Baseline demand forecast

WRMP19 Supporting Appendix 5

12 August 2019

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What does this appendix do?

This appendix supports the submission of South East Water's Water Resources Management Plan for 2020-2080 and provides:

- Description of the demand forecasting methods we have undertaken in accordance with national guidance
- Details of the baseline demand forecast we have developed for each demand component and each water resource zone. The baseline demand forecast is our initial forecast before taking account of options in our preferred plan

The evidence you will find in this appendix

The following evidence is included in this appendix:

- The population we serve is expected to increase by 22% from 2.2 million in 2017/18 to 2.7 million in 2044/45, and to increase further to 3.3 million by 2079/80.
- Baseline average household per capita consumption under dry weather year conditions is predicted to reduce from 154 litres/head/day in 2017/18 to 140 litres/head/day in 2044/45 as a result of our customer metering programme, continued promotion of water efficiency and expected changes in appliance use.
- Baseline demand under dry weather conditions is forecast to reduce from 527 million litres per day (Ml/d) in 2017/18 to 522 Ml/d in 2019/20 after completing our customer metering programme and then gradually increase to 564 Ml/d by 2044/45 as the population continues to grow
- Our final planning demand forecast incorporates demand management options in our preferred plan, which will significantly reduce future demand.

The decisions we have made based on this evidence

We have made the following decisions based on this evidence:

- The baseline demand forecast has been used in the supply-demand balance analyses and option appraisal to help identify the schemes that make up our preferred plan.

The data tables you will find in this appendix

You will find the following data in this appendix:

- Tables and graphs of household, population, demand component and total baseline demand forecasts
- Tables and graphs that describe the uncertainty in the demand forecast

Other evidence and data that supports our decisions

You will find additional evidence in the following documents:

- Supporting demand forecasting documents Appendices 5A to 5D
- Final planning demand forecasts in Chapter 9 "Our preferred plan" of the Main Report

Need further information?

Please email [wre@southeastwater.co.uk] if you require further information or wish to clarify anything in this appendix.

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Executive Summary

Setting the scene

We have prepared a detailed baseline water demand forecast for our company area and for each of the 8 water resource zones that form the South East Water supply area. This has been carried out in accordance with regulatory requirements as part of the work to develop our Water Resources Management Plan 2020 to 2080. The baseline demand forecast is our initial forecast, which excludes the effects of any leakage reduction or other demand reducing options in our preferred final plan.

In 2017/18 we supplied some 517 million litres per day (Ml/d) to 2.21 million population and 49,000 non-households across parts of South East England. The quantity of water we have put into supply has reduced in recent years as a result of our demand management programme, which has included a household metering programme so that over 83% of households are currently billed on the basis of their measured water use. We expect to complete our programme metering of households that it is practical to meter by 2018/19, with household meter penetration increasing to about 90%.

What have we found?

We expect average household per capita consumption under dry weather year conditions to reduce from 154 litres/head/day in 2017/18 to 140 litres/head/day by 2044/45 as a result of our customer metering programme, continued promotion of water efficiency and expected changes in appliance use. However, the total population we serve is forecast to increase from 2.2 million in 2017/18 to 2.7 million in 2044/45, and to 3.3 million in 2079/80. As a result our baseline demand forecast under dry weather conditions (including increased demand due to dry weather and climate change) is forecast to gradually increase from 527 Ml/d in 2017/18 to 564 Ml/d by 2044/45, and to 634 Ml/d by 2079/80. We have recognised there is uncertainty in the demand forecast estimates and have applied alternative demand scenarios in our risk-based options appraisal.

How have we used the findings?

Our baseline demand forecasts have been used as an important part of determining the initial water supply-demand balances for each water resource zone. The demand forecasts have therefore been used to help identify cases where supply deficits occur and the analysis of options to determine the preferred plan to maintain adequate water supply reliability.

What is the impact on customers?

We will complete our customer metering programme by 2018/19 whereby a further 50,000 customers will have meters installed and have the opportunity to influence their water bills by using water more wisely.

Our customers will benefit from our continuing promotion of water efficiency measures to help them save water and money. They will also benefit from improved security of supply in those water resource zones where further actions are required to resolve current supply deficits.

1. Setting the scene

1.1 Background

We have prepared a detailed baseline water demand forecast for our company area and for each of the 8 water resource zones that form the South East Water supply area. This has been carried out in accordance with regulatory requirements as part of the work to develop our Water Resources Management Plan (WRMP). The baseline demand forecast is our initial forecast, which excludes the effects of any leakage reduction or other demand reducing options in our preferred final plan. The final plan demand forecast can be found in Chapter 9 “Our Preferred Plan” of the Main Report.

In 2017/18 we supplied 517 million litres per day (Ml/d) to 2.211 million population and 49,000 non-households across parts of South East England, as shown in Table 1.

Table 1. Summary of our customers and water supplied in each water resource zone in 2017/18

	Total population served	Number of household customers	Number of non-household customers	Total water put into supply
RZ 1 Tunbridge Wells WRZ	163,000	63,000	4,000	33 Ml/d
RZ 2 Haywards Heath WRZ	314,000	122,000	7,000	65 Ml/d
RZ 3 Eastbourne WRZ	259,000	107,000	7,000	55 Ml/d
RZ 4 Bracknell WRZ	687,000	260,000	12,000	158 Ml/d
RZ 5 Farnham WRZ	136,000	52,000	3,000	37 Ml/d
RZ 6 Maidstone WRZ	253,000	97,000	5,000	61 Ml/d
RZ 7 Cranbrook WRZ	80,000	31,000	3,000	22 Ml/d
RZ 8 Ashford WRZ	319,000	122,000	8,000	86 Ml/d
Whole Company	2,211,000	855,000	49,000	517 Ml/d

Note: Values may not sum exactly due to rounding

As shown by Table 2, although the population we serve is increasing, the quantity of water we have put into supply has reduced in recent years as a result of our demand management programme. This has included a household metering programme so that over 83% of households are currently billed on the basis of their measured water use. We expect to complete our programme of metering those households that it is practical to meter by 2018/19, with household meter penetration increasing to about 90%. Customers who have had meters installed have reduced their consumption by an estimated average of 18%. The significant reduction in the number of non-household customers in recent years has arisen mainly due to reclassification (in 2016/17) of some properties to comply with new regulatory guidance.

Table 2. Summary of our customers and water supplied in 2011/12 and 2017/18

	2011/12 (base year for 2014 WRMP)	2017/18 (base year for 2019 WRMP)
Total population served	2.05 million	2.21 million
Total number of household customers	0.80 million	0.86 million
% households that are metered	46%	83%
Total number of non-household customers	62,000	49,000
Distribution input (i.e. total water put into supply)	549 Ml/d	517 Ml/d

1.2 Purpose of this appendix

This appendix (Appendix 5. Baseline Demand Forecast) describes the analysis that has been carried out by South East Water to derive our baseline demand forecast across the planning horizon to 2079/80, with particular emphasis on the required minimum planning horizon of 2044/45 for our 2019 WRMP. We have used an extended planning horizon to provide a longer term perspective to 2079/80.

The focus of this report is on calculation of the "baseline" demand forecast which includes current demand management policies with respect to leakage reduction, customer metering and water efficiency programmes.

Baseline demand forecasts exclude the effects of additional demand management measures identified by the options appraisal (Appendix 7) to determine the best value approach to resolving any supply-demand deficits or resilience requirements. The impacts of such measures are included in the final planning demand forecasts.

1.3 Changes since Draft WRMP

There have been no changes in methodology for the calculation of demand forecasts since the Draft WRMP (published in February 2018).

The following changes have been made to text or base data since preparation of the Draft WRMP:

- In response to comments received on the Draft WRMP, we have provided further clarification on: how we applied national guidance in the preparation of property and population forecasts; the adjustments made to reconcile property numbers to the billing system; and the approach to extrapolate property and population forecasts after 2044/45.
- The base year for forecasting demand for each water resource zone has been changed from 2016/17 to 2017/18 so that data from the most recent complete reporting period can be used. This results in some changes to the starting position for the demand forecast for each water resource zone.

- The high peaking in demands experienced during the extreme hot, dry weather during June and July 2018 has been used in the estimation of peak week household consumption levels (as described in Appendix 5C).

- The PCC forecasts after 2044/45 have been more closely aligned with trends prior to 2044/45 (as outlined in Appendix 5C).

- The non-household consumption forecasts have been modified following further analysis of past consumption data.

The overall implications of these changes on the total demand forecast are very small. For example, the Draft WRMP forecast that the company's annual demand under dry weather conditions would increase from 526 Ml/d in 2017/18 to 573 Ml/d in 2044/45, whilst the latest forecast estimates the demand levels as 527 Ml/d in 2017/18 and 564 Ml/d in 2044/45.

1.4 Structure of appendix

Figure 1 summarises the key stages of our demand forecasting approach and how this document is structured to describe them.

This appendix is supported by the detailed data presented in the water resources planning tables and the following documents:

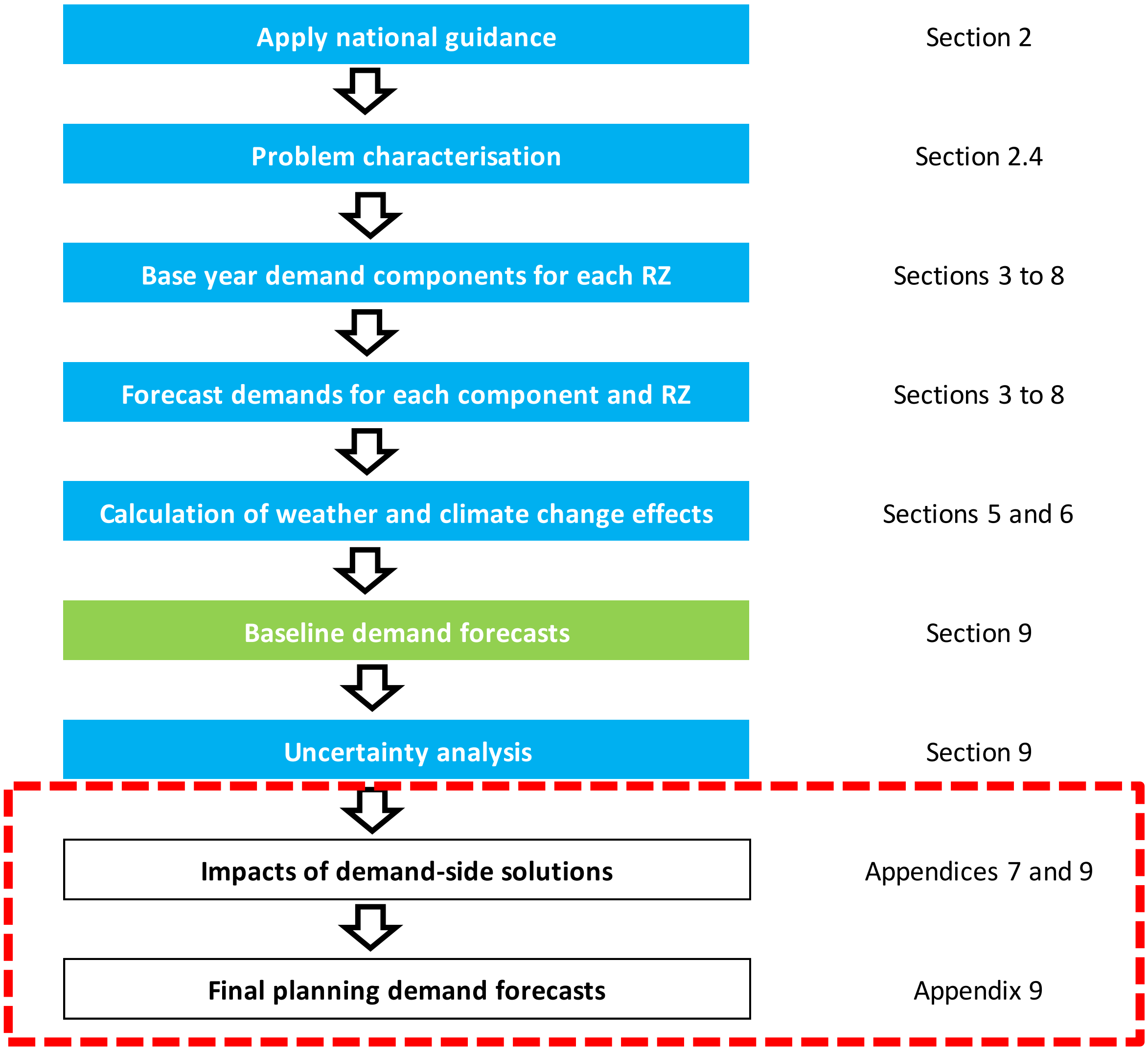
- Appendix 5A. Population and household property forecasts

- Appendix 5B. Derivation of micro-component values

- Appendix 5C. Household consumption forecasting

- Appendix 5D. Leakage

Figure 1. Schematic of our demand forecasting approach



2. Our demand forecasting approach

2.1 National guidance

Our calculation of demand forecasts has been carried out in accordance with national guidance as set out in:

- Guiding Principles for Water Resources Planning (Defra, 2016)
- Water Resources Planning Guideline (Environment Agency and Natural Resources Wales, 2017)
- Water Resources Planning Decision Making Process (UKWIR and Environment Agency, 2016)
- National good practice methods

This appendix describes how we have achieved this.

2.1.1 Guiding principles

The guiding principles document describes Government policy expectations of water companies in preparing WRMPs, which include:

- Taking a long-term, strategic approach
- Continuing the trend of reducing overall demand for water
- Promotion of water efficiency and leakage control
- Considering increasing universal customer metering if the company is in an area of serious water stress (which South East Water is)
- Reduction in per capita consumption
- Continuing the downward trend in leakage
- Choosing of demand-side options as part of the preferred programme for delivering the supply-demand balance

2.1.2 Water resources planning guideline

The guideline (in Section 5) sets out the Environment Agency's expectations of water companies in preparing their demand forecasts. These include:

- Application of national methodologies (where appropriate)
- Undertaking calculations for each demand component taking account of the factors that may influence future demand
- Calculating demand forecasts for various scenarios including (where applicable): baseline dry year annual average; baseline critical period; final planning dry year annual average and final planning critical period.
- Basing forecast population and property figures on local plans published by local councils or unitary authorities
- Consulting with retailers about non-household customers
- Allowing for uncertainty

2.1.3 Decision making process guidance

We have applied the new decision making process for developing the supply-demand balance and options appraisal. It includes, for example, a new stage called problem characterisation that helps water companies decide on the complexity of analysis that is appropriate for their situation (see Section 2.4).

2.1.4 Good practice methods

National good practice methods prepared by UK Water Industry Research Ltd (UKWIR) or approaches in general use by UK water companies have been used to undertake the calculations as described in the following sections. This includes methodologies for:

- Population and property forecasting (UKWIR and Environment Agency, 2015a)
- Household consumption forecasting (UKWIR and Environment Agency, 2012, 2015b and 2016a)
- Non-household demand forecasting (UKWIR and Environment Agency, 1997)
- Leakage assessment (UKWIR, 2011 and 2017; and Environment Agency, 2017b)
- Critical (peak) period demand forecasting (UKWIR, 2006)
- Climate change impacts on water demand (UKWIR and Environment Agency, 2013)

2.2 Demand components

Demand forecasting for each water resource zone has been undertaken for each of the standard water demand components:

- Measured household consumption
- Unmeasured household consumption
- Measured non-household consumption
- Unmeasured non-household consumption
- Water taken unbilled – for example licensed standpipe use by fire service and local authorities and illegal water use
- Distribution system operational use – water used by us in operating the distribution system, such as cleaning mains after repair work
- Total leakage – including distribution losses from our distribution system and underground supply pipe leakage from customer pipes.

The values for these seven components sum to the total water put into supply from our water treatment works, known as “distribution input”. We calculate household consumption by multiplying the population by the estimated average per capita consumption (PCC). Hence the calculation of total demand can be expressed as presented in the following text box:

Equation for calculation of total demand

Distribution Input =

Measured household population * Measured household PCC

+ Unmeasured household population * Unmeasured household PCC

+ Measured non-household consumption

+ Unmeasured non-household consumption

+ Water taken unbilled

+ Distribution operational system use

+ Total leakage

2.3 Base year starting position

Our starting position to forecasting future demand is to first define the "base year" demand – our base year for the WRMP is 2017/18. As explained in the following sections, each component has been estimated for the base year and then forecast from that starting position for each future year for the WRMP.

Therefore, one of the first steps involved in preparing the demand forecast is to derive the base year water balance. This is done by a formal, audited annual reporting process. Data is collected from the company's extensive monitoring systems, such as:

- recorded volumes from meters at water treatment works
- billing system information on customers and the quantities of water supplied
- flow and pressure recording in each part of the distribution network including each district meter area (DMA)
- records of licensed standpipe water use, other unbilled consumption and distribution operational water use.

This data is used to estimate, for each water resource zone, the volume of water for each demand component in the base year. The quantity of water put into supply from water treatment works (distribution input) is compared with the sum of component volumes: a small variance is usually found. Therefore, a water balance reconciliation using maximum likelihood estimation in accordance with regulatory guidance is undertaken to derive reconciled volumes, such as shown in the following table.

Table 3. Reconciled water balance for the company area in the base year (2017/18)

Component	Average volume (Ml/d)
Measured household consumption	245
Unmeasured household consumption	80
Measured non-household consumption	91
Unmeasured non-household consumption	3
Water taken unbilled	10
Distribution system operational use	<1
Total leakage	88
Distribution input	517 Ml/d

2.4 Demand scenarios

Water resources planning requires assessment of a range of demand scenarios, as described in Water Resources Planning Guideline. We have assessed demand forecasts for the following scenarios:

- Baseline normal year annual average demand (NYAA)
- Baseline dry year annual average demand (DYAA), together with upper and lower forecast scenarios to examine potential uncertainty ranges
- Baseline dry year critical period (peak week) demand (DYCP)
- Final planning versions of the above that include the effects of any leakage reduction or other demand-side solutions in our final plan – see Chapter 9 of the Main Report

2.5 Problem characterisation

Problem characterisation, as described by UKWIR/Environment Agency (2016b), provides a framework for reviewing the risks and uncertainties that a water company needs to consider in order to develop a justifiable and proportionate response to future water resources planning requirements. We are operating within a region of high forecast population growth and significantly restricted supply availability. Overall, reflecting the connectivity within the regional network, we determined that South East Water is a medium level of risk with respect to problem characterisation - see Appendix 1 for more details.

The company should therefore undertake a medium level of complexity of demand forecasting. Simple demand forecasting making significant use of industry-wide benchmarks is not appropriate. Use of highly complex analytical techniques is not necessary. We have therefore used standard good practice techniques based on good local data, and analysed uncertainties and their implications.

The medium level classification of the problem characterisation has resulted, for example, in the following choice of demand forecasting methods:

- Plan-based property and population forecasts, and use of trend-based and econometric-based forecasts to provide comparative alternative predictions
- Micro-components analysis for per capita consumption forecasting using detailed information from our customer survey and authoritative external data sources, and cross-checking the data by comparing alternative data sources where possible
- Use of customer segmentation and factor analyses to take account of different consumption characteristics of different types of households
- Sectoral statistical analyses of non-household consumption to examine the possible effects of a range of factors that may influence consumption of each non-household sector
- Weather-demand modelling of historic data to identify statistical relationships that can be used in the estimation of the weather and climate change effects on consumption by households, agriculture and horticulture
- Use of our extensive flow and pressure monitoring throughout our distribution system to calculate leakage levels.

2.6 Changes in approach since WRMP14

The main principles of national guidance for demand forecasting have not changed in recent years and so the approach adopted for WRMP19 is similar to that used for WRMP14. There are still 8 resource zones, the components of demand are unchanged and planning scenarios are unchanged. The methods used for calculation of demand are similar to before, but there have been improvements such as:

- A problem characterisation has been undertaken to clarify the level of complexity of analysis needed
- The latest national methodologies have been applied to improve clarity and rigour in our approaches
- Experience has been gained from the metering programme to improve our understanding of the effect of metering on water use by those household customers who are transferred from unmeasured to measured
- Fresh modelling studies of future population, properties, household water use and non-household water use
- Fresh statistical analyses of weather and climate change effects.

2.7 Water Resources in the South East

We are part of the Water Resources in the South East (WRSE) project. The WRSE Group was set up to determine a regional water resources strategy comprising a range of strategic options to find the best solutions for customers and the environment in the South East of England. The Group is exploring opportunities for existing and new water resources to be shared in the most efficient and effective way, that provide reliable, sustainable supplies at best value to customers while protecting the environment. We have provided the WRSE Group with demand forecast and other data for each of our water resource zones to assist the options modelling for the regional strategy.

3. Our baseline demand management strategy

3.1 Government expectations

The Guiding Principles for Water Resources Planning (Defra, 2016) places emphasis on demand management as a means of controlling demand. It is expected that water companies will increase customer metering, promote water efficiency and undertake innovative leakage control, and thereby aim to continue the trend of reducing overall demand for water.

Table 4 compares the actual outturn demand characteristics for 2017/18 with 2011/12 values and the forecasts in our 2014 WRMP. It shows that demand has reduced more quickly than anticipated. Our demand management programme, including customer metering and leakage reduction, has contributed significantly to the reduction in the total volume of water we have put into supply from 549 Ml/d in 2011/12 (the base year for WRMP14) to 517 Ml/d in 2017/18. We will continue to take measures in the future to control demand as described below.

Table 4. Key changes in estimated annual average demand since 2011/12 for the company area

Comparator	2011/12 (actual)	2017/18 (forecast by WRMP14 for normal weather)	2017/18 (actual)	Change 2011/12 to 2017/18
Average per capita consumption	167 l/h/day	155 l/h/day	150 l/h/day	-17 l/h/d
Household population	2.05 million	2.18 million	2.17 million	+ 0.12 million
% households metered	46%	80%	83%	+37%
Household consumption	333 Ml/d	327 Ml/d	325 Ml/d	-8 Ml/d
Non-household consumption	110 Ml/d	112 Ml/d	94 Ml/d	-16 Ml/d
Total leakage	95 Ml/d	90 Ml/d	88 Ml/d	-7 Ml/d
Other water use	11 Ml/d	11 Ml/d	10 Ml/d	-1 Ml/d
Distribution input	549 Ml/d	540 Ml/d	517 Ml/d	-32 Ml/d

Note: Values may not sum exactly due to rounding. The demand figures presented here are actual recorded values, and so have not been adjusted for potential dry weather and climate change effects.

3.2 Our metering strategy

Our metering policy is in accordance with Government's 2017 WRMP Direction. We therefore continue to extend metering of our customers as follows:

- All new households and non-households will continue to be metered
- Households will continue to be able to voluntarily opt to be metered under our free meter option scheme
- Widespread metering of households under our customer metering programme is continuing
- Selective metering of currently unmeasured non-household properties is being undertaken where feasible

As our water resource zones are in an area of serious water stress we investigated the merits of widespread metering in our previous WRMPs. We concluded that widespread metering of our household customers was an efficient measure to contribute to the achievement and maintaining of adequate water supply security.

We have made substantial progress on our plan to meter 90% of customers by 2020. Since 2011/12 we have installed meters at about 300,000 homes that were previously unmetered. As a result meter penetration has increased from 46% in 2011/12 to 83% in 2017/18. This has been accompanied by a comprehensive customer and stakeholder communication programme that helped customers understand why metering is needed and support the work.

We expect to complete our current customer metering programme by 2018/19, but extensions to it are included in the options appraisal (Appendix 7) and our preferred plan (Appendix 9). It is not feasible to meter all households because there are some homes (e.g. flats or terraced properties with shared supply pipes) where it is technically complex and expensive to install a meter, and because some customers do not respond to multiple contact requests made whilst metering the area.

We will continue to require that all new properties are metered and to offer a free meter option scheme for any further customers who wish to voluntarily transfer to metering.

Metering encourages customers to reduce their water use as their water bill will be based on the amount of water they use. Our studies estimate that water consumption has reduced by about 18% at homes in our customer metering programme. As a result our customer metering programme will have reduced consumption by about 25 Ml/d by 2018/19.

We have considered possible new tariffs for charging customers to further incentivise them to reduce water consumption. These have been included in our options appraisal – see Appendix 7 Options.

3.3 Our water efficiency strategy

We have a statutory duty to promote water efficiency to all our customers. The core parts of our continuing baseline water efficiency strategy include:

- Customer communication: including innovative tailoring of communications, as described below.
- Website communication: our website contains water saving information for customers.
- Education: both in schools and direct to customers via the bill, website, community talks and other events and campaigns.

- Customer metering: we plan to meter 90% of customers by 2019 as this has been shown to be the most cost-effective way of incentivising customers to reduce their water use. We provide free water saving packs to each home that is newly metered.
- Provision of water saving devices: including the promotion of free cistern displacement devices, water butts, shower regulators, etc.
- Partnership working to widen the delivery of water efficiency services across the region.
- Targeting non-households by offering water audits and working with them to monitor leakage and provide advice.
- Ourselves: installation and monitoring of water efficiency measures at our own sites, and targeting leakage reduction from our own pipework and from customers' underground supply pipes.

Understanding our customers is fundamental to achieving long term reductions in water use. We have built on the success of our metering programme and joined forces with behavioural science experts Advizzo to develop new innovative approaches that empower customers to better control the water they use and therefore the bill they pay. We have run behavioural training for frontline staff focused on how to understand the emotional state of a person and how best to communicate with them.

A mix of qualitative and quantitative research has enabled us to create six attitudinal segments. Understanding the views of these different segments will allow us to improve our interaction and service to customers. We will be able to tailor our communications approach, the water saving information we provide, and the services we offer based on what is important to them.

Our baseline household demand forecasts includes the saving benefits of these activities during the planning period assuming that current trends will continue.

3.4 Our leakage control strategy

We have continued to actively control leakage by focussing on improving key aspects of leakage management, increasing operability of leakage monitoring, and investing in innovative new technology to reduce leakage levels below the performance commitment. As a result total leakage (i.e. total water losses from our distribution system and our customers' external supply pipes) has reduced from 95.2 Ml/d in 2011/12 to 87.7 Ml/d in 2017/18. This is lower than the 90.0 Ml/d target set in our 2014 WRMP for 2017/18.

Our baseline leakage forecast assumes, as an initial starting position, continuation at the 2017/18 level of 87.7 Ml/d.

We have identified actions to further improve our leakage performance and use of smart technology, which are included in our options appraisal (Appendix 7). These are based on seven work streams:

- Customers: (supply pipes, ease of reporting leakage/incentives, education and engagement)
- Innovation and training (smart network team, valve operation training, operational improvements)
- Smart networks (permanent loggers, system integration, real time network modelling, failure anticipation)
- Calm networks (intelligent pressure management)
- DMA operability (increase in number of operable DMAs, proactive meter replacement etc)
- Trunk mains and reservoirs (trunk main condition monitoring, metering enhancements)
- Water balance (void and occupancy review, analytics on consumption, improvements to night use estimates)

Our strategy is underpinned by innovation, with smart water network and calm network being its two main pillars.

Our leakage assessments are described further in Appendix 5D Leakage.

3.5 Final planning demand management

This section (section 3) has outlined our baseline demand management programme. Additional water management opportunities have been costed and quantified within the options appraisal and, where selected as best value, have been included in our preferred plan and in the final planning demand forecast. This results in reductions in our final planning household consumption, non-household consumption and leakage forecasts compared with the baseline forecasts. The selected options and the final planning demand forecasts are summarised in Chapter 9 “Our Preferred Plan” of the Main Report.

4. Properties and population forecast

4.1 Our approach for forecasting properties and population

English water companies are expected to base forecast property and population forecasts on local plans published by local councils or unitary authorities (Environment Agency and Natural Resources Wales, 2017). This is based on advice from Defra that WRMPs must ensure that there is adequate availability of water to support housing and economic growth set out in local plans.

In collaboration with other water companies in south east England, we employed Experian, a specialist demographic forecasting consultancy, to consult with local authorities and develop property and population forecasts for our water resource zones. They followed the latest good practice methodology (UKWIR/Environment Agency, 2015a). This work included use of official population estimates and projections from the Office for National Statistics as local plans often provide limited details of future population.

A copy of the Experian report is presented in Appendix 5A.

4.1.1 Application of national good practice guidance

National guidance and good practice methods have been followed by Experian and ourselves to calculate household property and population forecasts. The six key steps (Tasks A to F) and good practice guidance in UKWIR/Environment Agency's "Population, household property and occupancy forecasting (2017) have guided the approach and calculations:

- Task A: Assess needs and make choices. The water resource zone vulnerabilities and problem characterisation led us to ask Experian to undertake the forecasts using very detailed small area census geography and to calculate four different types of forecast. We adopted the plan-based forecasts to ensure compliance with regulatory guidance that forecasts should be based on local plans.
- Task B: Assess Local Development Plans. Experian contacted all local authorities in our supply areas and obtained all available local plans, to produce robust plan-based forecasts.
- Task C: Calculate population and household forecasts. Experian calculated plan-based, trend-based, econometric and hybrid forecasts in accordance with the good practice guidance. Plan-based forecasts were found to be higher than the other forecasts for seven of our eight water resource zones, confirming the choice of plan-based forecasts for our WRMP.
- Task D: Calculate occupancy rates. Average occupancy rates were calculated for each water resource zone and were checked for consistency.
- Task E: Analyse uncertainty. The uncertainties in property and population forecasts were assessed and taken into account, along with other demand forecast uncertainties, in our risk-based option modelling.
- Task F: Review and finalise. Careful checking of the calculated forecasts was undertaken.

Descriptions of how these tasks were undertaken are presented in the rest of this section and in Appendix 5A.

4.1.2 Use of Experian forecasts

The Experian study provided household and population forecasts for each water resource zone. In order to use the results for the WRMP we had to make some choices and undertake some adjustments as follows:

- As the WRMP contains forecasts to 2079/80 and the Experian data goes up to 2044/45, we needed to extrapolate the Experian forecasts. We achieved this by assuming continuation of the plan-based trends beyond 2044/45 to 2079/80.
- We identified that our billing system provides the most reliable data on the number of household customers in each of our supply areas. We therefore needed to make small adjustments to the Experian data on households to be consistent with the billing system. See also Section 4.2.1.
- We decided to use the plan-based property and population forecasts, which use local authority development plans, in preference to other forecasts. This is consistent with regulatory guidance. See also Section 4.2.2.
- We allocated future households to different meter status types to facilitate household consumption forecasting. This recognised that we will complete our current customer metering programme by 2018/19, by which further homes that are currently unmeasured will have meters installed and we will achieve 90% meter penetration. We also took account of statutory requirements, whereby all new properties will be metered and some household customers will opt to be metered under the meter option scheme. See also Section 4.2.3.
- Our calculations assume that there are no people living in households classified as unoccupied (“void”) on our billing system, and that the number of private water supplies to households is negligible. Therefore, we allocated all the population values produced by Experian to our billed household or non-household customers. We allocated Experian’s estimates of communal population to non-households and the rest of the population to households. See also Section 4.3.

These adjustments and choices are in accordance with the national good practice guidance.

4.2 Properties

4.2.1 Base year properties

Our billing system provides the most reliable data on the number of household customers in each of our supply areas. The base information for average property numbers in 2017/18 was extracted from our customer database system which has been developed and audited to classify and report all connections to the supply network in accordance with the regulatory requirements. The property data is reported annually to the regulators and has been rigorously audited. The database can provide detailed reports of property classifications – as household and non-household – by water resource zone, and whether measured or unmeasured. Occupied and void (i.e. unoccupied) properties can also be clearly identified and reported. These data derive the base year property figures from which forecasts are projected.

We needed to make small adjustments to the Experian data on households to be consistent with the billing system, as shown in the following table. The differences in household numbers arise for two main reasons:

- The growth in households to 2017/18 due to construction of new homes has been less than forecast by the local authority data.
- Some household customers counted as a single property on our billing system are multiple-occupancy dwellings (e.g. group of flats), which are counted as multiple households in the local authority-based data that Experian used.

Table 5. Number of properties we served compared with Experian estimates 2017/18

	Measured properties ('000)	Unmeasured properties ('000)	Unoccupied properties ('000)	Total properties served ('000)	Experian estimated households ('000)	Difference ('000)
RZ1 households	56.3	6.9	1.9	65.0	66.7	1.7
RZ2 households	105.1	17.2	2.8	125.1	131.2	6.1
RZ3 households	94.1	13.2	3.0	110.2	116.3	6.1
RZ4 households	221.5	48.9	5.5	265.9	276.4	10.5
RZ5 households	46.1	6.2	1.1	53.4	56.3	2.9
RZ6 households	87.2	9.7	2.2	99.0	102.9	3.9
RZ7 households	21.0	9.8	0.7	31.5	33.2	1.7
RZ8 households	91.9	29.7	3.3	124.9	128.1	3.2
Households (all RZs)	713.2	141.5	20.5	875.1	911.1	36.0
Non-households (all RZs)	46.2	2.6	4.8	53.6	n/a	n/a

Note: Values may not sum exactly due to rounding

4.2.2 Forecast households

Experian developed four sets of household forecasts for each water resource zone:

- Plan-based (based on Local Plans)
- Trend-based (based on official statistics e.g. data published by the Office for National Statistics)
- Econometric forecasts (i.e. taking account of economic factors)
- Hybrid forecasts (i.e. combination of the other forecasts)

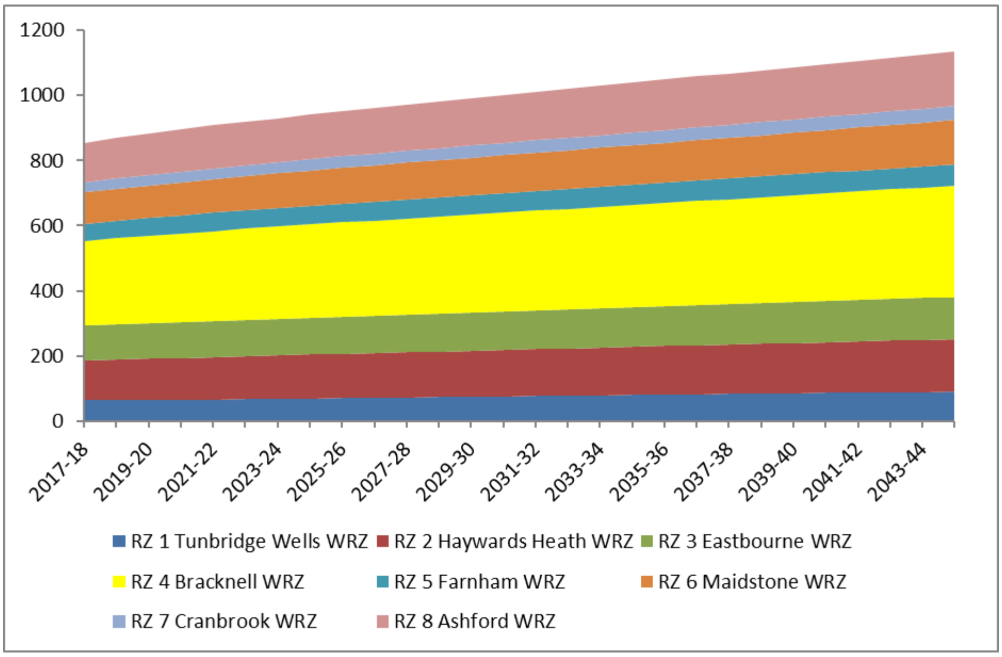
We have adopted the plan-based forecasts in line with regulatory guidance. Therefore, the growth in numbers of households in our water resource zones reported in local plans is fully reflected in our property and population forecasts.

In order to derive plan-based forecasts, Experian contacted each local authority in the areas we serve and reviewed their websites to obtain their latest information on the numbers of dwelling they have included or expect to include in their local plan. Information was provided by 34 of the 36 local authorities that cover the South East Water supply areas. These were used to derive plan-based forecasts of household properties, with official statistics used for the two authorities without plan data. The local authority data was adjusted to produce numbers that relate to the areas covered by our water resource zone area. As most local plans extend to 10 to 20 years into the future the trends in the plan-based forecasts were extrapolated to cover the entire WRMP period to 2079/80, using the trends in the local plans.

The plan-based forecast for occupied households we serve is for the total households to increase by 33% from 0.855 million in 2017/18 to 1.136 million in 2044/45, and to increase further to 1.479 million in 2079/80. The forecasts for each water resource zone are summarised in Figure 2. The growth between 2017/18 and 2044/45 for each water resource zone ranges between 26% and 43%.

For most water resource zones, the plan-based forecast was higher than the other forecasts. In 2044/45 the plan-based forecast total number of households for the whole company is 4% higher than the trend-based forecast and 7% higher than the econometric forecast. See Section 4.5.

Figure 2. Plan-based households by water resource zone ('000)



4.2.3 Categorisation of households

Household properties are considered separately from non-household properties.

We divide households into categories according to their meter status because they can have distinctly different water usage characteristics. In particular measured households tend to use significantly less water than unmeasured households because they are billed according to the volume of water uses and so have an incentive to save money by saving water.

Our household categories are:

- **Current measured households** – households that were billed according to their metered water consumption in 2017/18
- **New build households** – new homes built in the future (from 2018/19) – all new homes are metered
- **Compulsory measured households** – homes that were unmeasured in 2017/18 but will be metered in the future under our widespread compulsory metering programme. It is expected that our current programme will be completed by 2018/19, apart from any households that are difficult to meter
- **Optional measured households** – a small number of homes that will voluntarily opt to be transferred to metering apart from the compulsory metering programme
- **Unmeasured households** – those households that remain unmeasured and are not transferred to metered status

The following table summarises the expected numbers in each category.

Table 6. Summary of household numbers by category (excluding void properties) ('000)

	2017/18 (base year)	2019/20 (end of CMP)	2044/45 (minimum WRMP horizon)	2079/80 (our WRMP horizon)
Current measured households	713	713	713	713
New build households (relative to 2017/18 base year)	-	30	282	625
Compulsory measured households (relative to 2017/18 base year)	-	36	36	36
Optional measured households (relative to 2017/18 base year)	-	3	4	4
Unmeasured households	141	103	102	102
Total occupied households	885	884	1136	1479
% meter penetration (excluding void i.e. empty properties)	83%	88%	91%	93%

Note: values may not sum exactly due to rounding

4.2.4 Non-household properties

The number of non-household customers we serve has been reducing, and particularly in 2016/17 as a result of the reclassification of some properties as household instead of non-household in accordance with new regulatory guidance. The number of non-households that are unmeasured has been reducing as we have been installing meters where practical. The reducing trend for the total number of non-household properties is unlikely to continue in the long-term. Also, there is uncertainty surrounding the impact that Brexit will have on the economy and employment. For these reasons we have assumed that the number of non-household customers will remain steady in the future, as shown in the following table. The forecast number of non-households has very little effect on the demand forecast. The dominant demand component relates to measured non-household consumption and this is forecast based on volumetric analyses not property number trends (Section 6).

Table 7. Summary of non-household numbers by category (excluding void properties) ('000)

	2011/12 (base year for 2014 WRMP)	2017/18 (base year for Draft 2019 WRMP)	2044/45 (minimum WRMP horizon)	2079/80 (our WRMP horizon)
Measured non-households	56.4	46.2	46.2	46.2
Unmeasured non-households	5.4	2.6	2.6	2.6
Total occupied non-households	61.8	48.8	48.8	48.8

4.3 Population

4.3.1 Base year population

The Office for National Statistics (ONS) publishes official estimates of population in each local authority area and for a variety of small areas. Experian used the ONS data for Lower Super Output Areas (of between 1000 and 3000 people in each) to build up estimates of base year (2017/18) population in each water resource zone. They estimate that the total population we served in 2017/18 was 2.211 million.

ONS also publishes estimates of the number of people living in communal residences at the last census, in 2011. Communal residences include care homes, hospitals, educational establishments and prisons. Experian used this data to estimate the communal population in each water resource zone in 2017/18. We have allocated communal population as non-household population because such properties as classified as non-households. The following table summarises the estimates for 2017/18.

Table 8. Resident population we served in 2017/18 ('000)

	Population in measured properties	Population in unmeasured properties	Total ('000)
Households	1731	437	2168
Non-households	41	2	43
All properties			2211

4.3.2 Forecast population

Experian found that population data were not produced on a consistent basis in local plans. They therefore modified trend-based population forecast (derived from population projections published by the Office for National Statistics) to account for plan-based household projections.

The plan-based population forecast increases by 22% from 2.211 million in 2017/18 to 2.708 million in 2044/45, and is forecast to increase further to 3.293 million in 2079/80. The forecasts for each water resource zone are summarised in Figure 3. The growth between 2017/18 and 2044/45 for each water resource zone ranges between 15% and 29%.

Table 9 summarises our population forecasts for each property type, calculated using Experian's population forecasts and our occupancy trends for each property type in line with the general trend for average household size to be reducing.

Our plan-based household and population forecasts imply that average household occupancy will reduce from 2.54 in 2017/18 to 2.33 in 2044/45. Similar trends apply for each water resource zone and each meter status type.

Figure 3. Plan-based population by water resource zone ('000)

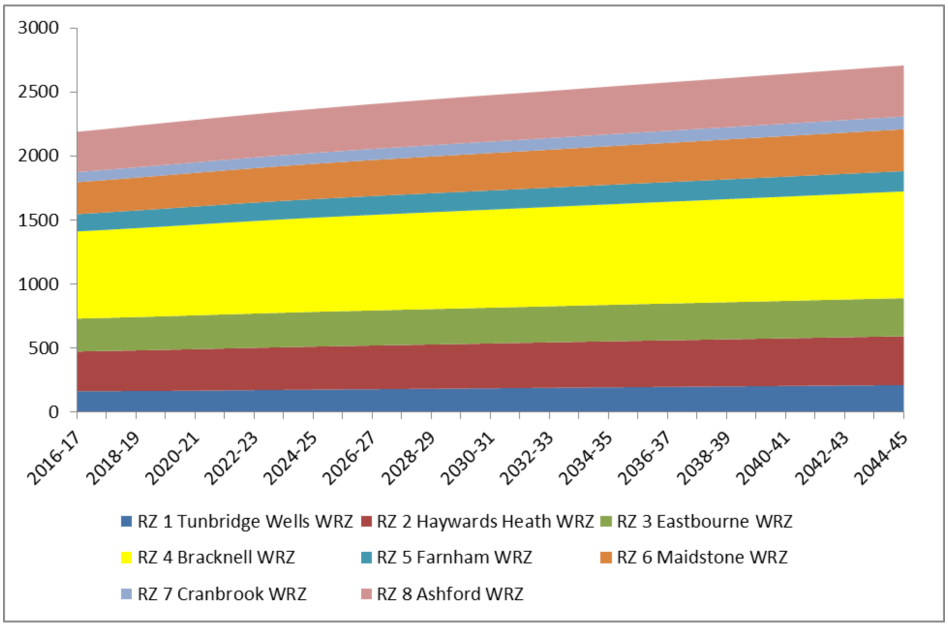


Table 9. Summary of population forecast by property category for whole company ('000)

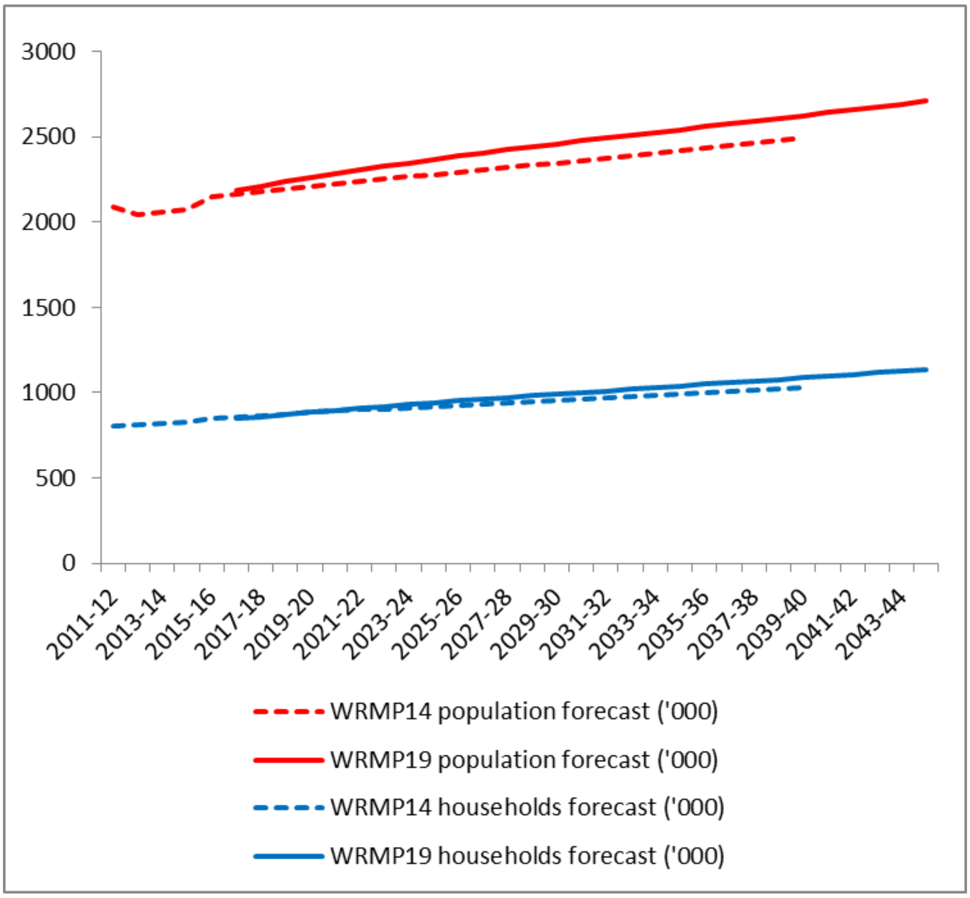
	2017/18	2019/20	2024/25	2034/35	2044/45	2079/80
Population in measured households ('000)	1731	1897	2022	2218	2407	2984
Population in unmeasured households ('000)	437	318	299	268	238	222
Population in non-households ('000)	44	44	47	55	62	86
Total population ('000)	2211	2259	2367	2542	2708	3293
Average occupancy in measured households	2.43	2.43	2.41	2.37	2.33	2.17
Average occupancy in unmeasured households	3.09	3.09	2.94	2.64	2.35	2.19
Average household occupancy (i.e. total household population / total occupied households)	2.54	2.51	2.47	2.39	2.33	2.17

Note: Values may not sum exactly due to rounding.

4.4 Comparison with WRMP14 forecasts

Our forecasts of total population and total household served are close to those forecast in our 2014 WRMP as shown by the following graph.

Figure 4. Comparison of WRMP14 and WRMP19 population and household forecasts

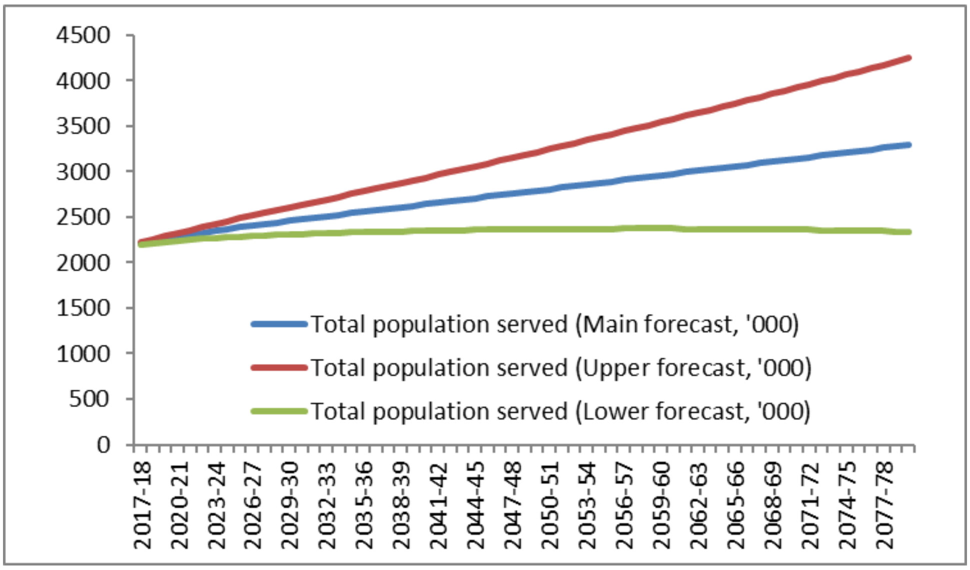


4.5 Uncertainties

The work by UKWIR/Environment Agency (2015a) included guidance on how to assess the uncertainty of population and household forecasts and provided look-up tables of uncertainty ranges which we have used in developing our forecasts.

There is significant uncertainty in the population forecasts for our water supply area as shown by Figure 5 - the upper and lower forecasts are 13% higher and 13% lower than the main forecast at 2044/45. This range is based on the analysis by UKWIR/Environment Agency of the accuracy levels achieved by the Office for National Statistics in predicting future population – ONS found that it is particularly difficult to accurately forecast the levels of net migration in local areas.

Figure 5. Main, Upper and Lower total population forecasts for the company area ('000)



Significant uncertainty was also found by Experian's study – see Appendix 5A. They derived a range of household and population forecasts which are summarised in the following graphs for the whole company area. For most water resource zones the plan-based forecasts were higher than the alternative forecasts. It is possible that plan-based forecasts over-estimate future development but we are required to ensure that we provide adequate water supply to meet planned growth, and the plan-based forecasts provide the potential benefit of some headroom in our forecasts. Therefore we have used the plan-based forecasts for the WRMP.

Figure 6. Comparison of household forecasts for company area

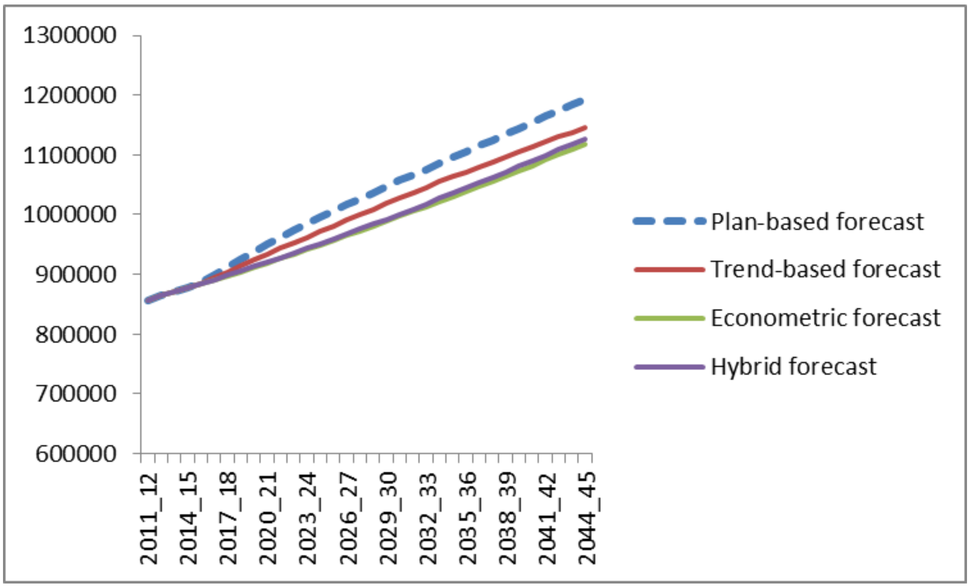
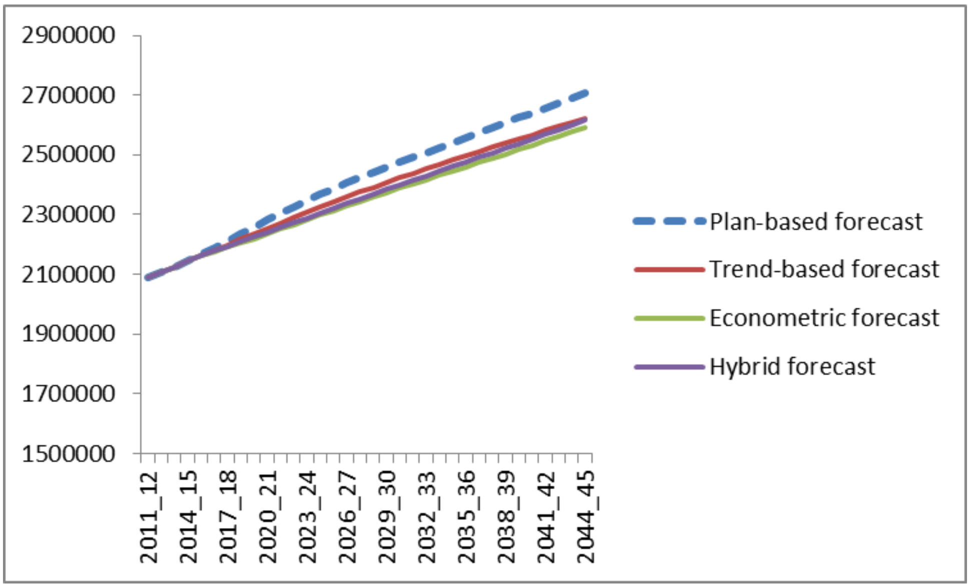


Figure 7. Comparison of population forecasts for company area



5. Household consumption forecast

5.1 Our approach to household consumption forecasting

We have followed national guidance and good practice methods to calculate household consumption rates. In particular:

- The ten steps and good practice guidance in Household Consumption Forecasting Manual (UKWIR/Environment Agency, 2015b) have guided the approach and calculations.
- The Environment Agency et al (2017) expect water companies to "understand current behaviours and attitudes to water use and report these through use of micro-components in water resources planning tables". We have followed this guidance.
- We have applied the national guidance on calculation of micro-component water use by households (UKWIR/Environment Agency, 2012).
- The principles in Integration of Behavioural Change into Demand Forecasting and Water Efficiency Practices (UKWIR/Environment Agency, 2016a) were applied to understand customer behaviour through detailed customer surveys and exploring relationships between water use and potential explanatory factors.

Our approach has therefore included:

- Taking account of the medium problem characterisation category that was determined for our water supply area. So we have undertaken detailed analysis using data that applies to our area, but complex additional methods of analysis are not necessary.
- Carrying out a detailed customer survey of water use by a sample of 14,374 household customers and undertaking micro-component assessment of consumption. This has enabled us to gain a detailed understanding of our customers and the way they use water.
- Developing PCC forecasts for a range of weather scenarios.
- Assessing the sensitivity of PCC forecasts to assumptions and alternative scenarios (see Section 5.7).

Our main assumptions are:

- Our formal, audited water balance provides robust estimates of total PCC for measured and unmeasured households for each water resource zone in the base year
- Our future metering programme will be as defined in Section 4
- Results from our large customer survey, combined with data from authoritative external data sources, provide reliable information about current ownership and water usage of appliances, as detailed in Appendix 5B
- Authoritative external data sources (e.g. Market Transformation Programme) provide realistic forecasts of how water use by domestic appliances will change in the future, as discussed further in Appendix 5B
- The customer metering programme will result in customers who are transferred from unmeasured to measured status reducing their water consumption by an average of 18% based on our studies.

Further details of our assessment of household consumption rates are presented in Appendix 5B Derivation of micro-component values and Appendix 5C Household consumption forecasting.

5.2 Use of micro-component analysis

Micro-component analysis is a method that estimates the consumption rates associated with each component of household consumption (e.g. toilet flushing, clothes washing etc.). We chose micro-component analysis as the preferred method for forecasting future household consumption rates because:

- Micro-component modelling provides results which directly satisfy Environment Agency guidance
- The results can be directly entered in the reporting tables
- It is a well-established method, which has been widely used by South East Water and other UK water companies
- It makes transparent assumptions about how ownership and usage of each appliance are expected to change in the future
- National good practice guidance exists on how to undertake it (UKWIR/ Environment Agency, 2012)
- It does not require detailed modelling of past consumption. In South East Water's case (and other companies in south east England) this would be affected by the major metering programme and periods of water restriction in recent years, and changing PCC levels. These would make year-to-year comparisons of PCC values difficult to achieve on an accurate basis.

As described in Appendices 5B and 5C, the following have provided the main sources of data for deriving appliance ownership and usage values:

- South East Water's 2016 customer survey, which collected detailed information on current appliance ownership and usage characteristics from 14,374 household customers, comprising 11,165 measured homes and 3209 unmeasured homes
- WRc's compendium of micro-component values (WRc, 2012) prepared for South East Water and provides results on water usage by individual appliances
- Defra's Market Transformation Programme reports that describe past and potential future ownership and usage of domestic appliances
- Metered volume records from our billing system for measured households and our unmeasured household monitoring system have provided the data used to calculate total per capita consumption rates for measured and unmeasured households in our formal water balance assessment for the demand forecast base year (2017/18)

Our micro-component analysis has also taken account of key factors that influence household consumption such as meter status category, occupancy, property type, likely technological developments of appliances, and changing customer behaviour characteristics. We tried developing a full statistical model relating water consumption at the 11,165 metered households in our customer survey with occupancy, appliance ownership and water usage factors. However, few factors were found to be statistically significant, and the overall relationship was very weak with only 20% of the variation in consumption being explained. Therefore, we did not use this model, but instead took account of potential explanatory factors in our micro-components analysis, described in Appendix 5C.

The forecast micro-component per capita consumption (PCC) rates at 2044/45 are compared with estimated 2017/18 levels in Table 10. The main trends are:

- Water use for toilet flushing is reducing as more homes install and use low flush toilets
- Water for showering is expected to increase as people shower more frequently, and use showers instead of baths

- Bath water use is reducing as fewer people take baths for personal washing
- Water use for washing clothes and dishes are forecast to decrease as new washing machines and dishwashers continue to become more water efficient
- The forecast reduction in miscellaneous internal water use reflects the expected reduction in future average household occupancy
- Although external water use is also expected to reduce due to reducing occupancy, the impact of climate change results in an overall increase – it is assumed that the climate change effects will predominantly affect external water use (as explained in Section 5.5).

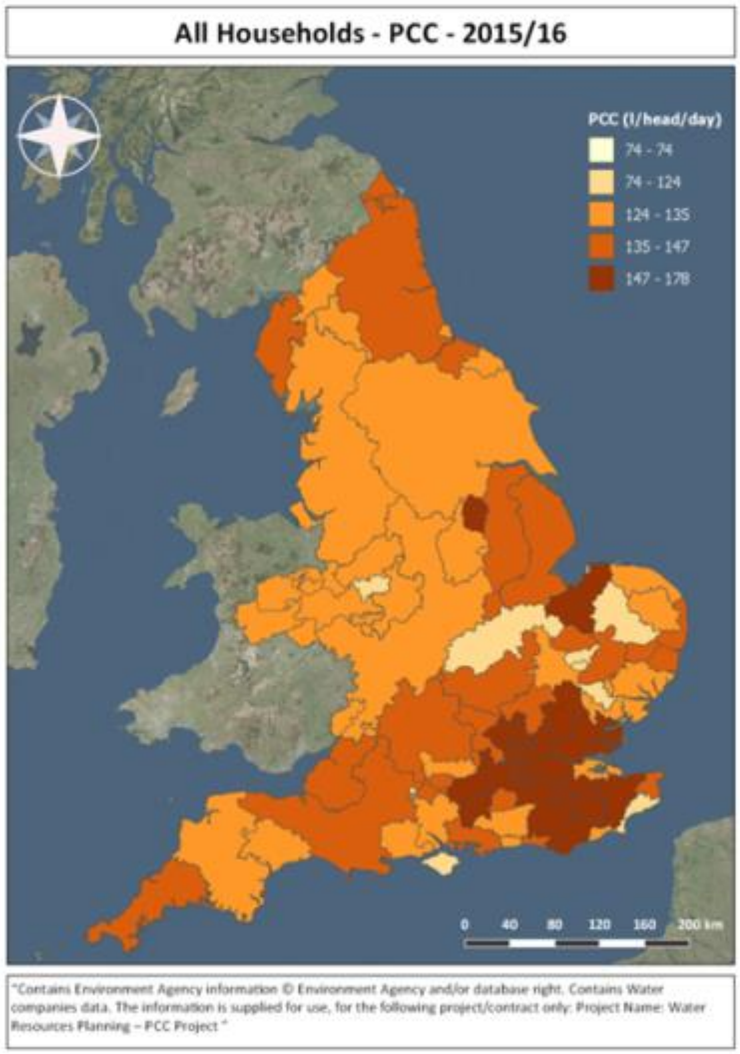
The values reported in Table 10 include the effects of dry weather and climate change on household consumption as described in the following sub-sections.

Table 10. Summary of micro-component PCCs for the whole company under DYAA conditions at 2017/18 and 2044/45 (averaged across measured and unmeasured households)

Component	PCC (l/h/d) at 2017/18	PCC (l/h/d) at 2044/45	Change (l/h/d) between 2017/18 and 2044/45
Toilet flushing	27.4	19.5	-7.9
Personal washing (i.e. showering, bathing and hand-washing)	60.5	56.2	-4.3
Clothes washing	22.9	19.7	-3.2
Dishwashing	9.1	8.9	-0.2
Miscellaneous internal use (including handwashing and other tap use)	15.7	15.7	-
External water use	18.6	20.2	+1.6
Total DYAA PCC	154.2	140.2	-14.0

Household water consumption rates vary significantly across the country as shown by the following map (Figure 8) of actual PCCs in 2015/16. Studies of variations in reported PCCs across England (Ofwat, 2007 and Artesia Consulting, 2017) have found that there are distinct regional differences. Reported PCCs tend to be higher in areas of higher affluence and warmer/drier summers in south and east England than areas in north and west England, which tend to be less affluent and have cooler/wetter summer weather. Our PCCs are consistent with those reported for the South East region. For example, our average PCC value of 160 l/h/day in 2015/16 (149 l/h/day in 2016/17) is above the national average value of about 141 l/h/day, but is near the middle of the range reported by companies in south east England.

Figure 8. Variation in PCC levels across England in 2015/16 (from Artesia Consulting, 2017 in preparation)



5.3 Effect of metering on demand

On our behalf Artesia Consulting have undertaken a study to measure the reduction in consumption achieved by the customer metering programme (CMP) at a property level. They analysed the consumption recorded on the billing system for properties that have been part of our CMP and compared it with unmeasured property consumption data for the same period from our existing unmeasured per capita consumption monitoring control areas.

Data for an 18 month period from April 2012 to September 2013 from 45,000 CMP properties was analysed and compared with data from the control areas. Artesia found that the average consumption by unmeasured households was 397 l/prop/day whilst the post metering consumption at CMP properties was 324 l/prop/day. This indicates a reduction of 18%, which is higher than the reduction of 15% assumed in the 2014 WRMP.

As the meter penetration increases it is becoming more difficult to maintain accurate monitoring of consumption at unmeasured households using our existing area-based monitoring system. We are therefore examining options in accordance with recent new national guidance (UKWIR, 2017) and plan to establish an improved unmeasured household consumption monitor.

5.4 Our approach to weather effects on demand

Variations in weather can have a strong influence on customer demand, in particular household consumption. For example, during periods of wet weather in summer months, customers tend to do little garden watering and so consumption may be similar to winter levels. In contrast, dry conditions accompanied high temperature in spring or summer can increase customer consumption on garden watering and other external water use. This has been observed by many studies including UKWIR (2013).

It is usual practice to calculate water demands for the following weather-related scenarios:

- Normal year annual average demand (NYAA)
- Dry year annual average demand (DYAA)
- Dry year critical period (peak week) demand (DYCP)

The Water Resources Planning Guideline (Environment Agency and Natural Resources Wales, 2017) requires water companies to report DYAA and, where applicable, DYCP values.

The UKWIR/Environment Agency manual (2015b) identifies a range of possible approaches for the calculation of weather effects. One of the most rigorous approaches involves statistical modelling of how past fluctuations in weather have affected household demand.

A weather-demand modelling study has been undertaken by the Met Office and HRW (previously known as HR Wallingford) on behalf of South East Water. It developed statistical models of relationships between weather parameters and household water consumption in each water resource zone. The results were used to calculate the following factors:

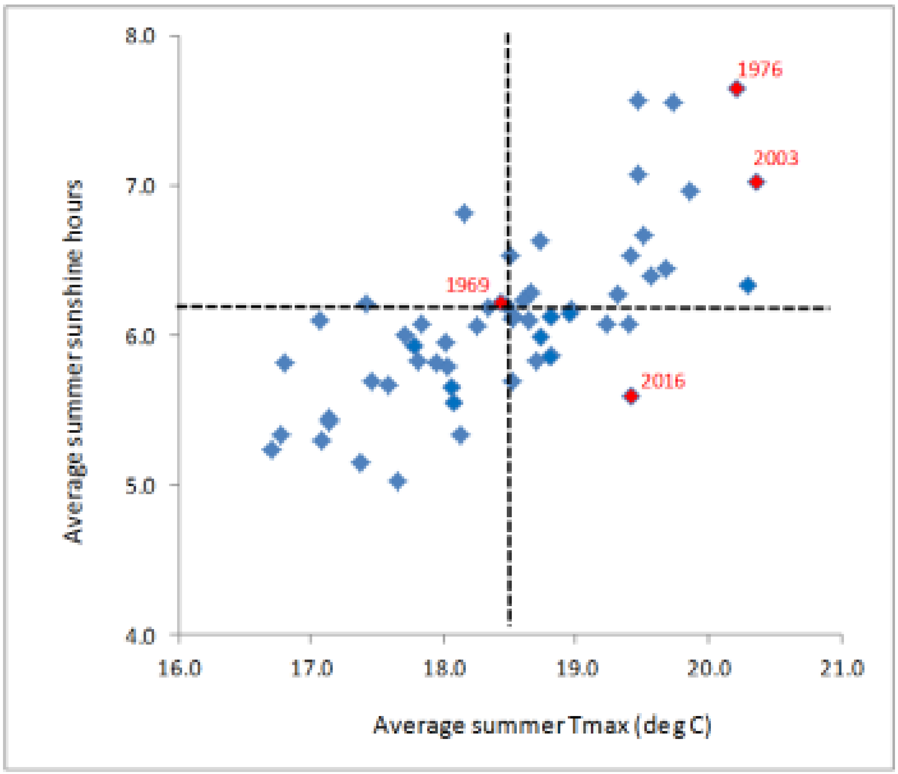
- **NYAA factor** – Factor to adjust base year annual average household demand to normal weather year conditions.
- **DYAA factor** – Dry year uplift factor to adjust normal weather year demands (NYAA) to dry year demands (DYAA).
- **DYCP factor** – Factor used to calculate the peak week demand in a dry year. The factor for each water resource zone has been adjusted since the Draft WRMP to take account of and align with the peak demands that occurred during the exceptionally hot weather in June and July 2018. The weighted average DYCP factor for the whole company is unchanged from the Draft WRMP.

In order to calculate these factors, specific years were chosen as reference normal year and dry year:

- The year 1969/70 was selected as the reference normal year for assessing “Normal year annual average (NYAA)” demand.
- The year 2003/04 was selected as the reference dry year for assessing “Dry year annual average (DYAA)” demand. This is consistent with the choice of 2003/04 as the dry year (without water restrictions) used in the 2014 WRMP.

The detailed daily weather-demand modelling done by the Met Office on South East Water data found that the weather factors that most significantly affect household demand in each water resource zone are maximum daily temperature and sunshine hours. The following “quadrant graph” compares average maximum temperature and average sunshine hours for each summer from 1960 to 2016. The values shown are averages across the company’s water resource zones, based on the data used by the Met Office for a variety of their weather stations in each resource zone. This summary graph helps to confirm summer 1969 as “normal/average” for temperature and sunshine and summer 2003 as much warmer and sunnier than average.

Figure 9. Quadrant graph of summer sunshine and summer temperature 1960 to 2016



Notes: This graph relates to whole company area averages; the dotted vertical and horizontal lines show average values for the summers in the period 1960 to 2016

The following table summarises the findings. The DYAA factor for the whole company (1.018), for example, suggests that household water consumption averaged across the year is 1.8% higher in a dry year than in a normal weather year. Likewise the DYCP factor for the whole company (1.294) indicates that household water consumption in the peak week of a dry year is 29.4% higher than average household consumption in a dry year.

Table 11. DYAA and DYCP factors for household demand

Resource zone	DYAA factor	DYCP factor
RZ 1 Tunbridge Wells WRZ	1.017	1.331
RZ 2 Haywards Heath WRZ	1.027	1.315
RZ 3 Eastbourne WRZ	1.025	1.198
RZ 4 Bracknell WRZ	1.010	1.380
RZ 5 Farnham WRZ	1.020	1.185
RZ 6 Maidstone WRZ	1.024	1.383
RZ 7 Cranbrook WRZ	1.032	1.457
RZ 8 Ashford WRZ	1.017	1.071
Whole Company	1.018	1.294

Note: DYAA demand = NYAA demand * DYAA factor; DYCP demand = DYAA demand * DYCP factor
These factors apply to all years of the WRMP.

5.5 Our approach to climate change effects

National guidance (UKWIR/Environment Agency, 2013) has been prepared on the calculation of climate change effects on water demand. As part of the recent weather-demand modelling study for South East Water, HRW undertook updated analysis of climate change effects on household demand in accordance with the UKWIR approach. The following table summarises the climate change factors that were derived.

The values in Table 12 assume that climate change effects should be applied to current as well as future household demands, in line with Environment Agency guidance (2017a). The studies carried out for the 2014 WRMP suggested that the increase in household consumption from 2012 to 2035 due to the impact of climate change would be 1.3% (i.e. a factor of 1.013). The 2014 WRMP study also used the UK Climate Projections 2009 (UKCP09) as the basis for climate changes but undertook less detailed modelling of how demand is affected by variations in weather.

Table 12. DYAA climate change factors for household demand

Resource zone	DYAA climate change factor at 2017/18	DYAA climate change factor at 2044/45
RZ 1 Tunbridge Wells WRZ	1.012	1.020
RZ 2 Haywards Heath WRZ	1.023	1.038
RZ 3 Eastbourne WRZ	1.022	1.036
RZ 4 Bracknell WRZ	1.013	1.022
RZ 5 Farnham WRZ	1.017	1.028
RZ 6 Maidstone WRZ	1.019	1.031
RZ 7 Cranbrook WRZ	1.026	1.043
RZ 8 Ashford WRZ	1.017	1.027
Whole Company	1.017	1.028

Note: DYAA demand with climate change = NYAA demand * DYAA factor * DYAA climate change factor

5.6 Baseline household demand forecast

We have used our plans for further metering, and our forecasts of population forecasts and per capita consumption rates to calculate household demand forecasts. PCC rates are expected to reduce but as a result of growing population the total household consumption volumes under dry weather conditions are expected to increase by 11% from 334 Ml/d in 2017/18 to 371 Ml/d in 2044/45. These volumes include the effects of dry weather and steadily increasing climate change on household demand.

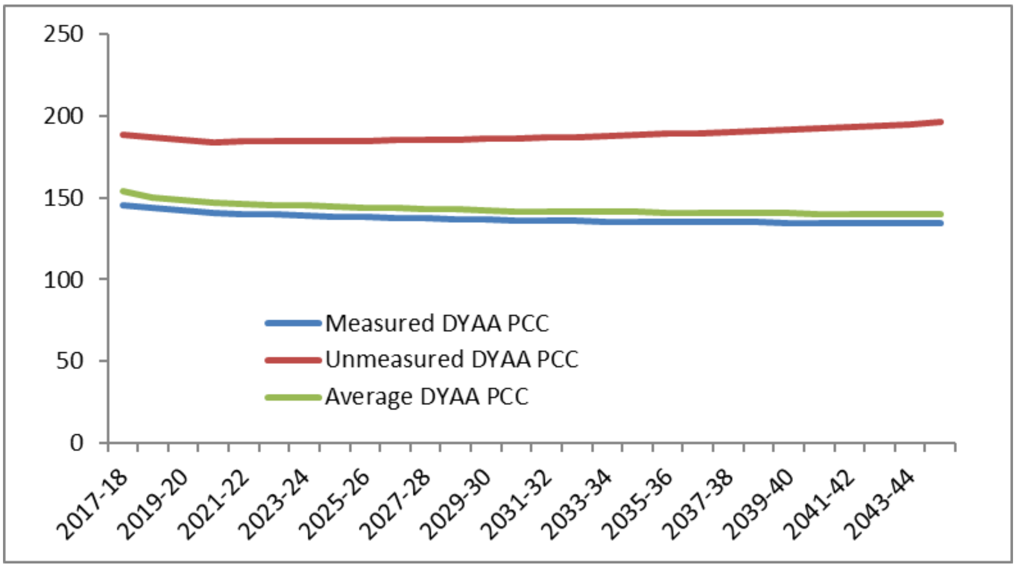
Figure 10 shows that average PCC (averaged across all households) reduces in line with the measured household PCC forecast as measured households represent the vast majority of people.

Table 13. Summary of baseline annual average household consumption forecast under dry weather conditions (DYAA) including climate change impacts

	2017/18	2019/20	2024/25	2034/35	2044/45	2079/80
Population in measured households ('000)	1731	1897	2022	2218	2407	2984
DYAA average PCC for measured households (l/h/day)	145	142	139	136	135	133
DYAA household consumption for measured households (Ml/d)	252	270	280	300	324	396
Population in unmeasured households ('000)	437	318	299	268	238	222
DYAA average PCC for unmeasured households (l/h/day)	189	185	185	188	196	198
DYAA household consumption for unmeasured households (Ml/d)	82	59	55	51	47	44
Population in all households ('000)	2168	2215	2321	2486	2646	3206
DYAA average PCC for all households (l/h/day)	154	149	145	141	140	137
DYAA household consumption for all households (Ml/d)	334	329	336	351	371	440

Note: Values may not sum exactly due to rounding

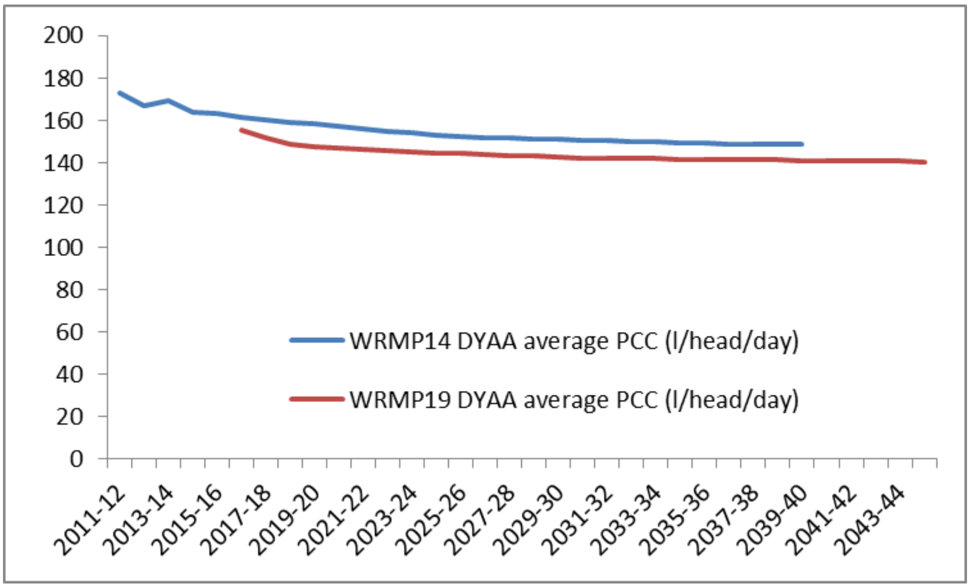
Figure 10. Baseline per capita consumption (PCC) forecasts under dry weather conditions (DYAA)



5.7 Comparison with WRMP14 forecast

Our downward future trend in average PCC is very similar to that derived in our 2014 WRMP, as shown in the following graph. The PCCs are slightly lower as a result of the customer metering programme having been implemented faster than proposed in the 2014 WRMP and, as noted above, the effect of metering on customer water use is greater than expected.

Figure 11. Comparison of WRMP14 and WRMP19 average PCC forecasts under dry weather conditions



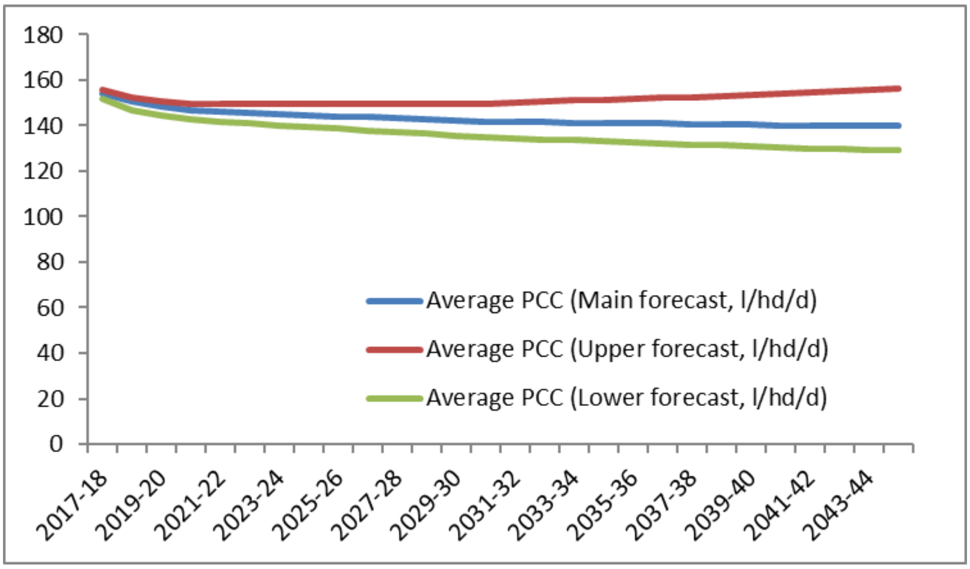
5.8 Uncertainties

There is inevitable significant uncertainty around future PCC rates as household customers change the way they use water in the future. Our main forecast predicts that average per capita consumption under dry weather year (DYAA) conditions will reduce from 154 l/h/day in 2017/18 to 140 l/h/day by 2044/45. In deriving this forecast we have used specific assumptions about the future ownership of water using appliances, how they will be used in homes and future technological improvements.

Actual levels of ownership and usage may vary from our estimates. Also, we recognise that our experience to date of an 18% reduction in water use by households transferred to metering may not be sustained in the future. Levels of between 10% and 15% are commonly reported by other water companies. There is potential for some “bounce-back” in water use by our existing metered customers, as well as future metered customers, as people get used to metering. We will continue to promote water efficiency measures to help minimise any “bounce-back” effect.

Our range of average PCC forecasts (i.e. weighted average across measured and unmeasured households) under DYAA conditions is shown in Figure 12, and detailed further in Appendix 5C.

Figure 12. Main, Upper and Lower DYAA average PCC forecasts (l/h/day)



6. Non-household consumption forecast

6.1 Our approach to non-household consumption forecasting

6.1.1 Background

Non-households comprise properties that are not occupied as domestic premises - for example, factories, offices and commercial premises – but which receive drinking water supplies. This includes water used by agriculture, the service sector (e.g. commercial, hotels, leisure, retailers, hospitals, schools, communal establishments and local authorities) and the non-service sector (including manufacturing, other industrial processes and utilities). The definition of "non-household" has changed since retail separation in April 2016, which has resulted in some customers that were previously classified as non-household now being classified as household, or vice-versa. As a result there has been a significant net reduction in the number of non-households.

In April 2017 the non-household retail market opened, with non-household customers in England now able to choose their water supplier (retailer). South East Water is a wholesale water provider and will normally continue to produce the water supplied to non-household customers in our area. The retailers will provide the retail services including billing and main customer contacts. We have consulted with retailers in our area to understand their expectations for future water demand and will continue to liaise with them on promotion of water efficiency. As the retail arrangements are new, the understanding about how it affects water resources planning is still developing, and so some retailers may find it difficult to be fully engaged in the consultation at this stage.

6.1.2 Our approach

We have followed national guidance and good practice methods to calculate non-household consumption. In particular:

- The good practice guidance in Forecasting Water Demand Components (UKWIR, 1997) has guided the approach and calculations.
- The Environment Agency and Natural Resources Wales (2017) expect water companies to produce a forecast for non-household demand and consult with water retailers providing retail services to non-household water customers.

Our approach has therefore included:

- Taking account of the medium problem characterisation category that was determined for our water supply area. We have undertaken detailed analysis using data that applies to our area, but complex additional methods of analysis are not necessary.
- Consulting with water retailers about their expectations of future water demand
- Carrying out a sectoral statistical analysis of factors that may affect water consumption by each type of non-household customer in our area
- Developing consumption forecasts for a range of weather scenarios
- Assessing the uncertainty in non-household consumption forecasts

Our main assumptions are:

- Our formal, audited water balance provides robust estimates the for the base year numbers of customers and volumes supplied for measured and unmeasured non-households

- Our billing system is the best data source for identifying volumes of water supplied to each sector in past years to investigate possible trends and relationships with economic factors
- There are three main customer categories that we should separately analyse: agriculture and horticulture; service sector and non-service sector. This is in line with common practice, as the use of more categories is likely to result in less accuracy in allocating volumes without improvement in explaining variations in consumption.

We have also assumed that the effect of switching from private water supplies will be negligible. This is because some customers on private supplies might wish to transfer to mains supply, while others, currently supplied by South East Water, may opt for an alternative supply in the future. The two trends are likely to balance out with the overall effect being negligible. However, we plan to discuss this further with retailers for our final plan.

6.2 Our analysis of non-household demand trends

6.2.1 Non-household sectors

Our primary data source was the metered volume records on our billing system. We extracted water demand volumes for each non-household customer for each year from 2007/08 to 2016/17.

When undertaking non-household demand forecasting, it is usual good practice to segment (i.e. categorise) customers into broad sectors so that differences in trends between sectors can be taken into account. We decided to analyse the three commonly used broad sectors:

- Agriculture and horticulture
- Service sector
- Non-service sector
- Note: the small number of unclassified or dual use properties were assigned as “Other”

The service sector includes commercial properties, hotels, leisure centres, hospitals, schools and local authorities. The non-service sector includes manufacturing, industrial and utility businesses.

We considered defining more detailed sector categories but, as found in our previous analyses, we were concerned about inaccuracies in correctly allocating customers to sectors. For WRMP14 we used the Standard Industrial Classification (SIC) codes on our billing system to classify our customers into 13 categories, however these codes are often incorrect or out-of-date. Instead, we are planning to classify all customers according to the BLPU (basic land and property unit) code for each property recorded on Ordnance Survey’s Address Base system. Each BLPU defines the type of business or household property type. Ordnance Survey will keep this information up-to-date and so we expect it will become an efficient means of maintaining accurate information.

For the current assessment we were able to classify 52% of customers (44% by volume) to our chosen sectors using BLPU codes, as summarised in Table 14. SIC codes were used to classify the remaining customers. We are working to improve the percentage of BLPU codes that can be assigned to non-household properties. The largest sector is non-service, which represents 46% of total non-household demand and 62% of total non-household properties.

Table 14. Percentage allocation of customers to sectors

Sector		BLPU allocation	SIC allocation	Total
Volume	Service	12.4%	32.4%	44.8%
	Non-Service	29.3%	16.8%	46.1%
	Agriculture and horticulture	1.8%	6.2%	8.0%
	Other	1.0%	0.2%	1.2%
	Total	44.4%	55.6%	100%
Properties	Service	5.4%	20.6%	26.0%
	Non-Service	44.3%	17.8%	62.1%
	Agriculture and horticulture	1.0%	9.4%	10.4%
	Other	1.0%	0.4%	1.4%
	Total	51.7%	48.3%	100%

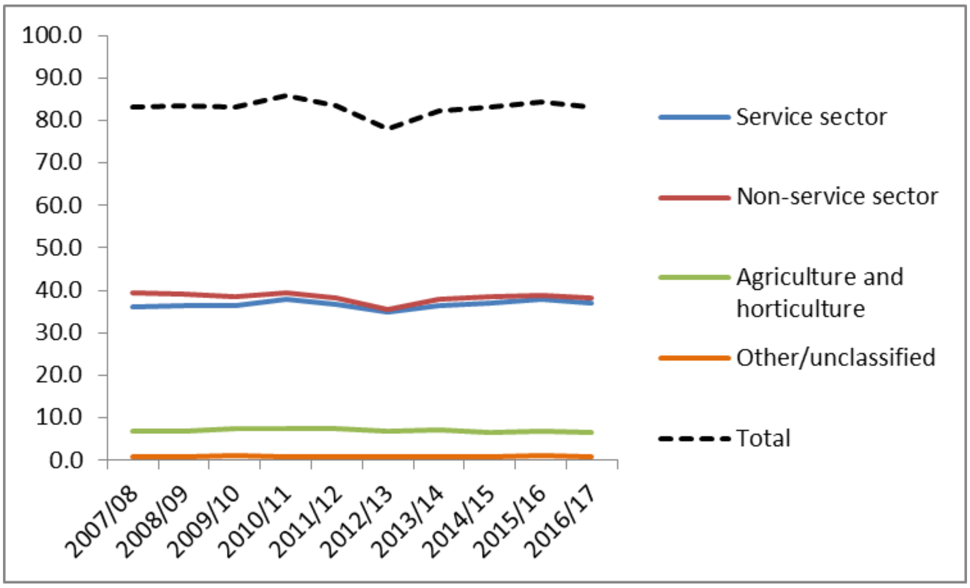
Note: Values may not sum exactly due to rounding

6.2.2 Analysis of demand

For each category we undertook econometric and trend-based statistical analyses to seek relationships between total annual demand and possible explanatory factors, such as economic growth and employment factors and time trend. It was necessary to use annual data because meters are read quarterly on a rolling basis for most customers and so the audited annual data, derived at the end of the financial year, provides the most reliable volumes.

The annual volumes since 2007/08, as calculated from meter reading records are presented in Figure 13. These have been derived on a consistent basis from the billing system but before allowing for meter registration, water balance reconciliation and dry weather effects, and so they are not directly comparable with the dry year annual average volumes presented later in this section.

Figure 13. Annual metered non-household volumes by sector (Ml/d)



Note: As explained above, these volumes are not equal to DYAA volumes

We found correlations between demand and economic factors for the agriculture/horticulture and service sectors, but the strength of the relationships was weak. In view of the significant uncertainties for the economy and employment in south east England as a result of Brexit over the planning period it was decided that forecasts of economic factors are too uncertain for use in the forecasting. Although there have been some fluctuations from year to year, non-household demand has generally remained at a steady level over the last 10 years. The fluctuations are relatively small and our latest analyses have found that there are no statistically significant trends. Therefore, it was decided to assume, for the purpose of the demand forecast, that non-household water consumption under normal weather conditions will remain at current levels in the future. We have recognised potential substantial uncertainty in our demand scenarios as explained in Section 6.9.

6.3 Consultation with retailers

We have consulted with each of the retail water suppliers in our area, in particular to understand their expectations of future demand. As yet we have not received any responses that affect our plan. We will revisit the implications as further consultation responses are received.

6.4 Our approach to weather effects on demand

Recent studies by UKWIR/Environment Agency (2013) of weather effects on non-household demand found that water consumption by agriculture and horticulture in south east England was affected by weather; water demand increased in hotter, drier weather. Insufficient evidence was found to derive reliable relationships between water demand and weather for other non-household sectors.

On our behalf, consultants HRW updated the analysis they used for the UKWIR study to establish new estimates for the effect of weather on water demand by agriculture and horticulture across our water supply area. The results are summarised below for dry year annual average and peak week conditions (DYAA and DYCP respectively).

Table 15. DYAA and DYCP factors for agriculture and horticulture demand

Resource zone	DYAA factor	DYCP factor
All water resource zones	1.099	2.530

Note: DYAA demand = NYAA demand * DYAA factor; DYCP demand = DYAA demand * DYCP factor

The DYAA factor for the whole company (1.099), for example, suggests that water consumption by agriculture and horticulture averaged across the year is 9.9% higher in a dry year than in a normal weather year. Likewise the DYCP factor for the whole company (2.530) indicates that water consumption by agriculture and horticulture in the peak week of a dry year is 2.53 times the average consumption in a dry year.

6.5 Our approach to climate change effects

National guidance (UKWIR/Environment Agency, 2013) has been prepared on the calculation of climate change effects on water demand. As part of the recent weather-demand modelling study for South East Water, HRW updated the analysis of climate change effects on agriculture and horticulture demand in accordance with the UKWIR approach. The following table summarises the climate change factors that were derived for dry year annual average and peak week conditions (DYAA and DYCP, respectively).

These values assume that climate change effects should be applied to current as well as future household demands, in line with Environment Agency guidance (2017a). No allowance for climate change was included in the 2014 WRMP for any non-household sector.

Table 16. Climate change factors for agriculture and horticulture demand (for all water resource zones)

	Climate change factor at 2017/18	Climate change factor at 2044/45
Factor for DYAA conditions	1.076	1.125
Factor for DYCP conditions	1.077	1.126

Notes: DYAA demand with climate change = NYAA demand * DYAA factor * DYAA climate change factor;
DYCP demand with climate change = DYAA demand * DYCP factor * DYCP climate change factor

6.6 Unmeasured non-household consumption

Unmeasured non-households are usually relatively small users of water and their supply pipework configuration makes it difficult to install metering.

Our demand forecast for unmeasured non-households is summarised in the following table. It shows that the number of unmeasured non-households has reduced substantially over the last 5 years as a result of our non-household metering programme and reclassification of some non-households as households in line with new regulatory requirements. Most of the remaining unmeasured non-households are considered impractical to meter and so we have assumed only a small further reduction in the future. We have assumed that the average consumption will remain at about 1100 l/prop/day, and changes due to variations in weather are negligible.

Table 17. Summary of unmeasured non-household demand forecast

Resource zone	2011/12	2017/18	2044/45
Number of unmeasured non-households ('000)	5.4	2.6	2.6
Estimated average consumption (l/prop/day)	1100	1100	1100
Unmeasured non-household water consumption (Ml/d)	6.1	2.9	2.9

6.7 Baseline non-household consumption forecast

The following graph and table summarise our forecasts of annual average non-household consumption in dry weather (DYAA). The values include dry weather and climate change effects on the consumption by measured agriculture and horticulture customers – no weather or climate change effects have been applied to other customer volumes. Figure 15 summarises the forecast of total non-household demand for each water resource zone. Table 18 shows that total non-household consumption is forecast to remain similar to current levels in the future, but consumption by agriculture and horticulture is expected to increase as a result of climate change impacts.

Throughout the development of the non-household demand forecast, discussions with stakeholders who work closely with non-household water users were held via the Kent Water Task Group and South East Water's WRMP19 Environmental Focus Group (EFG). These groups include representatives from the Environment Agency, National Farmers Union, Kent County Council, East Malling Research and local farmers.

These discussions helped to inform the agricultural and horticultural demand forecast. Overall it was concluded that a declining forecast based on historic trends is appropriate. During an EFG meeting a representative from Kent County Council made the point that since the WRMP14 forecast was developed the situation has changed. Proposed changes to abstraction licencing due to abstraction reform has resulted in farmers becoming more self-sufficient by increasing on site storage and also by maximising the use of their abstraction licences to ensure that their licences were preserved in the future.

Figure 15. DYAA non-household consumption forecast by water resource zone (Ml/d)
(including measured and unmeasured consumption)

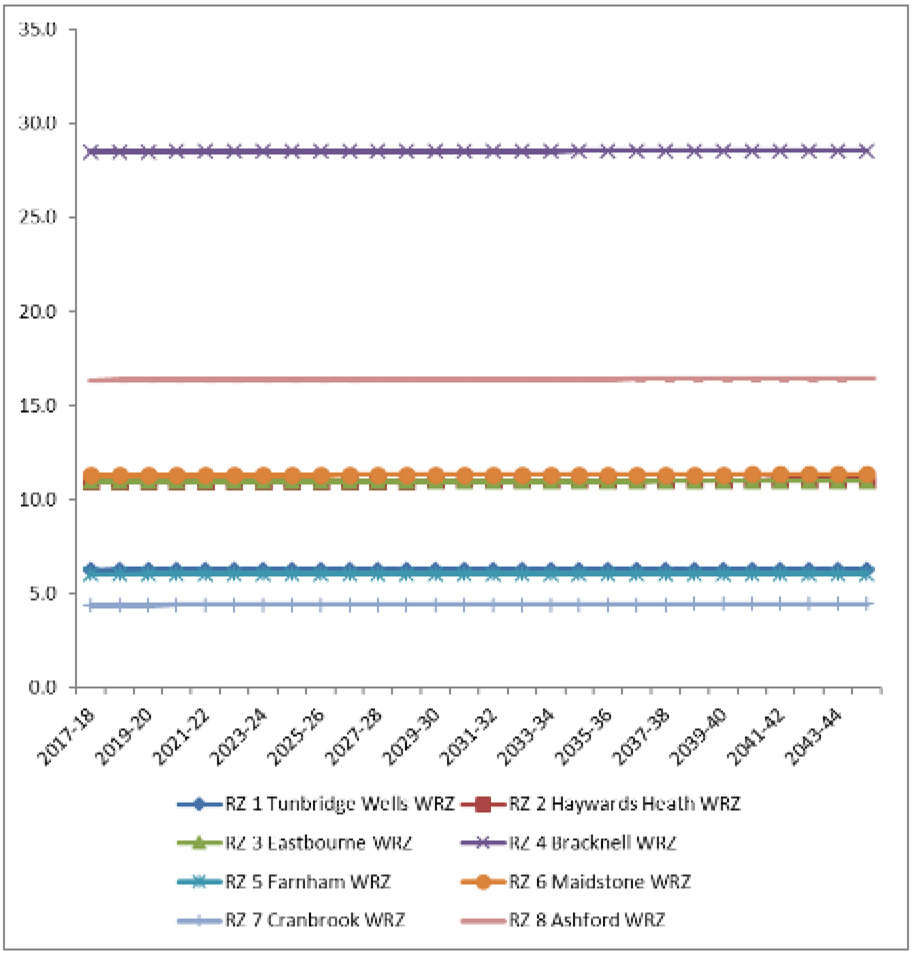


Table 18. DYAA non-household consumption forecast by property type (Ml/d)

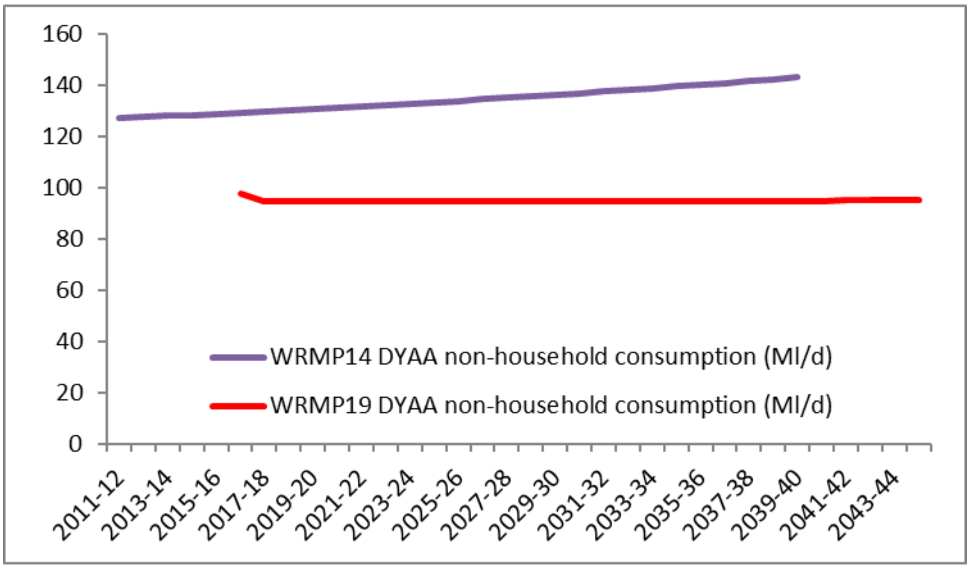
	2017/18	2044/45	2079/80
Measured consumption by agriculture and horticulture (including dry weather effects and climate change) (Ml/d)	8.0	8.4	8.9
Measured consumption by service and non-service sectors, and unclassified non-households (Ml/d)	83.8	83.8	83.8
Unmeasured consumption by non-households (Ml/d)	2.9	2.9	2.9
Total non-household consumption (Ml/d)	94.7	95.1	95.6

6.8 Comparison with WRMP14 forecast

Our total non-household consumption forecast under dry weather conditions is compared with the 2014 WRMP14 forecast below. We are forecasting a lower rate of increase based on our latest analyses because:

- Some properties have been reclassified as households in line with new regulatory guidance
- Our latest, more detailed, studies suggest that the effect of weather on non-household demand is less than previously estimated.

Figure 16. Comparison of WRMP14 and WRMP19 DYAA forecasts of total non-household consumption

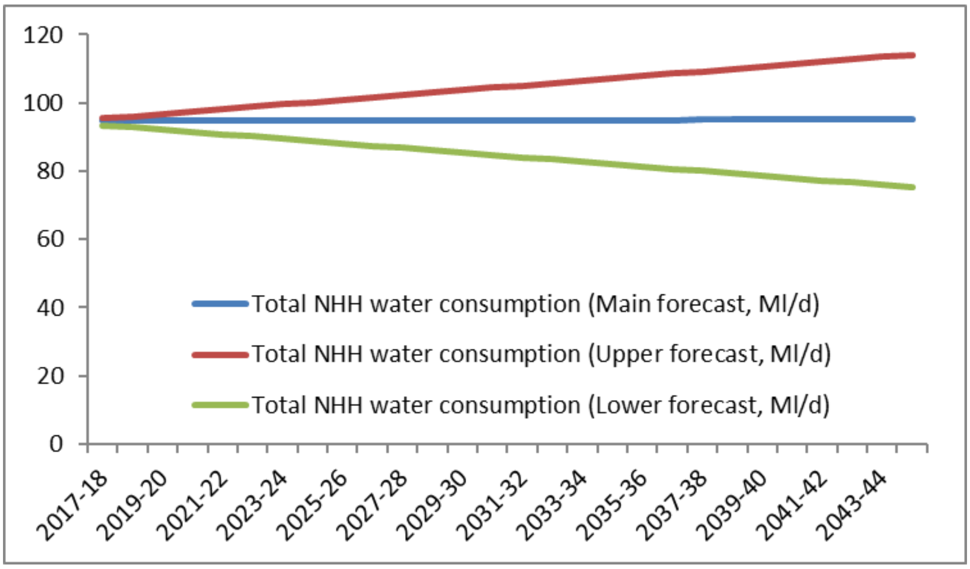


6.9 Uncertainties

There is inevitable uncertainty in estimates of future non-household demand. Economic and employment growth profiles are inherently uncertain, but particularly so at present as the potential effects of Brexit are unknown. We expect there will be further changes in agricultural and horticultural practices, further structuring of the non-service sectors, and continuing drives to be more efficient by reducing water use where possible. Also there will be the introduction of new types of non-households over the long-term. The effects of weather and climate change on consumption by some customers is also uncertain.

We have therefore allowed for significant uncertainty in our range of forecasts for non-household demand, as shown in Figure 17 - the upper and lower forecasts are 20% higher and 20% lower than the main forecast at 2044/45. The ranges have been included in our overall uncertainty appraisal in Section 9.

Figure 17. Main, Upper and Lower non-household demand forecasts under dry weather (DYAA) conditions (Ml/d)



7. Minor water use forecast

7.1 Water taken unbilled

Water taken unbilled includes:

- Licensed standpipe use by the fire service, road cleaning agents for local authorities and builders in construction of new properties
- Unbilled water use at our offices and other sites
- Water taken illegally by customers (either knowingly or unknowingly)

We estimate that the volume of water taken unbilled in 2017/18 across our supply area amounted to 9.7 Ml/d. This is based on a combination of meter readings and records or estimates of such activities and the volumes of water involved. We assume that water taken unbilled will continue at this level in the future.

7.2 Distribution system operational use

Distribution system operational use is water that South East Water uses in carrying out its operations on our distribution system. This includes water used to clean mains, or other distribution system assets, after repair or new installation.

We estimate that distribution system operational use in 2017/18 across our supply area amounted to 0.7 Ml/d. This is based on records of mains cleaning and asset cleaning, and estimated volumes of water used. We assume that distribution system operational use will continue at this level in the future.

7.3 Summary of minor water use

Our forecasts of minor water use are summarised in the following table. We have not included any allowance for dry weather effects as we consider that that any change in minor use due to variations in weather conditions is negligible.

Table 19. Summary of minor water use

	2017/18	2044/45
Water taken unbilled (Ml/d)	9.7	9.7
Distribution system operational use (Ml/d)	0.7	0.7

8. Leakage forecast

8.1 Our approach to leakage estimation

For calculation of leakage levels we have applied nationally accepted good practice methods (e.g. UKWIR, 2011) using information from our extensive network of monitoring flows and pressures throughout our distribution systems. Also, we have assessed the implications of the recent guidance on improving consistency of reporting by water companies (UKWIR, 2017b and Environment Agency, 2017b). We have identified some changes that will be implemented over the next few years.

Further details of our leakage estimation and leakage control activities are given in Appendix 5D Leakage. It also describes our application of the recent UKWIR guidance on consistency of reporting performance measures for leakage and policies that could impact on future leakage levels.

8.2 Baseline total leakage

Total leakage (i.e. total water losses from our distribution system and our customers' external supply pipes) has reduced from 95.2 Ml/d in 2011/12 to 87.7 Ml/d in 2017/18. This is lower than the 90.0 Ml/d target set in our 2014 WRMP for 2017/18.

Our baseline leakage forecast assumes re-setting of the baseline leakage level at the 2017/18 level of 87.7 Ml/d. We have assumed that, in line with regulatory guidance, leakage levels will not increase in the future and so our baseline forecast is for leakage to remain at the 2017/18 level, as summarised in the following table. We have identified potential innovation and technological improvements that could enable more economic measures for leakage reduction, which are discussed in Appendix 5D and assessed in our options appraisal in Appendix 7.

The estimated volume of leakage from customer supply pipes has reduced, as shown in Table 20, as a result of the customer metering programme which has helped incentivise customers to get leaks on their pipes repaired more quickly. Our baseline forecast assumes that the volume of customer supply pipe leakage will remain at current levels despite the continual growth in the number of homes being connected to our water mains.

The average total leakage per property is expected to continue to reduce significantly as we maintain the baseline volume of total leakage at no more than 87.7 Ml/d.

Table 20. Summary of baseline leakage forecast

Resource zone	2011/12	2017/18	2044/45
Distribution losses (Ml/d)	71.2	70.0	70.0
Customer supply pipe losses (Ml/d)	24.0	17.7	17.7
Total leakage (Ml/d)	95.2	87.7	87.7
Average total leakage per property (l/prop/day)	107	94	72

Note: The volumes presented in this table are for the baseline position, and so exclude the effects of the leakage reduction options in our preferred plan.

8.3 Final planning total leakage

Significant leakage reduction in the future has been identified as part of our plan to maintain reliable water supplies, as described in Appendix 9 Our preferred plan.

9. Baseline total demand forecast

9.1 Total baseline demand forecast

This section summarises our annual average baseline demand forecasts in a dry weather year (Ml/d) (DYAA forecasts). The values include the effects of climate change. The baseline forecasts presented in this report exclude the effects of additional demand management measures that are part of our preferred plan and are included in the final planning demand forecasts presented in Appendix 9.

Table 21 and Figure 18 show that distribution input is expected to continue to reduce while we complete our customer metering programme and those households that are transferred to metering reduce their consumption. Unmeasured household consumption reduces and metered household consumption increases.

After completion of the metering programme in 2018/19 metered household consumption steadily increases as a result of new homes being built and increased population. Also the effect of climate change on consumption by households and the agriculture and horticulture sector is expected to gradually increase. In consequence, our baseline demand forecast increases in the future.

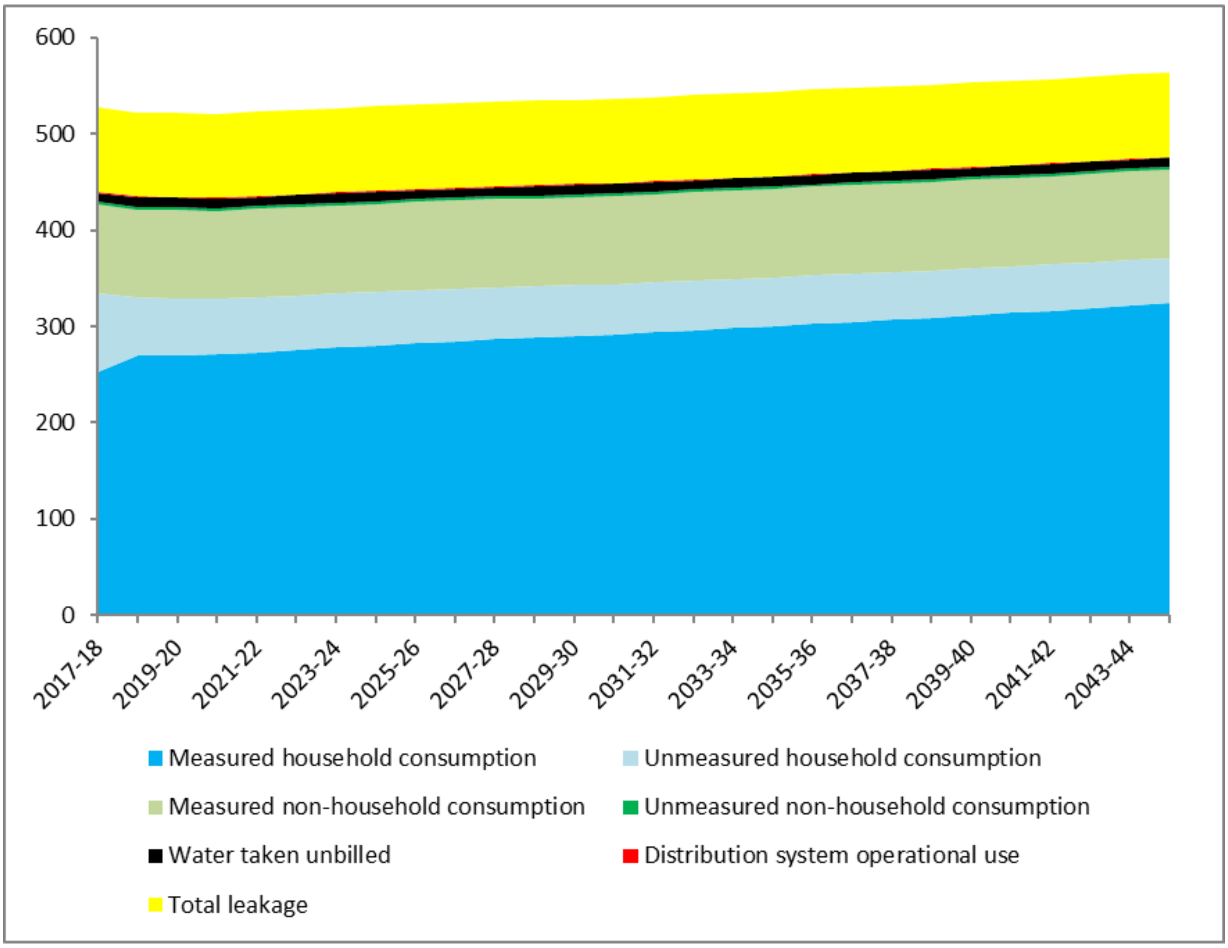
As shown by Figure 19, the baseline demand forecast trends are similar for each water resource zone.

Table 21. DYAA baseline demand forecast for whole company by demand component (Ml/d)

	2017/18	2019/20	2024/25	2034/35	2044/45	2079/80
Measured household consumption	252	270	280	300	324	396
Unmeasured household consumption	82	59	55	51	47	44
Measured non-household consumption	92	92	92	92	92	93
Unmeasured non-household consumption	3	3	3	3	3	3
Water taken unbilled	10	10	10	10	10	10
Distribution system operational use	1	1	1	1	1	1
Total leakage	88	88	88	88	88	88
Total DYAA distribution input	527	522	528	544	564	634

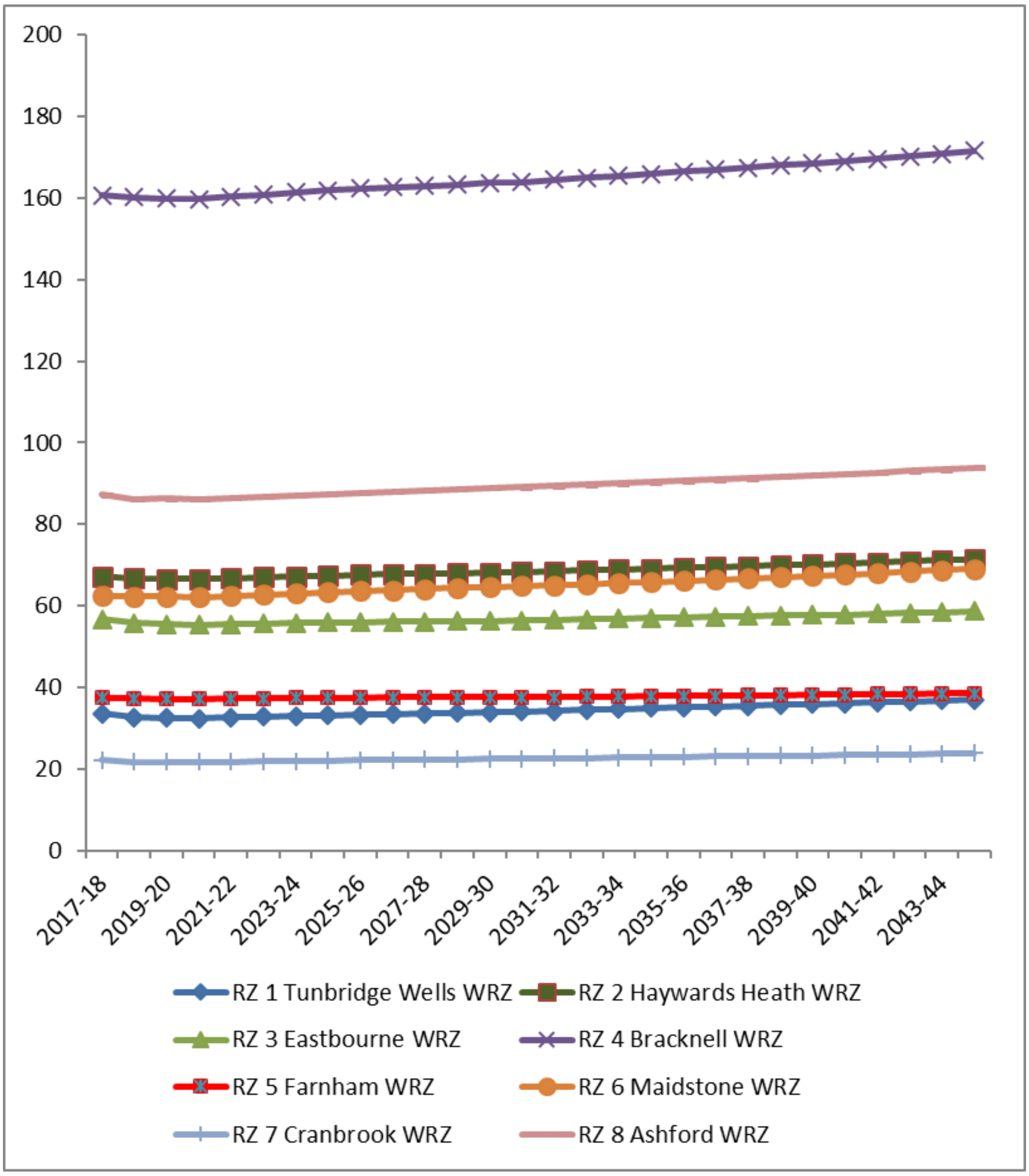
Notes: Values may not sum exactly due to rounding. These baseline leakage and consumption forecasts do not take account of any new demand side options selected for inclusion in the final plan. Those effects are included in the final planning forecasts.

Figure 18. Summary of DYAA baseline demand forecast for whole company by demand component (Ml/d)



Note: These baseline forecasts do not take account of any new demand management options selected for inclusion in the final plan. The effects on leakage and consumption are included in the final planning forecasts.

Figure 19. DYAA total baseline demand forecast by water resource zone (Ml/d)

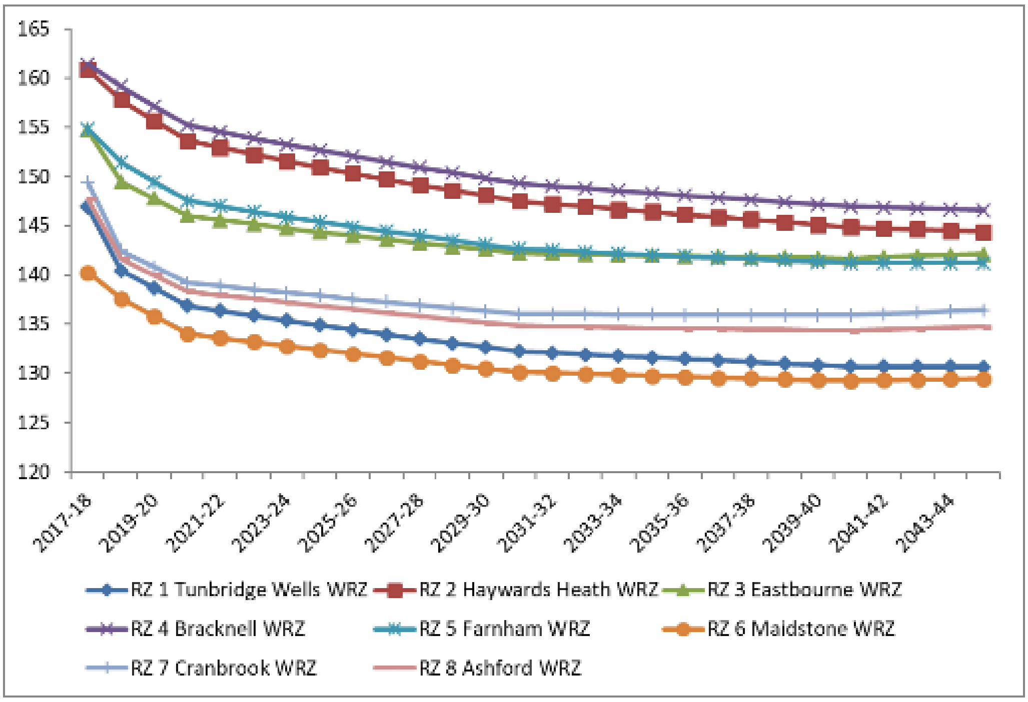


Note: These baseline forecasts do not take account of any new demand management options selected for inclusion in the final plan. The effects on leakage and consumption are included in the final planning forecasts.

9.2 Per capita consumption forecast

We expect average per capita consumption (i.e. averaged across all our household customers) for dry year annual average (DYAA) conditions to reduce from 154 l/h/day in 2017/18 to 140 l/h/day in 2044/45. These result from our continuing demand management programme and expected changes in appliance ownership and usage. The forecast reductions for each water resource zone are shown in Figure 20.

Figure 20. Baseline DYAA average per capita consumption forecasts by water resource zone (l/h/day)

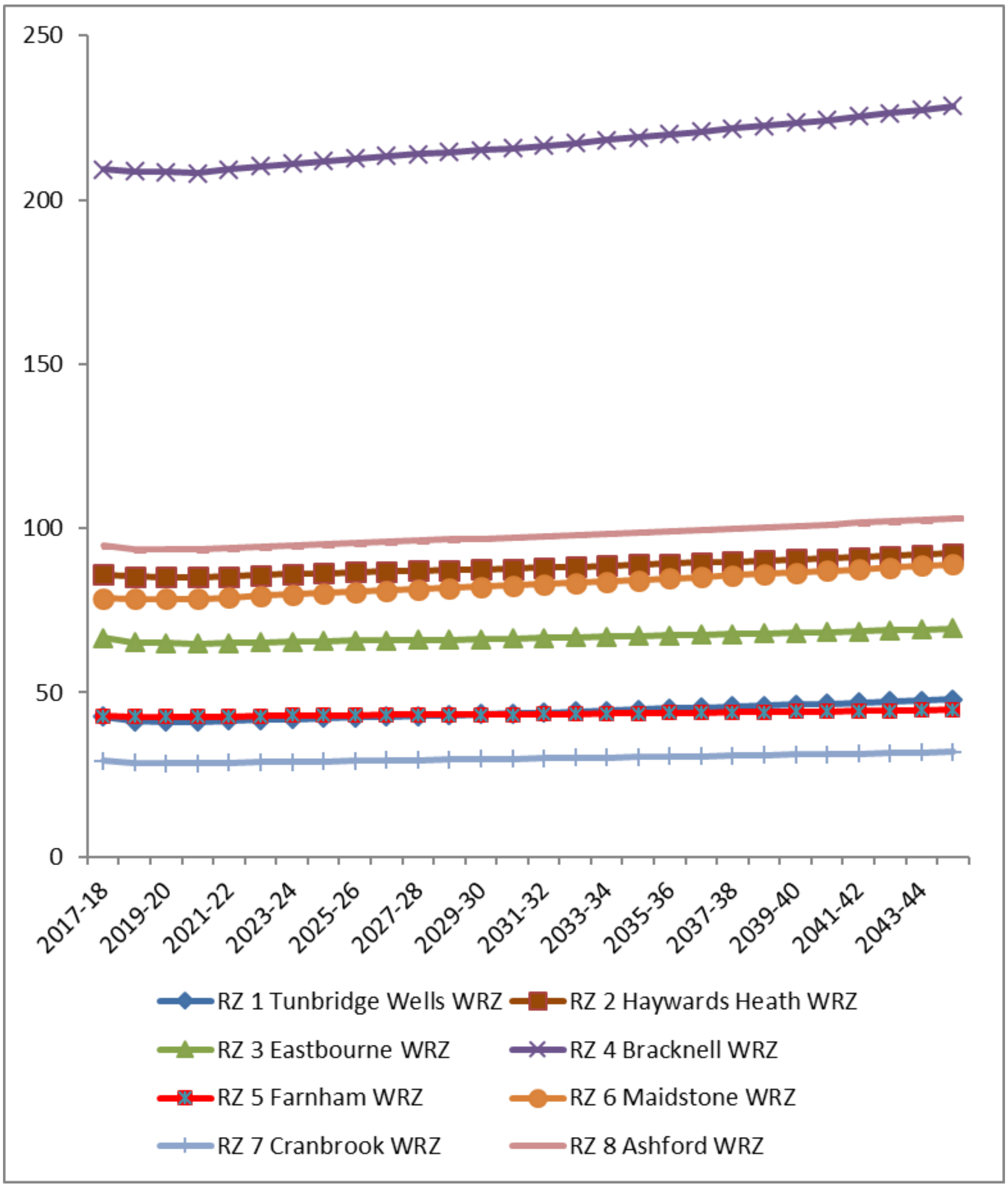


Note: These baseline forecasts do not take account of any new demand management options selected for inclusion in the final plan. The effects on leakage and consumption are included in the final planning forecasts.

9.3 Critical period demand forecast

The following graph presents the peak week (critical period) demand forecast in dry weather (DYCP) for each water resource zone. The values include climate change effects. The factors used to calculate peak week household and non-household demands are presented in Sections 5.4, 5.5, 6.4 and 6.5.

Figure 21. DYCP total baseline demand forecast by water resource zone (Ml/d)



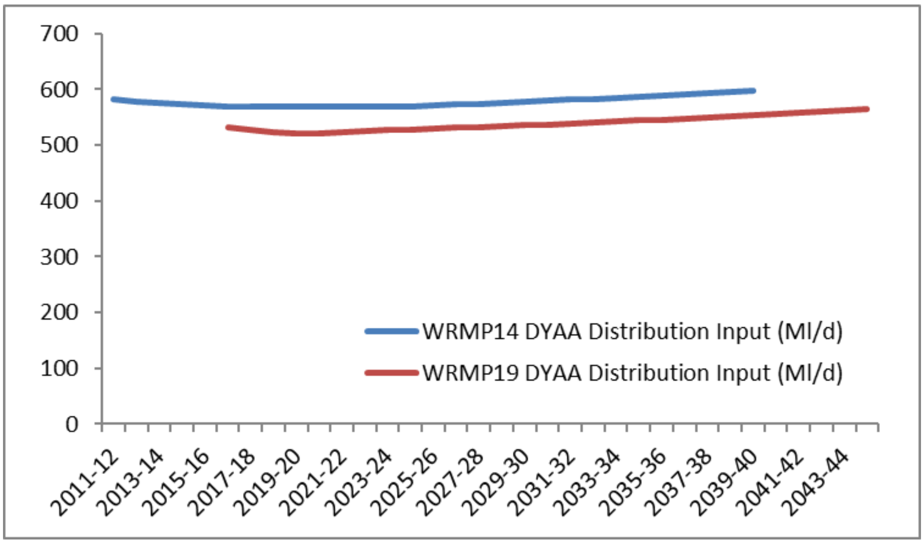
Note: These baseline forecasts do not take account of any new demand management options selected for inclusion in the final plan. The effects on leakage and consumption are included in the final planning forecasts.

9.4 Comparison with WRMP14 demand forecast

We have compared our latest demand forecast with that produced for our 2014 WRMP. Figure 22 shows the comparison for dry weather year conditions. The future trend is very similar – both forecasts assume reduction in demand in the early years until completion of the customer metering programme, and slow increases in demand thereafter resulting from the increasing population.

As explained in Section 3.1 water demand has reduced more quickly since 2011/12 (the base year for WRMP14) than forecast in the 2014 WRMP, partly as a result of our demand management programme.

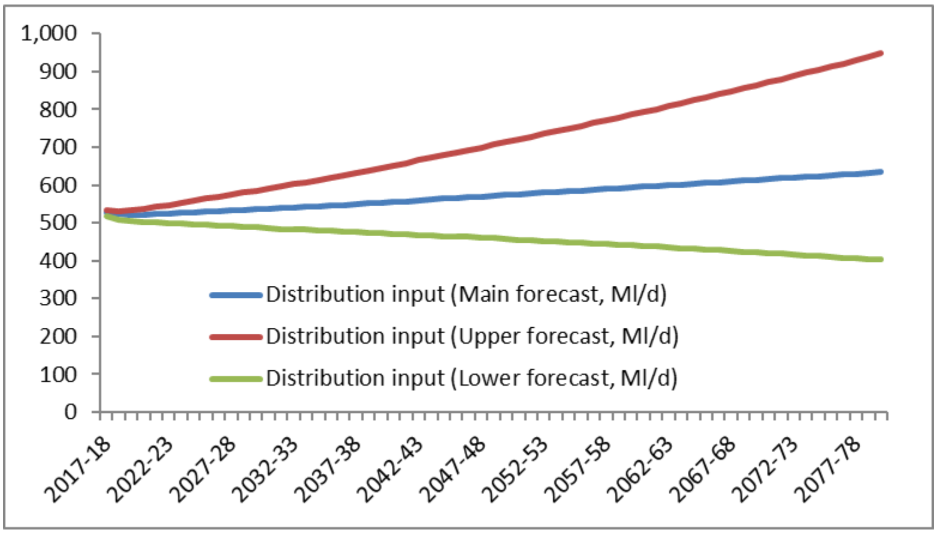
Figure 22. Comparison between WRMP14 final planning and WRMP19 baseline DYAA demand forecasts (Ml/d)



9.5 Uncertainty appraisal

There is significant uncertainty in demand forecasts as it is difficult to accurately predict future trends. For example, population growth, water use patterns by customers and climate change impacts may be different to our current best assessments. Figure 23 summarises our range of baseline forecasts under dry year annual average (DYAA) conditions - these do not take account of the significant additional demand management measures included in our preferred plan.

Figure 23. Main, Upper and Lower DYAA baseline demand forecasts (Ml/d)



Note: These baseline forecasts do not take account of any new demand management options selected for inclusion in the final plan. The effects on leakage and consumption are included in the final planning forecasts.

Table 22 examines the degree of sensitivity of the dry year annual average demand forecast to a range of key assumptions. It shows that uncertainty in the population forecast (which we have applied to the household population) is the largest source of uncertainty – this is based on the work of UKWIR/Environment Agency (2015a) as described in Section 4. Uncertainty in future per capita consumption rates as household customers change the way they use water in the future is also significant, as described in Section 5.

Table 22. Sensitivity of the baseline DYAA demand forecast for the whole company area at 2044/45 to key assumptions for the Main, Upper and Lower forecasts

Element	Assumption for Main forecast at 2044/45	Assumption for Upper forecast at 2044/45	Assumption for Lower forecast at 2044/45	Range of impact on DYAA forecast at 2044/45 relative to Main forecast
Forecast population in households	2.65 million	3.00 million (13% higher than Main)	2.30 million (13% lower than Main)	-46 Ml/d (lower) +51 Ml/d (upper)
Average PCC forecast	140 l/h/day	154 l/h/day (10% higher than Main)	133 l/h/day (5% lower than Main)	-18 Ml/d (lower) + 40 Ml/d (upper)
Metering effect on consumption for metered household customers	18% reduction in consumption	15% reduction in consumption	21% reduction in consumption	-1 Ml/d (lower) + 1 Ml/d (upper)
Non-household consumption forecast	95 Ml/d	114 Ml/d (20% higher than Main)	76 Ml/d (20% lower than Main)	-19 Ml/d (lower) + 19 Ml/d (upper)
Leakage forecast	88 Ml/d	92 Ml/d (5% higher than Main)	84 Ml/d (5% lower than Main)	-4 Ml/d (lower) + 4 Ml/d (higher)
Climate change impacts	Included	Included	No climate change impacts	-10 Ml/d (lower) 0 Ml/d (upper)
Total DYAA demand at 2044/45	**564 Ml/d**	**679 Ml/d**	**465 Ml/d**	**-98 Ml/d (lower) +115 Ml/d (upper)**

Note: Values may not sum exactly due to rounding

We have allowed for significant uncertainty in non-household demand as we recognise the potential for changes in agricultural practices and changes in water uses by other non-household customers (see Section 6.9). We also recognise that the UK's exit from the EU will impact on housing and economic developments in the long-term but it is very difficult to quantify what the effects will be or in which direction (up or down).

The results from our demand uncertainty assessments have been used in our target headroom and our risk-based options appraisal (see Appendix 6 Supply-demand balance and Appendix 7 Options).

9.6 Final planning demand forecasts

This appendix presents baseline demand forecasts, which are our initial forecasts before taking account of leakage reduction and other significant demand reducing options in our final plan. Our final planning demand forecasts are summarised in Chapter 9 “Our preferred plan” of the Main Report.

10. Conclusions

We have undertaken baseline demand forecasting analysis for our company area and for each of our 8 water resource zones in accordance with regulatory guidance and national good practice methods. The baseline demand forecast is our initial forecast, which excludes the effects of any leakage reduction or other demand reducing options in our preferred final plan. The final planning demand forecast is summarised in Chapter 9 of the Main Report.

Our baseline demand forecast includes the following features:

- We plan to complete of our customer metering programme to achieve about 90% meter penetration by 2018/19.
- We have calculated plan-based property and population forecasts:
  - The total number of households we supply water to is anticipated to increase by 33% from 0.86 million in 2017/18 to 1.14 million in 2044/45, in line with local authority planning forecasts.
  - The total population we supply water to is expected to increase by 22% from 2.2 million in 2016/17 to 2.7 million in 2044/45.
- We have used micro-components analysis to calculate household consumption forecasts. Average household per capita consumption under dry weather year conditions is forecast to reduce from 154 l/h/day in 2017/18 to 140 l/h/day by 2044/45 as a result of our customer metering programme, continued promotion of water efficiency and expected changes in appliances, their ownership and their usage.
- Econometric and trend-based analyses have been used to investigate the factors that may affect non-household demand. No statistically significant factors were found. Non-household demand under normal weather conditions is therefore forecast to remain at current levels.
- A detailed weather-demand modelling study was undertaken to identify how water consumption by households, agriculture and horticulture are affected by variations in weather. The results were used in the assessment of demands under different weather scenarios and to estimate the impact of climate change.
- Baseline total leakage, before taking account of leakage reduction measures identified by the options appraisal, is forecast to remain at 2017/18 levels.
- Total dry weather annual average (DYAA) baseline demand is forecast to continue to reduce from 527 Ml/d in 2017/18 to 522 Ml/d in 2019/20 as a result of completing our customer metering programme. DYAA demand is forecast to gradually increase to 564 Ml/d by 2044/45 as a result of new homes being built and growing population.
- We have recognised there is uncertainty in the demand forecast estimates and have applied alternative demand scenarios in our risk-based options appraisal.

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