WRMP 2019 Technical Document:

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Demand Forecast

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This is a technical report that supports our WRMP submission.

This document describes our demand forecast methodology in conformance with Defra/EA guidance.

It describes the processes by which all elements of the Anglian Water demand forecast have been derived including household and population projections, non-household forecasts, distribution input (DI) projections, per capita consumption (PCC) projections, and associated influent factors.

Contents

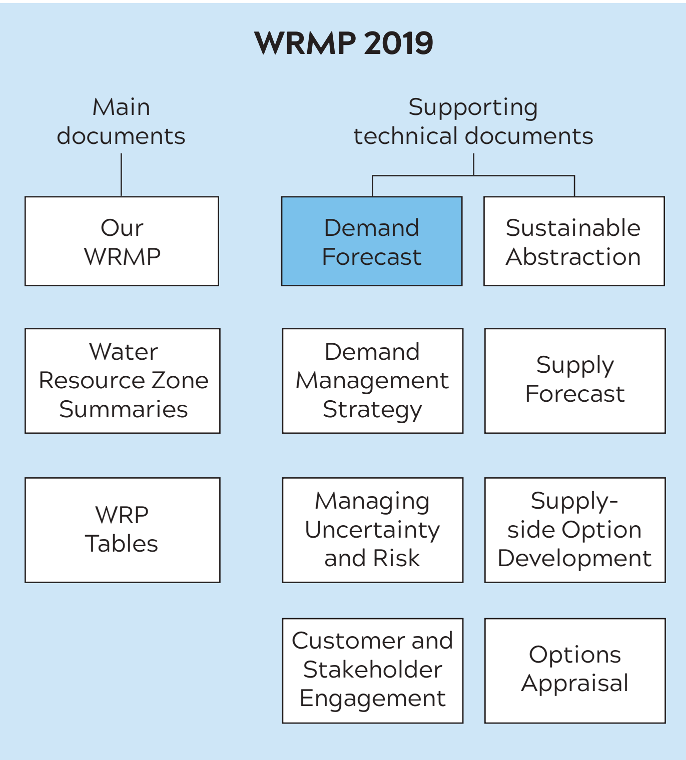
1. Introduction

We have collaborated and engaged extensively in the development of our WRMP. We feel that this is of particular importance due to material water resource challenges we face in our supply area.

1.1 The Water Resources Management Plan

Our WRMP submission is comprised of several reports, as set out in the diagram below. The main submission is supported by technical documents that explain our methodologies and provide the detailed results of our analysis.

Figure 1.1: WRMP 2019



This Technical Document describes our methodology for demand forecasting for the WRMP 2019, covering the following;

- Interpretation of the Guidance: The methodology demonstrates that we have understood the guidance.
- Adherence to the guidance: We have demonstrated how the methodologies adhere to the guidelines.
- Suitability of approaches: The assessment of the various components of demand matches the requisite level of sophistication suggested by the risk based approach for a given Water Resource Zone (WRZ).

1.2 Background

Water companies have a statutory obligation to produce a Water Resources Management Plan (WRMP), which sets out how a company intends to maintain the balance between supply and demand for water over a minimum 25 year period.

In the development of a WRMP, companies must follow the Water Resource Planning Guideline ("Guidelines") and have regard to broader government policy objectives, as set out in Defra's Guiding Principles document. WRMPs should ensure a secure and sustainable supply of water, focus on efficiently delivering the outcomes that customers want, while reflecting the value that society places on the environment.

The latest forecasts of demographic change in the UK suggest that population and household growth will be a common characteristic of the Anglian Water region, over the next 25 years. A sustained period of new housing growth, ageing population profiles and a reducing average household size are expected to be key considerations for planners and policy makers.

As the number of homes and population increase, they will require more water and water recycling services, with the existing geographical disparities between the supply and demand for water projected to become significantly more acute.

1.3 Guidance

The EA/UKWIR provides detailed guidance with respect to the demand forecasting element of the Water Resources Management Plan:

- EA, Defra and Ofwat (2016) 'Final Water Resources Planning Guideline'
- Defra (2016) 'Guiding principles for water resources planning'
- UKWIR (2016) 'Population, household property and occupancy forecasting' - Guidance manual, supplementary report and worked example
- UKWIR (2016) 'WRMP19 methods - Household consumption forecasting' - Guidance manual and supplementary report
- UKWIR (2006) 'Peak water demand forecasting methodology'
- UKWIR (2016) 'WRMP19 methods - Risk based planning'
- UKWIR (2016) 'WRMP19 methods - Decision making process'
- UKWIR (2016) 'Integration of behavioural change into demand forecasting and water efficiency practices'
- UKWIR (2012) 'Customer behaviour and water use - A good practice manual and roadmap for household consumption forecasting'
- UKWIR (2013) 'Impact of climate change on water demand'
- UKWIR (2002) 'An improved methodology for assessing headroom'

In developing the demand forecast for WRMP 2019, the EA recommends that our methodology balances simplicity and accuracy, and that more detailed analysis should be undertaken where there is vulnerability to growth within a given Water Resource Zone (WRZ).

Given the significance of growth across our region, we have designed a new forecast model suite, which applies the same sophisticated approach to all WRZs.

Furthermore, we have aimed to fully align water and recycled water demand forecast modelling, in order to develop a coherent single demand forecast for all growth related investment. However, this paper will concentrate on the requirements of the WRMP 2019.

2. Demand Forecast Scope

Table 2.1: (5.1) What should be covered in your demand forecast? - Defra/EA guidance

Number	Action
148	You have provided a demand forecast for the dry year annual average where demand is unrestricted, which includes adjustments for likely future changes in demand due to factors such as climate change, population growth, household size, property numbers, and current company demand management policy/activity. (Sections 2.1, 2.3, 2.5, 2.7)
149	You have provided a demand forecast for the critical period (if considered in your plan) that accounts for the factors you expect will drive demand during the critical period, such as seasonal changes or population growth. (Sections 2.1, 2.3, 2.6, 2.7)
150	You have provided a demand forecast for the final plan dry year annual average which includes adjustments to reflect solutions identified through your options appraisal. (Sections 2.1, 2.3, 2.5, 2.7, 2.8)
151	You have provided a demand forecast for the final plan critical period which includes adjustments to reflect solutions identified through your options appraisal. (Sections 2.1, 2.3, 2.6, 2.7, 2.8)
152	You have explained how demand forecasts have been arrived at and documented any underlying assumptions, including how you have determined unrestricted demand. (Sections 2.2, 2.3)
152	You have explained your reconciliation of current best estimates of demand with other parts of the water balance. (Sections 2.4 and 3.2)

2.1 Objectives

The new demand forecast system has been designed to fulfil the following objectives;

- Report in a spatially flexible manner,
- Produce an aligned basis for demand forecasts for water and waste water (Water Resource Zones, (WRZ), Planning Zones, (PZ), and, water recycling catchment areas (WRCs)),
- Align with longer term modelling for the WRE project (Water Resources East),
- Produce demand forecasts for the required minimum 25 year projected period,
- Reflect all factors and influences on consumption for the plan period, to produce baseline DYAA and CP scenarios,
- Include preferred demand management options in the final plan scenario, and
- Meet all statutory requirements and follows industry 'best practice'.

The demand model produces:

- A 'Baseline Dry Year Annual Average' forecast (Ref. 148) - the baseline demand forecast has been adjusted to account for forecast climate change impacts, population growth, changes in household size (occupancy for both measured and unmeasured customers), changes in property numbers, the 'Business As Usual Water Efficiency' (BUSWE) programme and has been derived to reflect the Dry Year Annual Average demand.
- A 'Baseline Critical Period' forecast (Ref. 149) - this includes factors which drive the highest critical period demand e.g. seasonal peak/summer consumption.
- A 'Final Plan Dry Year Annual Average' forecast (Ref. 150) - the final demand forecast, adjusted to include savings resulting from demand management options that have been identified through the option appraisal process (refer to the demand management strategy), has been derived to reflect the Dry Year Annual Average demand.

- A 'Final Plan Critical Period' forecast (Ref. 151) - a final plan critical period demand forecast, adjusted to include savings resulting from demand management options that have been identified through the option appraisal process, and includes factors which drive the highest critical period demand.

This new model has been designed to include Local Planning data, 'local development intelligence' and reflect both 'plan' and 'trend' based data, as appropriate in the forecast time line. As required by the EA/UKWIR, 'Local Authority plan' based information has be used as the core of the near term (5 to 15 year) demand forecast period.

2.2 Demand Forecast Processes (152)

We have developed demand forecasts, identifying each demand segment and their respective influences; household, non-household, measured and unmeasured, Distribution System Operational Use (DSOU), distribution losses, water taken un-billed (WTU) and leakage.

The forecasts have included assessments for the following influences on demand:

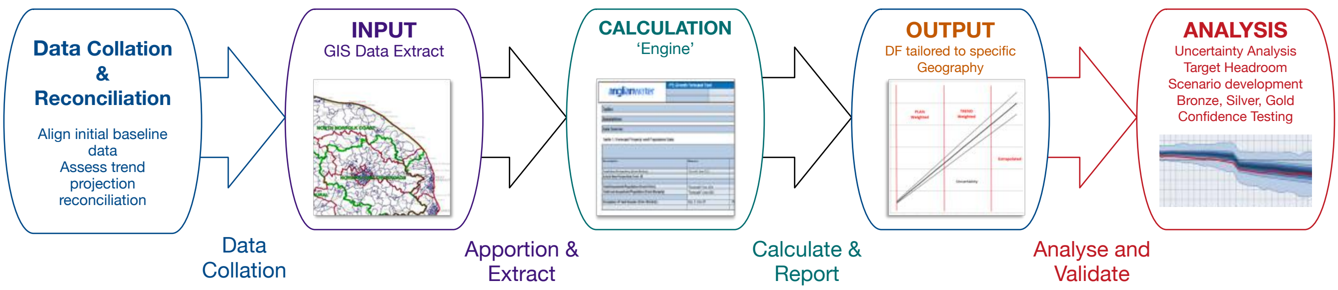
- Population changes
- Water use; changes in behaviour (in both household and non-household customers)
- Metering and meter opting
- Increasing water efficiency and sustainable practices
- Changing design standards of devices that use water (e.g. efficiency)
- Changes in technology and practices for leakage detection and repair
- Climate change and weather patterns.

These influencing factors have been applied, appropriately, to each designated segment, for the forecast period. These aggregated demand elements then produce the total demand consumption forecast for the required geography, for the projection period.

The model has been designed to produce separate input, calculation and output elements, clearly indicating constants, factors, reconciliations and making all calculations and assumptions transparent and explicit.

Thus, in simple terms, the forecast process has been conceptualised as a process involving data collation and validation; apportionment and attribution to the correct geographies; modelling, output and analysis.

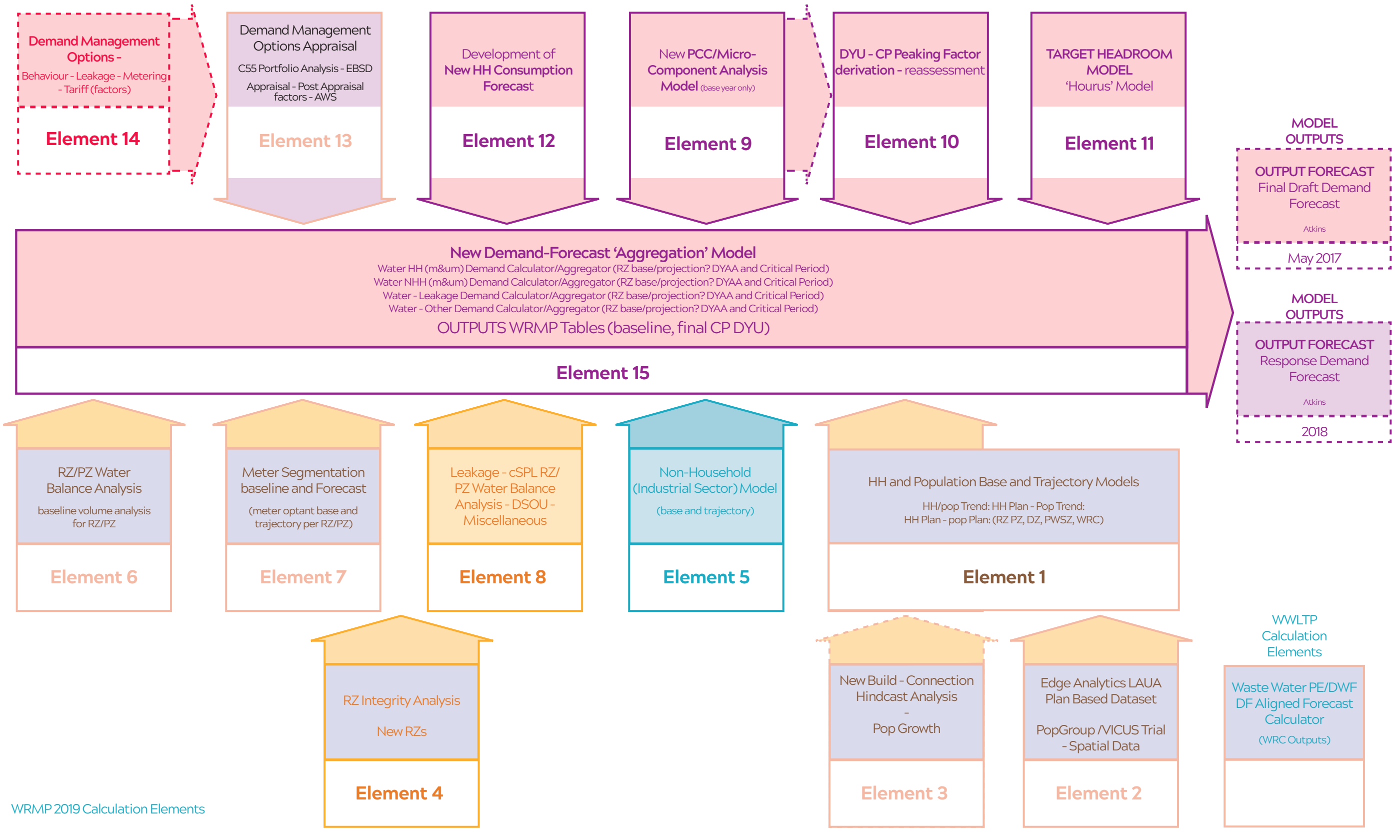
Figure 2.1: Simple conceptual view of processes involved in the production of the demand forecast



In detail, the demand forecast elements may be visualised, as comprising a number of analysis elements/modules, which have been aggregated to derive the complete forecast, including all factors and influences on future demand.

The detailed process elements may be shown and described:

Figure 2.2: Detailed view of demand forecast elements/modules



- **Element 1. Household/Population Model -** The Household/Population forecast (derived using AWS SAP premise base-line data and ONS/MHCLG/ Local Authority adopted/Emergent/Draft plan data (collated by Edge Analytics). This also includes the forecast for non-household population based upon Census data.

- **Element 2. Edge Analytics Data -** Edge Analytics collated LAUA Planning household growth trajectories (used to inform near term household growth projections)

- **Element 3. Historic Analysis -** AWS internal analysis of previous historic domestic connection data (used for comparative analysis with future projections)

- **Element 4. WRZ Integrity Analysis -** The WRZ integrity assessment, based upon initial estimates for the future supply-demand balance, is used to redefine a new Resource Zone geography (in accordance with EA Guidance). All new baseline/ forecasts and datasets are aligned to this new geography, for WRMP 2019 reporting purposes.

- **Element 5. Non-Household Forecast -** Non-Household Consumption Forecast (Produced by Servelec Technologies). This forecasts future non-household consumption, based upon internal non-household billing data, the internal AWS SINCON non-household consumption monitor dataset and derives the forecast based upon non-household sector by sector growth, EEFM GVA forecasts and forecast sector employment rates.

- **Element 6. WRZ/PZ-Water Balance data -** Water Resource Zone/Planning Zone Water Balance Analysis. Consumption data is analysed at PZ level (by the Leakage Team) providing baseline information on consumption for all sectors and leakage (household/non-household, measured, unmeasured).

- **Element 7. Meter Segmentation baseline and forecast -** Water Resource Zone/Planning Zone level analysis has been produced for current meter segmentation (optant, enhanced etc.) and forecast rates of change for each meter segment (Metering Team).

- **Element 8. Leakage and Miscellaneous use analysis -** Future leakage, customer supply pipe leakage (CSPL) and other miscellaneous demands have been assessed. Additional import/export factors have also been included.
- **Element 9. PCC/MCA Baseline modelling -** Per Capita Consumption (PCC) is re-evaluated using current AWS domestic consumption monitoring data and weather dependency. Micro Component analysis has also provided an assessment of customer usage based upon EA/UKWIR characterisation.
- **Element 10. Peaking Factors -** Dry Year Uplift (DYU) and Critical Period (CP), have been re- assessed and re-aligned for the new WRZ geographies.
- **Element 11. Target Headroom -** Uncertainty modelling has been re-evaluated and uncertainty parameters re-assessed and re-aligned for the new WRZ geographies.
- **Element 12. Household consumption forecast -** A new household consumption forecast has been produced, evidencing behaviour/technology and efficiency savings expected to influence future water usage (not including any further demand management savings included in the demand option development process).
- **Element 13/14. Demand Management Options -** Options have been developed utilising internal AWS data and external reported findings, to produce portfolios of demand interventions (leakage, metering, behaviour, efficiency, tariff) designed to reduce consumption.
- **Element 15. Demand Forecast Consumption 'Aggregate' Model -** This model aggregates all demand components and influent factors at an WRZ level; it reports all components of demand in the appropriate WRMP Table format.

The Consumption Module/element consequently, collates, compiles and calculates all inputs required for the WRMP 2019 Tables.

2.3 Factors and influences (148, 149, 150, 151, 152)

The forecast of future water demand has been determined, whilst including a number of influences and factors:

- Population and demographic changes;
- Changes in water usage behaviour (in both household and non-household customers);
- Metering effects on demand;
- Increasing water efficiency and sustainability practises;
- Changing design standards of devices that utilise water;
- Changes in technology and practises for leakage detection and repair, and
- Climate change and weather patterns.

In addition to housing and population changes, the demand characteristics of the various customer segments (measured, unmeasured, switcher and new-build) have been modelled, as they vary initially and over time.

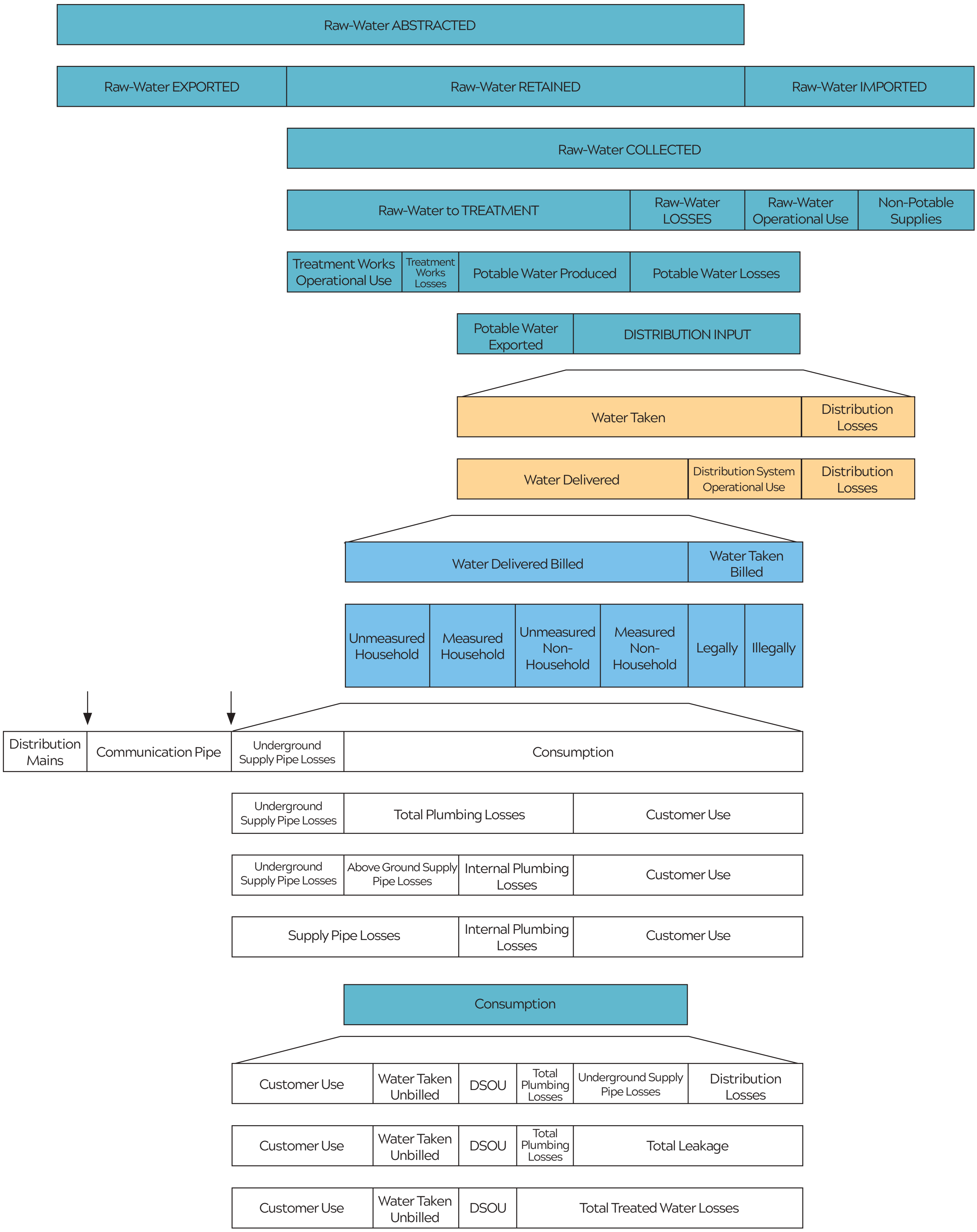
These differences have been factored into the demand forecast, as delineated by the segment descriptions and meter status (household, non- household, metered, un-metered, enhanced-metered and optant), aligned with Anglian Water consumption data.

The demand forecast segmentation base and forecast data is, consequently, derived from 'billing' premise data and metering team analysis of historic trend data; customer survey data; SoDCon metering analysis (SoDCon is the Anglian Water Survey of Domestic Consumption - detailed demographic/ consumption data regarding 1000 measured/1000 unmeasured customers); leakage data; micro- component analysis and technological efficiency estimation. These datasets provide baseline and trend analysis for:

- Measured household demand
- Unmeasured household demand
- Measured non-household demand
- Unmeasured non-household demand
- Water taken un-billed
- Distribution System Operational Use, and
- Distribution Losses

The volumetric components of demand, as defined by the EA/UKWIR can be summarised as follows (note this does not include metering/ behavioural change programme segmentation). These components and their variation through time have been analysed, informing the quantitative assessment of water demand, as described.

Figure 2.3: Components of demand as defined in 'Demand Forecasting Methodology Main Report Joint R&D WR-01/A' Pages 15-19



2.4 The water balance and base-year assessment (153)

In order to produce the demand forecast, an initial assessment has been made regarding base year values for each of the components of demand. Thus, the demand forecast relies upon the initial understanding of base-year information (water-balance data).

- The number of unmeasured household properties per WRZ. (PZ water-balance data (aggregated to WRZ), based upon AWS 'billing' information)
- Unmeasured household occupancy rates per WRZ. (derived from internal 'SodCon' surveys and apportioned Official ONS Local Authority rates)
- Unmeasured per capita consumption per WRZ. (PCC) values (water-balance data)
- The number of measured household properties per WRZ. (water-balance data, based upon AWS 'billing' information)
- Measured household occupancy rates per WRZ. (derived from internal 'SodCon' surveys and apportioned Official ONS Local Authority trend based occupancy rates)
- Measured per capita consumption (PCC) values per WRZ. (water-balance data)
- Numbers of void properties (household/non-household) per WRZ.
- WRZ distribution loss leakage values.
- Customer supply pipe leakage values for measured/unmeasured/household/non-household customers (per WRZ)
- 'Distribution System Operational Use' and 'Water taken unbilled' values per WRZ.

Base year consumption and leakage data has been derived using internal water-balance (WB) analysis. The water balance calculations (WB) compare 'top-down' estimates of the total water into supply with 'bottom-up' estimates of the demand, based on the measurement and estimation of components of legitimate usage. (see section 3 - Forecasting household demand)

2.5 Dry year uplift and the 'Dry Year Annual Average' forecast (148, 150)

We understand that the derivation of appropriate dry year and peak demand forecasts is a key element of the demand forecasting methodology. This methodology for producing peaking factors has been re-evaluated during the production of WRMP 2019.

An assessment has, therefore, been derived for the 'Dry year annual average' demand (DYAA); defined as the average level of water demand in a dry year. This 'Dry year annual average' is considered to represent a period of low rainfall and unrestricted demand and will be used as the basis of the baseline WRMP 2019 forecast scenario.

The dry year uplift has been calculated at the company level using the current PCC-MC model (see table 2.2).

Base year customer data and weather data for the years back to 1994 has been assessed, resulting in a re-based mean annual Per Capita Consumption (PCC).

Consequently, a reference dry year has been defined as 1995, along with a number of other dry years (1996, 2003, 2006, 2011), based on an analysis of PCC (measured, unmeasured and combined; summer, winter and average) and rainfall (summer, winter).

A 'pure' and final dry year uplift value has been calculated as follows:

A 'pure' dry year uplift has been defined as the difference between the average PCC in the reference dry year (1995) and long-term average PCC (excluding years defined as dry).

A 'final' dry year uplift has been defined as the difference between the reference dry year average PCC and the base year (as calculated by the PCC- MC model).

The 'final' dry year factor has been applied to household consumption in order to produce the Dry Year Annual Average (DYAA) Forecast for the WRMP.

Table 2.2: Dry Year Uplift Factors

	Measured Households	Unmeasured	Combined
Dry Year Uplift Factor	1.028	1.032	1.029

2.6 Peak demand and the 'Critical Peak' forecast (149, 151)

Weather related variation in demand has also been accounted for in the demand forecast process, by the use of a critical peak scenario demand forecast.

The derivation of periods of peak demand strain, known as a 'Critical period', has been reassessed as part of the development of the new forecast.

Peak demand has been evaluated at the WRZ level using the existing per capita consumption and micro component (PCC-MC) model and Deployable Input (DI) demand data, to produce a 'Critical peak' scenario, with factors for measured, unmeasured, household and non-household demand.

The peak period is defined as 3 days, which relates to observed demand peaks and operational processes. Base year customer data has been used in addition to weather data for the years back to 1994 to identify these peaks.

Household peak per capita consumption (PCC) values are compared with DI peaks for the same customer period (i.e. 2006/07) for each WRZ. Average (3-day) peaks have been identified for DI and a normalised DI peak factor is found by dividing this value by an equivalent 3-day peak that excludes the months of June, July and August; this normalisation process follows the UKWIR 2006 guidance.

Each Resource Zone DI peak factor has been derived as a proportion of the company DI peak factor. These values are then multiplied by the calculated company PCC peak factor (calculated with outputs from the PCC-MC model) to produce the overall PCC peak factor for each WRZ.

A peak factor (rather than volume) approach has been selected to reflect our assumption that demand largely relates to the resident population, and the customer base will change due to growth and customers switching from being unmeasured to measured.

Non-household peak factors have been derived using an alternative methodology, due to the lack of equivalent data for non-household consumption.

An implied non-household peak demand has been calculated by subtracting the household peak demand from the overall peak in DI. The implied additional non-household peak demand is subsequently this value minus the average non-domestic demand, which is a sum of the following components for the base year:

- Distribution system water use;
- Water taken un-billed;
- Unmeasured non-household consumption;
- Measured non-household consumption;
- Total leakage.

The implied non-household peak demand factor has been applied to measured non-household demand only and is calculated by dividing the implied additional non-household peak demand by measured non-household demand. The peak factor for unmeasured non-household demand was set at 1 (i.e. no peak) as there is little demand in this category.

Analysis of peak values of PCC has revealed that peaks are concentrated in the summer months of June, July and August. Ranking of 3-day rolling mean PCC revealed that peak values were concentrated in the years 1995, 1996, 2000, 2006 and 2010.

These factors have been used to produce the Critical Period (CP) Forecast for the WRMP.

Table 2.3: Peaking Factors

	Measured HH	Unmeasured HH	Measured NHH
Bury Haverhill	1.333	1.411	1.449
Bourne	1.282	1.357	1.294
Central Essex	1.277	1.352	1.417
Central Lincolnshire	1.278	1.353	1.377
Cheveley	1.333	1.411	1.449
East Lincolnshire	1.306	1.382	1.345
Ely	1.333	1.411	1.449
East Suffolk	1.277	1.352	1.417
Happisburgh	1.483	1.570	1.440
Hartlepool	1.000	1.000	1.000
Ixworth	1.333	1.411	1.449
North Fenland	1.324	1.402	1.321
North Norfolk Coast	1.483	1.570	1.440
North Norfolk Rural	1.341	1.420	1.381
Norwich and the Broads	1.283	1.359	1.296
Nottinghamshire	1.256	1.330	1.358
Newmarket	1.333	1.411	1.449
Ruthamford Central	1.254	1.327	1.355
Ruthamford North	1.254	1.327	1.355
Ruthamford South	1.254	1.327	1.355
Ruthamford West	1.254	1.327	1.355
South Essex	1.277	1.352	1.417
South Fenland	1.324	1.402	1.321
South Lincolnshire	1.256	1.330	1.358
South Norfolk Rural	1.341	1.420	1.381
Sudbury	1.333	1.411	1.449
Thetford	1.333	1.411	1.449

2.7 Climate change (148, 149, 150, 151)

To forecast the impact of climate change on household demand, annual percentage change factors, developed by UKWIR (2013) 'CL04B impact of CC on water demand', have been used. Average factors from the two models provided have been extrapolated to 2045 and cross referenced. It is noted that, UKWIR (2013) found no consistent weather-demand relationship for non-household demand; consequently, following guidance no climate change allowances have been made. (See Section 10)

2.8 Demand management options and the final plan (149, 150)

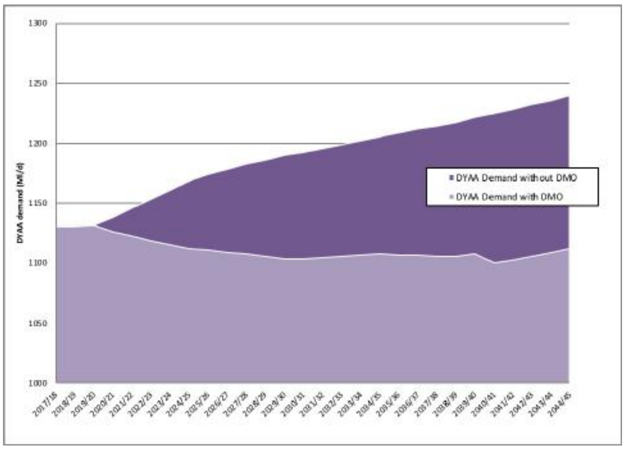
As a part of the demand forecast process, demand management options have been evaluated for their feasibility in addressing increasing demand from a growing population. (See the 'Demand Management Strategy technical report')

Options have been developed for metering, leakage, and household water efficiency programmes and combined into portfolios; targeting both savings from behaviour, efficiency and leakage.

Those options deemed to be most cost effective in addressing demand issues have been quantified and the savings have been applied to the appropriate demand segments (measured/ unmeasured, consumption, cspl or distribution losses) to produce DYAA and CP final plan forecasts (including the demand management option savings).

Thus demand with and without demand management options can be shown for the dry Year Annual Average forecast (DYAA):

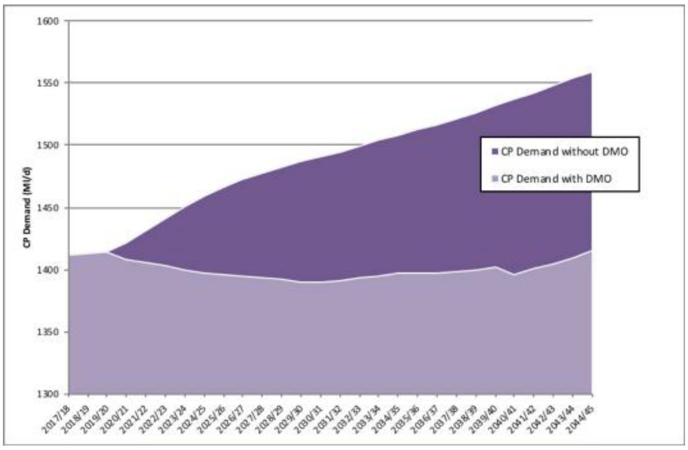
Figure 2.4: DYAA Demand with and without the preferred demand management options



For the baseline Dry Year Annual Average forecast, demand is set to increase from 1130 Ml/d to 1239 Ml/d by 2045 (a 109 Ml/d increase) without demand management interventions. The preferred demand management options mitigate this growth with the final consumption figure being 1111 Ml/d in 2045 (a 19 Ml/d reduction from 2017/18).

Demand with and without demand management options can be shown for the Critical Period (CP) forecast;

Figure 2.5: CP Demand with and without the preferred demand management options



For the critical Peak forecast, demand is set to increase from 1412 Ml/d to 1559 Ml/d by 2045 (a 147Ml/d increase) without demand management interventions. The preferred demand management options mitigate this growth with the final consumption figure being 1414 Ml/d in 2045 (a 2 Ml/d increase from 2017/18).

Demand management options will be discussed in more detail in the 'Demand Management Strategy Technical Report'

3. Forecast Household Demand

Table 3.1: (5.2) Forecast household demand - Defra/EA guidance

Number	Action
154	You have demonstrated how you have arrived at your forecast of population and property numbers and the assumptions on which these are based. (See Section 4 - forecast population and properties)
155	You have demonstrated an understanding of what is driving future household demand and how you have estimated this. (Sections 3.1, 3.2, 3.3, 3.4)
156	You have included forecast savings data for existing water efficiency initiatives in your baseline forecast. (Section 3.3.4)

3.1 Household demand factors [155]

In order to understand how household driven demand will change over time, households have been segmented for both the baseline and forecast period.

The populations of these segments; unmeasured, optant and measured form the cohorts which, along with their respective consumption and PCC values, drive the 'population and PCC' based household demand forecast.

It is understood that measured and unmeasured customers have different demographic characteristics, with higher average occupancy rates for unmeasured properties and with differing consumption profiles for each segment. Unmeasured customers tend to have higher per capita consumption rates, which tends to reduce upon their being switched to measured customers.

Consequently, understanding how the measured and unmeasured customer profile is reflected at resource zone level (WRZ) has been key to determining household consumption over the WRMP 2019 planning period.

Household customers have been segmented and derived for the WRMP 2019 period, to separate:

- Customers - measured
- Customers - unmeasured
- Customers forecast to switch from being unmeasured to measured (as determined by the metering team);
    - Meter optants (customers who decide to become measured)
    - Change in status upon change of occupant (Move in)
- New customers added each year (derived from the Plan based household forecast)

A new cohort based model based upon population and per capita consumption has been created.

For household consumption, the forecast demand is driven by an understanding of the changes in population for each of the segments, as the unmeasured population is forecast to decrease and the measured population increases due to opting and as additional population enters measured/ metered new-build properties.

3.2 Base year information [155]

In order to produce the demand forecast, an initial assessment has been made regarding base year values for each of the components of demand.

Base year consumption and leakage data has been derived using internal water-balance (WB) analysis. The water balance calculations (WB) compare 'top-down' estimates of the total water into supply with 'bottom-up' estimates of the demand, based on the measurement and estimation of components of legitimate usage.

Differences between these estimates are then distributed between the major components based on an assessment of their uncertainty using the industry established method of Maximum Likelihood Estimation (MLE). The computation of MLE adjustments to the water balance calculations use relatively accurate AWS data regarding;

- Water resource outputs,
- Domestic and commercial metering,
- Property numbers
- Leakage management data
- Estimates of other components of water use (based on industry standard best-practice assumptions)

However, for unmetered/unmeasured properties and consumers, a sample based upon the Survey of domestic customers (SodCon) has been used to estimate this diminishing component of demand. This unmetered /unmeasured element of the WB tends to accumulate errors, causing a potential over- and under-estimate of the per household (PHC) and per capita consumption (PCC) and other demand components; with PHC being calculated from the unaccounted-for remainder of the water supplied and the number of unmeasured properties and PCC being additionally derived using Local Authority based occupancy rates.

Due to the importance of this dataset, we have sought to improve its water balance and leakage calculations by creating its whole-company water balance from the aggregation of individual water balances undertaken at the planning zone level (81 no. PZs) to Water Resource Zones (WRZs).

Thus, the demand forecast relies upon the initial understanding of base-year information (water-balance data);

- The number of unmeasured household properties per WRZ - water-balance data, based upon AWS ‘billing’ information
- Unmeasured household occupancy rates per WRZ - derived from internal ‘SodCon’ surveys and apportioned Official ONS Local Authority rates
- Unmeasured per capita consumption per WRZ - (PCC) values (water-balance data)
- The number of measured household properties per WRZ - water-balance data, based upon AWS ‘billing’ information
- Measured household occupancy rates per WRZ - derived from internal ‘SodCon’ surveys and apportioned Official ONS Local Authority trend based occupancy rates
- Measured per capita consumption (PCC) values per WRZ - water-balance data
- Numbers of void properties - household/non-household per WRZ.
- WRZ Distribution Loss Leakage values.
- Customer supply pipe leakage values for measured/unmeasured/household/non- household customers (per WRZ)
- ‘Distribution System Operational Use’ and ‘Water taken unbilled’ values per WRZ.

For unmeasured customers the following base-year values have been determined:

Table 3.2: Base-year values for unmeasured customers (2017/18)

WRZ	Unmeasured household Properties	Unmeasured Population	Unmeasured Household Occupancy Rate	Unmeasured household properties void	Unmeasured Household PCC Excl CSPL (l/h/d)	Unmeasured Household consumption and UR and CSPL
Bourne	9950	28860	2.900	335	173.972	5.46
Bury Haverhill	6737	19539	2.900	162	103.854	2.32
Central Essex	4000	11494	2.873	112	53.515	0.79
Central Lincolnshire	37555	105512	2.811	1762	156.670	18.17
Cheveley	551	1608	2.916	17	70.326	0.14
East Lincolnshire	36219	101128	2.793	2457	205.238	22.34
East Suffolk	20890	59527	2.850	464	53.181	4.08
Ely	6244	18509	2.965	207	192.951	3.84
Happisburgh	1726	4675	2.708	54	203.746	1.03
Hartlepool	24750	57841	2.337	1322	124.959	8.12
Ixworth	1560	4518	2.896	48	48.808	0.29
Newmarket	3254	9632	2.960	122	128.323	1.38
North Fenland	7601	21841	2.873	311	208.097	4.88
North Norfolk Coast	8018	21760	2.714	330	209.535	4.91
North Norfolk Rural	7413	21502	2.900	305	67.864	1.78
Norwich and the Broads	35143	97371	2.771	1084	171.809	18.27
Nottinghamshire	10424	28805	2.764	531	142.939	4.57
Ruthamford Central	16268	49834	3.063	277	142.757	7.83
Ruthamford North	60568	178811	2.953	1862	146.752	28.89
Ruthamford South	29600	88005	2.973	661	260.922	24.26
Ruthamford West	4886	14696	3.007	131	107.673	1.80
South Essex	16519	48466	2.934	458	170.066	8.97
South Fenland	9976	28336	2.841	400	212.552	6.46
South Lincolnshire	6848	19654	2.870	295	124.841	2.75
South Norfolk Rural	4088	11730	2.870	120	127.471	1.67
Sudbury	2404	6809	2.832	64	123.853	0.95
Thetford	2403	7008	2.916	83	132.281	1.03

And for measured customers the following base-year values have been determined:

Table 3.3: Base-year values for measured customers (2017/18)

WRZ	Measured household	Measured Population	Measured Household Occupancy Rate	Measured household properties	Measured Household PCC Excl CSPL (l/h/d)	Measured Household consumption and UR and CSPL
Bourne	54720	120044	2.193	1650	132.510	16.728
Bury Haverhill	41257	90860	2.202	1056	126.764	12.137
Central Essex	10425	22203	2.129	301	142.101	3.312
Central Lincolnshire	116689	247745	2.125	4344	124.034	32.481
Cheveley	1409	3060	2.172	63	143.894	0.462
East Lincolnshire	128941	266836	2.070	5453	124.91	35.268
East Suffolk	113365	242978	2.143	3350	145.071	36.951
Ely	28774	64701	2.248	1074	118.735	8.114
Happisburgh	6152	12134	1.972	201	118.412	1.529
Hartlepool	16558	31427	1.898	443	127.682	4.154
Ixworth	7684	16765	2.181	171	147.881	2.595
Newmarket	15745	35375	2.246	655	119.036	4.447
North Fenland	33508	72154	2.153	1302	117.462	8.978
North Norfolk Coast	35040	69714	1.990	1523	117.459	8.715
North Norfolk Rural	40705	89388	2.196	1279	124.722	11.760
Norwich and the Broads	111313	227216	2.043	3918	128.815	30.940
Nottinghamshire	21348	43170	2.023	1327	125.404	5.734
Ruthamford Central	102595	243914	2.377	3074	136.258	34.775
Ruthamford North	324956	730026	2.247	10233	131.053	100.551
Ruthamford South	158262	359562	2.272	4833	125.263	47.416
Ruthamford West	28155	64992	2.308	877	129.462	8.837
South Essex	83473	185753	2.225	2692	134.255	26.191
South Fenland	31667	66732	2.107	1280	126.932	8.946
South Lincolnshire	39434	85473	2.1676	1388	130.851	11.776
South Norfolk Rural	15090	32420	2.148	529	123.008	4.214
Sudbury	11226	23721	2.112	400	132.225	3.305
Thetford	12087	26641	2.204	304	131.764	3.692

Once combined with the forecast data below, this allows future household consumption to be determined.

- The number of optants properties per year per WRZ.
- The optant/switcher population per year (based upon an assumed value for optant/switcher occupancy per WRZ).
- Additional New-build Properties. (LAUA plan based data) per WRZ
- Additional Population per year (Assumed to be measured and derived from the overall WRZ 'plan' based projection for households and ONS trend based occupancy rates).

3.3 Forecast calculations [155]

3.3.1 Population

The cohort model functions, such that year on year changes in population are calculated as below, with total WRZ populations being based upon the Household/Population Model (plan derived).

The forecast population measured/unmeasured year on year change is calculated: For measured population:

Pop (meas) **= Pop** (meas-previous year) **+ Pop** (switcher) **+ Pop** (newbuild) **+/- Pop** (inter-year change birth/death/migration)

Where:

- **Pop** (meas) = The Measured Population
- **Pop** (meas-previous year) = The Previous Year's measured population
- **Pop** (switcher) = This year's Switcher Population
- **Pop** (newbuild) = This year's New-build Population (Plan derived)
- **Pop** (inter-year change birth/death/migration) = The adjustment to reconcile to the 'top down' population total, accounting for all population changes in the WRZ (change, split by meter penetration)

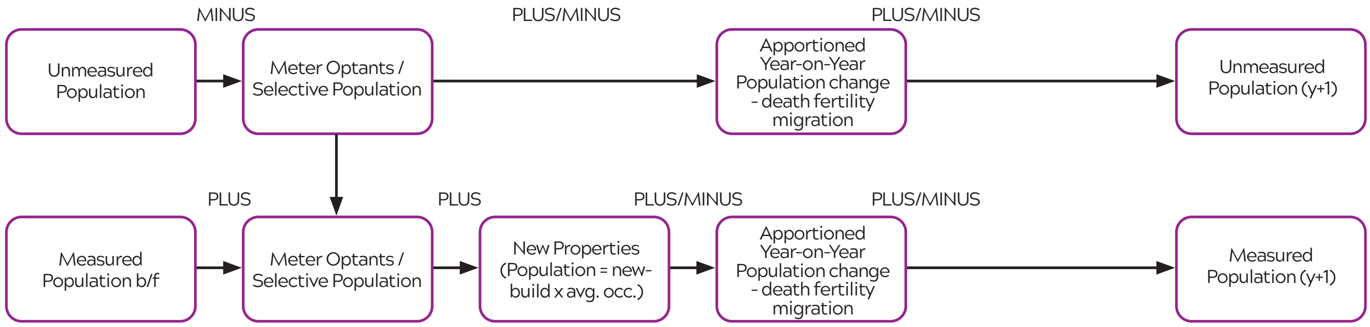
And for the unmeasured population:

Pop (unmeas) **= Pop** (unmeas-previous year) **+ Pop** (switcher) **+ Pop** (newbuild) **+/- Pop** (inter-year change birth/death/migration)

Where:

- **Pop** (unmeas) = The Measured Population
- **Pop (unmeas-previous year)** = The Previous Year's measured population
- **Pop** (switcher) = This year's Switcher Population
- **Pop** (newbuild) = This year's New-build Population (Plan derived)
- **Pop** (inter-year change birth/death/migration) = The adjustment to reconcile to the 'top down' population total, accounting for all population changes in the WRZ (change, split by meter penetration)

Figure 3.1: Model population calculations



A value has been calculated for the assumed New build population = New property (year on year) x average WRZ occupancy.

- Note that planned new properties are used to calculate the total WRZ population per year in the household/population model, but this uses the average overall WRZ trend based occupancy rates for the derivation of the yearly total WRZ population. This overall occupancy determined population will also include demographic changes due to birth/death/migration rates, such that additional WRZ populations per year do not equal the previous years total plus the new-build x average WRZ occupancy population. This is why an additional inter-year change is needed to reconcile the 'top down' population forecast.

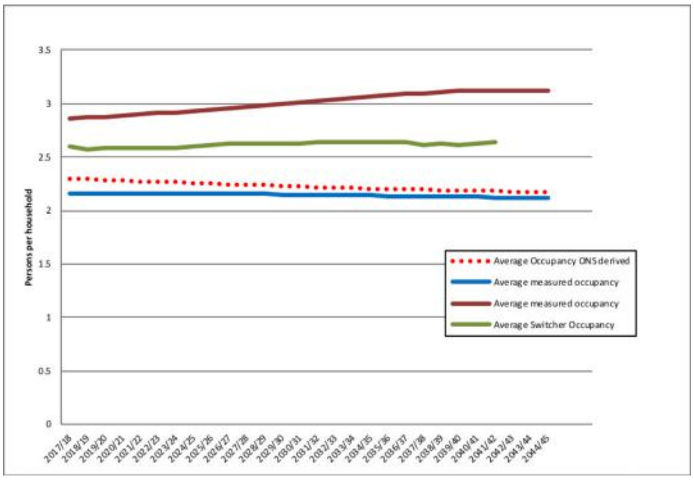
3.3.2 Occupancy and switcher populations

Given that the metering optant forecast is based upon properties and the model is based upon population and PCC, switcher/optant populations have been calculated using the following assumptions:

- The Base-year and forecast AVERAGE WRZ Occupancy are derived from Household/Population Model (Plan derived)
- Switcher Occupancy = Average of [(Unmeasured Occupancy) and (WRZ Average occupancy (Plan derived)
    - This reflects the fact that the switcher population is not expected to reflect the average unmeasured demographic.
- New-build Occupancy = average WRZ Occupancy derived from Household/Population Model (Plan derived)
- Base-year WRZ measured/unmeasured Occupancy generated by Water-Balance.
- Forecast measured/unmeasured occupancy is derived post switcher and post additional year on year population.

Thus, as populations are transferred from unmeasured to measured, the measured occupancy tends towards the WRZ average and unmeasured occupancy rates tend to increase. Note, as opting and switchers decline (as meter penetration reaches saturation) the unmeasured occupancy rate tends to reflect the declining overall occupancy rates for the region.

Figure 3.2: Regional occupancy rates Average/ Switcher/measured/unmeasured (2017/18 baseline)



3.3.3 Consumption

For consumption, base-year measured/unmeasured consumption is derived from the water-balance PCC and populations.

Switcher Consumption is assumed to be;

- Pre-switch (deducted from unmeasured) = Previous year (unmeasured PCC x population)
- Post-switch (added to measured consumption) = Previous year (unmeasured PCC x 85%) x population)

Unmeasured consumption is, therefore assumed to decrease by 100% of the switcher consumption and measured consumption increase by 85% of the switcher consumption (i.e. a 15% saving)

New-build Consumption is assumed to be equivalent to the measured consumption for the WRZ for that year.

Thus forecast household consumption is calculated as;

Measured Consumption = (Current Year measured population x Previous Year measured PCC (inc. BUSWE)) + (New-build population x Previous Year measured PCC (inc. BUSWE)) + (Switcher population x (Unmeasured PCC x 85%)); see below,

Measured Consumption:

$$\text{Con}_{(meas)} = [\,\text{Pop}_{(meas\text{-}current\ year)} \times \text{PCC}_{(prev\text{-}meas)}\,] + [\,\text{Pop}_{(new\text{-}build)} \times \text{PCC}_{(prev\text{-}meas)}\,] + [\text{Pop}_{(switcher)} \times (\text{PCC}_{(unmeasured)} \times 85\%)\,]$$

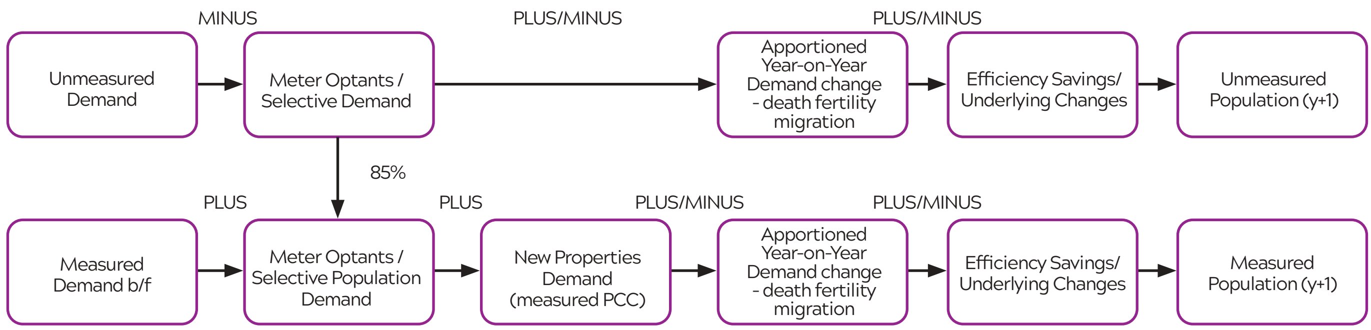
And unmeasured consumption is calculated;

Unmeasured Consumption = (Current year unmeasured population x Previous year unmeasured PCC) - (Switcher population x previous year Unmeasured PCC)

Unmeasured Consumption:

$$\text{Con}_{(unmeas)} = [\,\text{Pop}_{(unmeas\text{-}current\ year)} \times \text{PCC}_{(prev\text{-}unmeas)}\,] - [\,\text{Pop}_{(switcher)} \times (\text{PCC}_{(unmeasured)} \times 100\%)\,]$$

Figure 3.3: Model consumption calculations



3.3.4 Forecast assumptions (155)

As described all baseline values for the measured/ unmeasured properties, population, occupancy, and per capita consumption have been aligned with water balance data at WRZ level.

Additionally it has been assumed that:

- The optant/switcher occupancy has been calculated, as the average of the yearly value for unmeasured occupancy and WRZ average occupancy (as it has been assumed that the optants/switchers will form a slightly different cohort to the 'standard' unmeasured population, with lower than average unmeasured consumption and demographic characteristics, either being a driver for opting/switching, or reflecting the nature of customers who are optants upon 'moving in'.
- New build properties, for the forecast period have all been assumed to be metered and measured, as they are added to the total number of properties per year.
- Additional population per year has been adjusted to reflect the overall changes in average occupancies for the WRZ per year, in order to reflect declining occupancy rates and changes due to birth rates, death rates and migration (Thus, additional population has not been calculated as 'new properties' x 'occupancy' as this would not account for the other demographic changes)
- It has been assumed that as customers switch their consumption reduces to reflect their new status (or reflect their demography in the case of optants who choose to be measured upon 'moving in'); this reduction has been assumed to be 15% of the

pre-switch, unmeasured, consumption value for the particular WRZ.

- Within the model, switcher consumption is NOT conserved. Consequently, as the switcher consumption is recalculated from 'Pre-switch' to 'Post-switch' (i.e. Average unmeasured consumption - 15%); the 15% reduction is removed from the overall household demand total. This reduction has been assumed, in alignment with the findings of other water companies who have reported savings of 16.5 and 17%.

- It is also assumed that measured household consumption will be reduced by the effect of 'Business As Usual Water Efficiency Measures' (BUSWE). The metering team has determined that this can be assumed to be equivalent to a saving of 0.3 l/prop/d on average, giving an approximate saving of 0.1 l/h/d, per year over the 25 year period. This tends to counteract the, slight increase in PCC over the period, as higher than average consumption values are transferred with unmeasured switchers (i.e. Even including the 15% saving, as unmeasured customers become measured, because their PCC's can be significantly higher than the average measured PCC, they still transfer a higher than average volume per head per day, raising the overall average PCC). (156)

3.4 Results [(155)]

Baseline DYAA consumption has been modelled to increase from 463Ml/d to 686Ml/d for measured household consumption and decrease from 175Ml/d to 69Ml/d for unmeasured household consumption, giving final year total 756Ml/d.

Including the preferred demand management options DYAA measured household consumption is expected to increase from 463ml/d to 632Ml/d and unmeasured household consumption is expected to decrease from 175Ml/d to 66Ml/d, giving a final year total 698Ml/d.

Figure 3.4: Baseline DYAA Household consumption

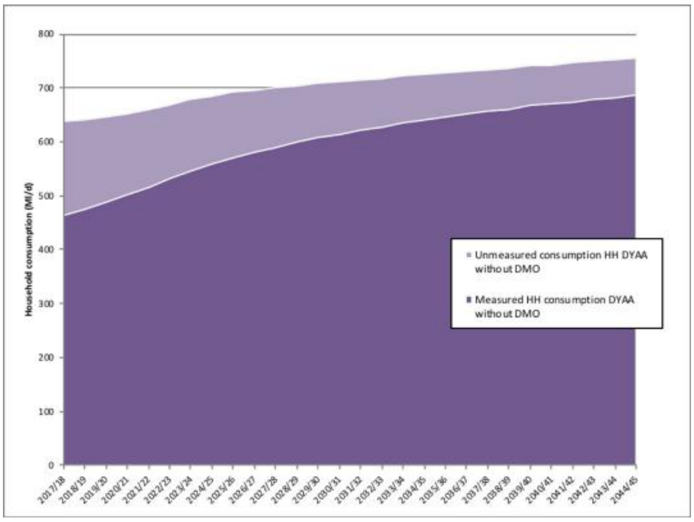
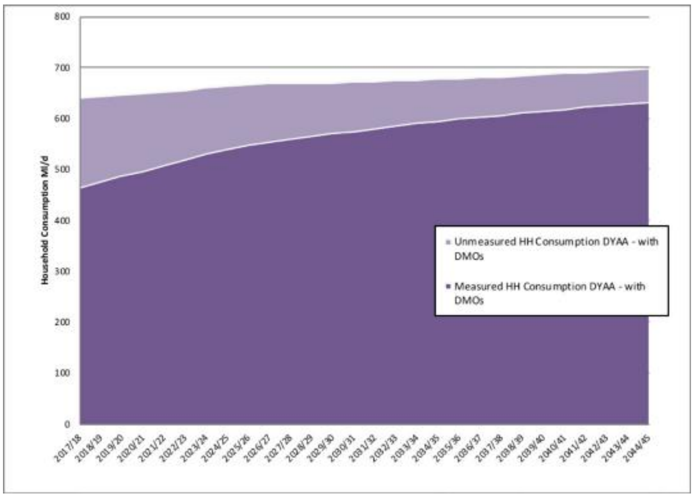
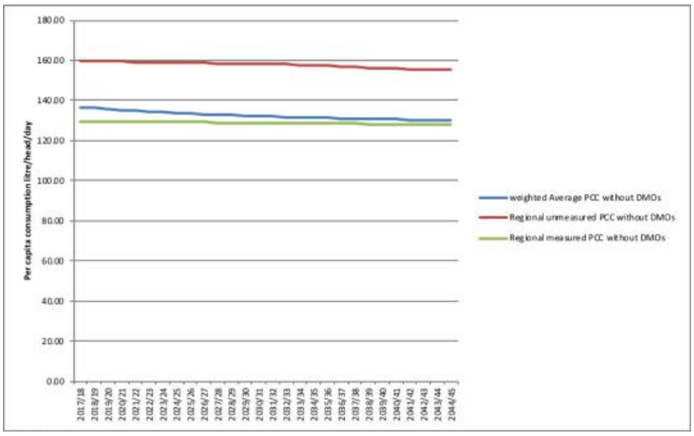


Figure 3.5: DYAA Household consumption with demand management options



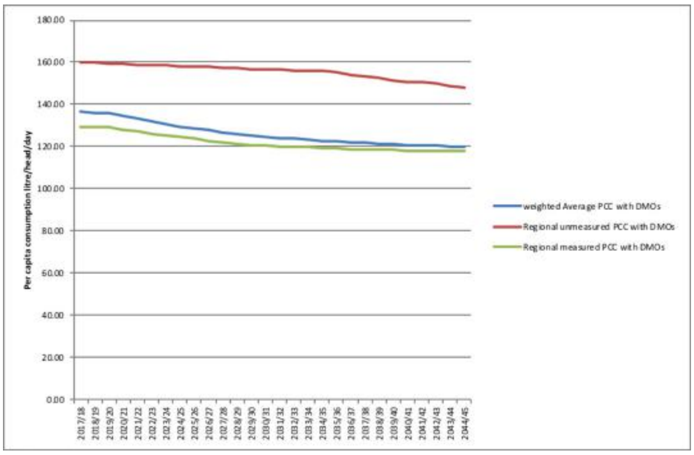
Additionally, PCC values can be shown for both the baseline forecast (including BUSWE and climate change) and for the final plan forecast which include the demand management options.

Figure 3.6: Baseline PCC values for measured/ unmeasured and weighted average customers



For the base-line forecast, average (weighted) per capita consumption (PCC) values are set decrease from 136l/h/d to 130l/h/d, by 2045, driven by the changes in consumption due to customers switching from unmeasured to measured status and baseline water efficiency strategies.

Figure 3.7: Final Plan PCC values for measured, unmeasured and the weighted average for customers with demand management options



Including the preferred demand management options average (weighted) per capita consumption (PCC) values are set decrease from 136l/h/d to 120l/h/d, by 2045.

4. Forecast population, properties and occupancy

Table 4.1: (5.3) Forecast population, properties and occupancy - Defra/EA guidance

Number	Action
157	For water companies supplying customers in England you have aligned your method for forecasting population and property growth with the most recent local plans published for your area(s), and accounted for potential changes in published figures if a local plan is not yet finalised. (Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6)
158	Where no local plan project(s) exist to inform your plan, you have used other appropriate methods such as household projections for Dept. for Communities, Local Government, those produced for DCLG by the ONS or the methods outlined in Population, household property and occupancy forecasting (UKWIR, 2016). You have documented and explained assumptions and data sources used. (Sections 4.1, 4.4, 4.5)
159	You have provided evidenced justification if your property forecasts deviate from planned figures. (Sections 4.1, 4.4, 4.5)
160	You have accounted for the planning period in your forecast property and population figures and have explained where/if different forecasting methods are applied for different time horizons, especially if your planning period is longer than 25 years. (Sections 4.1, 4.4, 4.5)
162	You have demonstrated that your plan does not constrain supply such that it may not meet planned property forecasts.(Sections 4.1, 4.4, 4.5, 4.9)
163	You have engaged with local planning authorities to inform your analysis and understand uncertainties in your forecast population and property figures.(Sections 4.1, 4.4, 4.5)
164	You have properly communicated limitations in your forecast and uncertainty associated with your forecast.(Sections 4.7)
165	You have described assumptions and supporting information that you have used to develop property and occupancy forecasts, including uncertainties. (Sections 4.1, 4.4, 4.5, 4.6)
166	You have explained how you have allocated unaccounted for populations for each WRZ, including your assumptions. (Sections 4.8)
167	You have accounted for local council and neighbourhood plans, when calculating future demand. (Sections 4.1, 4.4, 4.5)

4.1 Overview (157, 158, 160, 162, 163, 167)

WRMP Guidance states that forecast population and property figures shall be based, wherever possible, upon plans published by local authorities (particularly by utilising published 'adopted', 'emergent', 'consultation' and 'draft' local plans). It is, however, noted that all local councils are at different stages of publication of local plans and that these plans usually only cover a period of 15 years.

As stated on page 21 of the Ofwat technical water resources planning guidelines:

"If your local council has:

- A published, adopted, plan that is not being revised, you must take account of the planned property forecast. You will need to ensure your planned property forecast and resulting supply does not constrain the planned growth by local councils. If you adjust the planned property forecast and select a higher number you will need to justify why you have selected a higher forecast and provide evidence.

- Published a draft plan, but it has not yet been adopted you must take account and use this as the base of your forecast. You should discuss with your local council whether it expects to make changes to the forecast for the adopted plan.
- Not started or published a draft plan you should use alternative methods such as household projections from Department of Communities and Local Government or derive your own analysis using methodologies outlined in UKWIR (2016) Population, household property and occupancy forecasting."

To support the WRPG demographic guidance, UKWIR has produced a suite of documents which provide advice on the development of population, property and occupancy forecasts. The UKWIR documentation is in three forms: a Guidance Manual; a Worked Example; and a Supplementary Report. The Guidance Manual identifies six key stages in the development of demographic forecasts, the second stage of which involves engagement with local Councils:

- Task B. "Assess Local Development Plans" - This involves collating and assessing the housing growth forecasts set out in Local Development Plans, and engaging with local authorities, as appropriate, to obtain further information and understanding about the housing plans.

In order to facilitate the collation of Local Authority Planning information, we have utilised a specialised demographic analysis company Edge Analytics, who have been commissioned to collate and produce assessed household build trajectories for all Local Authorities in the Anglian Water Region.

These 'Plan' based projections (and supporting data) have been used to inform near term projections of both housing and population growth.

Where 'plan' based data has been used, plan based derivations of population have been generated for each Local Authority, based upon the revised household projections and trend derived occupancy rates.

Official ONS (Office of National Statistics) data informs time frames beyond those included in 'Plan' based datasets (approximately 2030-2045).

The methodology has been kept simple and flexible (using official statistics), using an approach largely based upon apportioned ONS data, Local Authority Planning data and DCLG household projections, in alignment with policy guidance. It is understood that this method of analysis is robust, well-established and based upon reliable statistical methodologies, subject to expert panel review.

Trend based forecasts for population figures have been derived from official ONS census and sub-national population projections (snpp) at the local authority level. Additionally, ONS Mid-Year Estimates (MYE) have been used, as released, to update LAUA projections.

Plan based forecasts for population have been generated using the modified 'Plan based' household projections and apportioned trend based occupancy rates and these have been used as the near term population projections, in order to assess demand and ensure that supply is not constrained, such that it may not meet planned property/population forecasts.

Households and population have been apportioned using internal billing 'premise' data, spatially mapped to WRZ geographies, determining the percentage of households (and, therefore, population) within intersecting Local Authorities. This allows the production of forecast WRZ household/population projections, based upon the applied percentages to the respective 'plan' and 'trend' based LAUA/DCLG projections.

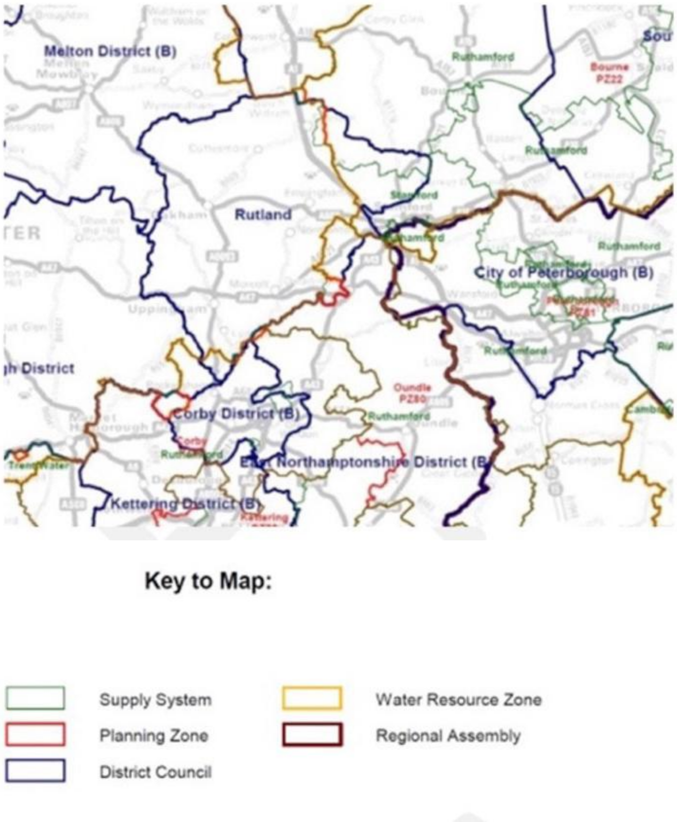
Non-household population projections have been determined for all Local Authorities in our region, using WRZ apportioned Census data.

Uncertainty has been assessed using EA/UKWIR 'look-up' tables which indicate the current assessments of projected household/population uncertainty, based upon historical ONS discrepancies. (See the 'Managing uncertainty and risk report')

4.2 Geography and spatial attribution (157, 164)

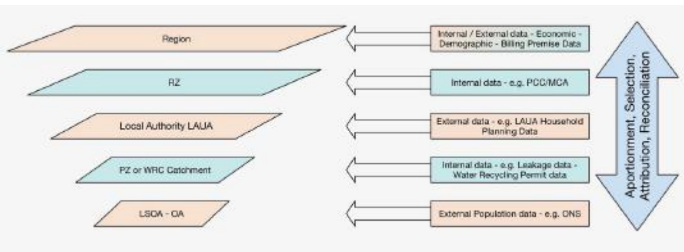
With regard to population and properties, geography and spatial data analysis is at the core of the demand forecast process. Data is aligned with diverse geographic spatial areas and must be reapportioned, or reallocated, in order to be aligned with internal AWS reporting requirements (Resource Zones, WRZs, planning zones, PZs). The alignment and combination of diverse spatially aligned datasets is, thus, key to formulating both baseline and trend figures in order to produce accurate demand forecasts.

Figure 4.1: Spatial datasets are to be aligned to appropriate areas (Internal and External) which intersect and may be non-contiguous



Input data has been entered into a GIS (Graphical Information System) database system, and subsequently, correctly attributed to relevant geographies, using either apportionment or data point collation. This has allowed data apportionment and extraction, based upon alternate external (ONS) and internal (AWS) geographies.

Figure 4.2: Spatial datasets are to be aligned to appropriate areas (Internal and External) which intersect, may be non-contiguous and which can then be apportioned using GIS (Note OA - ONS output area, LSOA - ONS lower super output area)



GIS has enabled the apportionment of households (AWS billing customer premise data) to their respective WRZ, PZ and LAUA (local Authority) geographies, allowing the assessment of the percentage of households from given LAUAs within WRZ boundaries. This has facilitated the correct apportionment of LAUA projected growth to the intersected WRZ.

Similarly, non-household premises have been apportioned to their respective AWS and Local Authority geographies, Small-form ONS data outputs (OA output Areas, LSOA lower super output areas), have also been utilised to assess base-line population figures.

It is understood that the manipulation of information attributed to smaller geographies can increase uncertainty within both the baseline and forecast and this has been accounted for within Target headroom.

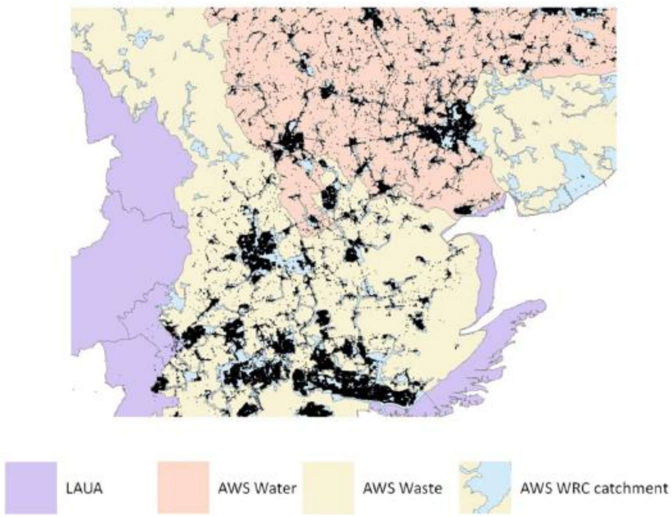
4.3 Baseline property and population figures

(157)

Baseline population and property figures are derived for each LAUA, utilising ONS data and DCLG (now ONS) household data.

Actual recorded properties in our 'billing' system, for the base-year are then be compared to the LAUA household official totals, either directly though GIS or via parish attribution. This allows the percentage of households served by Anglian Water to be determined.

Figure 4.3: Point mapping and attribution to Anglian Water geographies

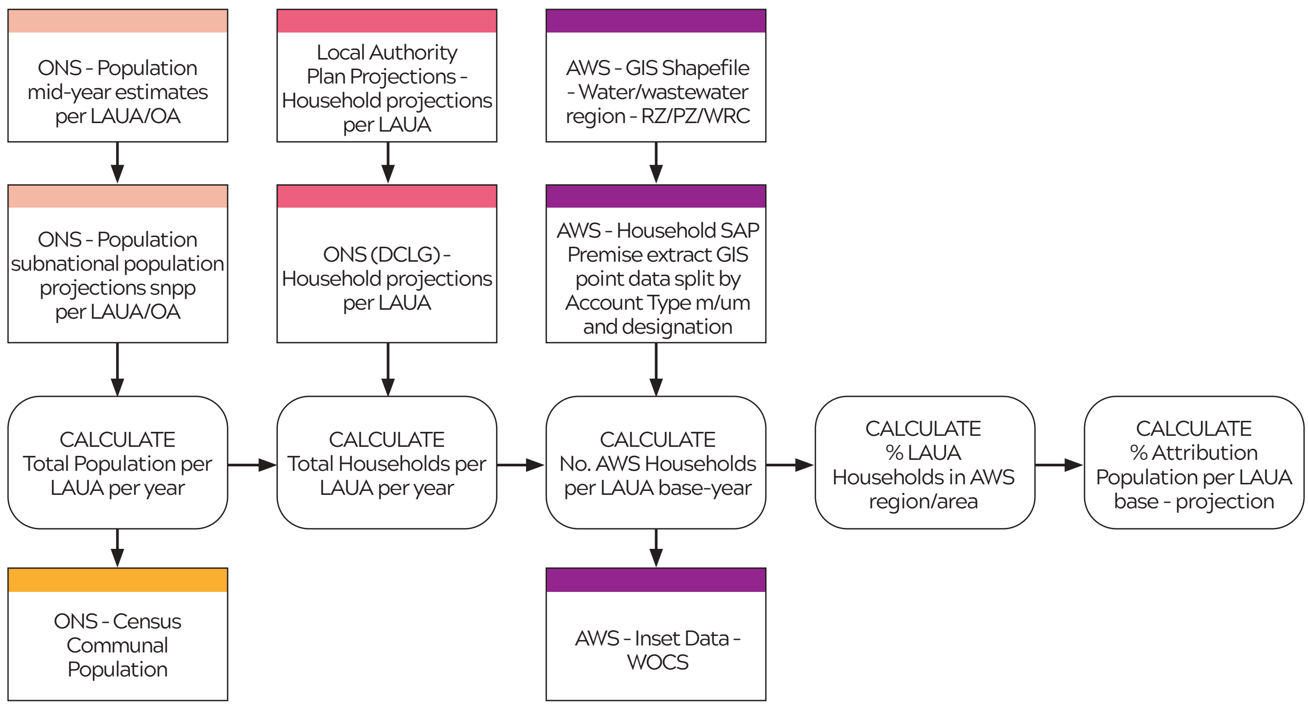


These property totals for the Anglian Water statutory water and wastewater geographies, once derived are confirmed with the 'Income and Tariff' team and 'Leakage' team and are then used to provide the baseline for the Yearbook and forecast models.

Baseline population totals are then derived using the known household percentages derived from the comparison of Anglian Water and DCLG totals and applying these to the ONS snpp population figures (per LAUA).

Similarly, projections are derived using these percentage allocations to determine the proportions of each Local Authority within the Anglian Water statutory boundary and within each WRZ.

Figure 4.4: The process for calculating base-line households and population



4.4 Household projections (157, 158, 160, 162, 163, 167)

The latest forecasts of demographic change in the UK suggest that population and household growth will be a common characteristic of local communities over the next 25 years. A sustained period of new housing growth, ageing population profiles and a reducing average household size are key considerations for planners and policy makers.

Population and housing growth trajectories produced utilising plan and trend based data have been modelled separately and then combined.

In accordance with EA Guidelines, Local Plan yearly additional household totals have been selected as initially dominant for the forecast period from 5 to 15 years and are then superseded by ONS trend based yearly totals over the longer term, to the end of the plan projection.

Thus for population forecasting, trajectories have been produced, based upon Local Authority Development Plans (medium term - 0 - 15 years). Robust official ONS (Office of national Statistics) trend based trajectories have been produced to extrapolate beyond 'Plan' projections (0 - 25 years).

In order to facilitate the collation of Local Authority Planning information, we have utilised a specialised demographic analysis company Edge Analytics, who have been commissioned to collate and produce assessed household build trajectories for all Local Authorities in the Anglian Water Region.

Edge Analytics, along with Anglian Water contacted all the 65 local authorities that are either wholly or partially included within the Anglian Water operational boundary, in order to collect Local Plan housing growth evidence.

Each of the 65 local authorities are at a different stage of Local Plan development, with each collating a variety of demographic and economic evidence to inform its plan-making process. Some plans have been adopted; others remain under development or open for consultation.

The starting point for the collection of Local Plan data has been each Council's planning pages of their websites. Each Council typically has a webpage designated to its Local Plan, which contain links to the published Local Plan drafts and any evidence documents.

These published sources have been used to collect the latest information on the status of Local Plans, the time-period to which the Local Plan relates, its housing growth target within the plan-period and any underpinning trajectory or phasing of the housing growth.

Documents and data that have been collected from each local authority have included the following:

- Housing Trajectory
- Local Plan (issues and options, draft, main modifications)
- Annual Monitoring Report (AMR)
- 5-year housing supply documents
- Strategic Housing Land Availability Assessment (SHLAA)
- Strategic Housing Market Assessment (SHMA)
- Housing and Economic Land Availability Assessments (HELAA)
- Housing and Economic Development Needs Assessment (HEDNA)

Planning Officers within Councils have been contacted to confirm details published online, to seek to obtain pertinent information not currently in the public domain and to source additional housing data, particularly digital information relating to planned site developments.

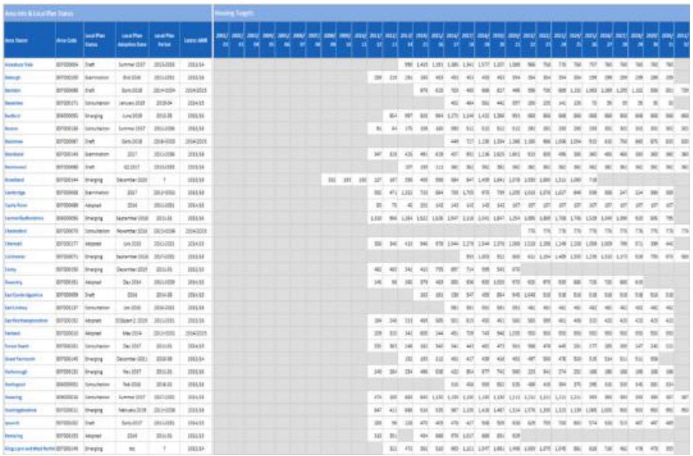
For the Local Plan housing trajectories, a short history of the most recent and most relevant documents and associated housing data has been compiled for each local authority. This has provided the basis for the derivation of a housing growth trajectory for each local authority.

Each local authority's housing growth trajectory has been drawn from published information, combining information on past and projected housing completions. Trajectories have typically incorporated the most recent projected housing completions or five-year housing supply figure.

This has produced an assessed set of Plan based build-out trajectories for all Local Authorities in the Anglian Water region, including;

- Summary worksheets which lists all local authorities, their plan status, publication date and current housing targets.
- Detailed worksheets for each local authority which contains the following:
- Local Plan status
- Housing target summaries
- Housing trajectory detail (level and timing of developments)
- Links to a compiled set of all the key documents: Local Plan, Site Allocations, Annual Monitoring Report, Five-Year land Supply)

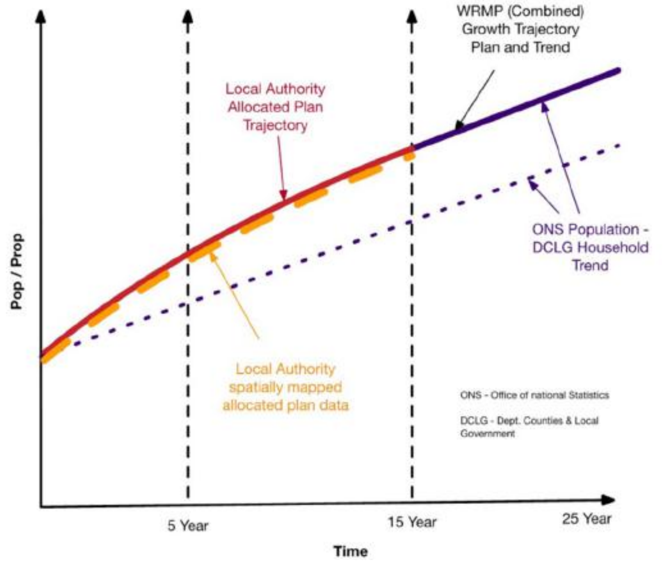
Figure 4.5: Edge Analytics collated LAUA Adopted/ Draft Plan data



Data has been collated and assessed to provide a 'best' assessment of Local Authority planning data, in accordance with the plan current status (Draft, Emergent, Under Consultation, Adopted), and all other associated information.

Thus, overall the reported trajectory can be visualised:

Figure 4.6: Household / population forecast - combined projections



4.5 Local Authority planning methodologies

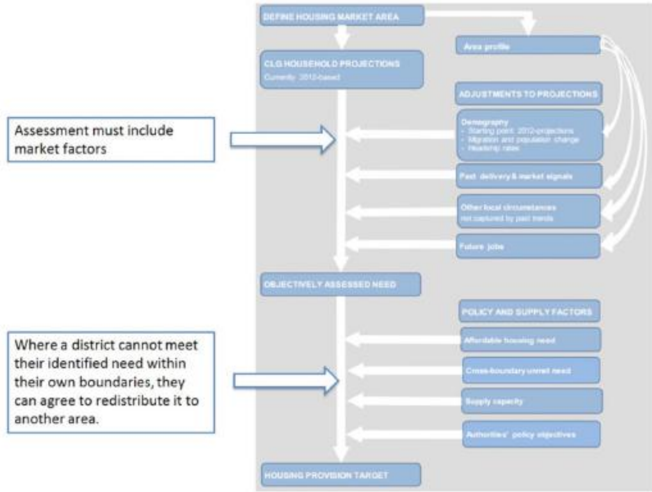
(157, 158, 160, 162, 163, 165,167)

The National Planning Policy Framework (NPPF) requires that local planning authorities identify objectively assessed housing need (the OAN). Local Plans translate those needs into land provision targets.

According to the NPPF, housing targets should be informed by robust and proportionate evidence, such that a plan aimed to meet aspiration, rather than actually assessed demand, would risk being undeliverable and be contrary to paragraph 173 of the NPPF.

Additionally, Local Plans go through statutory processes for review, including independent examination in public by an Inspector appointed on behalf of the Secretary of State. Developers, agents and the public are also able to challenge the methodology, during this assessment.

Figure 4.7: Housing provision target methodology



Thus, LAUA (Local Authority/Unitary Authority) plans have been collated by an external demographic company, Edge Analytics, (including all supporting data) who have produced an assessed set of Plan based build-out trajectories for all Local Authorities in our region.

It is also noted as part of our liaison with Local Authorities that a number of authorities are looking to establish joint spatial plans. These non statutory documents will not seek to determine housing need in their own right, but are expected to be based on the sum of housing targets across the area they cover.

Additional future changes are expected to impact planning:

- Non statutory spatial plans
- Oxford - Milton Keynes - Cambridge Corridor
- Impact on migration patterns resulting from Brexit
- Methodology changes by DCLG
- London Overspill
- Garden Settlements

Consequently we intend to anticipate future development on the basis of an adaptive approach, through phased decision-making, flexible strategies and a comprehensive water/waste water strategy.

This should minimise the probability of over investment or under investment and enable us to take effective measures in the short term that can be adapted to new insights or developments in the long term.

4.6 Occupancy (157)

Trend based occupancy values have been derived at WRZ level for the forecast period using data from the ONS (sub-national population projections) and DCLG (household projections), apportioned from LAUA to WRZ level.

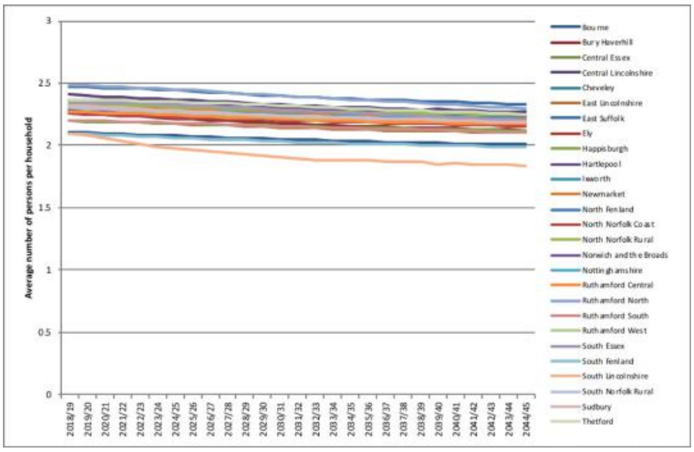
This has provided a trend based forecast and baseline set of occupancy rates each Local Authority within the AWS region.

This has allowed the calculation of trend based occupancy rates to be derived for each WRZ, via the apportionment of AWS properties from the WRZs to their respective LAUAs.

These average WRZ occupancy rates have provided the basis for the derivation of the 'Plan' based population forecasts; applying the LAUA trend occupancies to the plan based housing projections.

Overall occupancy rates all lie within the range 2.00 to 2.50 and all WRZ occupancy rates are forecast to decrease over the planning period, with the lowest rates being seen in Happisburgh, Hartlepool and North Norfolk Coast and the highest rates being seen in Ruthamford Central, South and West.

Figure 4.8: ONS trend based occupancy rates per WRZ



4.7 Uncertainty with regard to population and households (164)

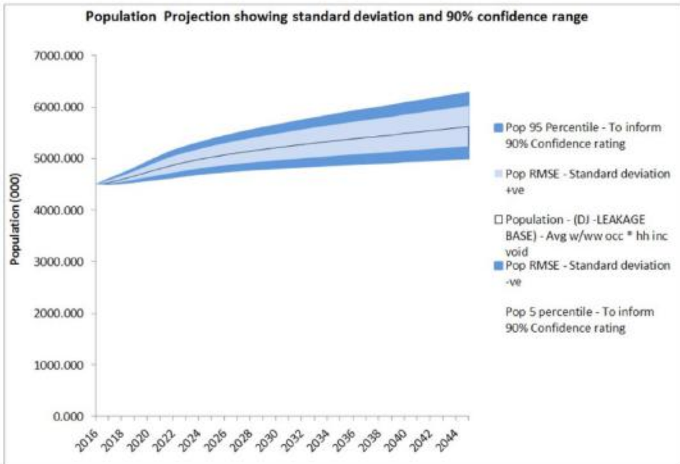
Estimates of uncertainty have been prepared, using EA/UKWIR 'look-up' tables (as applicable), which indicate the current assessments of projected household/population uncertainty, based upon historical ONS discrepancies. These factors have been applied to reflect the appropriate population/ property sizes as described in the UKWIR methodology.

Levels of accuracy have been assessed, by comparative analysis of alternate datasets (both trend and plan based).

At a WRZ level this uncertainty work has been used as one element to derive the upper and lower parameters for population, along with WRZ based high/low population/property scenarios; these in turn have been used to inform the Target Headroom factors.

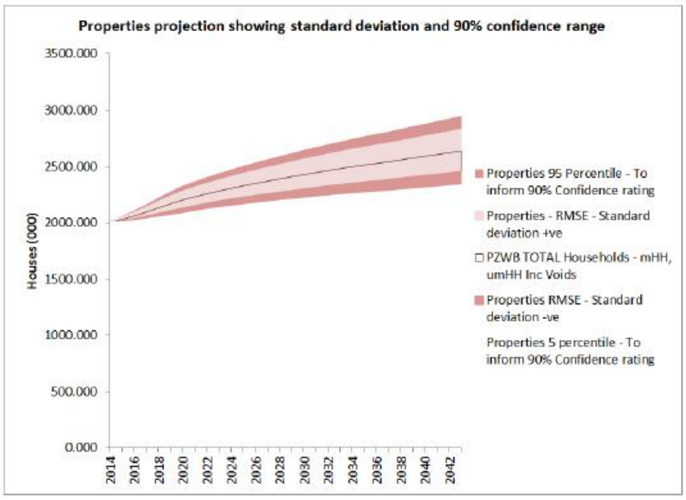
Thus for population the standard deviations and 90% confidence ranges can be shown;

Figure 4.9: Regional population projections with UKWIR uncertainty



For properties:

Figure 4.10: Regional property projections with UKWIR uncertainty



4.8 Non-Household and communal population

Values for non-household and communal populations have been derived from official sources (ONS Census), and apportioned to AWS geographies. These values have been aligned with AWS 'official' reported totals and the water-balance base line values.

This non-household population includes estimates for residents in; Medical and care establishments, NHS, Psychiatric hospitals, Local Authority Children's homes, Nursing Homes, Residential Care Homes, Other establishments, Defence establishments (including ships), Prison Service establishments, Probation / Bail hostels, Educational establishments (including Halls of residence), Hotels, Boarding Houses, Guest Houses and others.

Demand for these customers has been derived in the non-household forecast and is not directly linked to population forecast totals for these sectors. Thus, these forecasts have been based upon sector by sector regression analysis and future forecasts of population, GVA and employment per sector, as described in Section 6.

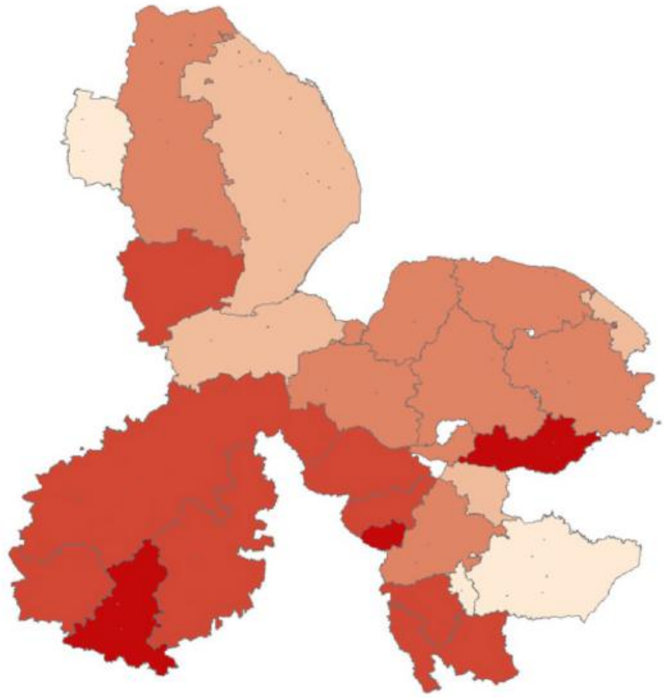
4.9 Forecast outputs [162]

Baseline Population and Housing totals have been derived from WRZ water balance data.

- Baseline Household Population 4.542M (2017/18)
- Baseline Properties 2.033M (2017/18 - including voids)
- Population is forecast to increase by 1.03M from 4.619M (2019/20) to 5.650M (2044/45), during the WRMP 2019 planning period.
- Note population is forecast to increase by 22% over the WRMP 2019 planning period, reflecting official ONS reducing occupancy rates.
- Households are forecast to increase by 573,000 from 2.079M (2019/20) to 2.653M (2044/45), during the WRMP 2019 planning period
- Households are forecast to increase by 28% from over the WRMP 2019 planning period, reflecting LAUA planning data.
- Note there is an additional allowance for communal non-household population. The consumption for this is accounted for in the Non-Household forecast.

Growth can be shown at the WRZ level as a percentage increase over the plan period.

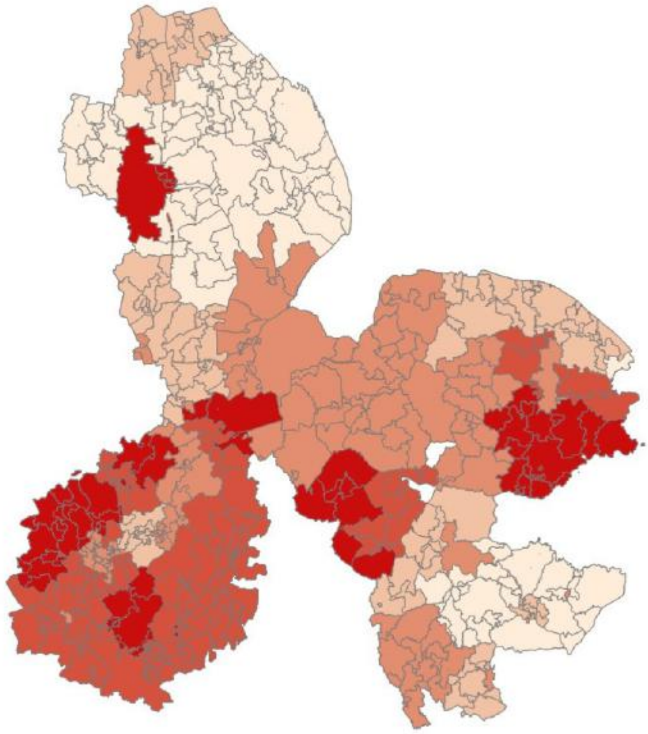
Figure 4.11: Relative % population growth - WRZ Resource Zone (Red = largest % change 2016-2045 - Note the colour grading is relative to for map)



Additionally growth 'hotspots' have been identified in;

- Central Lincolnshire WRZ (Lincoln),
- Ruthamford North WRZ (Corby, Wellingborough, Daventry, Peterborough),
- Ruthamford Central WRZ (Newport Pagnell, Milton Keynes)
- Newmarket (Newmarket)
- South Essex (Colchester, Braintree)

Figure 4.12: Relative % population growth - 'Hot-spots' - (shown in Demand Zones)

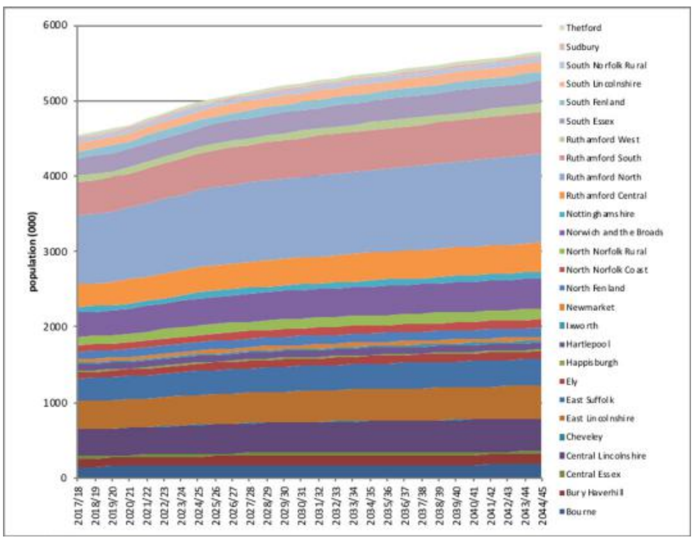


These levels of growth will have a direct impact on the amount of water required for distribution input, in order to supply this growing population.

Thus, for the Dry Year Annual Average scenario, unrestricted consumption is projected to increase by 109 Ml/d over the planning period (2020-2045) (DYAA forecast), rising from 1130Ml/d (2020) to 1239 (2045).

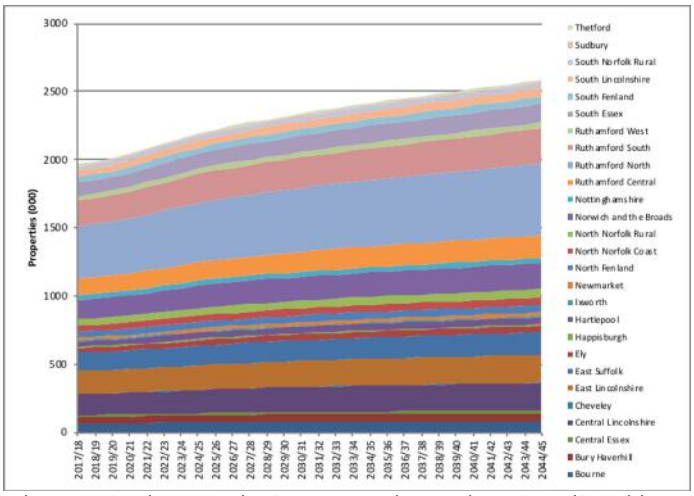
Population growth can be shown (Total AWS water region and WRZ).

Figure 4.13: Forecast Population (Total AWS Water Region) and RZ



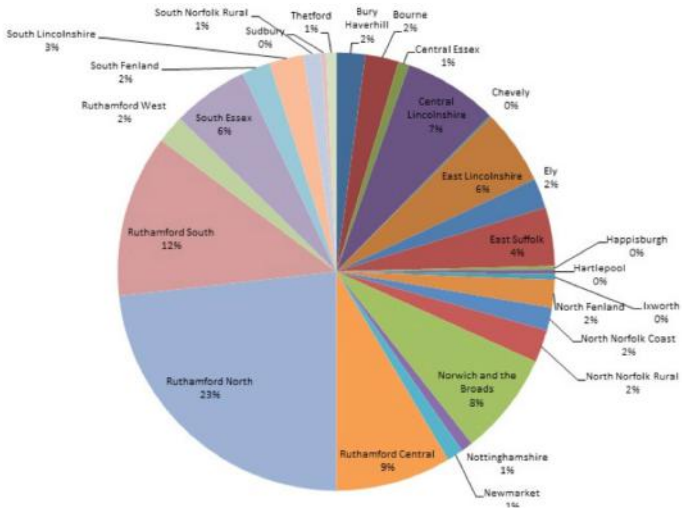
Housing growth can be shown (Total AWS water region and WRZ)

Figure 4.14: Forecast housing growth (AWS Water Region and WRZ)



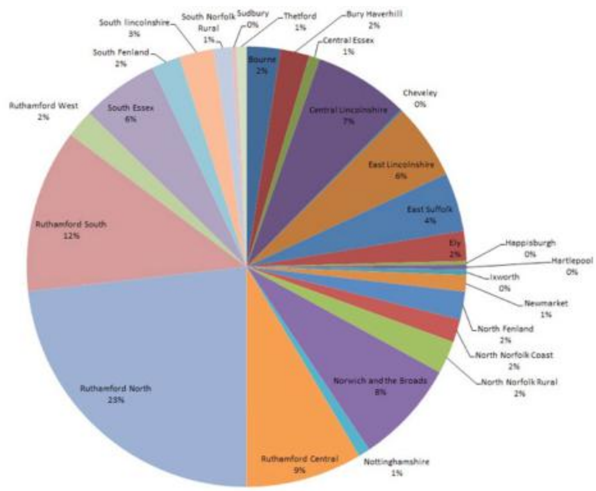
Alternatively population growth can be visualised by WRZ.

Figure 4.15: Additional population (2045) as a % of total additional growth attributed by WRZ



Housing growth can be visualised.

Figure 4.16: Additional property growth (as a percentage of the total) attributed by WRZ



5. Forecasting Customer Demand

Table 5.1: (5.3) Forecast population, properties and occupancy - Defra/EA guidance

Number	Action
168	You have selected a method for forecasting demand that is appropriate to each WRZ, based on the supply-demand situation, any problem characterisation approaches you have considered and the data available. (Section 5.1, 5.2, 5.3)
169	Your method for forecasting demand is aligned with the following guidelines: • WRMP-19 Household demand forecasting - Integration of behavioural change into demand forecasting and water efficiency practices (UKWIR 2016). • Customer behaviour and water use - good practice for household consumption forecasting (UKWIR, 2012). (Section 5.1, 5.2, 5.3, 5.4, 5.5)
170	You have documented your reasons for choice of method, including your assumptions and their associated uncertainties. (Sections 5.1, 5.2, 5.3, 5.4, 5.5)
171	You have demonstrated a forecast demand for the critical period scenario (if appropriate) as well as the dry year annual average. (See Section 2)
172	You have provided a breakdown of total consumption, per capita consumption and micro-components within the water resources planning tables. (Sections 5.1, 5.2, 5.3, 5.4, 5.5)

5.1 Forecasting customer demand 'top down' and 'bottom up' (168, 169, 170, 171, 172)

We have adopted a conventional demand forecast approach, consistent with our 'Resilience Tested' plan. (168)

According to the WRMP19 - Household Consumption Forecasting Guidance Manual (UKWIR, 2015), Micro components (MC) should be used to justify a water company's current and forecast household consumption - i.e. a "bottom-up" household demand forecast.

Our "top-down" base year household consumption estimates have been derived from the Planning Zone Water Balance which calculates demand from water into supply data. The "top-down" household forecast is driven by year-on-year changes in:

- The number of Switcher properties based on the business' metering plans and the assumption of consumption being reduced, as customers change from being unmeasured to measured (assumed to involve a 15% reduction in consumption and transfer of demand)
- The number of new-build properties and population based on WRZ property, population and occupancy forecasts derived from Office for National Statistics (ONS) forecasts and Local Authority Plans;
- The impact of climate change on demand taken from the 50th percentile forecast in UKWIR (2013);
- 0.3 litres per household efficiency saving applied to the baseline demand forecast. This is our Baseline Water Efficiency (BUSWE) efficiency saving; and
- for the Final Plan Demand Forecast, the influence of the preferred Demand Management Strategy Option on household demand.

It is considered that the MC approach to forecasting demand is a robust way for companies to understand their customers' demand for water and to identify the scope for changing water use. Using this approach, companies need to consider how advances in technology, changes in society and the role of regulation will influence growth or decline in water use over the next 25 years. This approach considers how socio-economic characteristics influence patterns of water use and affect appliance ownership.

For the "bottom-up" forecast approach, the following micro-components (MCs) should be used as a minimum:

- WC flushing;
- Clothes washing;
- Personal washing;
- Dishwashing;
- External use; and
- Miscellaneous (internal) use.

The Environment Agency (EA) believes from this baseline forecast, options for further 'enhanced' demand management (over and above the technological and behavioural changes assumed in the MC forecast) should be developed and added to the final planning solution, if found to be beneficial.

Following the EA Guidance, we have commissioned a review of our current PCC/MC model and data.

5.2 Household consumption trends and narrative

According to the Government's water strategy for the UK, "Future Water", published in 2008, its vision for 2030 sees per capita consumption (PCC) reduced to an average of 130 litres per head per day), or possibly even 120 litres per head per day depending on new technological developments and innovation. This is likely to be supported by:

- Customers using water wisely, appreciating its value and the consequences of wasting it;
- Water companies actively encouraging demand management to protect customer and environmental needs; and
- Water efficiency playing a prominent role in achieving a sustainable supply-demand balance, with high standards of water efficiency in new homes and water-efficient products and technologies in existing buildings. (DEFRA 2008)

The above behavioural changes highlight the complexity in differentiating long-term changes that should be included in the baseline and those that constitute enhanced demand management in the WRMP options appraisal, particularly water efficiency options that target behavioural change.

For this reason, we have ensured that the baseline and final plan demand forecasts do not double count demand management options, or the BUSWE efficiency savings in the baseline forecast.

According to UKWIR (2012), personal washing is likely to be a key area where behaviour may alter consumption in the future, in particular, the increase of showering as more people switch from taking baths. This is mainly due to the immediacy and convenience of showering compared to taking baths (MTP, 2011b). Increasing numbers of existing homes are also being modified to include additional bathrooms and/or en-suite facilities (MTP, 2011b).

PCC could also potentially increase as a result of an ageing population and trends towards increased home working (UKWIR, 2012). However, there is no evidence available to determine what this change would be. Although this may impact household PCC values, the net impact on water consumption of home working may not change, as the water footprint would be shifted from non-household demand to household demand.

5.3 DEFRA Market Transformation Programme

The Defra Market Transformation Programme (MTP) provides research to support the development and implementation of UK Government policy on sustainable products. The analysis collates MC data from studies by water companies to provide ownership, frequency and volume estimates of currently available devices. It also includes forecasts for England and Wales for total water demand under three alternative policy scenarios which relate to increasing levels of policy-led interventions by Government (UKWIR, 2012).

The 'Reference Scenario' is a projection of what is likely to happen without any new policy intervention. The scenario is based on current trends, technology development and policies that are already in place. The MTP also uses the 'Policy Scenario' and the 'Earliest Best Practice Scenario'. The 'Policy Scenario' estimates what could be achieved through an ambitious, but feasible, set of policy measures, if the agreement of all stake-holders could be obtained. The 'Earliest Best Practice Scenario' is a projection of what could happen if the best available products and technologies were adopted, coupled with ambitious Government policies (MTP, 2011a). For the purposes of the MC analysis the 'Reference Scenario' has been assumed to be the standard applied. This is consistent with the baseline forecast (i.e. without demand management options).

5.4 Micro component details

5.4.1 WC flushing

The MTP briefing note BNWAT01: WCs: market projects and product details (2011a) projects that WC water consumption will decrease from 2010 to 2030. We have assumed that this trend is likely to continue to 2045.

It is, therefore, assumed:

- Ownership of WCs and frequency of use for WC flushing will remain constant; and
- Volume per use for WC flushing will reduce. This will result in a 5.2% decrease in the volume of water used per head per day for WC flushing between 2015 and 2045.

Ownership - According to UKWIR (2012), multiple WCs in a property have a limited effect on the total number of uses. Base-year ownership has therefore been assumed at one per household. This is unlikely to change over the next 25 years.

Volume - Dual flush 6/4 toilets are the industry standard. Over time it is expected that sales of this product will decrease, and sales of 6/3 dual flush toilets and toilets with even lower flush volumes will increase. However, the decrease in the volume of water used per flush would continue to be less each year as households would already have these types of low flush WCs installed. It has, therefore, been assumed at 5.02 litres (based 2015 Reference Scenario data taken from MTP, 2011a). By 2045, volume per use is forecast to decrease to 4.76 litres.

Frequency - Base-year frequency of use per head per day is assumed at 4.71 (MTP, 2011a). The MTP assumes that the frequency of use will remain constant. However, frequency of use could potentially increase as a result of an ageing population and trends towards increased home working (UKWIR, 2012). However, there is no evidence available to determine what this change would be.

5.4.2 Clothes washing

There is a disagreement between water companies as to what will happen to clothes washing in the future. Some companies forecast that the volume of water used per person per day will decline, whilst others forecast a constant or rising trend (EA, 2009). The EA (2009) forecasts a slight decline. This is based on the assumption that, whilst washing machine use may increase in the future, the average volume will reduce as machines become more efficient.

It is, therefore, assumed:

- Ownership and frequency of use of washing machines will remain constant; and
- Volume per wash cycle will decrease by 10%. This will result in a 4.6% decrease in the volume of water used per person per day for clothes washing between 2015 and 2045 (Table 3-3).

Ownership - The vast majority of clothes washing is assigned to washing machines. The Office for National Statistics (ONS) (2017a) reports washing machine ownership at 96% in 2010. According to the MTP, there is no further capacity for growth in washing machine and washer-drier percentage ownership (Market Transformation Programme, 2010). Base-year ownership is therefore assumed at 0.96. This is unlikely to change over the next 25 years.

Volume - The average litres per wash cycle in 2010 is reported at 50 litres (Waterwise, 2012). With new water efficient models likely to use less water (between 35 and 45 litres of water per load according to Essex and Suffolk Water, 2009), there could continue to be a decline in the volume of water used per wash cycle. However, there is also a growing trend towards larger load machines that may counteract their improved water efficiency. Therefore, it has been assumed that reduction in litres used per wash cycle will be minimal.

Base-year volume per wash cycle is therefore assumed at 50 litres (Waterwise, 2012). From 2030, and it has been assumed that the volume per wash cycle would gradually reduce to 45 litres.

Frequency - The MTP assumes washing machines and washer-driers will be used 260 times per year from 2007, a 5% decrease from 274 times per year in 2000. The decrease allows for fewer washes with larger load machines. Base-year frequency of use is therefore assumed at 0.57 (EST, 2015). The MTP does not forecast further changes in frequency of use (Market Transformation Programme, 2010). There is no evidence to suggest that frequency of use will change post 2030.

5.4.3. Personal washing

This group contains bath, shower and hand basin sub-components and have been grouped together because of the inherent interdependence between them.

Personal washing is likely to be a key area where behaviour may alter consumption in the future (UKWIR, 2012).

5.4.3.1 Showers

Information from the MTP regarding customers shower usage has been supplemented by the following study information:

UK Shower Sustainability Study - In 2011, consumer goods giant Unilever commissioned a study to monitor actual showering behaviour using an innovative Shower Sensor, rather than relying on self-report. The study monitored 2,600 showers taken by 100 families across Essex and Suffolk Water, Severn Trent Water and Wessex Water supply regions over 10 days. The study revealed that:

- The average shower is eight minutes long (3 minutes longer than that reported in the MTP). This will result in an increase in the volume of water used per head per day for showering compared to PR14.
- An eight minute shower, with an average flow rate, uses 62 litres of water compared to 80 litres for a bath, expelling the myth that a shower uses considerably less water than a bath.

At Home with Water 2 - The Energy Saving Trust (2015) present the results from 58 properties monitored and analysed by Identiflow MC analysis in London, UK, between 10/10/2013 and 12/01/2014. The At Home with Water 2 study sought to develop an in-depth understanding of domestic water consumption. The study reports shower duration at minutes (median).

It has been assumed that between 2015 and 2045:

- Ownership of showers will increase by 10%;
- Volume per use for showering will increase by 29%; and
- Frequency of use for showering will increase by 17%.

This will result in a 65% increase in the volume of water used per head per day for showering between 2015 and 2045

Ownership - The current ownership of showers is not 100% (UKWIR, 2012) and is expected to increase. This is partly related to the addition of new homes and increasing numbers of existing homes are also modified to include additional bathrooms and/or en-suite facilities (Market Transformation Programme, 2011b). Multiple ownership is not assumed to directly impact on consumption, although, in some households, multiple showers may permit more and/or longer showers during a limited morning period (UKWIR, 2012).

Base-year ownership is therefore assumed at 0.89 (sum of electric, gravity mixer and power shower ownership reported by MTP (2011e)). It has been assumed that the overall ownership of showers will increase to 0.98 between 2015 and 2045 (based on the rate observed between 2015 and 2030 in the MTP forecast data).

Volume - The main factors affecting the amount of water used when showering are shower flow rate and duration.

Flow rate varies depending on the type of shower. Electric showers are particularly popular and have the lowest flow rate of approximately 5 litres per minute (MTP, 2011b). Mixer showers and power showers have a considerably higher flow rate and are becoming more common. This will result in an increasing volume of water being used for showering.

According to the UK Shower Sustainability Study (2011), the average shower is eight minutes long. According to the Energy Saving Trust (2015), the median shower is 7.5 minutes long.

In light of this evidence, base-year volume per use is assumed at 44.4 litres. The volume of water used for showering is likely to continue to increase into 2045 as customers switch from using electric to power showers. It has been assumed that by 2045, 70% of customers will own showers with a volume per use of 44.4 litres (also the base-year assumption) and 30% will own showers with a higher volume per use of 87 litres (average of the median and 90th percentile figures taken from EST (2015). This ratio is based on evidence published by the MTP (2011b) stating that, by 2030, 23% of households will own power showers and 77% will own electric or mixer. By 2045, volume per use is forecast at 57.18 litres.

Frequency - The MTP briefing note BNWAT02: Showers: market projections and product details (2011b) reports the frequency of showering (excluding other forms of bathing) in 2010 as 1.04 times per head per day. There is an overall increase in showering evident in the MTP data as more people switch from taking a bath to showering. This is because of the immediacy and convenience of showers compared to baths.

Base-year frequency of use for showering is assumed at 1.09 and continues to increase to 1.15 by 2044/45.

5.4.3.2. Bathing

It has been assumed that between 2015 and 2045:

- Ownership of baths and frequency of use for bathing will decrease; and
- Volume per use for bathing will remain static from 2020.

This will result in a 33.7% decrease in the volume of water used per head per day for bathing between 2017 and 2045.

Ownership - The ownership of baths in 2010 was 94%. The growth of showering and the wide range of showers now available may reduce the sales and hence ownership of baths (Market Transformation Programme, 2011c). Base-year bath ownership is assumed at 0.94 (based on MTP Reference Scenario data) (Table 3.7). It has been assumed that ownership of baths per property would decline by 13.3% between 2017 and 2045.

Volume - A reduction in litres per use over time reflects the uptake of more efficient baths with a lower volume. The trend towards smaller properties means that bathroom space is limited, and therefore smaller baths are likely to be installed more often in the future. Base-year volume per use is estimated at 84.83 litres (based on MTP Reference Scenario data). However, lack of evidence on this trend means that volume per use is assumed to remain at 84.95 litres from 2020.

Frequency - The frequency of showering is increasing and bathing decreasing as more people switch from taking a bath to showering. Essex and Suffolk Water (2009) report frequency of bathing in Essex in 2006/07 for unmeasured households at 1.3 per head per day, and 0.31 per head per day for measured households. They assume a reduction in use of 0.5% per annum until 2010 and then a reduction of 1% per annum. Base-year frequency of use is therefore assumed at 0.28 (based on WRMP14 analysis) and it has been assumed that the frequency of use per head per day would continue to reduce by 1% per annum to 0.21 by 2045.

5.5.4 Basin taps

It has been assumed that basin tap usage will continue to remain constant between 2015 and 2045.

Ownership - A base-year assumption of 100% basin tap ownership is considered reasonable (UKWIR, 2012). It has been assumed that multiple pairs of basin taps have a limited effect on the total number is uses. There is no evidence to suggest this assumption will change over time.

Volume - The average duration of tap use is 39.3 seconds. Washbasin tap flow rates range between 3.54 litres per minute (standard) and 1.68 litres per minute (most efficient) (MTP, 2011d), resulting in a water consumption of between 2.32 litres and 1.10 litres per use. Base-year volume per use is therefore assumed at 2.32 litres. There is no evidence to suggest this assumption will change over time.

Frequency - According to the MTP briefing note BNWAT04 Taps: market projections and product details (2011d), each person uses a washbasin tap approximately 8 times a day Table 3-9. However, this frequency of use is based on limited evidence separating hand basin uses from kitchen tap use. There is no evidence to suggest this assumption will change over time.

5.4.5 Dish-washing and hand washing

It has been assumed that between 2015 and 2045:

- Ownership of dishwashers will remain constant;
- Volume per wash cycle will reduce by 3%; and
- Frequency of use will decrease by 2.5%.

This will result in a 0.6% decrease in the volume of water used per head per day for dishwashing between 2015 and 2045.

Ownership - The ONS (2017a) reports dishwasher ownership at 40% in 2010. It is assumed that those owning a dishwasher will do some washing up by hand (ESW, 2009). It has been assumed that the remaining 60% wash up by hand. According to the MTP (2009), ownership of dishwashers is not expected to rise much further.

Volume - The volume of water used by a dishwasher can vary from 50 litres per cycle to as little as 10 litres (Waterwise, 2012). According to 'Which?', the main wash programme on a full-sized dishwasher uses about 16 litres of water. The Energy Saving Trust (2015) report volume per use at 13.4 litres.

There may be a slight decline in the volume of water per use as older models are replaced with more water efficient models, however, customers may not buy the most water efficient models available.

It has therefore been assumed that volume per use will reduce to 13 litres by 2045.

People who have a dishwasher will also do some washing-up by hand. Data on the volume of water used for hand dish washing is limited. The academic paper Washing-up Behaviour and Techniques in Europe (Rainer Stramminger et al., 2007) reports a weighted average for washing-up by hand of approximately 10 litres per head per day. The MTP assumes a similar consumption of 9.9 litres per head per day and this has been assumed as the base-year volume per use.

Additionally, it has been assumed that the volume of water used for washing-up by hand per property per day will continue to remain constant over time as no evidence has been found on predicted manual washing-up trends. However, due to the average occupancy of households reducing between 2017 and 2045, the volume of water used per head per day for washing-up by hand will increase slightly.

Frequency - There is little reliable data regarding dishwasher use in the UK. Dishwashers are assumed to be used an average of 246 times per year and this is expected to decline gradually to 237 in 2030. The decline takes into account the potential for less frequent use in smaller households and the increase in capacity of future machines. Base-year frequency of use is therefore assumed at 0.79 (EST, 2015) and it has been assumed that frequency of use will reduce to 0.77.

5.4.6 External use

Domestic external water use refers to any potable water that is consumed outside of the domestic dwelling after being drawn from the mains distribution system. There are several different activities that contribute to external water use. The major contributors include: garden watering; vehicle washing; ponds and water features; pressure washers; and recreational use (Market Transformation Programme, 2008).

Based on the Environment Agency report Water resources MC demand forecasting (2009), most water company forecasts for external use (excluding car washing) are consistent, with only minor increases in the volume of water used per head per day over the forecast period.

Waterwise (2017) reports the percentage of household water use that is external at 7%.

Patterns of Water - The report Patterns of Water (2013) presents the findings of survey research on patterns of water using practices in households across the South and South East of England. Results have shown that those who actively water their garden tend to be older than average. The percentage of the population that is 65 years or older is projected to continue to grow to nearly a quarter of the population by 2045 (ONS, 2017). This suggests that external water use could increase over time as we move towards an ageing tend to be older than average.

Despite the evidence presented above, it has been assumed that external water use will remain constant over the planning period, as there is no evidence to suggest a potential increase.

5.4.7 Miscellaneous use

Miscellaneous use comprises of all the components of use that have not been included explicitly. Most water companies forecast that miscellaneous use will largely remain constant throughout the planning period, which is in line with the Environment Agency forecasts (Environment Agency, 2009).

5.5 Conclusion

In conclusion, research has identified three main socio-economic trends which are likely to influence future household consumption, including:

- Switching from taking baths to showering
- An ageing population and increased home working

However, additional drivers have been identified which aim to reduce PCC, include:

- Customers using water more wisely, appreciating its value and the consequences of wasting it;
- Water companies actively encouraging demand management to protect customer and environmental needs; and
- Water efficiency playing a prominent role in achieving a sustainable supply-demand balance, with high standards of water efficiency in new homes and water-efficient products and technologies in existing buildings (DEFRA, 2008).

The table summarises the percentage change in consumption per head per day for each MC between 2017/18 and 2044/45. It shows showers and baths are the main MCs driving change in PCC.

Baseline per capita consumption (PCC) can be shown for measured and unmeasured customers;

Final plan per capita consumption with the effects of the demand management options can be shown;

Table 5.2: Forecast percentage changes in MC values

Micro-component	Percentage change (%)
WC flushing	-5
Clothes washing	-5
Personal washing	+65
Shower	
Bath	-35
Hand basin	0
Dishwashing	-1
Dishwasher	
Washing up manually	+5
External use	0
Miscellaneous use	0

Figure 5.1: Baseline measured and unmeasured MC values

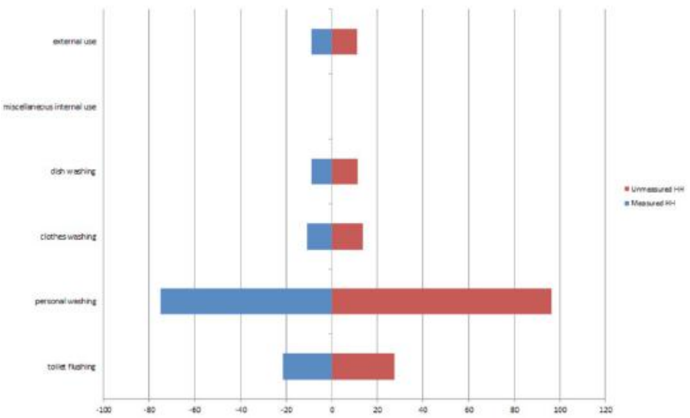
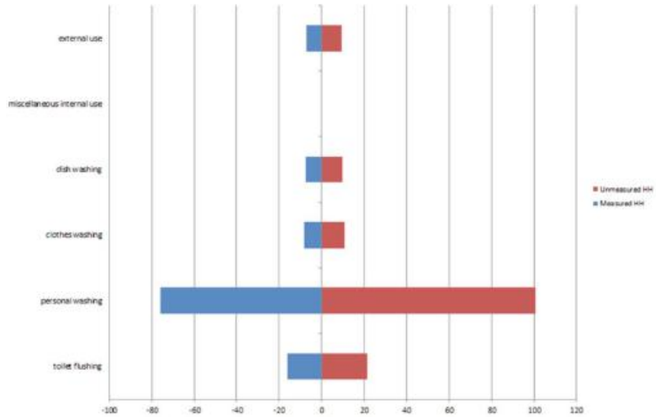


Figure 5.2: Final Plan measured and unmeasured MC values with preferred demand management options



6. Forecasting Non-household Consumption

Table 6.1: (5.5) Forecasting your non-household consumption - Defra/EA guidance

Number	Action
173	You have calculated a demand forecast for non-households. (Sections 6.1, 6.2, 6.3, 6.4, 173 6.5, 6.8)
174	You have described your assumptions about customer/property types that you have considered as non-household and demonstrated that your decisions are aligned with part 17C of the Water Industry Act 1991 and guidance on non-household customers as reported in Eligibility guidance on whether non-household customers in England and Wales are eligible to switch their retailer. You have consulted with retailers of water to non-household customers.(Sections 6.1, 6.2)
175	You have accounted for likely other retailers to non-household sectors in your area following the changes introduced in April 2017 and have consulted with retailers of water to non-household customers. (Sections 6.7)
176	You have determined non-household demand into different economic sectors, for example by using the UK SIC codes or applying a service and non-service split approach. (Sections 6.1, 6.2)
177	You have assessed the likely new uptake of public water from non-household customers/ sectors that previously used private supplies. (Sections 6.7)
178	You have examined and taken account of planned or existing water saving initiatives by both the wholesaler and retailer and have determined in the likely saving in non- household demand. (Sections 6.7)
179	You have included forecast savings data for existing water efficiency initiatives in the baseline forecast that you have presented. (Sections 6.7)

6.1 Overview (173)

We commissioned of annual average non-household demand across the Anglian Water region for the period to 2045 reporting to all WRZs.

This analysis has characterised non-household customers by geographical area and industry sector.

Separate regression models have been produced at WRZ level for each sector, and company averages have been obtained by aggregating the outputs from these models.

The calibration of each model has been based upon the appropriate selection of explanatory variables, such as numbers in employment or the level of economic activity (GVA), which most appropriately account for historical trends and variations in demand.

The following data has been used to derive the non-household forecasts:

- An extract of our billing data for non-household properties covering the periods between 2011 and 2016
- An extract of our billing data covering the periods between 2006 and 2010 for non-household properties not included in previous billing data
- GIS boundaries at WRZ and Planning Zone level
- The 'billing' history for non-household properties.
- The East of England Forecasting Model (Oxford Economics) which includes forecasts of Gross Value Added (GVA), Employment and Population
- Public domain evidence for prospective new Anglian Water major customers

Historical billing data, back to 2007, has been analysed to identify discrepancies, missing data and validate genuine consumption trends.

6.2 Industrial sector breakdowns (173, 174, 176)

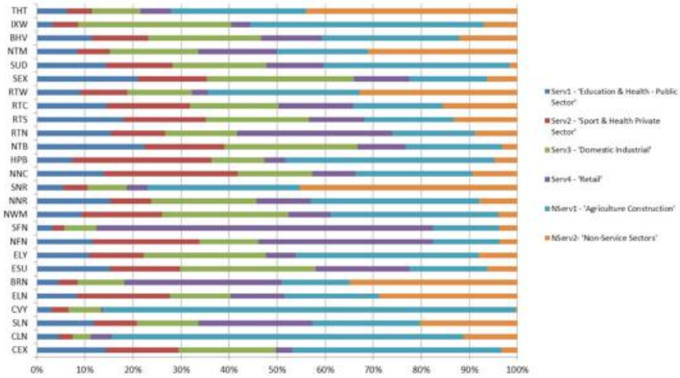
Each of the WRZs in the Anglian Water region have been modelled as individual areas.

Each of the WRZ models aggregates the industry sectors into seven groups, which have been aligned with the Standard Industrial Classification (SIC) codes.

- Group 1 (Serv1): “Education” and “Health” which are public sectors and tend to be more related to household population
- Group 2 (Serv2): “Hotel”, “Holiday Camp”, “Restaurant”, “Sport and Leisure”, “Pubs and Clubs”, “Amusement Parks” and “Hairdressing” (mostly recreational activities), which are more private sector focused and tend to be related to household population
- Group 3 (Serv3): “Office”, “Media”, “Renting and Leasing”, “Domestic”, “Washing and Dry Cleaning”, and “Transport” (mostly office or domestic activities), which are industries more focused on providing professional services
- Group 4 (Serv4): “Retail” on its own, which is both public and private sector focused, and it has the largest proportion of demand across all industry sectors in AWS
- Group 5 (NServ1): “Arable Agriculture”, “Agricultural Support”, “Aquaculture”, “Pastural Agriculture”, “Construction”, “Materials Manufacturing”, “Materials Production”, “Product Manufacture”, “Textile Manufacture” and “Mining”
- Group 6 (NServ2): The remaining non-service sectors, namely “Food Processing”, “Beverages”, “Facilities”, “Utilities”, “Repair and Maintenance” and “Waste”
- Group 7 (Unknown): Consumption without a known sector.

It is noted that for the N ‘unknown sector’ the demand from properties has been individually forecast in each of the resource zones. This sector represents 11.9 % of the total demand in 2015, although it is forecast that this sector demand follows a steady decreasing trend over the period to 2045.

Figure 6.1: Non-household industrial sectors (grouped - exc. unknown) by resource zone



WRZ show differing dominant sectors (by percentage), dependent upon their size, location and geography; WRZs such as Central Lincolnshire (large) and Chevely (Small) are dominated by ‘agriculture’ (NServ1), whilst WRZs such as Ruthamford Central, show a much more mixed picture with all sectors equally represented.

6.3 Unmeasured Non-household Demand (173, 174, 176)

The estimated unmeasured component of non-household demand only represents approximately 0.5% of the total.

In the absence of any evidence to the contrary, it is reasonable to assume that unmeasured non-household demand per property will remain constant. We, therefore, apply the current unmeasured non-household demand assumptions to their forecast unmeasured non-household property counts.

It is noted that Open Water may represent a driver for switching unmeasured non-households to measured billing. If this is the case, then the measured non-household demand should in principle be adjusted to compensate for the corresponding reduction in unmeasured non-household demand, although the amount of the adjustment would be negligible in the context of the uncertainty of the overall demand forecast.

6.4 Non-household properties and population (173, 174, 176)

Historical data indicates that there is no evidence of a causal link between the number of measured non-household properties and the total demand. The number of properties has shown a relatively steady reduction over the historical period; the demand is also reducing, but with increased variability.

Measured non-household property counts have consequently been modelled as a simple trend over the forecast horizon. The historical period 2007-08 to 2015-16 shows an average reduction of 433 properties per year, an average reduction of 0.3%. Thus, for WRMP purposes it has been assumed that there will be an average reduction of 0.3% per year.

For unmeasured customers, the historical data shows a steady downward trend as would be expected given that there will be no new unmeasured customers and the existing customers may become void, be demolished or become metered.

The average reduction in the period 2007-2008 to 2015-2016, is 327 unmeasured non-households per year. If this trend continued, then the unmeasured non-household customer base will disappear by approximately 2022. It has consequently been assumed that the average reduction in percentage terms will be 8.4% per year; giving a small residual number of unmeasured properties likely to remain at the end of the WRMP.

Values for non-household and communal populations have been derived from official sources (ONS Census), and apportioned to AWS geographies. These values have been aligned with AWS 'official' reported totals and the water-balance base line values.

This non-household population includes estimates for residents in; Medical and care establishments, NHS, Psychiatric hospitals, Local Authority Children's homes, Nursing Homes, Residential Care Homes, Defence establishments (including ships), Prison Service establishments, Probation / Bail hostels, Educational establishments (including Halls of residence), Hotels, Boarding Houses, Guest Houses and others.

6.5 Forecast assumptions [173, 174, 176]

The forecast implicitly assumes that historical trends in factors such as the impact of water efficiency programmes will continue. Additional demand management initiatives that may potentially be introduced as part of the WRMP are included as adjustment to the final plan forecast. (See the Demand management option technical report)

It is noted that non-household consumption is not linearly or directly linked to non-household population totals, so modelled inputs regarding population represent the total area population based upon data at LAUA level, rather than the population of the non-household customer base (noting that the health and education industries serve the whole local population).

The effect of new or demolished properties is already reflected by the rise or decline of demand, hence already assumed reflected in the forecast.

No adjustments have been applied (e.g. related to Meter Under-Registration or Supply Pipe Leakage) to the forecast values given the close historical agreement to the total demand.

6.6 Scenario analysis, uncertainty and additional impacts

Scenario analysis has also been conducted. The central scenario assumes a continuation of current trends involving, for example, pressures from the Environment Agency to reduce demand, metering and water efficiency programmes and use of effective appliances to reduce water consumption.

Impacts of climate change and retail separation have also been considered, however, no strong evidence of correlation between annual demand and climate change have been found, and so the variables associated with climate change have not been used in the forecast.

Impacts of retail separation have been considered (looking at the impact in Scotland), but again these are considered uncertain.

A high consumption scenario has been built, based upon faster economic and demographic growth across the Anglian Water region (increasing activities in the service and non-service sectors).

The high scenario assumes, in terms of growth rates;

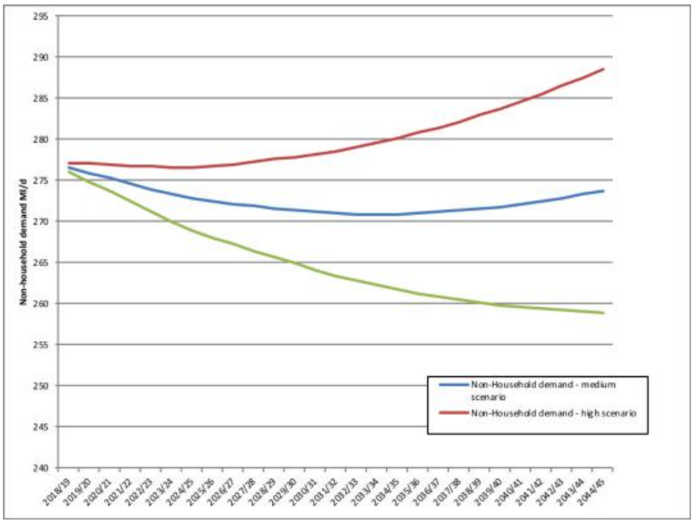
- Increase of employment and GVA growth rates by 0.5% more than in the central estimate.
- Increase of population growth rate by 0.25% more than in the central estimate.
- Increase of metered tariff rate by 0.25% more than in the central estimate.

A low consumption scenario has been built upon slower economic and demographic growth, (reducing activities in the service and non-service sectors).

- The low scenario assumes, in terms of growth rates,
- Decrease of employment and GVA growth rates by 0.5% less than in the central estimate
- Decrease of population growth rate by 0.25% less than in the central estimate.

It is noted that although in aggregate terms, these high/low scenarios produce higher and lower values, when disaggregated to WRZs, this is not always the case, as the factors do not act in a linear fashion. These scenarios were used to inform Target Headroom assessment.

Figure 6.2: Non-Household Demand Scenarios



6.7 Non-household demand, water efficiency and retail separation (175, 177, 178, 179)

We engaged with non-household retailers through the WRMP Pre-consultation and draft WRMP process. (Ref. 175)

With respect to non-household water efficiency measures, our relationship with our new Retailer Customer base is currently in development, since the market has been opened in April 2017. (Ref. 178)

However, we are continuing to pursue these relationships which include working with Retailers on operational matters, water demand and drought and we have engaged directly with each individual Retailer and provided an awareness of where we hold relevant information in our plans and with regard to the specific characteristics of our region.

Each Retailer has a dedicated 'Wholesale Account Manager' and water efficiency is now a standing item on agenda, reflecting our keenness to engage on innovative ways of collaboration, to ensure the efficient use of water.

In addition, we have launched our shop window project in Newmarket, which includes Retailers on our water efficiency efforts in this particular area. Retailers have been provided with direct access to the project manager and in turn Retailers have been supportive of our engagement directly with their end user customers in this area. A number of Retailers have shown a considerable appetite to do more and go further.

We are currently working on the next iteration of our engagement with Retailers on demand management, which is in the early stages of development. This will include a dedicated section on our Wholesale website providing targeted information for Retailers and also content which can be directed towards their end user non- household customers.

In recognising that the Retailer owns the relationship with the end-user non-household Customer and that they will, in most case, have a greater understanding of water consumption for their customers, we have a scheme which seeks to work with Retailers in helping us manage demand and optimise our network. This is advertised on our Wholesale website.

Currently we do not have enough data to support and quantify any adjustments to the non-household forecast, due to water efficiency savings, other than that implicit in the regression analysis per sector on the last 10 years' worth of data. However, it is noted that non-household demand is predicted to be relatively stable over the WRMP 2019 plan period, reducing from 275Ml/d to 273Ml/d. (Ref. 179)

Currently we have only been made aware of one major potential non-household customers looking to transition from private to public water supplies, and this has been factored into the non-household forecast for the relevant WRZ. If, through the consultation process, any further such requests are made, we will assess the implications of these for the WRMP. If necessary, the WRMP will be modified to account for any such requests. (Ref. 177)

6.8 Forecast outputs (173, 174, 176)

Model analysis indicates that overall measured non-household demand at company level, excluding the Hartlepool resource zone, is forecast to slightly decrease over the forecast period, with a slight dip in the middle of the planning period. Modelling of measured non-household demand provided detailed information for the WRZs and planning zones within the Anglian Water regions. Different model patterns and variations were observed, validations being based upon the selection of explanatory variables and the assessment of the fittings to yield the most probable output.

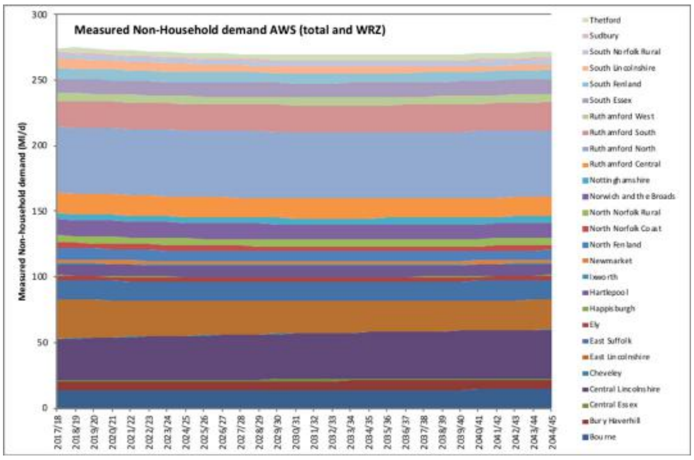
The model output forecasts measured non-household demand in each resource zone, excluding the Hartlepool area where demand is assumed to remain constant over the forecast period.

Demand in the service sector is forecast to marginally increase, but this is offset by demand from the non-service sector which is forecast to marginally decrease.

Analysis indicates overall measured non-household demand at company level, is forecast to decrease slightly over the forecast period, from 275.8Ml/d (2018) to 273.7Ml/d (2045) reaching a minimum forecast value of 270.9Ml/d in 2033 (excluding cspl and non-potable demand which has been modelled separately).

Unmeasured non-household demand comprises an additional figure of 0.75Ml/d (2018) to 0.74Ml/d (2045), with a minimum of 0.71Ml/d in 2033.

Figure 6.3: Non-Household demand (WRZ and Total) excluding non-potable



7. Forecasting Leakage

Table 7.1: (5.6) Forecasting leakage - Defra/EA guidance

Number	Action
180	You have determined baseline leakage over the planning period and explained your method in the WRMP (Sections 7.1, 7.2, 7.3)
181	You have used UKWIR Consistency of reporting performance measures (2017) to forecast levels of leakage. (Section 7.2)
182	If you are unable to use the guidance outlined in Consistency of Reporting Performance Measures (UKWIR 2017), you have explained why you have not used the revised approach for base year leakage, what steps you are taking to comply with the new approach and when this data will be available. (Section 7.2)
183	Where the revised approach to calculating base year leakage leads to uncertainty or significant changes in your base year or projected leakage, you have used scenarios to demonstrate how this affects your plan and any options you have selected. (Section 7.2)
184	You have described how your approach to calculating base year leakage affects your ability to meet government aspirations to reduce leakage over the planning period. (Section 7.2)
185	You have accounted for any actions or policies that may reduce leakage (e.g. mains improvements) in your leakage forecast. (Section 7.2)
186	You have accounted for your customers' views on leakage reduction and their resulting willingness to participate in demand management activities. (Section 7.2)
187	You have included all feasible options for further leakage control, and any other options you are actively investigating with support from your customers. (Section 7.2, 7.3)

7.1 Leakage overview

In 2007 Ofwat published its final report on 'Alternative approaches to leakage target setting' and following subsequent consultations this guidance was issued for PR09, including contemporary 'best practice'. Since this time Ofwat has continued to encourage additional studies, in cooperation with water companies and the industry research group UKWIR, and has produced reports directed towards more consistency in leakage management accounting practices. In this regard, our Optimised Networks Strategy (ONS) has made a significant contribution, as described in the 2015 EU reference document.

Most recently we and other water companies have been working together, co-ordinated by WaterUK and supported by Ofwat, to develop more consistent leakage reporting methodologies.

We have reported consistently low levels of leakage for many years. Recently (2016-17) the reported leakage has increased due to changes made to the leakage calculations in conformance with the latest regulatory guidance (averaging of whole months' data rather than weekday data) and new rules on adjusting for metering failures. Increased levels of confidence in night-flow records are expected to follow from the progressive increase in the size of the domestic consumption monitor, supported by data from smart meter trials (in Newmarket and Norwich).

The company has re-structured its procurement of maintenance activities for AMP6 and now has a joint operating company with contractors (Integrated Maintenance and Repair Alliance) which is incentivised on outputs which support improved KPI and ODI rewards.

Leakage management has also been restructured to give operational teams more ownership of leakage management targets and a larger operational team generates reports, develops strategies and manages budgets to deliver the ODI incentives.

This process can be characterised:

- DMA categorisation
- Field teams within the leakage unit undertake basic DMA checks on customer locations, metering equipment etc.
- Intensive leak detection using step test trackers, high accuracy meters and possibly restoration tankers. Anglian Water reported that the teams have found 3Ml/d leakage per year since being established including significant 'silent' leakage.
- Scheme designs (PRV, new mains, customer-side leakage etc)
- Construction
- Tracking of benefits

7.2 Leakage baseline forecast

Leakage of water from the water distribution network is a important component of demand.

The demand forecast estimates leakage over the planning period. This includes forecasts for;

- Distribution losses
- Measured household customer supply pipe leakage (cspl)
- Unmeasured household customer supply pipe leakage (metered) (cspl)
- Unmeasured household customer supply pipe leakage (unmetered) (cspl)
- Measured non-household customer supply pipe leakage (metered) (cspl)
- Unmeasured non-household customer supply pipe leakage (metered) (cspl)
- Household Void customer supply pipe leakage (cspl)

Base year leakage for all these elements, have been derived from the current reported actual leakage (rolling average of the previous 3 years) as reported in the water-balance data.

Existing policies and the impacts of any planned non-supply demand balance actions that may reduce leakage have been included, in the leakage forecast.

The baseline leakage over the planning period has been set at 177 Ml/d. This value (177Ml/d) has been based upon the pre-2017 methodology. (Ref 180)

With regard to the UKWIR 'Consistency of reporting performance measures' (2017), the level of leakage and the distribution of leakage between WRZs using the revised method had not been defined when the analysis of leakage reduction options had been undertaken. Re-applying the consistent methodology at planning level would have led to both differences in leakage levels in the resource zones and differences in the proportional distribution of leakage between resources zones. This would also have required a new set of water balances at planning zone level and time was not available to make these changes. In these circumstances the assessed leakage reductions have been retained even while the baseline leakage level has been changed. (Ref 181, 182)

It is noted that the adjustment to reported leakage as a result of the 'Consistency of Reporting' changes will be approximately +0.02 Ml/d in year 2017/18, (i.e. the 'consistent' method gives very slightly higher leakage value). (Ref 181, 182)

New WRZ and planning zone level water balances will potentially be available, using the 'Consistency of Reporting' method for leakage, for the final WRMP. If they produce a significant change then new leakage reduction options could be derived for this new WRZ level baseline. (Ref 182)

The revised consistent base year leakage reallocates water between leakage and demand. The effects of options have been assessed using the current (Pre-2017 method) leakage and demand. The effect of these options on distribution input should be negligibly affected by the reallocation. It would not be useful to try to re-assess the effect of options with the new calculation method, because the options themselves have been developed using the assumptions and methods that underpin the old calculation method. However, we do not consider the change to be significant enough to require a complete reassessment of the leakage demand management options. (Ref 183)

In order to meet government aspirations, of reducing leakage by a further 15% by the end of AMP 7, AWS have set a challenging baseline target (177Ml/d rolling average, 172Ml/d by the end of AMP6) and included further demand management options in the preferred final plan, intended to reduce overall leakage to 142Ml/d (19% reduction) by 2024/25 (end AMP 7) and to 106Ml/d (40% reduction) by the end of the WRMP planning period. Once the 'Consistency of Reporting' changes have been included, the difference as currently assessed, should not impact the 15% reduction. (Ref 184, 185)

All feasible options for further leakage control have been assessed, along with other options which are actively being investigated; these and customers views are discussed in the 'Demand Management Strategy' technical report. (Ref 186,187)

7.3 Base year and forecast outputs

- Total leakage for the base year (2017/18) was 182.66Ml/d.
- Approximately 12.4% of the water we put into supply is lost through leakage from our distribution system (138Ml/d - 2017/18)
- A further 4% of the water we put into supply are attributed to customers supply pipe leakage (44Ml/d - 2017/18).
- For the WRMP Planning period the baseline leakage level has been set to be maintained at a constant value of 177Ml/d (3 Year Average).
- AWS have made significant efforts to reduce leakage and are now below the previously derived sustainable economic level of leakage (SELL) - 211Ml/d.

The baseline forecast, required to maintain a constant level of leakage at 177Ml/d (3 year rolling average) is comprised of the following components:

Figure 7.1: Baseline Leakage forecast per WRZ

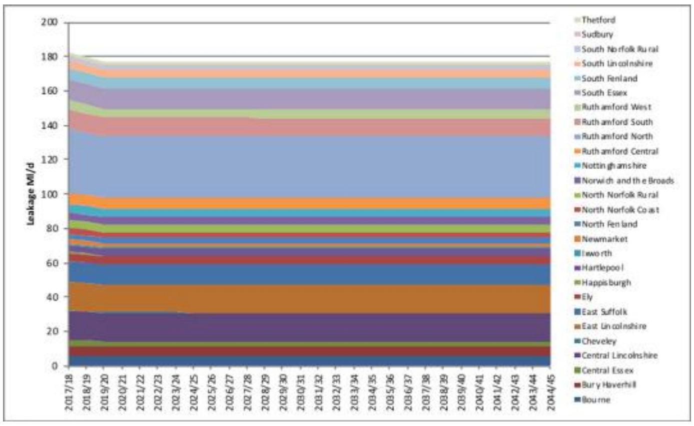
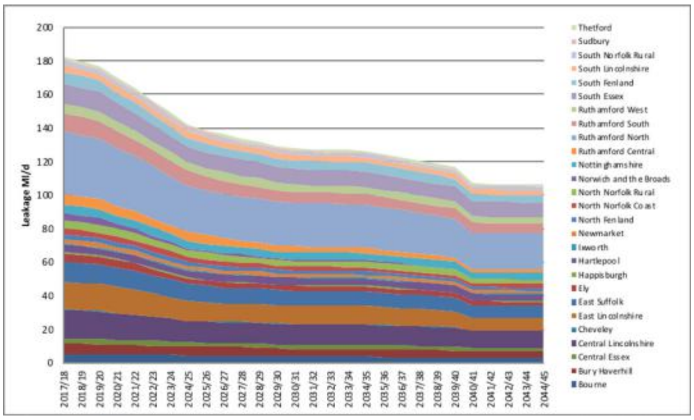


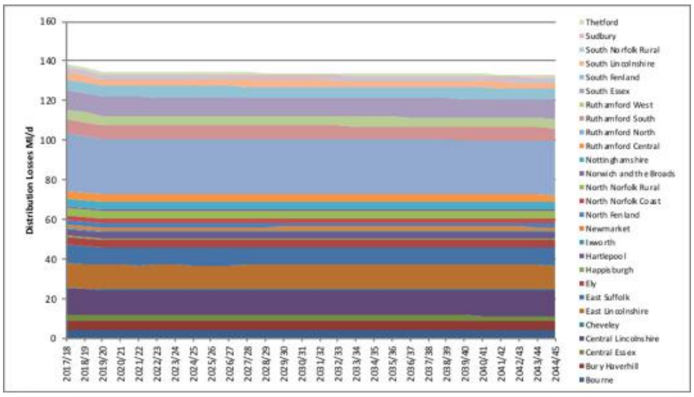
Figure 7.2: Final plan leakage forecast per WRZ with demand management options



Once demand management options have been included, leakage will be reduced from 182Ml/d to 106Ml/d at the end of the planning period.

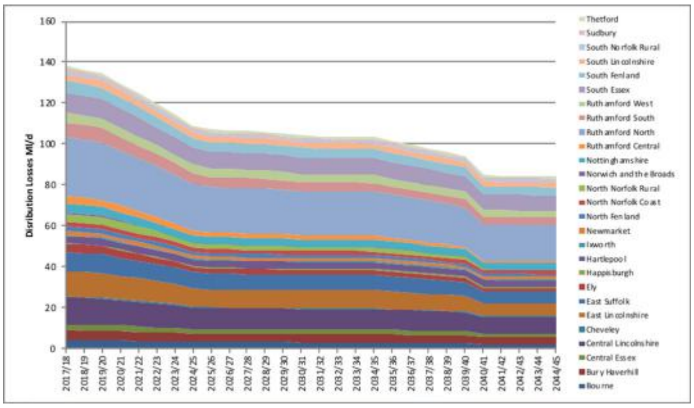
The baseline forecast Distribution losses are forecast to reduce from 138Ml/d to 133Ml/d over the plan period, without demand management interventions.

Figure 7.3: baseline forecast leakage distribution losses without demand management



With the leakage reduction options, distribution loses are forecast to reduce from 138Ml/d to 84Ml/d by the end of the plan period (and impact of smart metering).

Figure 7.4: forecast leakage distribution losses with demand management



Baseline measured household customer supply pipe leakage (cspl) is forecast to increase from 23Ml/d to 35Ml/d due to measured population growth and customers switching to measured status. With demand management this will reduce to 13Ml/d.

Figure 7.5: Baseline leakage forecast - measured household cspl without demand management

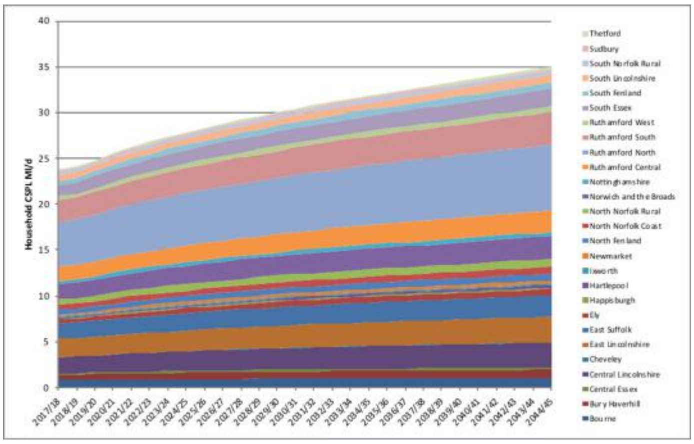
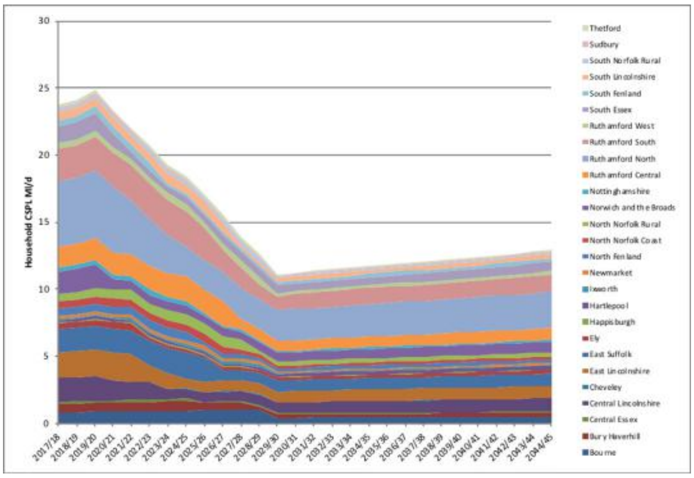
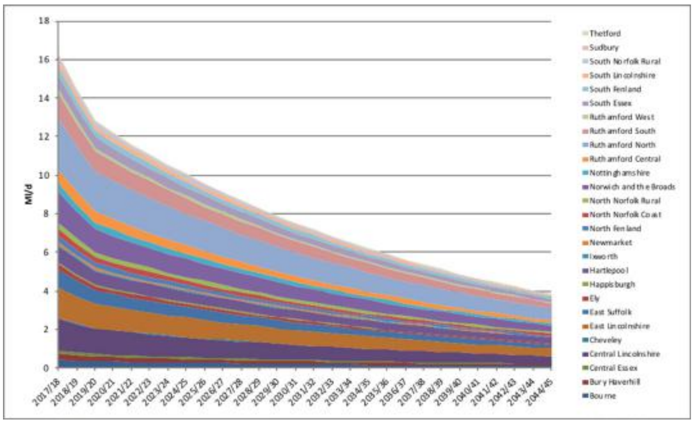


Figure 7.6: Forecast measured household cspl with demand management



Baseline unmeasured household customer supply pipe leakage (cspl) is forecast to decrease from 16Ml/d to 4Ml/d as customers switch to being measured and meter penetration reaches saturation (approximately 95% of customers)

Figure 7.7: Leakage - Forecast unmeasured household cspl



Additional forecasts have been made for measured/ unmeasured non-household cspl and void cspl, Once demand management options have been included, leakage will be reduced from 172Ml/d to 106Ml/d at the end of the planning period.

8. Other Components of Demand

Table 8.1: (5.7) Other components of demand - Defra/EA guidance

Number	Action
188	You have included details on other components of demand, the methods you have adopted for their calculation and your source datasets. (Section 8.1)

8.1 Overview

Additional derivation of the remaining components, as described in the Yearbook Commentary, has included;

- Water taken unbilled (estimated at the regional level and disaggregated to WRZ/PZ level)
- Distribution system operational use (estimated at the regional level and disaggregated to WRZ/PZ level)

Both of these components have been initially derived from the water-balance data at WRZ level, and have been assumed to remain constant throughout the forecast period with values of:

Table 8.2: DSOU and WTU

Component of Demand	Ml/d
Distribution system operational use	9.21
Water taken un-billed	24.81

9. Metering

Table 9.1: (5.8) Metering - Defra/EA guidance

Number	Action
189	You have reported household metering figures in the water resources planning tables. (Section 9.1)
190	For water companies in England, you have complied with the WRMP Direction 2017 with regard to household metering. (Section 9.1)
191	If you are in an area of serious water stress, you have considered the costs and benefits of compulsory metering. (Section 9.1)
192	You have assessed which tariffs are appropriate to your company as part of your options appraisal and included in your plan as appropriate. (Section 9.1)

9.1 Metering overview

Baseline figures for measured (metered) and unmeasured (metered and un-metered) customers have been derived from our water-balance data and the metering team.

Our metering team has produced forecasts for our WRZs (and PZs) for meter switcher/optant segmentation (switchers, selective, optant on 'move in'), as customers change from being unmeasured to measured over the WRMP 2019 planning period.

Our Metering Team in coordination with the Leakage Team (water-balance) have provided baseline and forecast values for:

- The Meter optant programme: number of meters per year
    - Note PPC has been assumed to be equal to unmeasured pre-switch and equal to (unmeasured -15%) post switch; occupancy has been assumed to be the average of unmeasured and ONS WRZ values
- The Selective metering programme; number of meters per year
    - Note PPC has been assumed to be equal to unmeasured pre-switch and equal to (unmeasured-15%) post switch; occupancy has been assumed to be the average of unmeasured and ONS WRZ values
- The number of 'move in optants' per year
    - Note PPC has been assumed to be equal to unmeasured pre-switch and equal to (unmeasured-15%) post switch; occupancy has been assumed to be the average of unmeasured and ONS WRZ values
- New Properties (Population): the number of additional meters has been derived from the Household Property/Population forecast (based upon Local Authority planning information).
- Meter under-registration
    - Meter under registration is included in the forecast base year values and forecast.

Anglian Water already has one of the highest meter penetrations in the industry and expects to achieve full market penetration (95%) during the WRMP planning period.

Thus the measured population is forecast to increase from 3.475M (2017/18) to 5.216M (2044/45) and unmeasured population is forecast to decrease from 1.067M (2017/18) to 0.434M (2044/45) over the planning period, as the population grows and customers switch.

Figure 9.1: Forecast measured and unmeasured properties

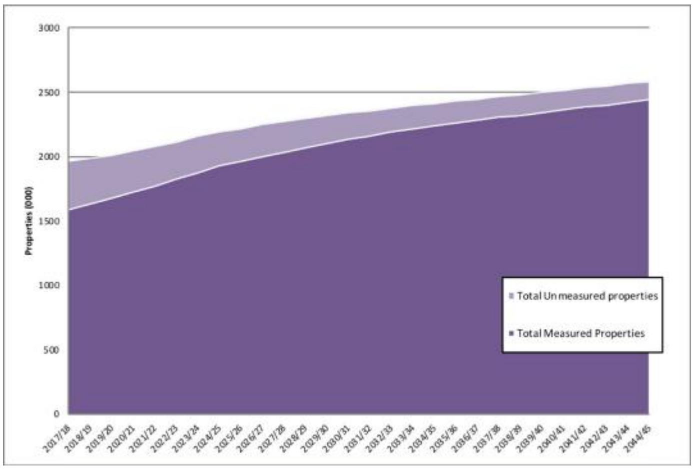


Table 9.1: (5.8) Metering

	2024/2025	2029/2030	2034/2035	2039/2040	2044/2045
Percentage of properties measured	89.73	93.07	94.48	94.76	94.92

Considerations, regarding compulsory metering and tariffs are dealt with in the 'Demand Management Option Appraisal Technical Supporting Document'.
(191, 192)

10. Impacts of Climate Change

Table 10.1: (5.9) Impacts of climate change - Defra/EA guidance

Number	Action
193	You have documented the allowance included in your plan for the impact of climate change on demand, including the assumptions on which this is based. (Section 10.1)
194	If your allowance is outside expected impact range (<3%), you have robustly demonstrated and justified the reasons for this. (Section 10.1)

10.1 Overview

To forecast the impact of climate change on household demand, annual percentage change factors, developed by UKWIR (2013) 'CL04B impact of CC on water demand', have been used. Average factors from the two models provided have been extrapolated to 2045 and cross referenced. It is noted that, UKWIR (2013) found no consistent weather-demand relationship for non-household demand; consequently, following guidance no climate change allowances have been made.

The 'regional tables' provided by UKWIR (2013) detail three demand criteria: annual average, minimum deployable output, and critical period. Percentiles are provided, to demonstrate the uncertainty in the UKCP09 model (10th, 25th, 50th, 75th, 90th). The calculation of these values has involved the production of demand figures for 2030, which have then been scaled across the planning period at time of publication (2012 to 2035).

For our demand forecast the average of Thames Water and Severn Trent household demand and climate change relationships have been used in line with the UKWIR (2013) Guidance. The WRMP planning horizon is from 2015-16 to 2044-45 and as mentioned, UKWIR (2013) climate change and demand factors are scaled from 2012 to 2035; we have, therefore, produced change factors linearly extrapolated to 2044-45 and change factors have been linearly scaled back from 2044-45 to reach 0% change in the base-year 2015-16.

The 50th percentile annual average factors have been used for the Dry Year Annual Average (DYAA) planning scenario (0.73% in the year 2044/45). The 50th percentile critical period factors were used for the Critical Period (DYCP) planning scenario (1.43% in the year 2044/45). To explore the uncertainty in the impact of climate change on demand, the 10th and 90th percentile values were modelled in the WRMP headroom analysis.

Climate change factors:

Table 10.1: (5.9) Impacts of climate change

	2024/2025	2029/2030	2034/2035	2039/2040	2044/2045
Dry year annual average (DYAA) Forecast	0.09	0.19	0.33	0.51	0.73
Critical period (DYCP)	0.17	0.37	0.65	1.00	1.43

Cover photo shows Rutland Water

Rutland Water is a reservoir in Rutland, England, east of the county town, Oakham. It is filled by pumping from the River Nene and River Welland and provides water to the East Midlands. It is one of the largest artificial lakes in Europe.

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