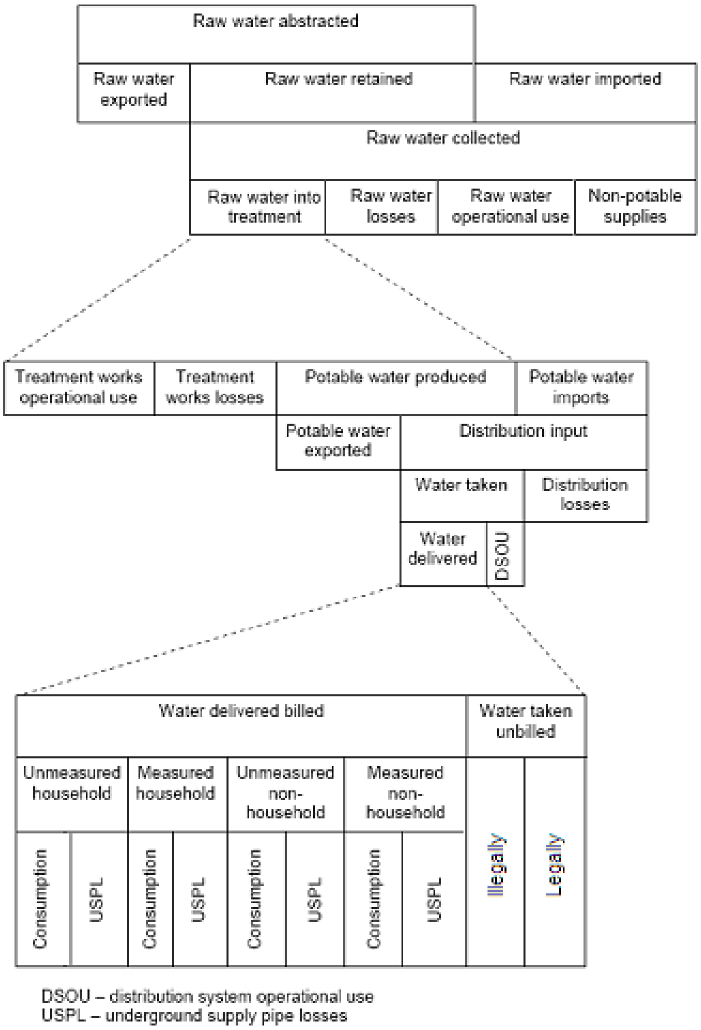

Figure 3-2: Overview of water balance

3.26 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.

3.27 A minor adjustment has been applied to water balance figures for use in WRMP:

- AR24 reported figures use WRZ-level MLE-adjusted figures from the water balance calculation, summed to company-level,
- WRMP adjusted figures instead use company-level MLE-adjusted figures, proportioned out to WRZ-level.

3.28 This adjustment results in values that are more accurate for company-level figures. This constitutes a minor change from rdWRMP.

Choice of base year and Covid-19 impacts

3.29 The base year of the demand forecast is 2023/24, this is the most recent reporting year available at the time of producing forecasts. This is an update from the rdWRMP, which used 2021/22 as the base year for demand forecasting.

3.30 Water demand in the years post Covid-19 has fluctuated, with company-level increases to non-household (NHH, commercial) customer consumption and corresponding decreases to household (HH) customer consumption, observed as a shift for the 2022/23 year, which was sustained in 2023/24.

3.31 In order to align forecasts based on 2021/22 figures to a baseline of 2023/24, we have taken the change over time from the original rdWRMP demand model and applied it to the new start point. Subsections below may refer to 2021/22 as the base year of the modelled forecasts, however the final adjusted model is ultimately using 2023/24.

Base year properties

3.32 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.

3.33 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.

3.34 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

WRZ	Households (000s)			Non-households (000s)		
	Unmeasured	Measured	Void	Unmeasured	Measured	Void
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

3.35 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.

3.36 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 Analytics[5]. This allowance totals an additional population of 665,170, the majority of which are within London.

3.37 Non-household population is population residing in communal establishments; based on the Ofwat eligibility criteria released in July 2016 [6].

3.38 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.

3.39 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 2011[7] for regions covering our London and Thames Valley zones.

3.40 To update population splits between measured and unmeasured households we have used the movement in properties, reductions in unmeasured properties as customers opt

[5] Clandestine and Hidden Populations Edge Analytics February 2020
[6] Eligibility guidance on whether non-household customers in England and Wales are eligible to switch their retailer – Ofwat July 2016
[7] Census 2021 detailed statistics will not be available until at least summer 2023

for a meter, and increases in measured properties associated with optants, in addition to newly built properties[8].

3.41 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
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 (2021-22)

New Appointments and Variations

3.42 Between the publication of our Revised Draft WRMP24 and final WRMP24, the Environment Agency clarified the approach that should be taken to dealing with demands from New Appointments and Variations (NAVs), otherwise known as Inset Appointments, in wholesale company WRMPs.

3.43 NAVs supply customers, often new housing developments, within our wholesale supply area, within defined geographical regions. As such, their supplies tend to be formed solely of imports from wholesale suppliers.

3.44 In our earlier drafts the approach taken was:

- In our supply forecast, we accounted for the export to NAVs that would be expected to be made in a dry year, according to their current level of demand.
- In our demand forecast, we accounted for growth across our wholesale (rather than retail) supply area. As such, we accounted for growth within existing NAV insets within our own demand forecast.
- In this way, we considered that we had appropriately accounted for growth expected in inset areas.

3.45 The Environment Agency clarified that, to ensure alignment, the approach to be taken should be:

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

- In our supply forecast, account for the contractual maximum export as negotiated in each bulk supply agreement with each NAV.
- In our demand forecast, ensure that we do not double count population or property forecasts for growth anticipated within existing inset areas.

3.46 As a result of this clarification, we have communicated with each of the companies who supply water in inset areas within our wholesale supply area, ensuring that we are supplied with up-to-date information regarding their forecasts of population, properties and consumption. We have removed forecast population growth, property growth and consumption changes from our own forecasts (which were produced for the wholesale supply area) to ensure that our Distribution Input forecast is only for our current retail supply area, alongside any as-yet unidentified inset areas. This ensures that our plans are aligned and that we do not double count demand from NAVs.

Household demand

3.47 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-registration[9], 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.

3.48 For 2023-24 the average, measured, and unmeasured PCC for each WRZ is shown in Table 3-3, including changes for NAVs. Note that this is using baseline figures inconsistent with WRZ-level AR24 reporting (as explained above in the section entitled "The water balance").

WRZ	Unmeasured PCC	Measured PCC	Average PCC	% Metered
London	162.8	119.3	137.8	57.2%
SWOX	138.6	132.3	134.4	67.6%
SWA	164.7	122.9	142.5	56.0%
Kennet Valley	153.5	125.3	137.5	59.5%
Guildford	127.7	134.7	131.6	56.9%
Henley	152.2	133.2	139.2	69.4%

Table 3-3: DYAA Per capita consumption (2023-24) (l/person/d)

Non-household demand

3.49 Most non-household demand is measured. It is primarily water used by commercial, industrial and agricultural premises, though there is a small population whose

[9] 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

consumption is included within the non-household category as they live in properties classified as 'mixed' (e.g. a flat above a shop).

3.50 Assessed non-household[10] 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 assigned by billing band type and number of billed units supplied by the Central Market Operating System (CMOS).

3.51 Non-household consumption for 2023-24 is shown in Table 3-4 (including changes for NAVs). Note that this is using baseline figures inconsistent with WRZ-level AR24 reporting (as explained above in the section entitled "The water balance").

WRZ	Measured	Unmeasured
London	311.03	11.37
SWOX	52.92	0.76
SWA	19.88	0.29
Kennet Valley	17.42	0.26
Guildford	6.97	0.16
Henley	1.44	0.04
Thames Water	409.66	12.89

Table 3-4: DYAA Non-household consumption (2023-24) (Ml/d)

Leakage

3.52 The reported leakage value for our AR24 was 590.28 Ml/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.

3.53 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

3.54 Leakage for the 2023-24 baseline is provided in Table 3-5. Note that this is using baseline figures inconsistent with WRZ-level AR24 reporting (as explained above in the section entitled "The water balance").

WRZ	Total Leakage
London	411.67
SWOX	77.45
SWA	47.82
Kennet Valley	26.71
Guildford	19.08

[10] Non-household properties where it is impractical to fit a meter

WRZ	Total Leakage
Henley	5.04
Thames Water	587.77

Table 3-5: DYAA Leakage (2023-24) (Ml/d)

Minor components

3.55 DSOU includes water used by a company to maintain water quality standards in the distribution system such as mains flushing. WTU includes public supplies for which no charge is made (sewer flushing etc.), fire training and fire-fighting supplies; it also includes water taken illegally.

3.56 At the company level, minor components add up to 87.84 Ml/d in the base year (including changes for NAVs).

Summary for 2021-22

3.57 Figure 3-3 shows the breakdown of the total demand reported in the water balance for 2023-24 by component. This split of total demand and its sub-components forms the base position for the demand forecast.

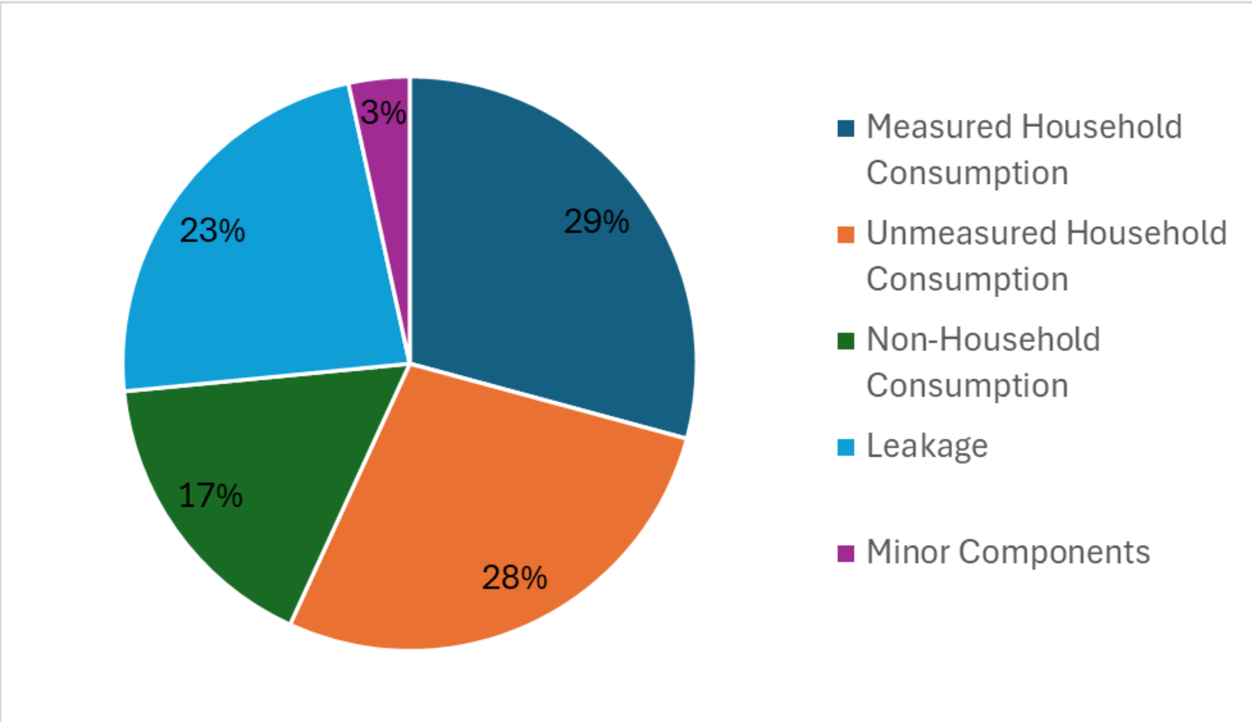

Figure 3-3: Sub-components of demand by Ml/d (2021-22)

Future demand – the demand forecast

Planning scenarios

3.58 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.

3.59 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) scenario[11]: 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

3.60 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

3.61 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.

3.62 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.

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

[11] The point where demand and supply are most closely matched

Peaking factors

3.64 Peaking factors are used to uplift or reduce out-turn demand in any year to the DYAA and DYCP planning scenarios.

3.65 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.

3.66 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, 01/04/2023 – 31/03/2024) 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).

3.67 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.

2023-24			
AR24 Dry and Normal Year Distribution Input Uplifts		Normal Year uplift	Dry Year uplift
London	AA	2.26	15.98
	CP	N/A	N/A
SWOX	AA	1.09	4.03
	CP	N/A	56.51
SWA	AA	-0.19	0.91
	CP	N/A	23.61
Kennet Valley	AA	0.38	1.14
	CP	N/A	16.07
Guildford	AA	-0.32	0.20
	CP	N/A	11.79
Henley	AA	-0.06	0.11
	CP	N/A	4.81

Table 3-7: Distribution input uplift volumes (Ml/d), 2023-24

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

WRZ	DYAA	DYCP	NYAA[12]
London	1935.17	1935.17	1921.45
SWOX	289.13	341.61	286.19

[12] Note that NYAA values presented here are including for changes to NAVs, as such these do not directly compare to values provided in WRMP Table 2a, which align to PR24 and as such do not account for these same changes.

WRZ	DYAA	DYCP	NYAA[12]
SWA	150.53	173.22	149.43
Kennet Valley	105.69	120.62	104.93
Guildford	49.72	61.30	49.20
Henley	13.99	18.69	13.82
Thames Water	2544.23	2650.62	2525.02

Table 3-8: Distribution Input (Ml/d) post uplift, 2023-24

Covid-19 Impacts on Demand Forecasts

3.69 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.

3.70 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."

3.71 This leaves us in the position whereby we are unable with confidence to predict a most likely outcome to include within our demand forecast. Having re-based our demand forecast using the 2023-24 start point gives us more confidence that our forecast is in line with post-covid demand conditions.

3.72 Given the uncertainty associated with this 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.

3.73 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

3.74 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).

3.75 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.

3.76 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 review.[14] 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.

3.77 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 scenarios.[15] which includes guidance for which growth forecasts should be considered.

3.78 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.

3.79 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."

3.80 Therefore, our central forecasts use projections produced by the local authorities.

3.81 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.

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[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)

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

Regulatory Guidance

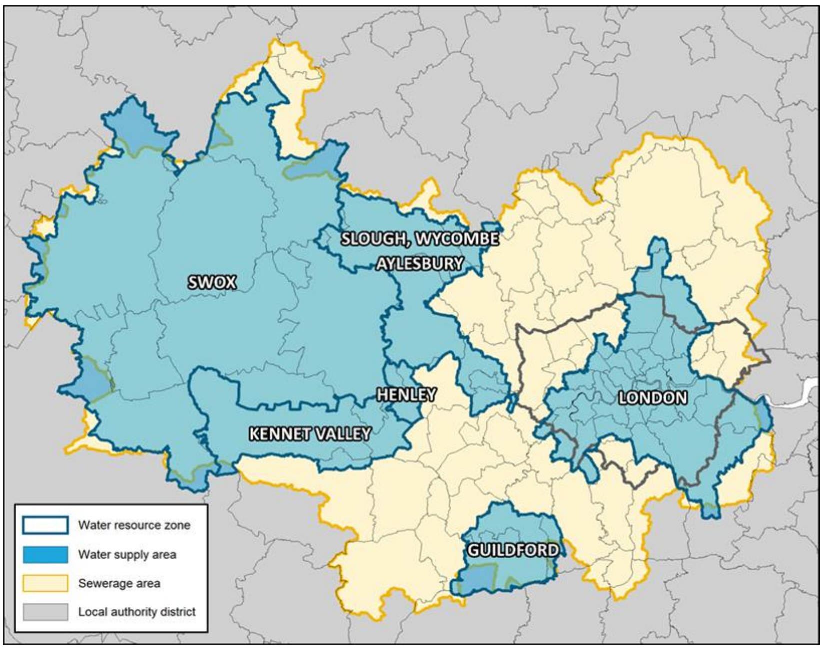
3.83 The WRPG provides a framework for water companies to follow when developing our WRMPs. The guidelines summarise the key requirements for population, property and occupancy forecasts that feed into WRMP evidence, emphasising the importance of using housing growth evidence from Local Plans.

3.84 Edge Analytics have, within their 2020 report[16] (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 report[17] which describes the work they have done to update the initial set of forecasts, within the same appendix.

Area definition

3.85 The Thames Water area (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.

3.86 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

3.87 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.

3.88 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.

3.89 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.

3.90 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)

3.91 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.

3.92 The data sourced is from LPA published documentation/statistics or directly from Councils, if not readily available.

Local Authority Forecasts

3.93 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.

3.94 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.

3.95 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.

3.96 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.

3.97 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, enabling the formulation of scenarios that consider housing need, housing requirement and planned delivery.

3.98 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.

3.99 The GLA includes its own housing-led outcome in its suite of scenarios[18]. 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.

3.100 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.

3.101 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

3.102 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.

3.103 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.

3.104 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)		

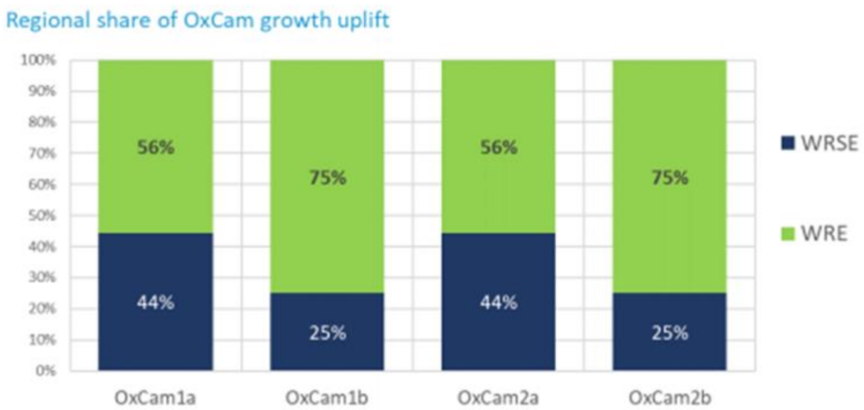


Figure 3-5: Oxcam Scenarios

Long-term Scenarios

3.105 For each of the scenarios presented in Table 3-9 a long-term growth outlook is considered, extending the scenario horizon to 2100[19]. 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

3.106 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.

3.107 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.

3.108 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.

3.109 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

3.110 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

3.111 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

3.112 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

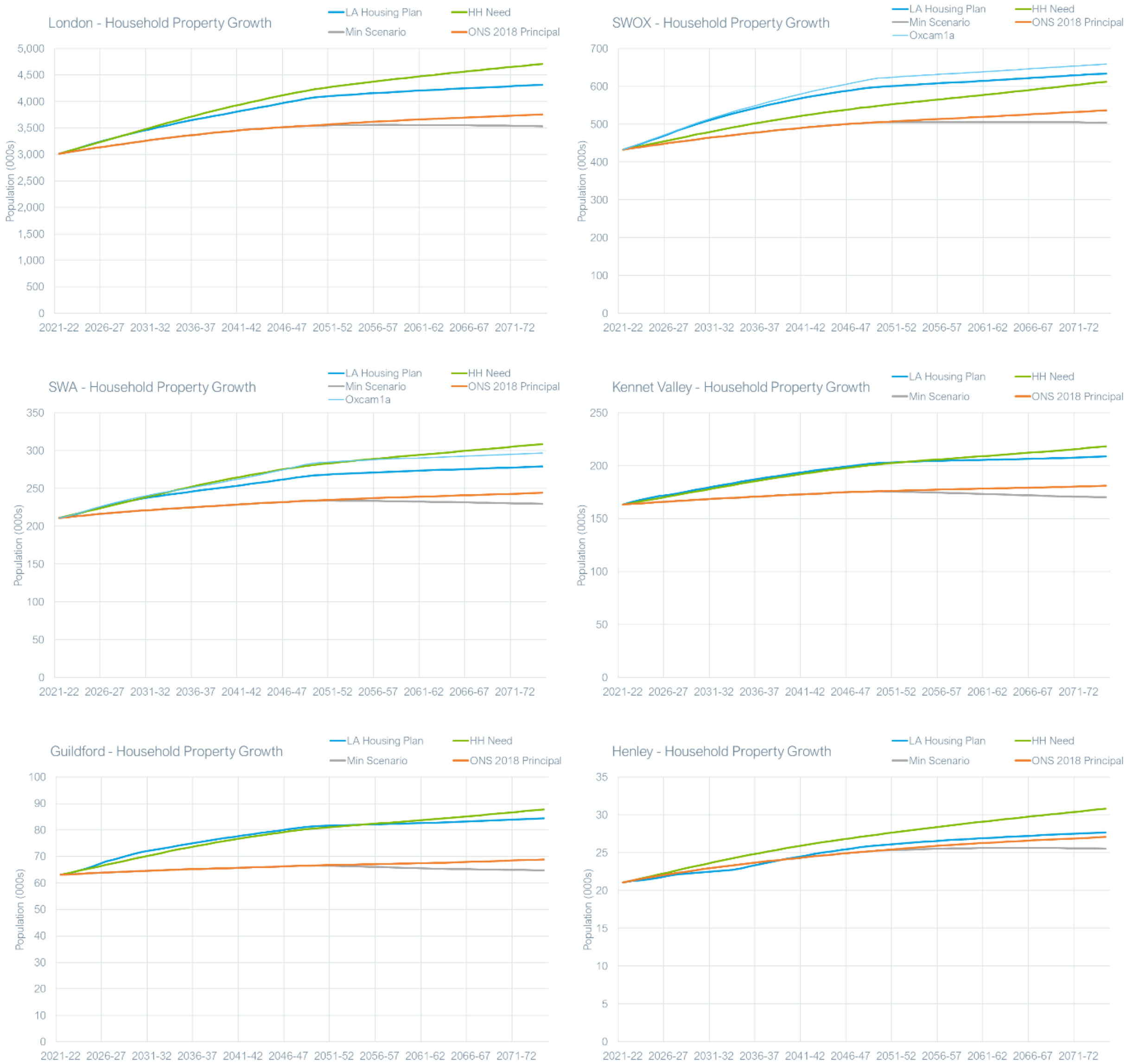


Figure 3-7: WRZ Property Growth Scenarios

3.113 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.

3.114 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.

3.115 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.

3.116 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.

3.117 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.

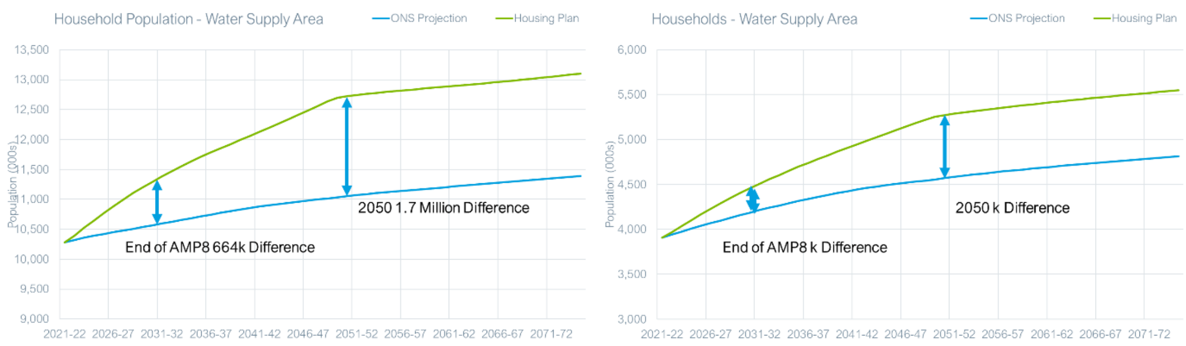


Figure 3-8: Difference in Population and households between ONS and Housing Plan Scenarios

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

WRZ	Total Population					% Change in Population from Base Year to 2100
	2021-22	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 Population Summary

WRZ	Total Population					% Change in Population from Base Year to 2100
	2021-22	2024-25	2029-30	2049-50	2074-75	
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%
Henley	50	51	53	56	58	15.71%

WRZ	Total Population					% Change in Population from Base Year to 2100
	2021-22	2024-25	2029-30	2049-50	2074-75	
Total	10,281	10,389	10,536	11,031	11,391	10.80%

Table 3-11: ONS-18 Based Population Summary

Measured and unmeasured property forecasts

3.119 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.

3.120 The first stage in this process is to calculate the change in measured and unmeasured households each year which is done using simple arithmetic.

3.121 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.

3.122 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.

3.123 These simple calculations allow us to produce household property forecasts segmented by their metering status.

3.124 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.

3.125 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		2021-22	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	1,337.045
		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	595.846
		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
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

WRZ	Parameter		2021-22	2024-25	2029-30	2049-50	2074-75
	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	182.612
		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	58.461
		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[20]

[20] Both plan-based and ONS-18 growth forecasts are based on the modelled 2021-22 start year and remain unchanged since rdWRMP.

WRZ	Parameter		2021-22	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	1,113.591
		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	514.928
		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
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

WRZ	Parameter		2021-22	2024-25	2029-30	2049-50	2074-75
		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	146.987
		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	55.477
		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-18 Growth Statistics[20]

Household water use

Introduction

3.126 We forecast future household consumption in line with the methods set out by "WRMP19 Methods – Household Consumption Forecasting.

3.127 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

3.128 The model takes the form:

$$\boldsymbol{Consumption} = \boldsymbol{\alpha} + \boldsymbol{\beta x_1} + \boldsymbol{\gamma x_2} + \boldsymbol{\delta x_3} + \boldsymbol{\eta x_4} + \boldsymbol{\upsilon x_5} + \boldsymbol{\varepsilon} \qquad \textbf{Equation } 1$$

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
- $\boldsymbol{\delta}$ 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
- $\boldsymbol{\eta}$ 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
- υ Rateable value (RV)
- ε Error term

3.129 These parameters are the same for both the London and Thames Valley data sets.

3.130 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.

3.131 This observed un-modelled trend is thought to be driven by both technological efficiency of water using devices and behavioural changes.

3.132 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.

3.133 It is possible that the strong Thames Valley and weak London trends could switch because evidence[21] showed more efficient appliances are installed in Thames Valley, thus leaving a greater potential for consumption reduction in the London area.

3.134 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.

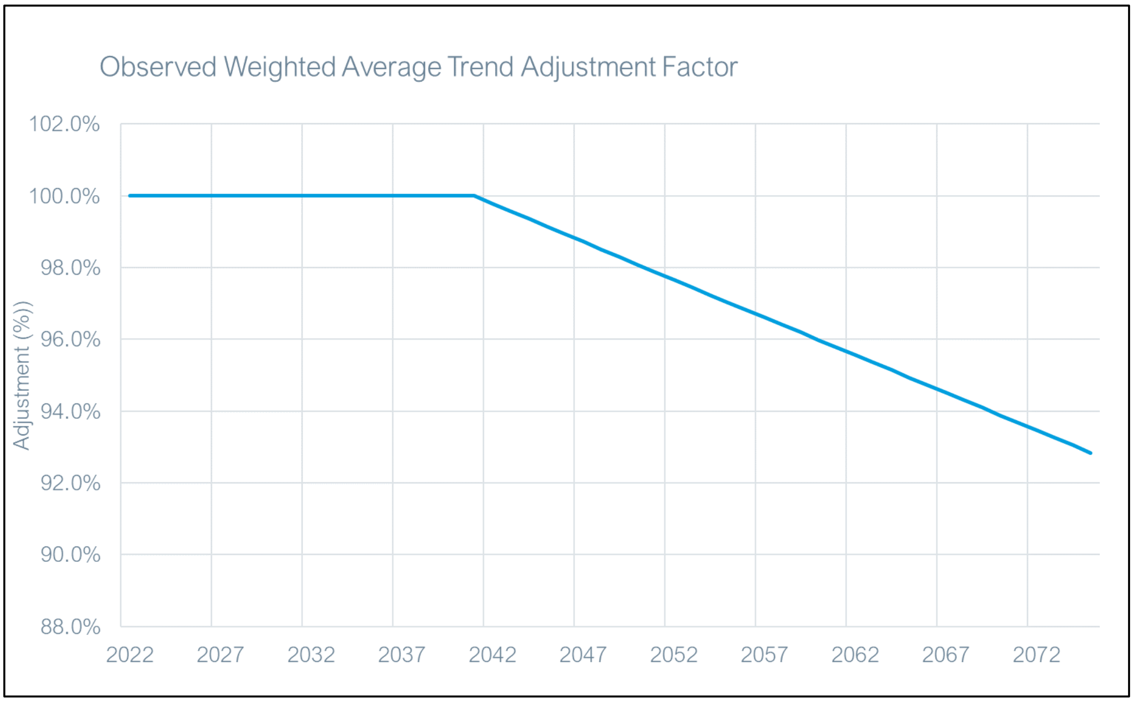


Figure 3-9: Household demand trend adjustment factor

[21] WRMP19 Household Consumption Forecast Final Report – Artesia Consulting 2017

Climate change

3.135 We commissioned the consultants HR Wallingford to carry out a study[22] 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 demand[23].

3.136 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.

3.137 We provided the following data sets:

- DWUS Unmeasured PCC by property type (2000-2010)
- PCC by property type for testDWUS[24] panel (2002-2004)
- Demand data (distribution input – minimum night line, 1998 onwards)
- Climate data (temperature, rainfall and sunshine hours, 1998 onwards)

3.138 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.

3.139 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.

3.140 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 WRMP is 2016/17 a scaling factor was calculated:

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

3.141 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.

3.142 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

[22] HR Wallingford (2012) EX6828 Thames Water Climate Change Impacts and Water Resource Planning. Thames Water Climate Change Impacts on Demand for the 2030s
[23] UKWIR 2013 Impact of Climate Change on Water Demand 13/CL/04/12
[24] 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).

3.143 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.

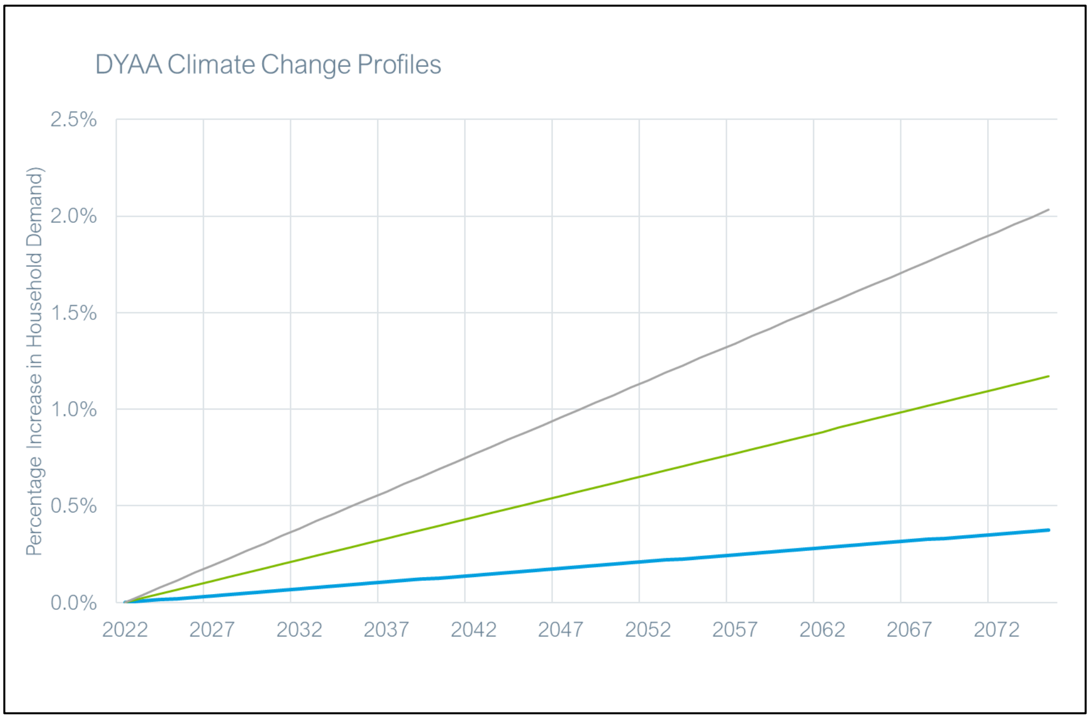


Figure 3-10: The impacts of climate change for the DYAA scenario

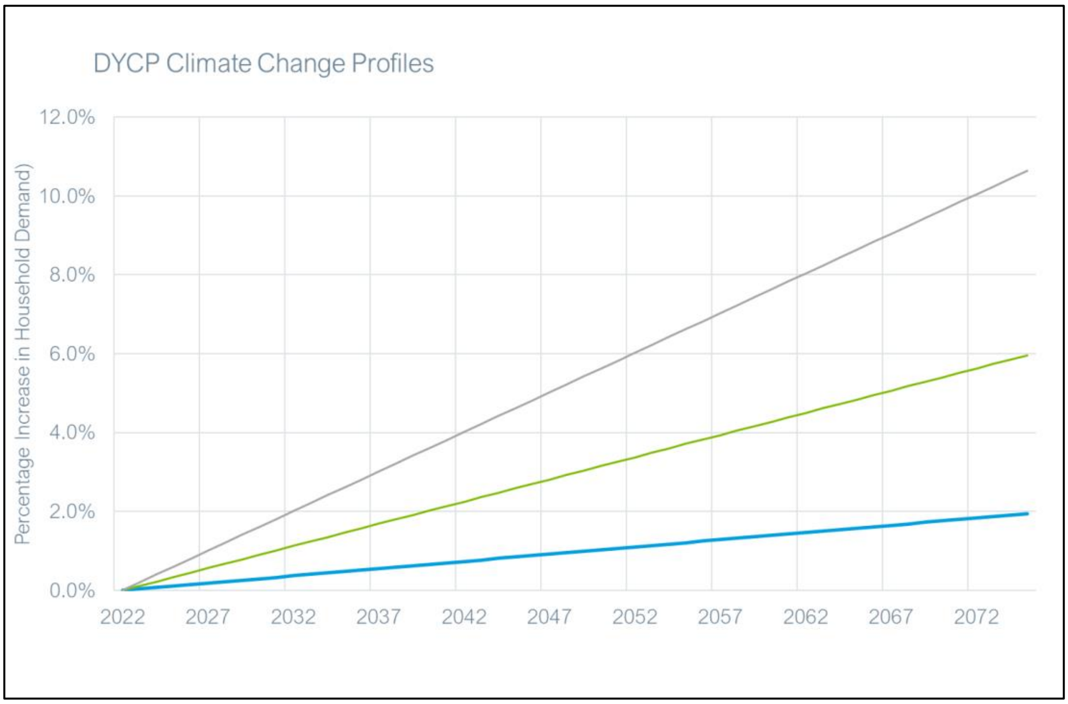


Figure 3-11: The impacts of climate change for the DYCP scenario

3.144 The volume impact of the mid climate change profiles for DYAA is shown in Table 3-14 and for DYCP in Table 3-15.

WRZ	2022	2025	2030	2050	2075
Henley	0.00	0.01	0.02	0.06	0.11
Guildford	0.01	0.02	0.06	0.22	0.41
Kennet Valley	0.03	0.05	0.13	0.50	0.92
London	0.66	0.99	2.79	11.01	20.84
SWA	0.04	0.06	0.18	0.71	1.32
SWOX	0.09	0.14	0.39	1.52	2.88

Table 3-14: Plan-based DYAA additional demand due to climate change (Ml/d)

WRZ	2022	2025	2030	2050	2075
Henley	0.01	0.01	0.03	0.09	0.18
Guildford	0.02	0.03	0.08	0.31	0.59
Kennet Valley	0.04	0.06	0.16	0.62	1.16
SWA	0.06	0.08	0.23	0.89	1.70
SWOX	0.12	0.18	0.50	1.92	3.69

Table 3-15: Plan-based DYCP additional demand due to climate change (Ml/d)

Baseline Demand Management

3.145 Planned baseline activity post our base year of 2023-24 is shown in the Table 3-16 below, setting out the demand reduction requirements to reach our WRMP start position. This includes metering (London only), water efficiency and leakage reduction activities, as well as additional leakage reduction activity as part of the conditional allowance. Conditional allowance activities are also separated in Table 3-17. The total demand reduction volumes are incorporated into our demand forecasts.

3.146 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.

3.147 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.

3.148 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.

3.149 We are now changing our in-home and in-business water efficiency visits to use 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	2024-25	2025-26	2026-27
London	PMP Installs	77,683		
	Dumb Meter Replacement	6,000		
	Small Bulk Meter	0		
	Bulk Meter	0		
	Total Leakage Reduction (Ml/d)	22.75	18.20	7.8
	Total HH Usage Reduction (Ml/d)	5.82	6.46	
	Total NHH Usage Reduction (Ml/d)	1.38		
	Total Demand Reduction (Ml/d)	29.95	24.66	7.8
SWOX	Total Leakage Reduction (Ml/d)	10.68		
	Total NHH Usage Reduction (Ml/d)	0.63		
	Total Demand Reduction (Ml/d)	11.31		
Guildford	Total Leakage Reduction (Ml/d)	2.96		
SWA	Total Leakage Reduction (Ml/d)	5.04		
Henley	Total Leakage Reduction (Ml/d)	0.52		
Kennet Valley	Total Leakage Reduction (Ml/d)	1.45		

Table 3-16: Baseline Demand Management Activity

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

Table 3-17: Conditional Allowance Leakage Reduction

Leakage Reduction

3.150 In the year 2022/23, due to the impacts of a cold winter and dry summer, our leakage was much higher than we planned. The uplifted "DYAA" leakage value was 629.9 Ml/d, at the company level.

3.151 Since the 2022/23 reporting year, we have implemented our turnaround plan and leakage has reduced significantly to the lowest annual average we have achieved during AMP7, closely aligning with our expected 585 Ml/d outturn shared in our Service Commitment Plan in January 2024.

3.152 To reduce company-wide leakage to the levels forecast in the WRMP, we also need to consider the amount of leakage fixes which will be necessary just to stop leakage increasing. In total, we forecast that we will need to deliver 359 Ml/d of leakage fixes in order to maintain our current leakage position. We forecast that we will need to deliver 500 Ml/d of leakage fixes in total, in order to achieve the levels set out in our WRMP24. This demonstrates the significant challenge that simply maintaining current leakage levels, let alone reducing them, poses.

3.153 Our year 5 leakage delivery plan includes the activities as set out in Table 3-18 below. The company-level plan described in the Table 3-18 is translated into regional and zonal delivery plans such that leakage reduction will be delivered in the WRZs where it is needed to achieve the required forecast position for each zone.

3.154 This includes additional activity which is being delivered as part of the conditional allowance programme. The conditional allowance programme is due to extend beyond AMP7 but is considered as part of the baseline for the purposes of the WRMP. Leakage reduction due to be delivered through the conditional allowance is included in Table 3-17.

Leakage activities in 2024/25	Leakage offset/reduction (Ml/d)
Find and fix	444
Calm Systems	4
Pressure Management	8
Metering customer side leakage	26
New Bulk meter installations	3
Bulk meter recurrence	4
Trunk Mains	10
Lead Pipe Replacement	1
Total	500

Table 3-18: Planned leakage activities for YR5

Green Economic Recovery

3.155 In our rdWRMP24 we included a programme of meter installations known as the Green Economic Recovery scheme, along with resultant customer-side leakage fixes and water efficiency activities. Funding for this scheme was made contingent on hitting our leakage targets. In light of Ofwat's decision not to adjust the funding conditions to reflect the impact of the summer 2022 drought and December 2022 freeze-thaw events on our leakage performance, we were left with no alternative but to stop the GER programme. The removal of the GER programme will negatively impact our supply-demand balance at the beginning of the planning period.

3.156 We have taken, or are taking, the following actions to mitigate the impact of the removal of this programme on our supply demand balance:

- 300,000 advanced meter install surveys and 20,000 household digs to prepare for meter installation have already taken place in AMP7 as preparatory work for GER meter installations.
- 1,500 small bulk meters, 200 large bulk meters and 1,502 NHH meter replacements were installed before the decision to stop the GER programme was made.
- We will continue delivery of our smart meter communication solutions in year 5 so that all smart meters installed are live from the point of installation.
- In year 5, 2024/25, there are plans to install 45,000 HH new smart meters and 7,700 NHH smart replacements in our Thames Valley WRZs by reprofiling meter installations planned in London WRZ. It should be noted that this reprofile is not currently represented in our demand forecasts, or supply demand balance.

3.157 These mitigating actions mean that there is no significant impact on our supply demand balance.

WRZ	GER Savings Removal (Ml/d)	Potential Metering Reprofile (Ml/d)	Supply-Demand Balance (Ml/d) (for reference)
London	0	-4.70	55.7
SWOX	-3.16	4.11	18.8
Guildford	-0.55	0.59	20.2
SWA	-1.55		24.7
Kennet	-1.03		37.4
Henley	-0.10		7.5

Table 3-19: Impact of changes on DYAA supply demand balance in 2024/25

3.158 Additional to the impact on supply demand balances, there is also a predicted 0.73 l/p/d impact on PCC in 2024/25 and a 1.00 Ml/d impact on leakage in 2024/25. The impacts on PCC and leakage are mitigated by delivery of the GER meter installations in AMP8.

Meeting Short-Term Demand Forecasts

3.159 This section provides the response to a request set out in the permission to publish letter sent to Thames water:

Publish a clear statement in your final plan on how you will mitigate the gap between your current actual demand (as reported in the latest annual review) and your planned demand starting point in WRMP24. Discuss and agree with the Environment Agency your plan to close the gap before updating your final plan for publication.

3.160 We have updated our demand forecast for our final WRMP. The forecasts have been rebased using AR24 outturn data and reflect our updated demand reduction programme. This incorporates the changes to our metering and leakage programmes outlined in the "Further information in support of the Statement of Response" and is consistent with our PR24 submission.

3.161 Table 3-20 and Table 3-21 below present the distribution input for the AR24(2023/24) adjusted DYAA and DYCP, against the planned DI start position for WRMP24 (April 2025, AR25).

3.162 AR24 adjusted values in Table 3-20, Table 3-21, and Table 3-22 below use outturn AR24 volumes, with (where appropriate):

- DYAA and DYCP uplifts applied (see "Peaking factors" section),
- NAV volumes removed (see "New Appointments and Variations" section),
- The adjustment to using a top-down AR figure (see "The water balance" section).

3.163 The tables show that to meet the WRMP24 start position for the DYAA, DI needs to be 39.6 Ml/d (1.6%) lower than reported at AR24, with the largest DI reductions required in the SWOX (3.5%) and Guildford (4.4%) water resource zones.

WRZ	AR24 adjusted DI 2023/24	DI 2024/25 (Forecast)	Difference
London	1935.3	1913.0	22.3
SWOX	289.3	279.2	10.1
SWA	150.6	146.9	3.6
Guildford	49.7	47.5	2.2
Kennet Valley	105.7	104.7	1.0
Henley	14.0	13.6	0.3
Company	**2544.6**	**2505.0**	**39.6**

Table 3-20: Dry Year Annual Average (DYAA) Distribution Input (Ml/d)

WRZ	AR24 adjusted DI 2023/24	DI 2024/25 (Forecast)	Difference
London	-	-	-
SWOX	341.8	331.6	10.1
SWA	173.3	169.6	3.6
Guildford	61.3	59.1	2.2
Kennet Valley	120.6	119.6	1.0
Henley	18.7	18.3	0.3

Table 3-21: Dry Year Critical Period (DYCP) Distribution Input (Ml/d)

3.164 We have reviewed our leakage, metering and water efficiency programmes for 2024-25 to confirm that that the planned activities will deliver the reductions required in each water resource zone (WRZ) to meet the WRMP24 forecast start position for demand (distribution input). This includes setting internal leakage reduction targets for the 2024-25 reporting year for each WRZ that reflect the need to focus our leakage reduction activity in in the Thames Valley zones. This is demonstrated in Table 3-16 above, and Table 3-22 below.

WRZ	AR24 adjusted outturn leakage	AR25 target	Planned leakage reduction
London	398.6	375.9	22.7
SWOX	74.7	64.0	10.7
SWA	47.2	42.2	5.0
Guildford	19.0	16.0	3.0
Kennet Valley	25.8	24.4	1.4
Henley	5.0	4.5	0.5
Company	**570.4**	**527**	**43.4**

Table 3-22: Planned annual average leakage reductions by WRZ (Ml/d)

Household Demand forecasts

3.165 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 DYCP.

3.166 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 as new properties are built with a meter installed and therefore drive an increase in measured demand, and because optant meter installations (those where a customer requests a meter installation) are factored into our baseline forecast.

3.167 This can be clearly seen in Figure 3-12 which shows total household demand for our whole water supply area for plan-based forecasts of demand.

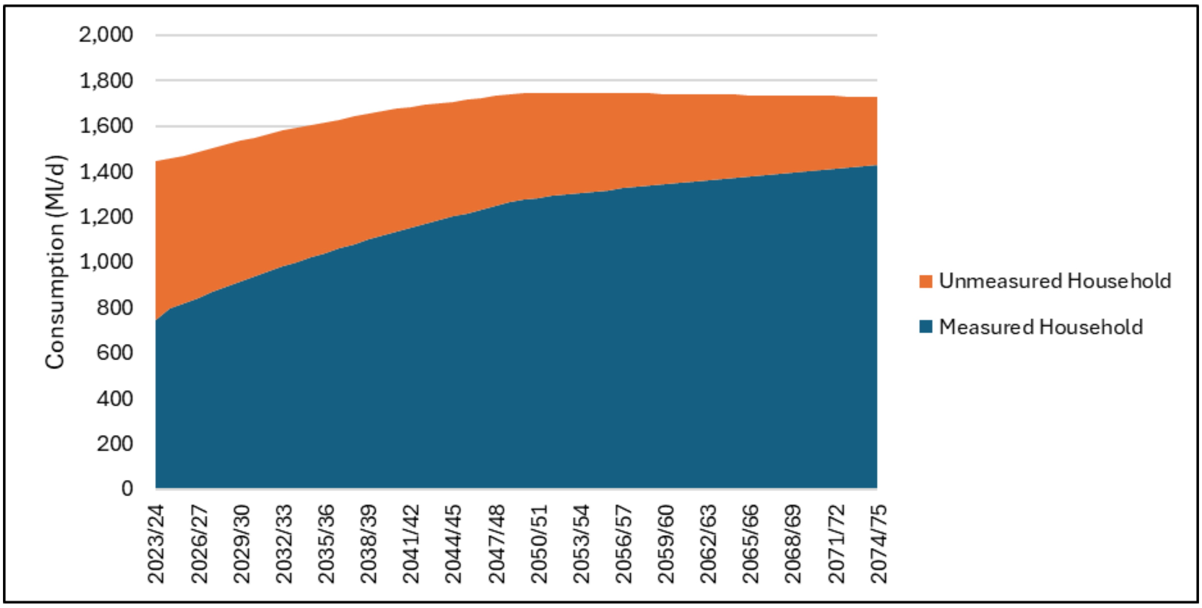


Figure 3-12: Baseline Total Household Demand – Company-level

3.168 The plan-based scenario predicts a total household consumption increase of 299 Ml/d to 2050, followed by a reduction of 16 Ml/d between 2050 and 2075, due to a combination of decreasing growth and continuing more efficient use of water as explained previously.

3.169 The PCC associated with these demands is shown in Figure 3-13 below.

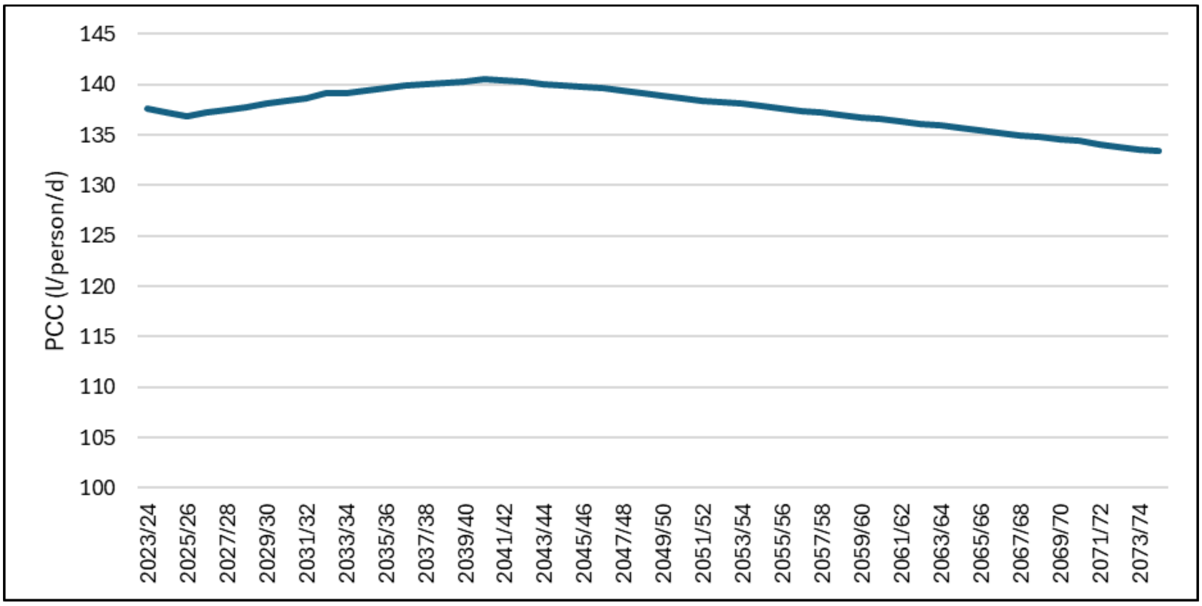


Figure 3-13: Baseline Per Capita Consumption – Company-level

3.170 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 now included 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 with consumption.

London

3.171 For the DYAA plan-based growth scenario London is forecast to begin AMP8 (2025/26) with a total household demand of 1,134 Ml/d, 55% of which is from customers on a measured tariff. This is forecast to increase to 1,371 Ml/d by 2050 and to 1,358 Ml/d by 2075, as shown in Figure 3-14.

3.172 A summary of PCC movements for the plan-based scenario can be seen in Figure 3-15.

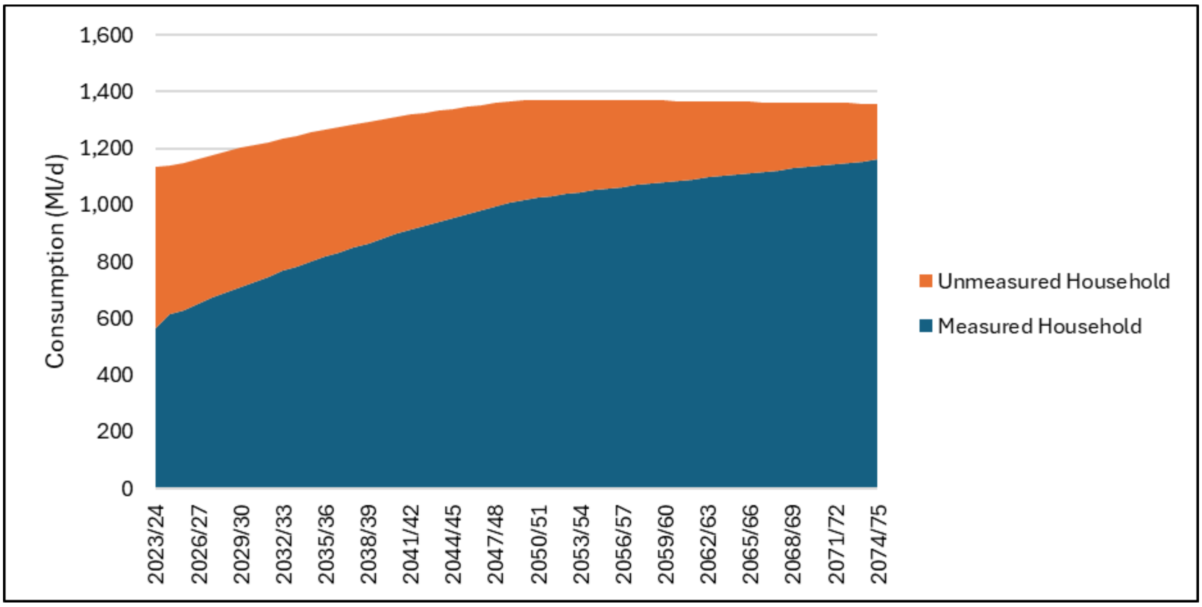


Figure 3-14: Baseline Household Consumption – London DYAA

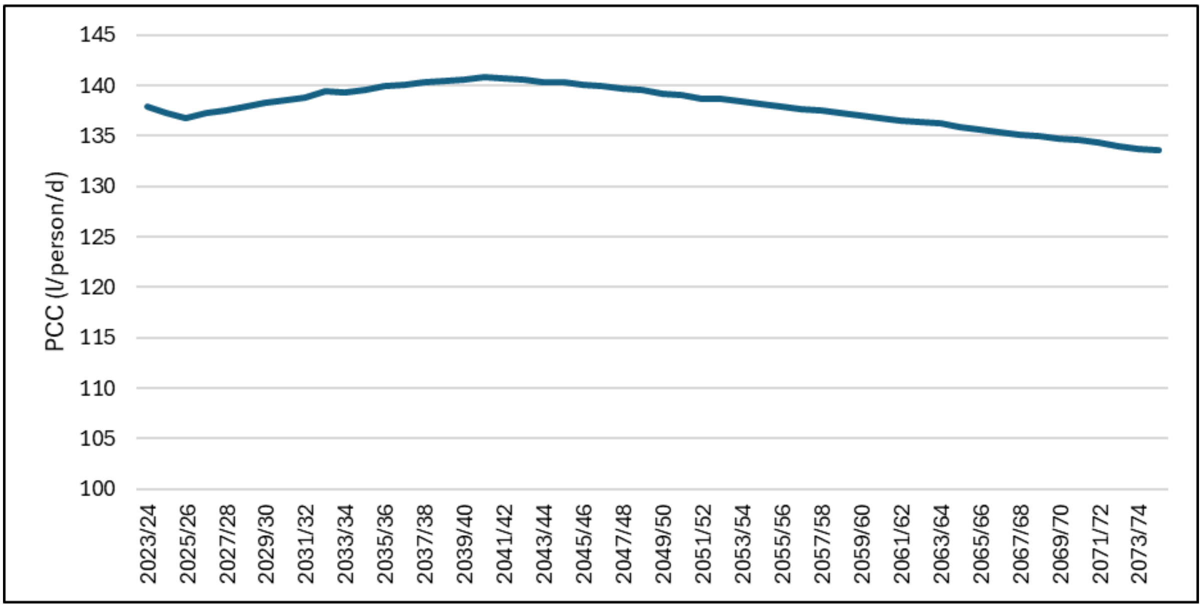


Figure 3-15: Baseline Per Capita Consumption - London

SWOX

3.173 For the DYAA plan-based growth scenario SWOX is forecast to begin AMP8 (2025/26) with a total household demand of 150.8 Ml/d. This is forecast to increase to 180.9 Ml/d by 2050 and to 180.40 Ml/d by 2075, as shown in Figure 3-16.

3.174 The DYCP plan-based growth scenario SWOX is forecast to begin AMP8 with a total household demand of 203.2 Ml/d. This is forecast to increase to 233.4 Ml/d by 2050 and to 232.9 Ml/d by 2075, as shown in Figure 3-17.

3.175 A summary of PCC movements for the plan-based scenario can be seen in Figure 3-18.

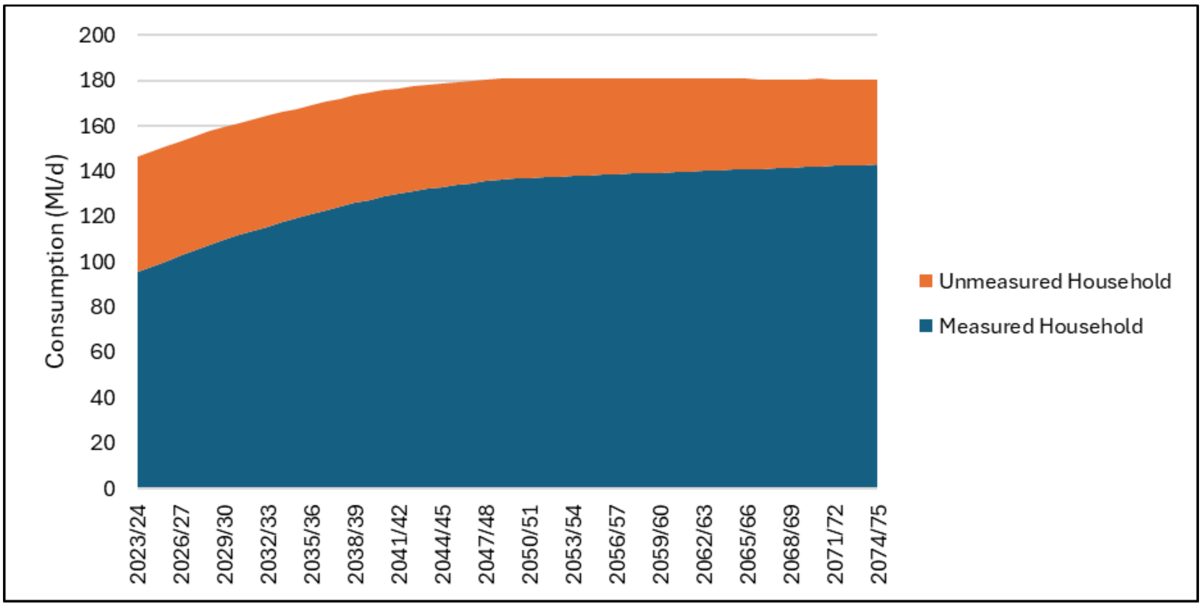


Figure 3-16: Baseline Household Consumption – SWOX DYAA

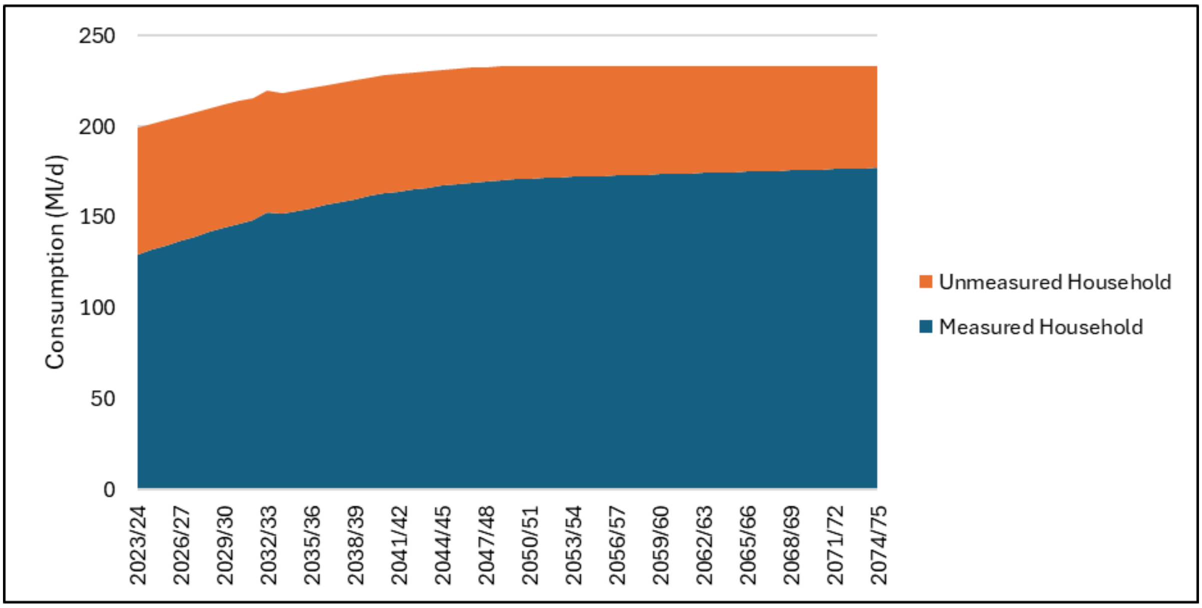


Figure 3-17: Baseline Household Consumption – SWOX DYCP

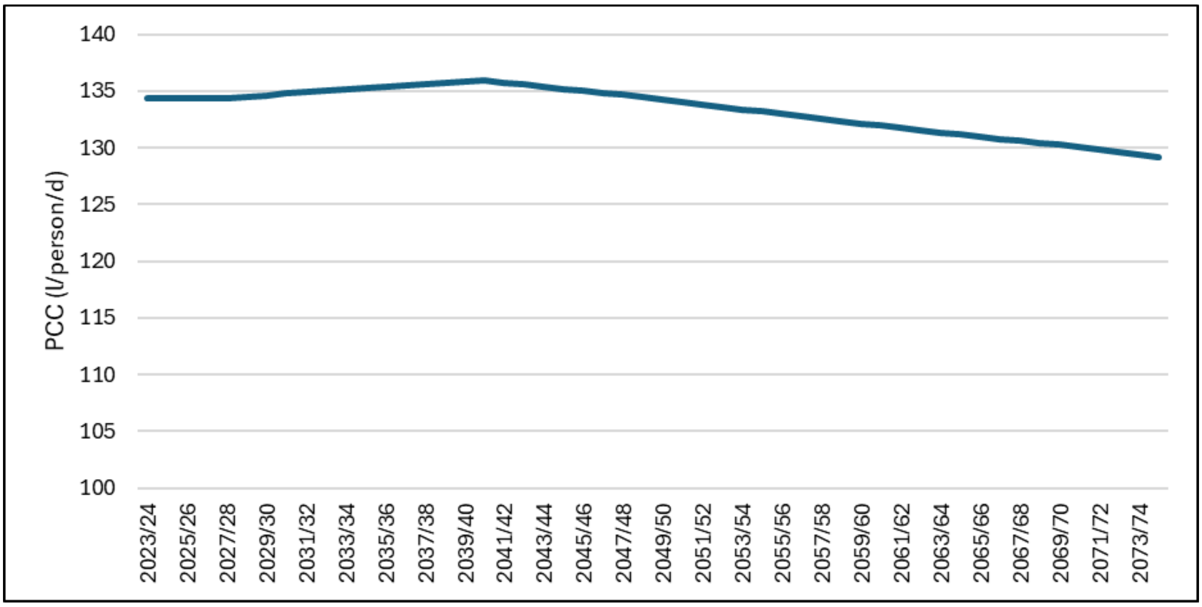


Figure 3-18: Baseline Per Capita Consumption - SWOX

SWA

3.176 For the DYAA plan-based growth scenario SWA is forecast to begin AMP8 with a total household demand of 81.0 Ml/d. This is forecast to increase to 91.2 Ml/d by 2050 and to 90.5 Ml/d by 2075, as shown in Figure 3-19.

3.177 For the DYCP plan-based growth scenario SWA is forecast to begin AMP8 with a total household demand of 102.2 Ml/d. This is forecast to increase to 112.4 Ml/d by 2050 and to 111.6 Ml/d by 2075, as shown in Figure 3-20.

3.178 A summary of PCC movements for the plan-based scenario can be seen in Figure 3-21.

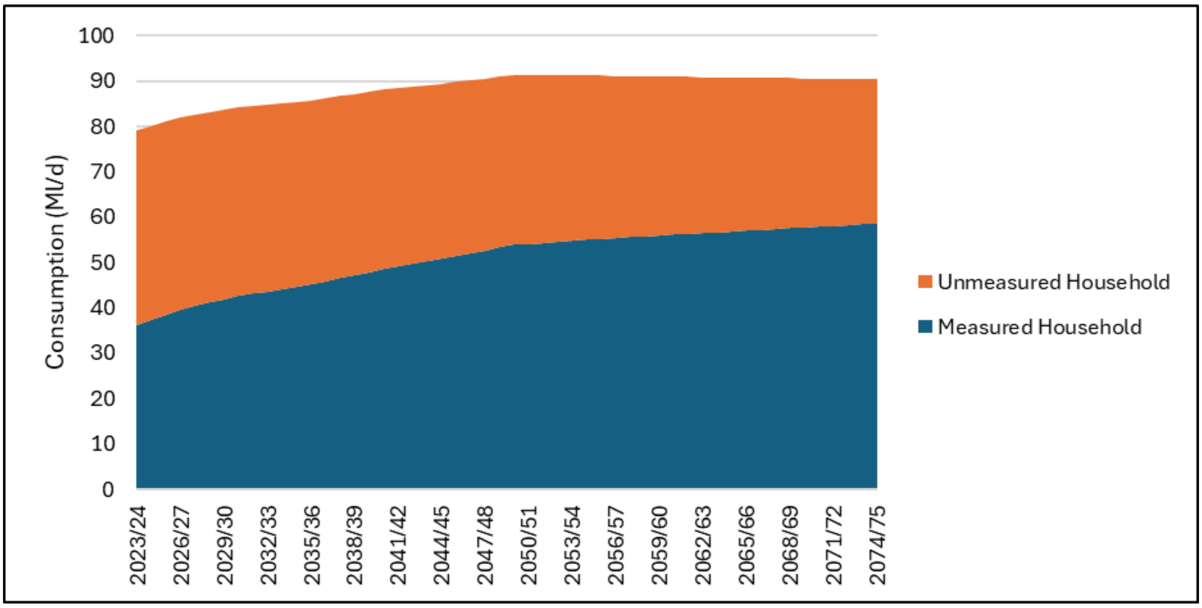


Figure 3-19: Baseline Household Consumption – SWA DYAA

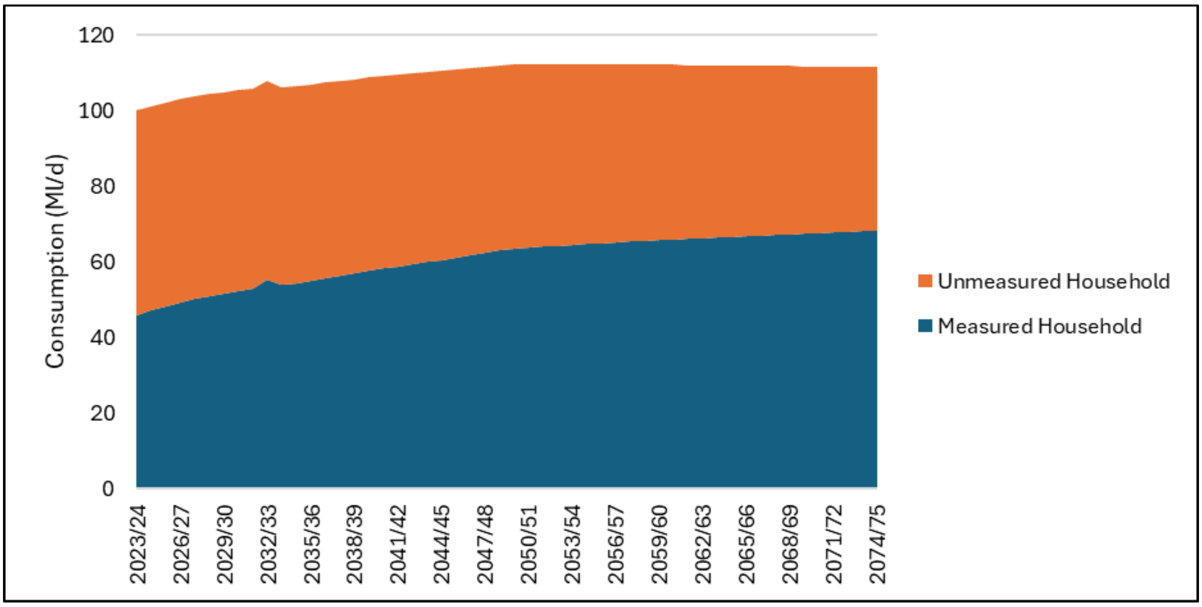


Figure 3-20: Baseline Household Consumption – SWA DYCP

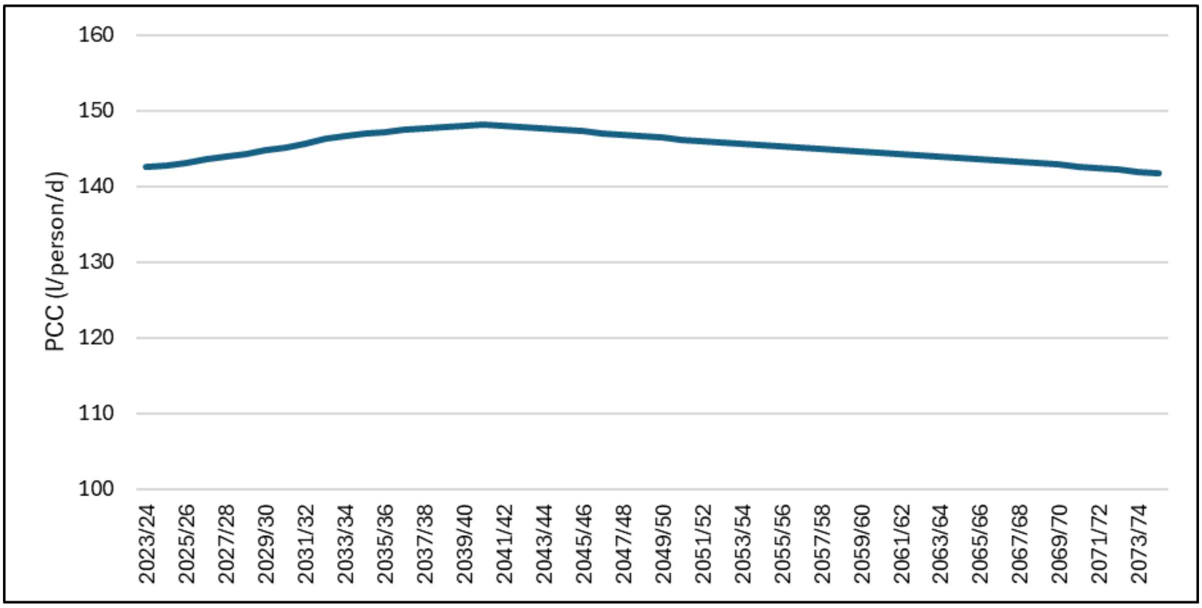


Figure 3-21: Baseline Per Capita Consumption - SWA

Kennet Valley

3.179 For the DYAA plan-based growth scenario Kennet Valley is forecast to begin AMP8 with a total household demand of 59.2 Ml/d. This is forecast to increase to 67.4 Ml/d by 2050 and to 66.0 Ml/d by 2075, as shown in Figure 3-22.

3.180 For the DYCP plan-based growth scenario Kennet Valley is forecast to begin AMP8 with a total household demand of 73.1 Ml/d. This is forecast to increase to 81.2 Ml/d by 2050 and to 79.9 Ml/d by 2075, as shown in Figure 3-23.

3.181 A summary of PCC movements for the plan-based scenario can be seen in Figure 3-24.

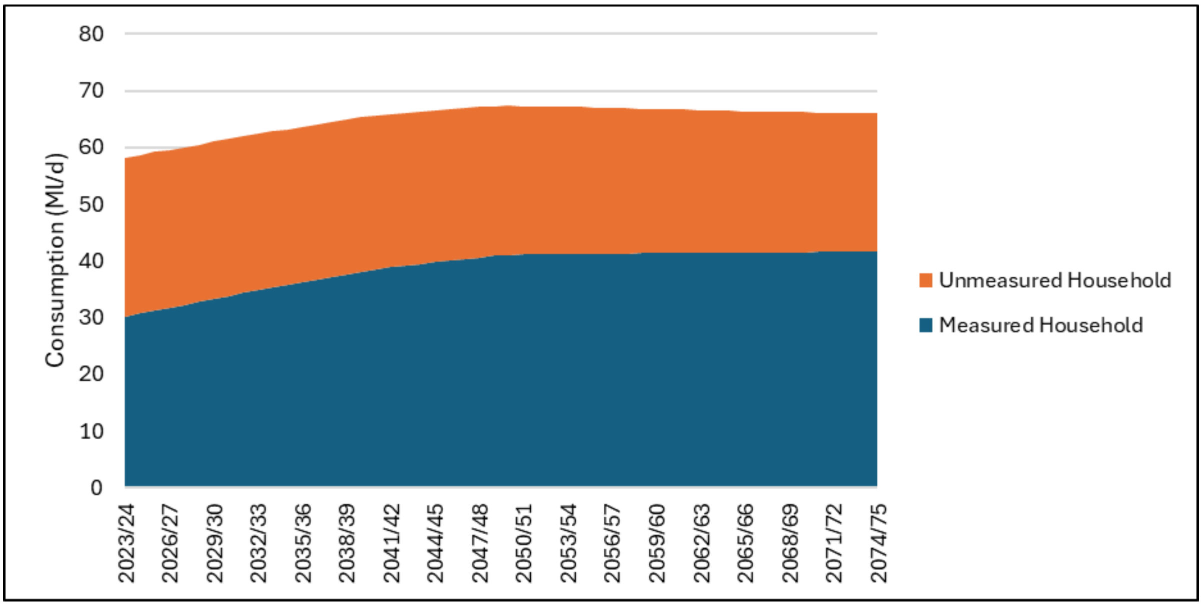


Figure 3-22: Baseline Household Consumption – Kennet Valley DYAA

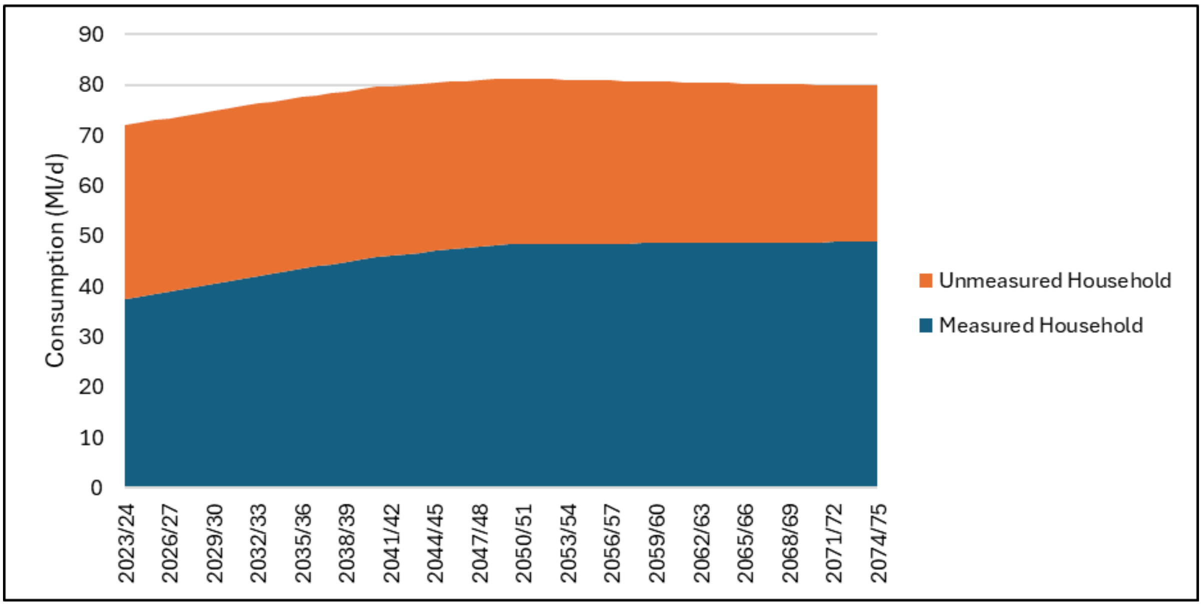


Figure 3-23: Baseline Household Consumption – Kennet Valley DYCP

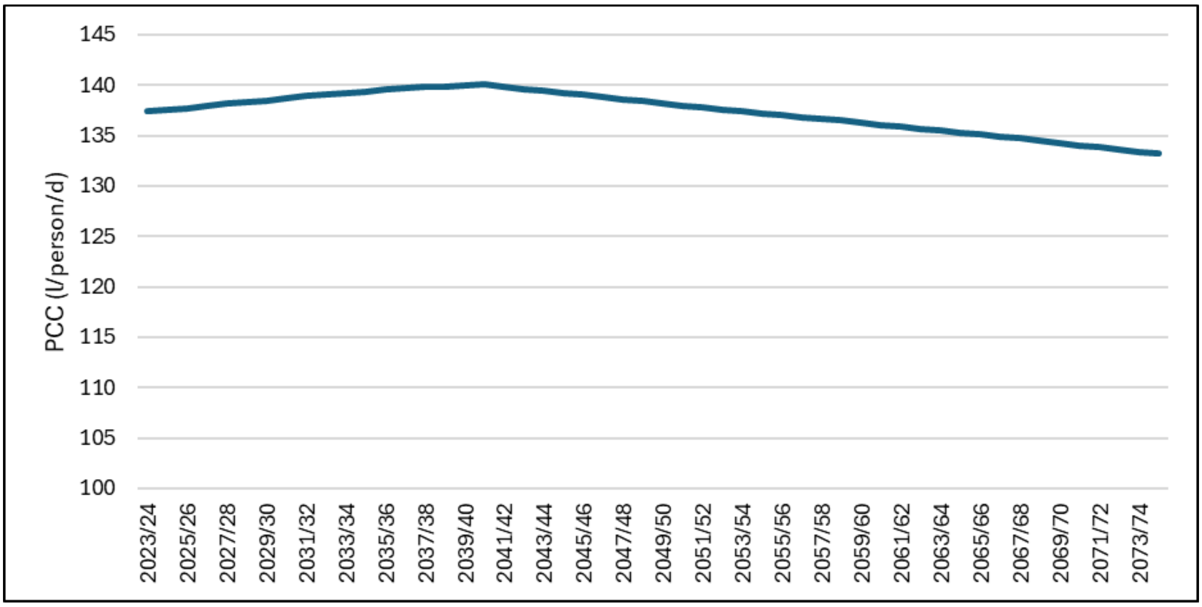


Figure 3-24: Baseline Per Capita Consumption – Kennet Valley

Guildford

3.182 For the DYAA plan-based growth scenario Guildford is forecast to begin AMP8 with a total household demand of 22.5 Ml/d. This is forecast to increase to 26.2 Ml/d by 2050 and to 25.7 Ml/d by 2075, as shown in Figure 3-25.

3.183 For the DYCP plan-based growth scenario Guildford is forecast to begin AMP8 with a total household demand of 33.1 Ml/d. This is forecast to increase to 36.9 Ml/d by 2050 and to 36.3 Ml/d by 2075, as shown in Figure 3-26.

3.184 A summary of PCC movements for the plan-based scenario can be seen in Figure 3-27.

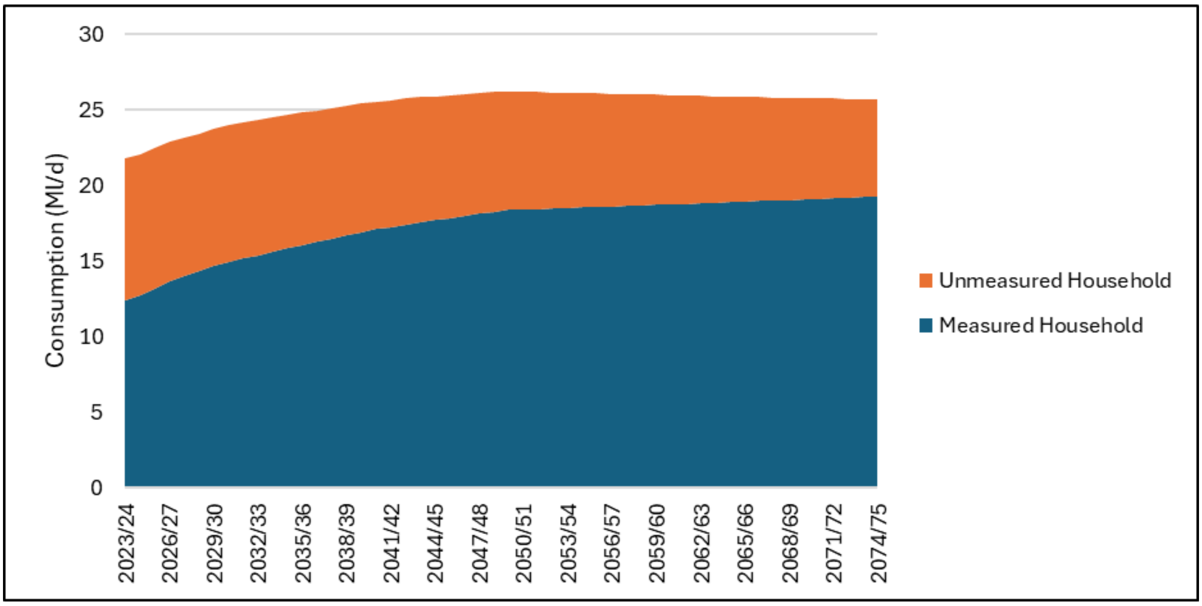


Figure 3-25: Baseline Household Consumption – Guildford DYAA

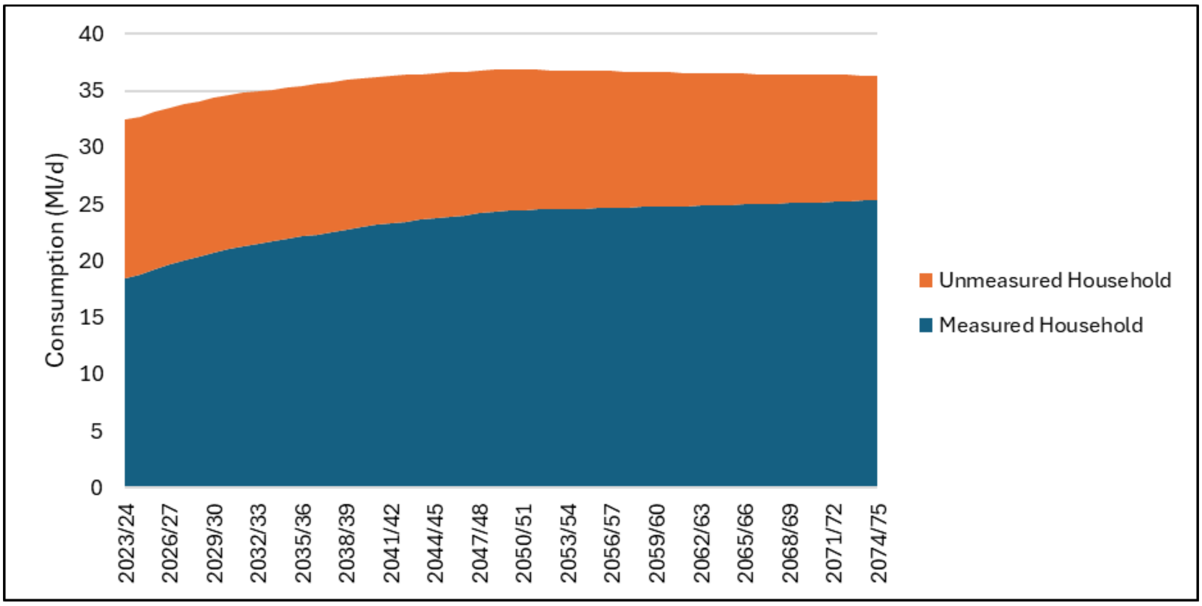


Figure 3-26: Baseline Household Consumption – Guildford DYCP

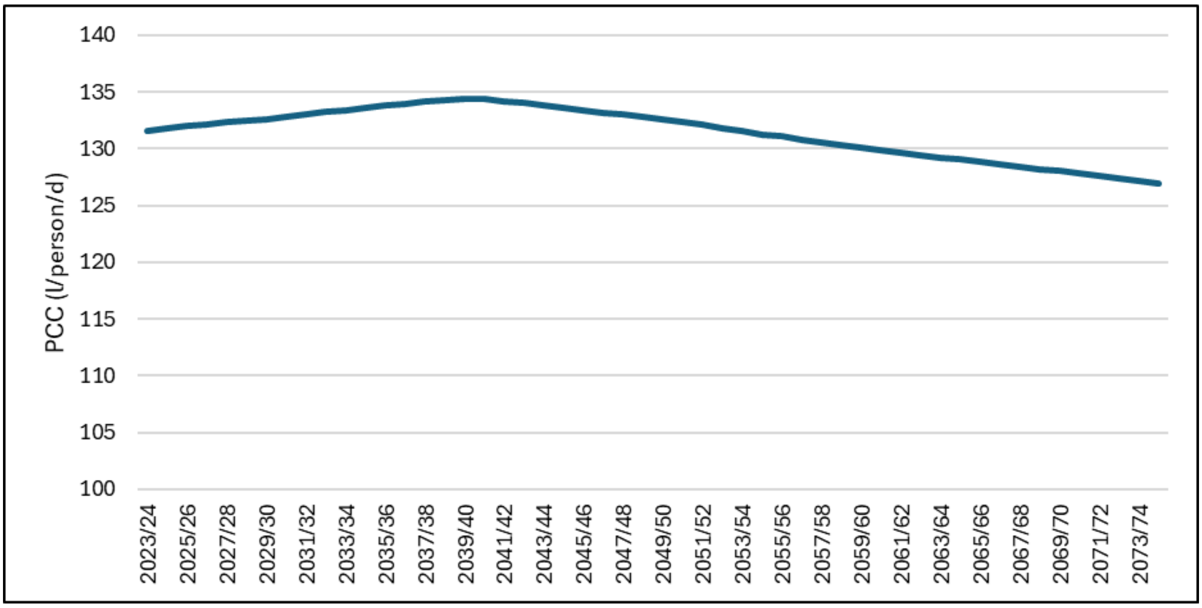


Figure 3-27: Baseline Per Capita Consumption - Guildford

Henley

3.185 For the DYAA plan-based growth scenario Henley is forecast to begin AMP8 with a total household demand of 7.2 Ml/d. This is forecast to increase to 8.4 Ml/d by 2050 and to 8.4 Ml/d by 2075, as shown in Figure 3-28.

3.186 For the DYCP plan-based growth scenario Henley is forecast to begin AMP8 with a total household demand of 11.7 Ml/d. This is forecast to increase to 12.9 Ml/d by 2050 and to 12.9 Ml/d by 2075, as shown in Figure 3-29.

3.187 A summary of PCC movements for the plan-based scenario can be seen in Figure 3-30.

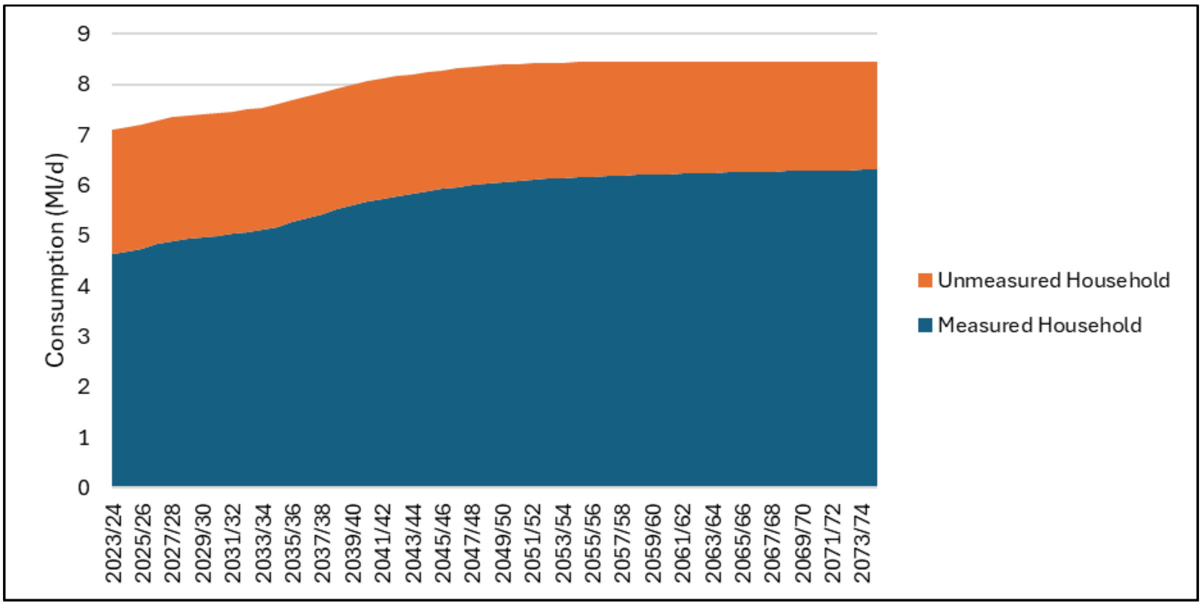


Figure 3-28: Baseline Household Consumption – Henley DYAA

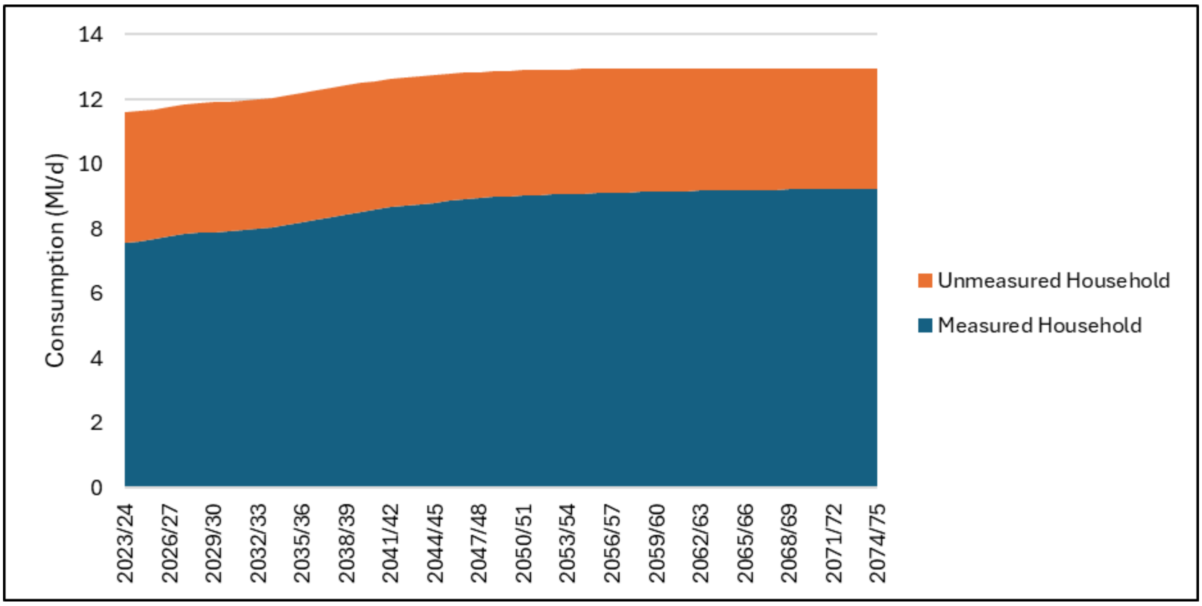


Figure 3-29: Baseline Household Consumption – Henley DYCP

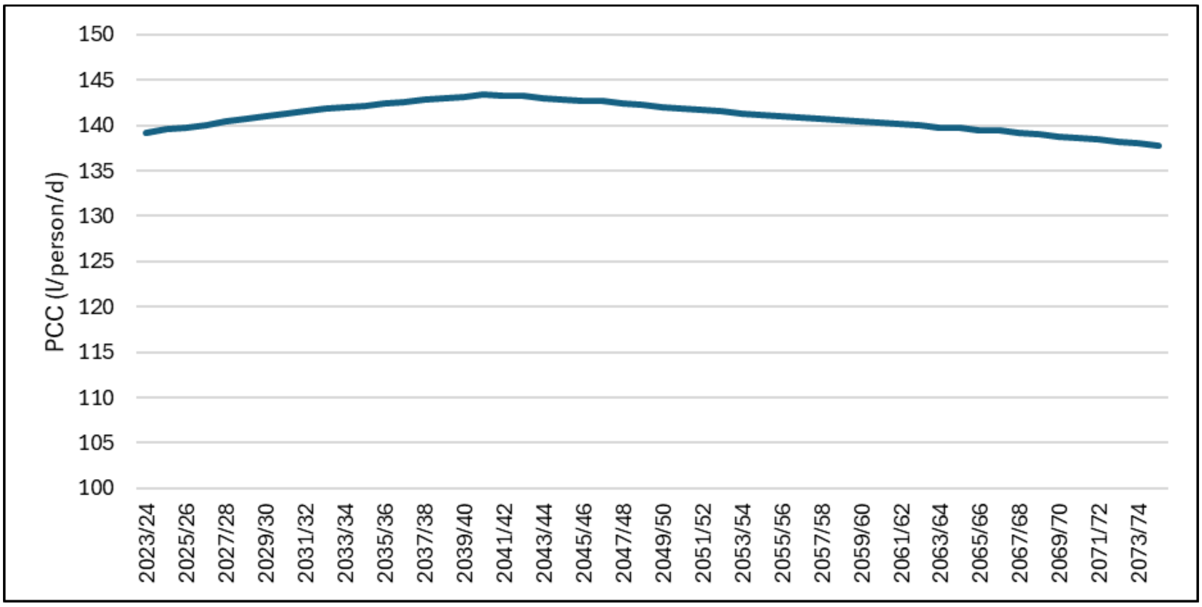


Figure 3-30: Baseline Per Capita Consumption - Henley

Non-Household water use

Introduction

Regulatory requirements

3.188 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.

3.189 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

3.190 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.

3.191 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.

3.192 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

3.193 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

3.194 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.

3.195 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 3-23.

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 3-23: Industry Groupings

3.196 Table 3-24 shows the proportion of properties and the proportion of consumption for each company that falls into each of the industry groupings as identified in Table 3-23.

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[25]	46%	34%

Table 3-24: Proportions of consumption and properties by Industry grouping

3.197 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.

3.198 A maximal theoretical dataset was created by creating all combinations of year (from OE, weather, consumption, and population datasets), WRZ (weather, consumption, and

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

population) and SIC/industry groups (consumption), with all variables joined to these where available.

3.199 This is then aggregated to industry grouping level, with group-specific numerical variables summed (consumption, employment, GVA) and other numerical variables re-joined at 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

3.200 The non-household forecast modelling is carried out in line with best practice[26].

3.201 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).

3.202 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

3.203 The MLR modelling is done at company level but considering industry groups independently. Calibration is then performed at WRZ level.

3.204 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

3.205 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.

3.206 To ensure the proportion between different sectors is maintained, the calibration has been further refined:

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

- 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

3.207 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.

3.208 Final NHH baseline forecasts are obtained separately for the measured and the unmeasured component.

3.209 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 Ml/d with a range of -144 Ml/d to +276 Ml/d indicating a high level of uncertainty.

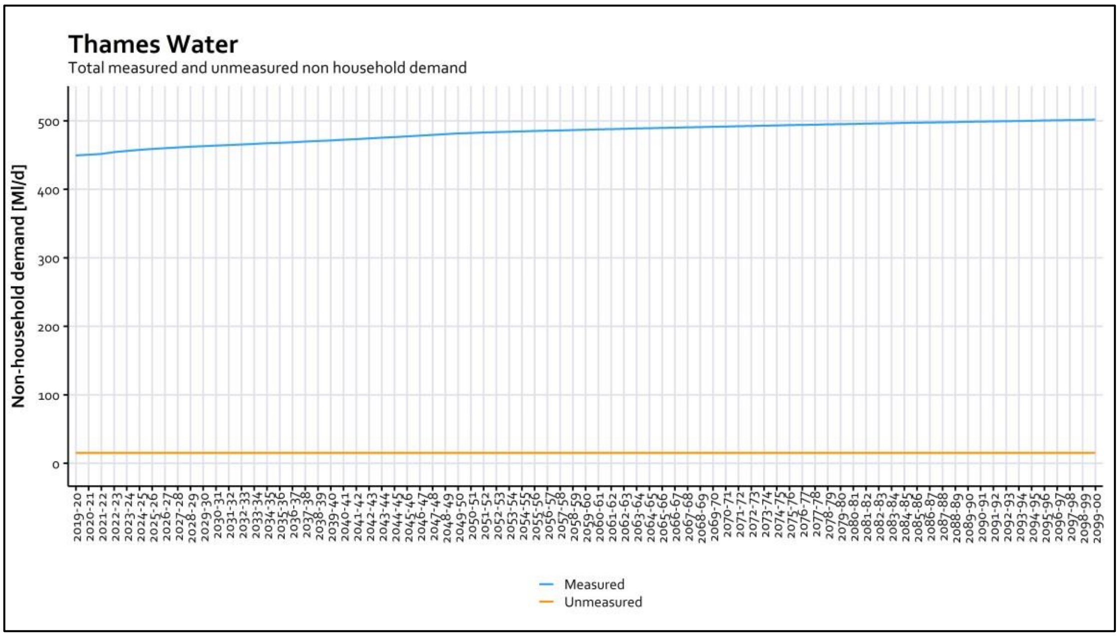


Figure 3-31: Thames Water measured and unmeasured non-household consumption

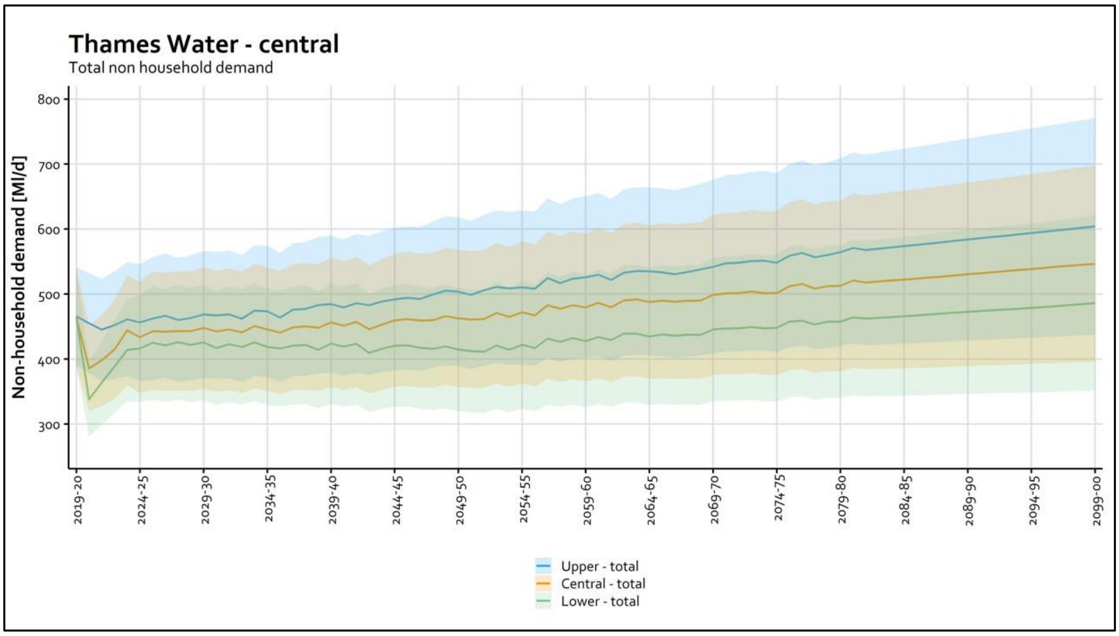


Figure 3-32: Thames Water region non-household consumption central, lower and upper scenarios

3.210 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.

3.211 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.

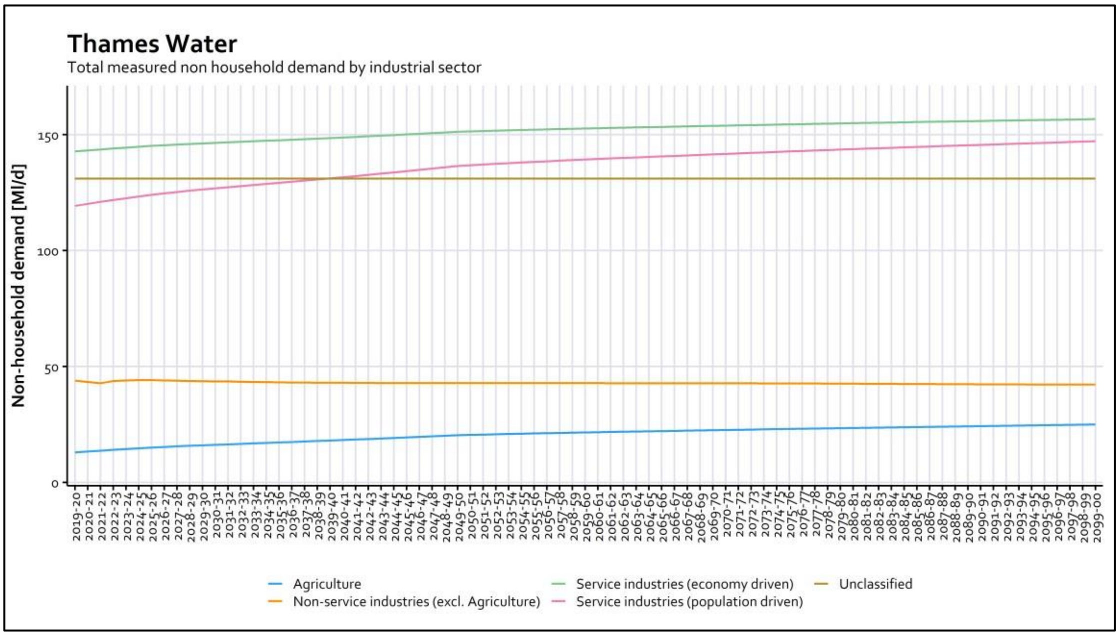


Figure 3-33: Modelled non-household by industrial Sector

Data Centres

3.212 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.

3.213 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.

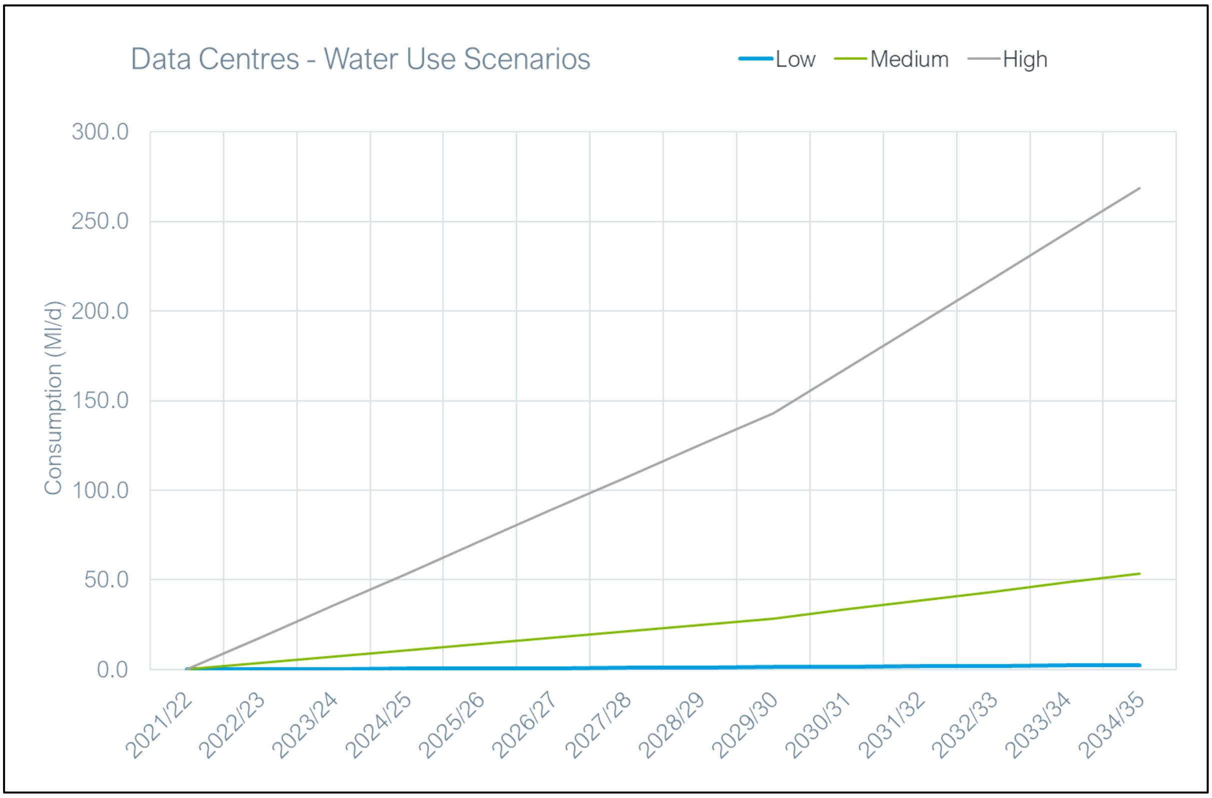


Figure 3-34: Data Centre Scenarios

3.214 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.

3.215 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.

3.216 The profile used within our demand forecasts is shown in Figure 3-35.

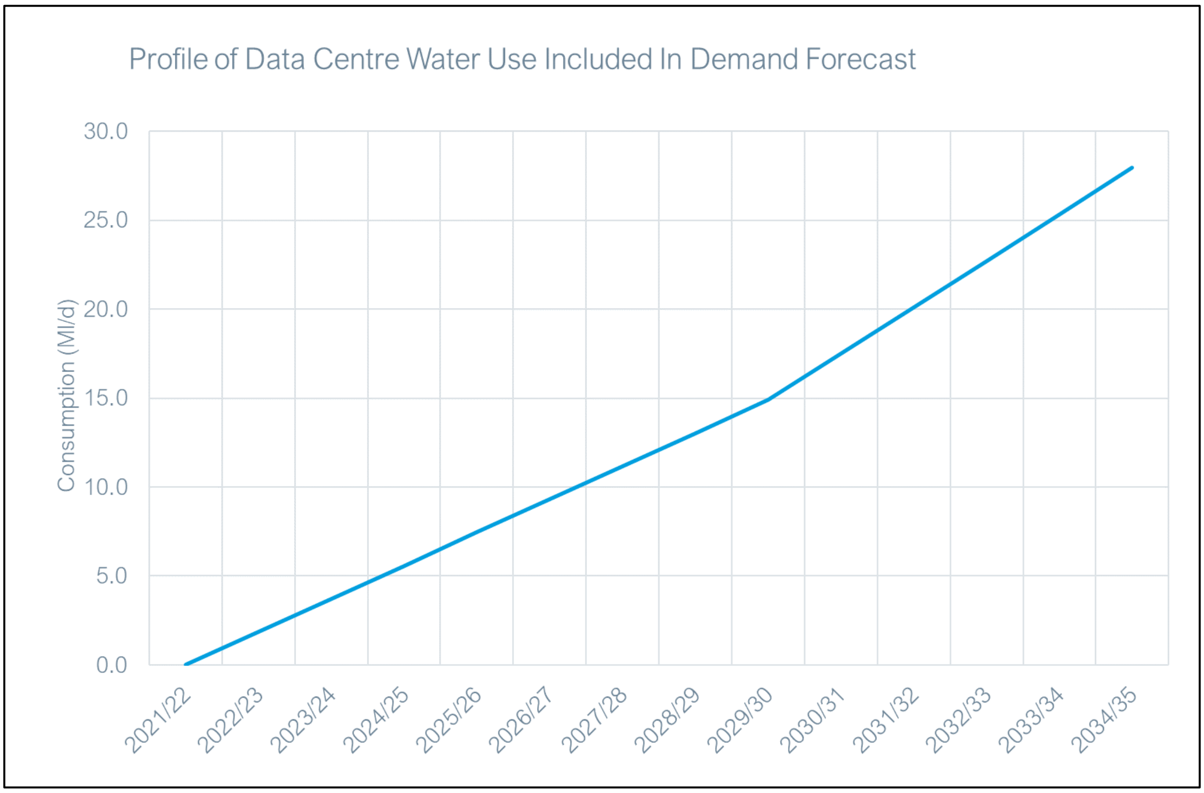


Figure 3-35: Data Centre Water Use Profile

3.217 Overall NHH demand increases across AMP8 and AMP9 due to the inclusion of data centres within the forecast. Beyond AMP9 profiles are generally flat.

3.218 The Jacobs study did not identify data centre growth being likely to impact Henley. Overall the change in non-household demand in Henley, a decrease of less than 0.6 Ml/d, is driven by forecast reduction in the service sector.

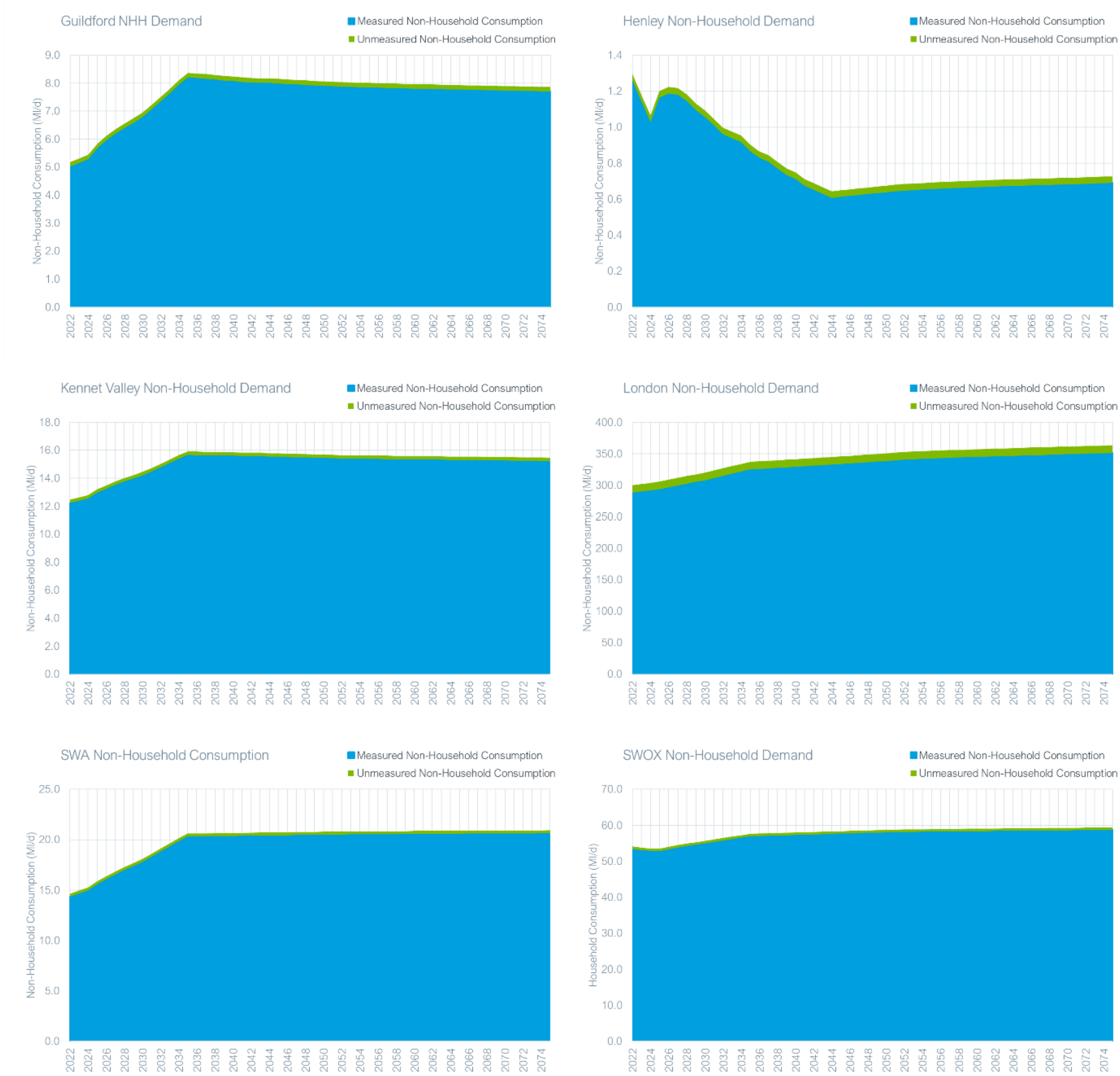


Figure 3-36: WRZ NHH Demand Totals

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

Baseline leakage and minor components

3.220 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.

3.221 We forecast minor components as unchanged over the planning period as there is no satisfactory method by which to forecast them, however minor changes over time from reductions in NAVs are affecting WTU, leading to a marginally non-flatlined profile.

3.222 The values for leakage, from year 2 of AMP8, and DSOU across the planning period can be seen in Table 3-25.

WRZ	Leakage	DSOU
Guildford	16.18	0.51
Henley	4.53	0.10
Kennet Valley	24.69	0.74
London	355.49	12.01
SWA	42.58	1.01
SWOX	65.05	2.66
Thames Water	508.52	17.03

Table 3-25: DYAA Leakage and operational usage (Ml/d)

Summary of our baseline, plan-based, demand forecasts

3.223 The baseline plan-based DYAA and DYCP demand forecasts (as Distribution Input (DI) for each WRZ are shown in Figure 3-37 with summaries presented in Table 3-26 and Table 3-27.

3.224 A consistent picture can be seen across our WRZs. Once the remaining demand reduction for AMP7 (leakage reduction in all WRZs, plus metering and conditional allowance for London) has been completed, demand increases over time. 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.

WRZ	Total DYAA Demand (as DI, Ml/d)		
	2025-26	2049-50	2074-75
London	1904.08	2150.63	2150.11
SWOX	281.50	316.24	316.44
SWA	148.34	162.94	162.32
Kennet Valley	105.42	115.80	114.26
Guildford	48.16	53.87	53.13
Henley	13.73	14.37	14.48

Table 3-26: Total DYAA Demand (Plan-Based Scenario)

WRZ	Total DYCP Demand (as DI, Ml/d)		
	2025-26	2049-50	2074-75
SWOX	333.97	368.72	368.91
SWA	171.04	185.63	185.02
Kennet Valley	120.36	130.73	129.20
Guildford	59.74	65.45	64.71
Henley	18.43	19.07	19.18

Table 3-27: Total DYCP Demand (Plan-Based Scenario)

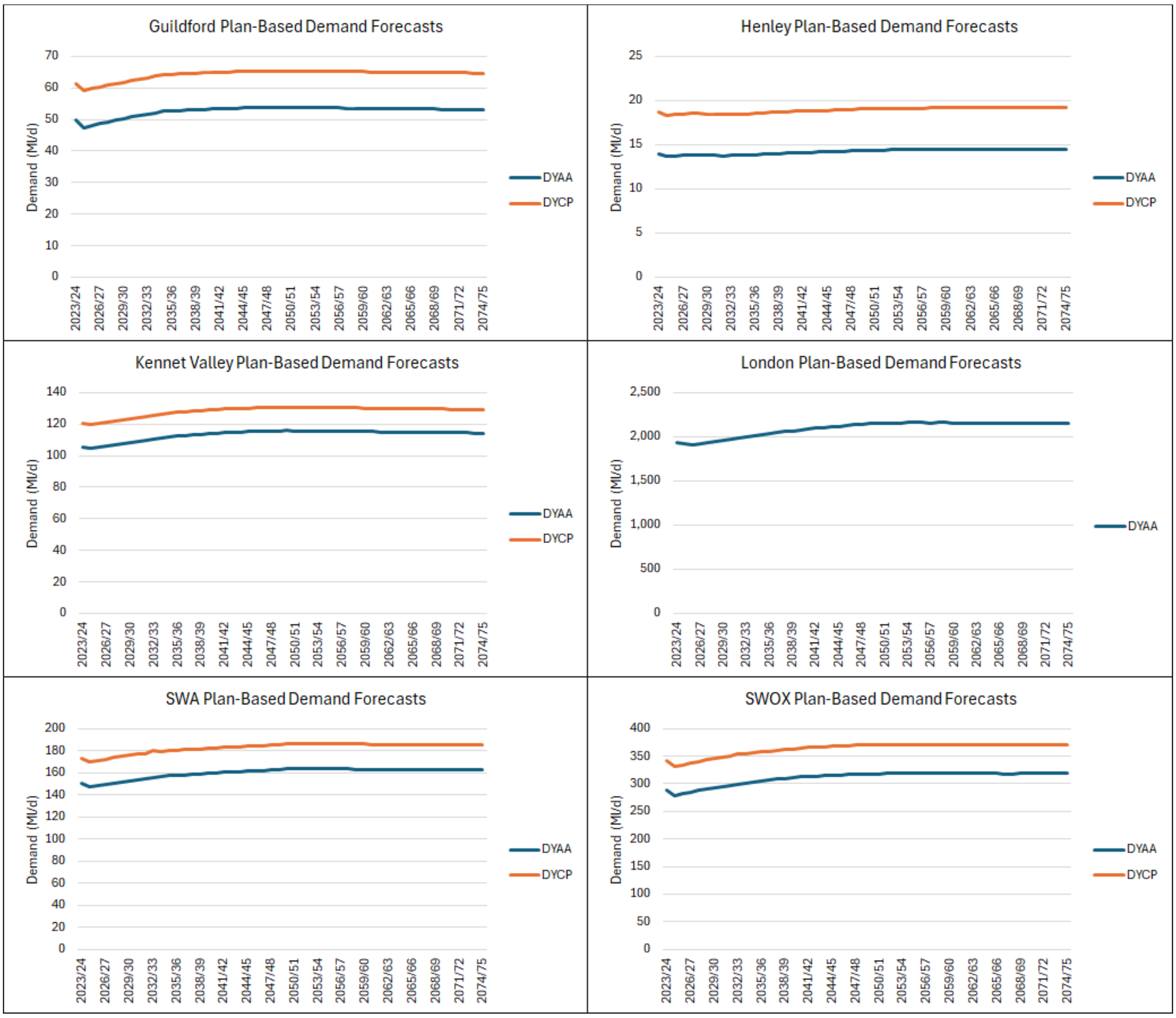


Figure 3-37: WRZ-level Distribution Input (plan-based forecasts)

Annex 1: Changes made between plan iterations

3.225 The text in the boxes below summarises the changes made to this Section between dWRMP24 and rdWRMP24, and between rdWRMP24 and final WRMP24.

Changes made between dWRMP24 and rdWRMP24

- 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.

Changes made between rdWRMP24 and final WRMP24

- The base year has been changed from 2021/22 to 2023/24 (AR24), in alignment with PR24 draft determination
- This change to base year includes a minor adjustment to AR24 report figures. 2023/24 baseline demand values now use company-level values, split to WRZ-level, rather than a WRZ-level bottom-up total.
- The green economic reduction policy has been removed, with replacement metering updated within the baseline demand management programme detailed in Section 8.
- We have adjusted our demand forecast to remove growth within existing areas supplied by New Appointment and Variations (NAVs), in line with changes made in our supply forecast, and as requested by the Environment Agency.
- Corrections have been made to CSL Baseline forecasts, to spread savings associated with any AMP7 savings over households only. This is relatively immaterial and doesn't affect total leakage.
- A correction has been made to London data centre demand. Previously this was incorrectly using the company total, essentially double-counting Thames Valley WRZ data centres. This correction has led to a ~15Ml/d lower NHH demand once the data centres are at full utilisation by 2034/35.

Annex 2: rdWRMP24 Household Demand Forecasts

3.226 For our final WRMP, as described earlier in this section, we have re-based our main consumption and distribution input forecasts to an AR24 start point, resulting in a minor change to our forecasts. ONS-18 forecasts have not been updated alongside the plan-base forecasts with the section on Household Demand forecasts above. As such for a comparison between the two, please see below copies of the comparisons made in our rdWRMP submission.

3.227 Figure 3-38 and Figure 3-39 below provide the household consumption forecasts as they were in rdWRMP24. Impacts of progressive metering and supporting water efficiency activities, either through the GER programme in Thames Valley zones, or otherwise, led to an overall drop in HH consumption over all WRZs in AMP7.

3.228 As with final WRMP HH demand, a general increase in consumption values is present in all WRZs until around 2049/50, with the removal of HH reduction trend factors (now accounted for within Government-led demand reduction) and increasing population as the main drivers. Additionally, the HH demand from 2049/50 to 2074/75 plateaus or declines, with the re-inclusion of the trend factors beyond 2050.

3.229 ONS-18 forecasts, by and large, present lower HH demand forecasts when compared to their plan-based equivalents. This is particularly obvious in the larger zones (e.g. London and SWOX).

3.230 These same patterns are replicated in the PCC profiles (Figure 3-40). These profiles also demonstrate the population as the major driver of demand, with both ONS-18 and Plan-based scenarios following roughly the same profile once population is removed from the picture.

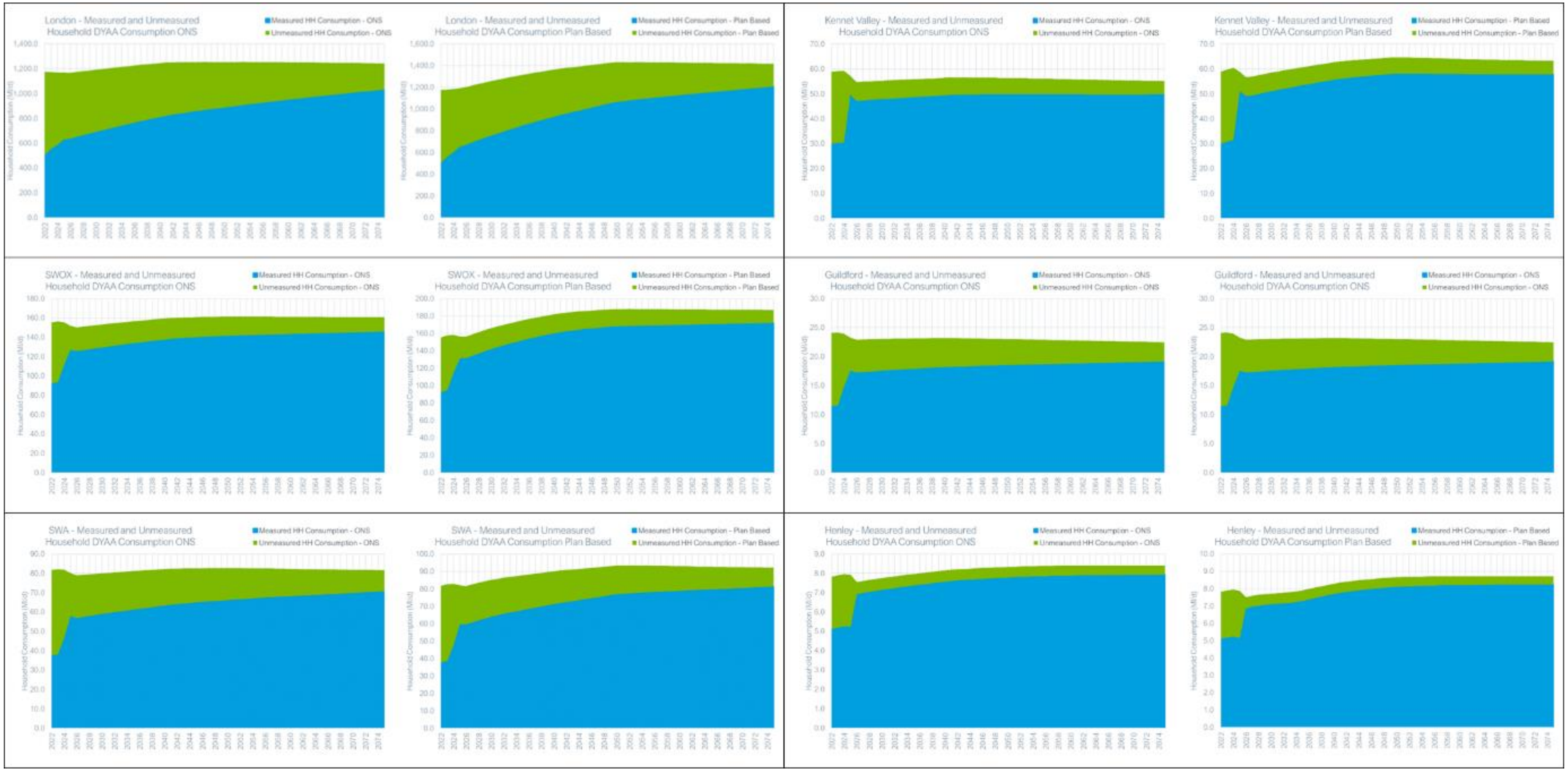


Figure 3-38: WRZ-level DYAA comparison charts for ONS-18 and Plan-based scenarios

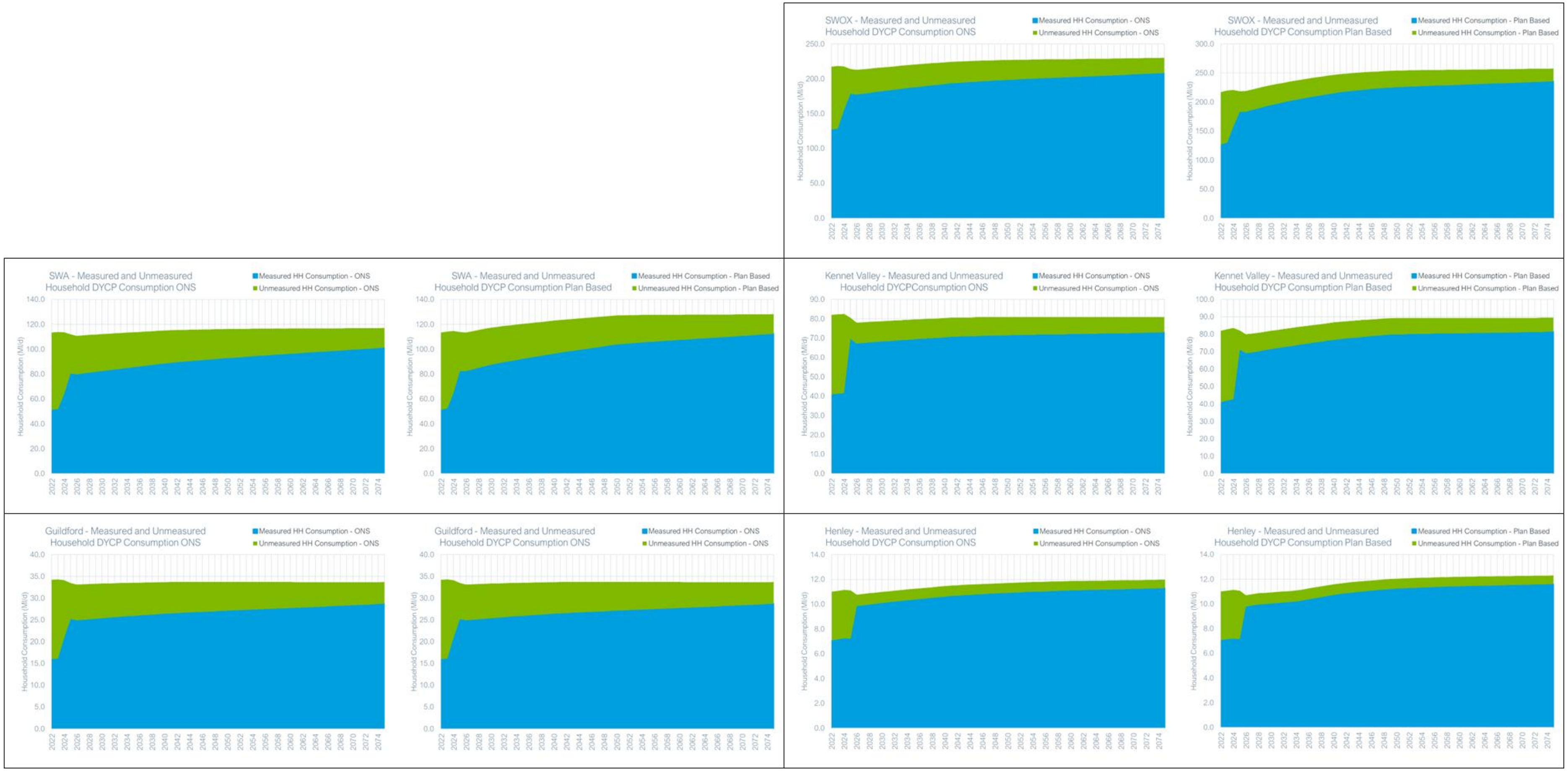


Figure 3-39: WRZ-level DYCP comparison charts for ONS-18 and Plan-based scenarios

Figure 3-40: WRZ-level DYAA PCC comparison charts for ONS-18 and Plan-based scenarios

Thames Water