Water Resources Management Plan 2019

Main Report

Issue No. 1

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August 2019

Document Revision History

Rev	Purpose	Originated	Checked	Reviewed	Authorised	Date
1	Initial draft for Director Approval	AM	AM	TK	TK	24/8/18
2	Final draft for submission – Issue 1	AM	AM	TK	TK	3/9/18
3	Revised to include Defra further information requests – Issue 2	AM	AM	TK	TK	6/5/19
4	Final plan – authorisation to publish given by Defra	AM	AM	TK	TK	20/8/19

Security Statement

This statement is to certify that this plan does not contain any information that would compromise national security interests.

It also does not contain any information that may be considered commercially confidential.

No information been excluded from this plan on these grounds.

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1.0 Glossary of Terms

Term	Definition
AA	Annual average
ADO	Average Deployable Output
AIC	Average Incremental Cost
AISC	Average Incremental Social Cost
ALC	Active Leakage Control
AMP	Asset Management Period
AMR	Automatic Meter Reading
AR	Artificial Recharge
ARU	Aquifer Resource Unit
ASR	Aquifer Storage and Recovery
BAG	Benefits Assessment Guidance (EA, 2002)
CAMS	Catchment Abstraction Management Strategy
CBA	Cost Benefit Analysis
CO2e	Carbon dioxide equivalents
CP	Critical period
CSL	Customer side leakage
CSP	Customer Scrutiny Panel
Defra	Department for Environment, Food and Rural Affairs
DI	Distribution Input
DMA	District Meter Area
DO	Deployable Output
DSOU	Distribution System Operational Use
DWI	Drinking Water Inspectorate
dWRMP	Draft Water Resources Management Plan
DY	Dry Year
EA	Environment Agency
EBSD	Economics of Balancing Supply and Demand
EFI	Environmental Flow Indicator
GES	Good Ecological Status
GIS	Geographic Information System
GLA	Greater London Authority
HDF	Hour Day Factor (to adjust NFM to account for daily pressure profile)
KNC	Known Night-time Consumption (legitimate night use in a DMA)
INNS	Invasive Non-Native Species
LoS	Level(s) of Service
MDO	Minimum Deployable Output
Ml/d	Million litres a day

NPV	Net Present Value
NRR	Natural Rate of Rise (of leakage)
NY	Normal Year
OA	Output Area
Ofwat	Water Services Regulation Authority
ONS	Office for National Statistics
PCC	Per capita consumption
PET	Potential Evapotranspiration
PR14	Periodic Review 2014
PR19	Periodic Review 2019
PDO	Peak Deployable Output
RBMP	River Basin Management Plan
SDS	Strategic Direction Statement
SELL	Sustainable Economic Level of Leakage
SESW	SES Water (trading name for Sutton and East Surrey Water plc)
SR	Sustainability Reduction
SSE	Scottish and Southern Energy
TPC	Traded Price of Carbon (for carbon emissions subject to the EU-Emissions Trading Scheme)
UKWIR	UK Water Industry Research
WAFU	Water Available For Use
WDHR	Worst Drought on Historic Record
WEFF	Water efficiency
WFD	Water Framework Directive
WINEP	Water Industry National Environment Programme
WRGIS	Water Resources Geographic Information System
WRMP(XX)	Water Resources Management Plan (14=2014, 19 = 2019, 24=2024)
WRPG	Water Resources Planning Guideline
WRSE	Water Resources in the South East group
WRZ	Water Resource Zone
WTW	Water Treatment Works
%ile	Percentile

2.0 Introduction

2.1 Overview of the Water Resources Management Plan Process

All water companies in England and Wales are legally required to prepare and maintain a Water Resources Management Plan (WRMP). Each plan sets out how the company intends to balance water supply and demand over a period of at least 25 years. Companies are also required by statute to produce a drought plan, which sets out the short-term operational steps needed as a drought progresses, to enhance supplies, manage demand and minimise environmental impacts.

This plan has been developed in line with the *Water Resources Planning Guidelines* (WRPG) including updates issued in July 2018, and associated supplementary guidance issued by the Environment Agency (EA) and Natural Resources Wales. Alongside these guidelines, Defra issued the document *Guiding Principles for Water Resources Planning* (May 2016).

In addition, Defra and the Welsh Government have issued specific requirements in the form of the Water Resources Management Plan Direction 2017, in April 2017. Other documents used in formulating this plan are listed in Section 2.3.

The process of producing a WRMP involves six stages, as shown in Figure 1, starting with a calculation of the supply and demand forecasts. Where the supply forecast is not sufficient to meet demand at any point in the planning period, then this deficit must be solved through a comparison of options. Possible options are discussed with stakeholders to gain their views on which options are in the best interests of customers and the environment.

Figure 1: WRMP Process

As stated in the WRPG, the methods selected throughout the process are determined by characterising the extent of the planning problem. This is described further in Section 3.3, alongside further details on how the plan is formulated, such as defining the water resource zone(s) to be used. The final stage of the process is to assess the environmental and social impacts of the options so that a preferred plan can be selected and put forward for consultation.

2.2 Our supply area

SES Water is a water supply only company covering an area of 835km^2. We currently supply 707,000 consumers in over 286,000 properties. As well as covering a large proportion of Surrey, the supply area extends into parts of Kent, West Sussex and Greater London (Figure 2).

On average, we supply 160 million litres of water a day with 85% of the raw water being extracted from groundwater resources and 15% from Bough Beech Reservoir, supplied by a pumped river abstraction from the River Eden in Kent. Our network contains trunk mains capable of transferring water from Bough Beech WTW to the central and northern parts of the supply area.

The geology of the supply area is shown in Figure 3, showing the bands of London clay, chalk, greensand and Wealden clay, occurring from the north to south of our area. We abstract groundwater from boreholes in both the chalk and greensand strata.

Figure 2: Our supply area and Water Treatment Works

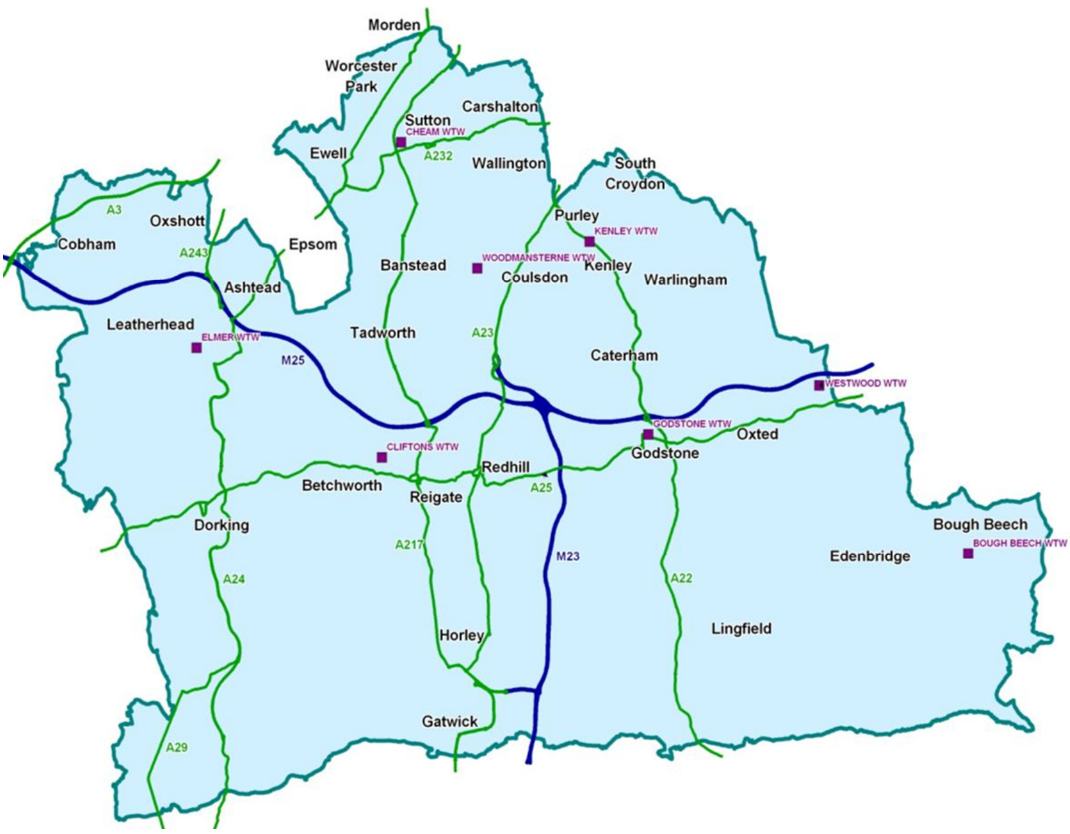
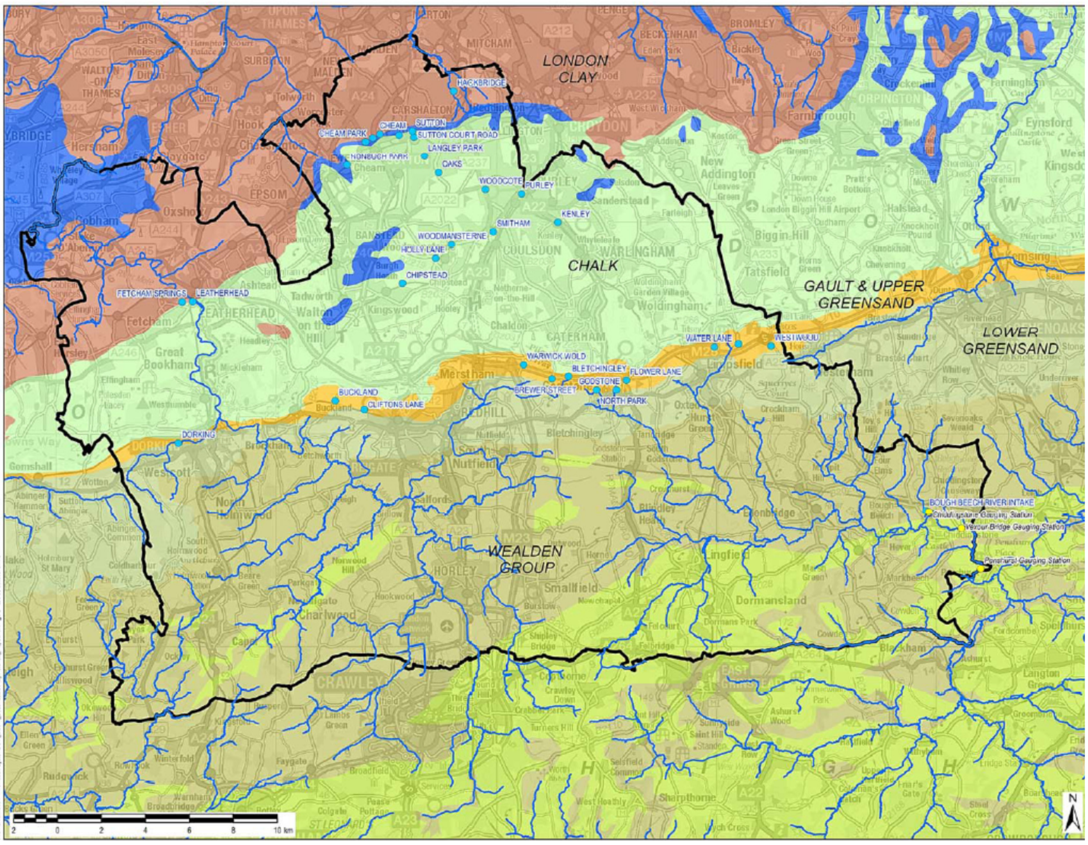


Figure 3: Geology of our supply area



2.3 Links to other plans

2.3.1 Talk on Water

We issued a document '*Talk on Water – Looking Forward*', to replace and update the Strategic Direction Statement (SDS) that we published in 2013. In this, we set out our key challenges and opportunities and how we intended to use customer and stakeholder expectations to inform our Business Plan.

2.3.2 Business Plan

We have prepared our Business Plan for the 2019 Periodic (Price) Review alongside the WRMP. Ofwat scrutinises water companies' proposals for company-wide activities (including water resources) and sets price limits for the following five-year period, known as an Asset Management Planning (AMP) period. In the case of PR19, price limits will be set for AMP7, from 2020/21 to 2024/25. The Final WRMP forms a part of water companies' Business Plans and is therefore subject to the same level of scrutiny with respect to price limit determinations.

We will focus on the five customer pledges central to our current Business Plan:

- High quality water all day, every day
- Fair prices and help when you need it
- A service that is fit now and for the future
- Excellent service, whenever and however you need it
- Support a thriving environment we can all rely upon

Building on this, our new Business Plan has been built around four key themes:

- Affordable bills
- Innovation
- Long-term resilience
- Customer Service

The first three of these themes are relevant to water resources planning, and have been considered throughout this plan. This is detailed further in Section 10.2.

2.3.3 Drought Plan

Water companies in England and Wales are required to prepare and maintain drought plans. These plans set out the operational actions companies will consider taking in response to drought events of different severities, guided by the position at any time of reservoir and groundwater levels in relation to specified triggers. The aim of the plan is to minimise environmental impacts, but where potential impacts are identified, it presents a balance of measures that may include restrictions on customers' use of water.

We published a draft version of the Drought Plan 2019 plan for consultation in October 2017, with a revised draft plan and Statement of Response issued in February 2018. In July 2018 we were notified by Defra that additional considerations are required before the final plan can be published. The final plan dated May 2019 was published in June 2019.

Although a drought plan is an operational plan whilst the WRMP is a strategic plan, there are some significant areas of overlap. Both plans utilise the same methodology for assessing the amount of water available for use and the level of resilience to severe droughts, by using a modelling approach to assess the risk of a 1 in 200-year drought. This is described further in Section 3.5. In addition, drought management actions are consistent with our target levels of service, which also underpin the assessments of deployable output as stated in the WRMP. Levels of service are described in more detail in section 3.7 of this plan.

As set out in the drought plan, as a drought progresses in severity (as defined by Zone Levels 1 to 3B), we implement various Drought Orders and Permits. These include both demand-side (water use restrictions) and supply-side (drought sources and transfers) measures. However, for the purposes of long-term water resources planning, we have not included the demand reductions or additional supplies in the calculations. Whilst this may not reflect reality, in that during a severe drought these measures are very likely to be in place, it ensures we are planning for a worst-case scenario since it is not known whether these mitigations can be enacted. For example, there may be insufficient flow in the River Eden to abstract during the summer period. In summary, this plan does not rely on drought measures being available and therefore is more resilient to future droughts.

2.3.4 Strategic Environmental Assessment

A Strategic Environmental Assessment (SEA) is required under the SEA Directive because the WRMP is a statutory plan that sets a framework for future development consent with the potential to have significant impacts on the environment. This work was carried out following the options selection stage. Outputs from the SEA have been integrated into the options appraisal as part of the programme appraisal process, as detailed in Section 10.2.5. The SEA Environmental Report is published alongside the WRMP. This report also includes a Habitats Regulations Assessment of the impact of the options selected.

2.3.5 River Basin Management Plans

Water companies have a duty to ensure that their WRMP supports the objectives of the Water Framework Directive (WFD) and the River Basin Management Plans (RBMP). The overall aim of the RBMP, which is updated every six years, is for water companies, stakeholders and communities to work together so that more water bodies achieve a 'good ecological status' or a 'good ecological potential'. Our supply area is largely within the Thames RBMP.

Specifically, we must ensure that planned abstractions will:

- Prevent deterioration in water body status (or potential) compared to the baseline reported in the 2015 RBMP
- Restore sustainable abstraction if there has been deterioration in the first RBMP cycle (2015 to 2021)
- Support the achievement of protected area objectives
- Support the achievement of environmental objectives
- Not prevent the future achievement of 'good' status for a water body

Further details on the assessment of how this plan supports the objectives of the WFD and RBMP is given in Section 4.1.4.

2.3.6 Local Authority Plans

All local authorities consult on and publish plans on how they will accommodate and plan for growth in their areas, including homes, schools, and businesses. This takes the form of *Local Development Frameworks* and *Development Management Plans*, with supporting *Supplementary Planning Documents.*

The information contained in the latest available projections form part of our demand forecast, since they indicate likely numbers of new properties to be built over the next 15 years. Local Authorities do not tend to forecast beyond this time horizon. The outcome of this assessment is given in Section 5.2.

2.3.7 Flood Risk Management Plans

We periodically complete an assessment of the flood risk of our critical infrastructure. Over the last AMP period, we have carried out a number of improvements to flood protection at key sites, especially at Kenley WTW where a significant flooding event occurred in March 2014. We will continue to work with local authorities, the Environment

Agency (EA) and local residents so that flood action plans can be implemented and discussed with the communities involved.

2.4 Water Resources in the South East Group

The Company is a member of the Water Resources in the South East Group (the WRSE Group). This group includes representatives from the EA, Ofwat, Defra, the Consumer Council for Water and the six water companies in the South East of England (Affinity Water, Portsmouth Water, Southern Water, South East Water, SES Water and Thames Water). One aim of the group is to consider the opportunities and options for sharing resources on a regional basis.

The WRSE group employs consultants to carry out modelling on how resources can be shared through strategic options using the data collated for the WRMP19 plans, to find the best solutions in terms of cost and future resilience. These solutions were tested by assessing against a range of scenarios. A separate publication was issued in early 2018 to explain the outputs of modelling carried out, which can be viewed at www.wrse.org.uk. The report recommended options that companies should consider in their Draft WRMPs. The model has been updated with detailed of additional options added after publication of the draft plans, and also considered scenarios related to achieving the recommendations included in the NIC report on PCC and leakage reduction. This is discussed further in Section 10.2.7.

2.5 Competitors in the our supply area

We have no current or pending licensed suppliers within our supply area, and therefore competition currently has no impact on our supply-demand balance. We have no information on which to forecast the impact of any future licensees and therefore we have made no provision for such impacts within the demand forecast. We will keep this issue under review and will make due allowance for such arrangements should they arise.

Section Summary - Introduction

We supply water to 707,000 customers in south east England, mainly from boreholes in the chalk and greensand strata across the North Downs. This plan follows the guidance and requirements issued by government and regulators, and is aligned with our Business Plan 2019 and Drought Plan 2019.

We work closely with the Water Resources in the South East group so that our plan meets the needs for the region as a whole as well as for our own customers.

We have carried out a Strategic Environmental Assessment and Habitats Regulations Assessment on the outputs of the plan.

3.0 Methodology

The WRPG require that companies use industry guidance for many of the technical parts of the planning process, in particular those published by the UK Water Industry Research (UKWIR). For the WRMP19 plans, the guidance states that the companies are expected to use UKWIR's *Decision Making Process Framework* and the *Risk Based Planning Guidance.* Both of these documents will be referred to within this section. We have also discussed our approach with the EA and incorporated feedback from the technical documents shared with them in the final reports.

3.1 Pre-consultation on the Draft WRMP

We have held a series of meetings with the EA's water resources planning team during the preparation of this plan, in order to obtain agreement on key issues and discuss the methods to be employed. Early engagement meetings have also been held with Natural England, Ofwat and the Company's Customer Scrutiny Panel. A record of our pre-consultation activities is provided in Table 1.

Table 1: Record of pre-consultation activities

Organisation	Pre-consultation activity	Date
Environment Agency & Natural England	Progress meetings and discussion of method statements	Bi-monthly from March 2016 to October 2017
	Pre-consultation letter	August 2017
Ofwat	Presentation and submission of technical method documents	August 2017
Historic England	Invited to take part in consultation on scoping of Strategic Environmental Assessment	February 2017
Other water companies in the South East	SESW has proactively engaged with other water companies through the WRSE group	From March 2015 to November 2017
Other third parties (in respect of option identification)	Notice published to advertise the opportunity for third parties to offer potential options for consideration in our Draft WRMP	August 2016
Consumer Council for Water (SE Region)	Pre-consultation briefings	March 2017 & October 2017
Customer Scrutiny Panel	Pre-consultation briefings	April, July and September 2017
SESW customers – research as part of Business Plan process	Qualitative research using focus groups	February – June 2017
	Quantitative evaluation of views	Autumn 2017

The Customer Scrutiny Panel (CSP) is a group of representatives from regulators, local organisations and independents who challenge:

- the quality of our customer engagement and
- how well our proposed outcomes and outcome delivery incentives reflect the research carried out on customers' views and priorities

In addition to the pre-consultation activities specified, a large amount of email correspondence has occurred between SES Water and the organisations with whom we have discussed our WRMP. We have also updated our Board at regular intervals on the decisions taken regarding methodology.

3.2 Water Resource Zone (WRZ) Definition

The WRPG sets out guidance for water companies to demonstrate that their WRZs meet the WRZ definition. Companies are required to follow this guidance in order to demonstrate that their main water resources planning units are fit for purpose.

The UKWIR/EA definition of a WRZ (2012) is:
"*The largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers will experience the same risk of supply failure from a resource shortfall.*"

A WRZ is an area in which the management of supply and demand is largely self-contained, with the exception of bulk transfers into or out of the zone. It is acknowledged in the WRPG that "*perfect integration is not possible, as there will always be limitations to a supply network. However, the main factor is that significant numbers of customers should not be experiencing different risks of supply failure*."

We have undertaken a formal WRZ integrity assessment in accordance with the guidelines, with the assessment provided to the EA in confidence (for reasons of security) during pre-consultation.

3.2.1 Overview of WRZ integrity assessment

From the time of the Company merger in 1996 up to the last plan in 2014, we based our resource planning on two WRZs; namely Sutton WRZ and East Surrey WRZ.

Over that period, a number of trunk mains have been commissioned to interconnect the two zones, mainly to be able to transfer water supplies from East Surrey into Sutton during peak periods. From the time of the last plan in 2014, significant lengths of additional mains have been installed to improve the ability of the supply network to deal with emergency outages, with further resilience work planned for commissioning before April 2020. This is to achieve the specific aim of being able to supply all customers from more than one treatment works by 2030. By 2020, the capacity of these trunk mains will be to transfer around 47% of demand from East Surrey zone to Sutton zone, and 41% from Sutton zone into East Surrey zone. On this basis, we have determined that the WRZ integrity criteria allows the whole supply area to be classified as one WRZ.

The EA indicated that they were supportive of the results of our assessment, and therefore we have continued to plan for future needs on this basis.

In terms of existing bulk supplies, we operate an export to SSE, agreed at a maximum of 0.27 Ml/d, and a small bulk export to Southern Water Services, agreed at a maximum of 0.05 Ml/d in perpetuity.

In the draft plan, we were expecting that South East Water would construct a new pipeline to transfer supplies from our Outwood Service Reservoir to their service reservoir in Whitely Hill. This option, identified through the WRSE model for the 2014 plans, was planned to be operational by 2020. This transfer was removed for the revised draft plan since South East Water have confirmed they no longer had a requirement for this water and therefore were not proceeding with the pipeline.

We have an agreement with Thames Water for a bulk import of up to 13.6 Ml/d from Merton Pumping Station, although in practice the quantity available for transfer has been limited to approximately 7.5 Ml/d. However, Thames Water has confirmed this bulk supply cannot be guaranteed during a drought period and hence we have not included an allowance for this bulk supply in our baseline supply assessment.

Under normal and peak operating conditions, there are no constraints to the supply or transfer of water to customers across the supply area. The network has sufficient capacity and capability to supply water where it is required. The base year critical period demand underpinning this plan has been based upon actual demands experienced by in the recent past.

We recognise that some network constraints remain which may limit transfers into certain areas from alternative sources under abnormal or emergency operating conditions, i.e. if a WTW or pumping station (and their relevant backups) were to fail. These resilience challenges will continue to be addressed as part of the business planning process, rather than issues limiting WRZ integrity in the context intended by the WRPG.

3.2.2 Maintaining WRZ integrity in the future

Where options are being considered to meet a supply-demand deficit, consideration is given to the cost of maintaining WRZ integrity from the point of view of any necessary trunk mains upgrades within the option costs. These upgrades may have simultaneous supply-demand and resilience benefits. This ensures that the strategic transfer of any additional resources across the supply area is maintained. It is likely that some local distribution network upgrades may be required to convey water from trunk mains to the particular areas where the forecast increases in demand actually occur. These requirements will not be known until development applications are received. Therefore, in respect of local distribution mains, we would not expect to require any additional upgrades during the planning period over and above those allowed for in our Business Plan under:

- Mains extensions for new housing and
- Incidental upsizing

Also we do not consider it feasible to include local distribution mains upgrades within specific supply-side scheme costs used to inform the preferred plan as there would be a risk of double counting of upgrades should they be required in more than one selected scheme.

3.3 Problem Characterisation

The WRPG requires that companies use the *Decision Making Process* guidance to identify the scale and complexity of the planning problem and the vulnerability to strategic issues, risks and uncertainties. This ensures the methods selected are proportional to that required to solve the issues identified, in terms of effort and cost.

The assessment results are detailed in Table 2. The Strategic Needs Score (of 3) and the Complexity Factors Score (of 4) were compared against the matrix in the guidance to give a level of concern assessment as ‘Low’. Despite this, in several areas we have selected assessment methods that would only be deemed necessary where the level of concern is deemed ‘Medium’ or ‘High’, to ensure our assessments are robust.

3.4 Planning Period

The guidelines require that companies select a planning period appropriate to the risks of the company, with the minimum being 25 years. The previous plan covered a 25-year period, from 2015 to 2040. For this plan, we have selected a significantly longer period of 60 years, covering the decades from 2020 to 2080.

This period was selected for the following reasons:

- A longer time frame allows large scale solutions to have a similar likelihood of being selected as short- and medium-term options, so that the best value plan is produced
- This period is the one selected for use in the Water Resources in the South East model, and therefore the same assessments can be utilised in both plans
- Improve assessments of the range of uncertainties involved over the long-term, in particular in relation to population growth, climate change and water quality

Naturally, forecasting supplies and demand over a much longer timescale presents additional challenges. This will be detailed further in Sections 4.0 and 5.0.

3.5 Drought Risk Assessment

In the 2014 plan, we assessed our supplies against the Worst Drought on Historic Record (WDHR). Using the Risk Based Planning guidance and the level of concern determined from the problem characterisation step, this would have been sufficient for this plan. This is termed a ‘conventional plan’ or risk composition 1.

However, as discussed in Section 2.3.3, we have also selected to forecast water supplies using a more challenging 1 in 200-year drought risk level (also known as a ‘severe’ drought). This type of plan is termed a ‘resilience tested plan’ or risk composition 2. To calculate this, a technique termed stochastics is used. Essentially this involves using a model to simulate a range of possible future droughts. As it is not based on historical records, the approach is forward-looking and means we are taking into account that the past may not be a good representation of the future.

The results of the 1 in 200-year drought is compared against that from the WDHR for comparison purposes, i.e. we have assessed water availability against two design droughts to determine which is the more challenging.

3.6 Planning Scenarios

Companies are expected to test their system by assessing the supply-demand balance under high demand and low supply conditions. The following demand scenarios have been investigated as part of this WRMP:

- Normal year annual average (NYAA) – average year-round demand
- Dry year annual average (DYAA) – average year-round demand in a dry year
- Dry year critical (peak) period (DYCP) – peak period in a dry year, usually experienced in early summer (May to July)

3.7 Levels of Service

Water companies plan to be able to manage demand by implementing to demand restrictions according to a certain return period. These return periods are termed 'Levels of Service' and are effectively a standard of service we provide to customers. Our target levels of service are that:

- We will prohibit the use of hosepipes and unattended watering devices (Temporary Use Bans or TUBs) no more than once every 10 years on average – i.e. there is a 10% risk of a TUB being required in any year.
- We will implement an ordinary drought order to restrict the non-essential use of water no more than once every 20 years on average, i.e. there is a 5% risk of an ordinary drought order being required in any year.
- We will require Emergency drought order measures (e.g. rota cuts, use of standpipes and phased pressure management) only in extreme droughts beyond a 1 in 200-year frequency or emergency situations, i.e. there is a 0.5% risk of an emergency drought order being required in any year.

The target levels of service are stable throughout the duration of the plan. That is, the annual risk of a prohibition or restriction on the use of water being imposed on our customers does not change over the planning period.

We carried out an assessment of the supplies required in the Worst Drought on Historic Record (around a 1 in 100-year drought frequency) scenario to achieve the levels of service being planned for. However, demand restrictions are implemented on a precautionary basis as a management response in preparation for a developing drought of unknown severity and therefore their frequency will not necessarily reflect the magnitude of the ultimate drought event. We assumed that the demand reduction achieved from a TUB or drought order is that set out in our draft Drought Plan 2018. In section 8.2, we show the additional volumes needed to reduce the risk of a TUB being required from 10% to 5%.

Table 2: Problem Characterisation Assessment

Area	Type of risk	No Significant Concerns 0	Moderately Significant Concerns 1	Very significant concerns 2	Don't Know	Comments
Strategic WRMP Risks						
Level of concern that customer service could be significantly affected by current or future supply side risks, without investment	Supply - side		1			Severe droughts, climate change
Level of concern that customer service could be significantly affected by current or future demand side risks, without investment	Demand side		1			Population growth, demand during drought conditions
Level of concern over the acceptability of the cost of the likely investment programme and/or that the likely investment programme contains contentious options (including environmental/planning risks)	Investment programme		1			Bough Beech dam raising to be considered
Strategic Needs Score (How Big is the Problem?)	**3**					
Supply Side Complexity Factors						
Are there concerns about near term supply system performance, either because of recent Level of Service failures or because of poor understanding of system reliability / resilience under different or more severe droughts than those contained in the historic record? Is this exacerbated by uncertainties about the benefits of operational interventions contained in the Drought Plan?	Supply - side	0				
Are there concerns about future supply system performance, primarily due to uncertain impacts of climate change on vulnerable supply systems, including associated source deterioration (water quality, catchments etc.), or poor understanding?	Supply - side		1			Climate change; Metaldehyde; algal blooms
Are there concerns about the potential for stepped changes in supply (e.g. sustainability reductions, bulk imports etc.) in the near or medium term that are currently very uncertain?	Supply - side	0				Possible sustainability reductions for sources related to the River Wandle. No bulk imports.
Are there concerns that the DO metric might fail to reflect resilience aspects that influence the choice of investment options (e.g. duration of failure), or are there conjunctive dependencies between new options (i.e. the amount of benefit from one option depends on the construction of another option). These can both be considered as non-linear problems.	Supply - side		1			Long term outage of sources or WTW; Option to provide supplies to SEW may be dependent on Bough Beech upsizing / dam raising

Area	Type of risk	No Significant Concerns	Moderately Significant Concerns	Very significant concerns	Don't Know	Comments
Demand Side Complexity Factors						
Are there concerns about changes in current or near-term demand, e.g. in terms of demand profile, total demand, or changes in economics / demographics or customer characteristics?	Demand side	0				Total demand steady
Does uncertainty associated with forecasts of demographic / economic / behavioural changes over the planning period cause concerns over the level of investment that may be required?	Demand side		1			Population growth high in London Boroughs, PCC forecasts over long term (beyond 25 years) difficult
Are there concerns that a simple 'dry year / normal year' assessment of demand is not adequate, e.g. because of high sensitivity of demand to drought (so demand under severe events needs to be understood), or because demand versus drought timing is critical?	Demand side	0				Subject to TUBs
Investment Programme Complexity factors						
Are there concerns that capex uncertainty (particularly in relation to new or untested technologies) could compromise the company's ability to select a 'best value' portfolio over the planning period?	Investment programme	0				
Does the nature of feasible options mean that construction lead time or scheme promotability are a major driver of the choice of investment portfolio?	Investment programme		1			Bough Beech dam raising - long lead time
Are there concerns that trade-offs between costs and non-monetised 'best value' considerations (social, environment) are so complex that they require quantified analysis (beyond SEA) to justify final investment decision?	Investment programme	0				
Is the investment programme sensitive to assumptions about the utilisation of new resources, mainly because of large differences in variable opex between investment options?	Investment programme	0				
Complexity Factors Score (How Difficult is it to solve the problem?)	**4**					

OVERALL LEVEL OF CONCERN Low

It is important to recognise that the level of service return period is not equivalent to the drought severity return period, discussed further in Section 4.0. Having said this, demand restrictions would not generally be expected during drought events with a return period of less than 1 in 10 years.

We use trigger curves as defined in our drought plan to inform when it may be appropriate to implement demand restrictions. These have been updated for the drought plan due to be published in 2019. With a changing climate, the frequency and magnitude of droughts will change and therefore the trigger curves that currently define levels of service may be breached more frequently in the future. We will continue to review our trigger curves in future drought plans in order to maintain our target levels of service.

Section Summary - Methodology

We started discussions on our planned approach with the Environment Agency and Natural England in 2016. One of the initial steps was to carry out a Water Resource Zone integrity assessment which showed we could now consider the whole company area as one resource zone.

We decided to extend the planning period from the minimum level of 25 years to 60 years, mainly to align with the regional approach. We opted to test our system by considering demand under normal and dry years, and in periods of high use (critical period) as well as annual average conditions.

We have maintained the levels of service used in our previous plan in terms of the frequency of needing to restrict usage. The risk of imposing a temporary use ban remains at 10% in any year of the plan, with the risk of needing restrictions on non-household usage at 5% and emergency measures at 0.5%.

In accordance with the guidance, we carried out a problem characterisation assessment, which showed the overall level of concern was low.

4.0 Supply Forecast

Water supplies are assessed by calculating the amount of Water Available for Use (WAFU). This is done from the base year, which for this plan is 2015/16, and then forecast to the end of the planning period.

WAFU =
Deployable Output – Raw Water & WTW Losses – Transfers – Outage

Each of these components is discussed in Sections 4.1 to 4.4. We then make an allowance for uncertainty on each of these, known as headroom. All values are presented in units of million litres per day (Ml/d).

4.1 Deployable Output (DO)

DO is the maximum average output of a source or group of sources. This is constrained by one of the following factors:

- Hydrological yield
- Licenced abstraction level
- Environmental constraints
- Raw water quality
- Pumping capacity
- Raw water main capacity
- Treatment capacity
- Trunk / Distribution main capacity

These are calculated for each source or source group in the supply area, covering 33 groundwater sources (including one spring source) and one surface water source (Bough Beech). Appendix A provides additional detail on the work undertaken by our consultants, AECOM, on the methodology employed and the results for each source.

We have followed the methods described in the UKWIR *Handbook of source yield methodologies* (2014). In the last assessment of DO, carried out in 2013, values were assessed against a 1 in 50-year drought event. It did not include DO values for the worst drought on historic record, a review of infrastructural constraints or a Levels of Service (LoS) analysis. The Bough Beech surface water source was considered in isolation to groundwater sources.

We undertook analysis in November 2015, in conjunction with the Water Resources in the South East (WRSE) Group, to estimate DO values under more challenging drought conditions, i.e. 1 in 100-year and 1 in 200-year drought events. This was done by curve-shifting the operational drought curve for each source through the application of scaling factors and based on the analysis of critical period observation borehole records.

For this plan, a review of constraints information has been undertaken. Lumped parameter models have been developed for key observation boreholes using historic climate data and catchment parameters, in order to predict groundwater levels during the worst drought on historic record (WDHR). Using existing scaling factors, these modelled groundwater levels were then used to provide an approximation of the water level condition at each groundwater source during this drought event. The operational drought curve for each groundwater source was curve-shifted to this water level condition and the critical constraints were examined, thereby providing an estimate of DO for this event.

For Bough Beech, an existing rainfall-runoff model (CatchMOD) for the River Eden has been refined using historic climate data in order to predict river flows during this event. The modelled river flows were used to provide an approximation of the water available for abstraction from the River Eden during this drought event, and to provide an estimate of DO.

In addition to assessing DO for the WDHR, we have tested against a ‘reference’ drought within the WRMP that might occur once every 200 years (i.e. a severe drought). The lumped parameters models and rainfall-runoff model were extended to include stochastically generated climate data in order to predict the groundwater levels/ river flows and reliable supplies that might be available in plausible droughts that are more severe than those experienced in the past, including those experienced in the 1970s and 1990s.

The factors used to calculate the difference between normal year (NY), dry year (DY) and critical peak (CP) are detailed in Section 5.1.

4.1.1 Groundwater Sources

Groundwater provides around 85% of our supplies, from four aquifer resources units (ARUs). There have been no changes to the number of sources available since the previous plan.

- North Downs Chalk (16 sources)
- Confined Chalk (1 source)
- Mole Valley Chalk (4 sources)
- Lower Greensand (12 sources)

The methodology and outline results of this plan’s groundwater DO assessment is given below. A full description is given in Appendix A.

The key purpose of undertaking individual groundwater source DO assessments is to define how each source works, the critical constraints to DO, and to define the relationship between source water levels and groundwater levels at appropriate critical period observation boreholes for use in the curve-shifting process. The process of source DO assessment also provides an opportunity to:

- Select appropriate ‘critical period’ records and gauging station records (i.e. good drought indicators)

- Identify and rank drought years using historic groundwater level and flow records
- Refine the source constraints information
- Review the source operational data
- Estimate individual source DO values for the worst drought on historic record (WDHR) and for the 1 in 200-year drought event

Table 3 lists the critical period observation boreholes selected for the assessment.

Table 3: Critical Period Observation Boreholes

EA Reference	Borehole Name	Length of Record	ARU	Comments
TQ25/013	Well House Inn	1942-2016	North Downs Chalk	Relatively unaffected by abstraction and does not dry out
TQ55/1	Riverhead	1965-2016	Lower Greensand	Longest local record in this ARU but outside SESW supply area

We have employed a lumped parameter model to generate a series of groundwater levels in response to rainfall events using climate and catchment data. The model is calibrated to observed levels and used to predict levels using different rainfall and potential evapotranspiration (PET) inputs.

The 2006 drought has been used as the WDHR for both chalk and greensand sources. In order to derive the 1 in 200-year event, a hydrological frequency analysis is carried out on the stochastically (randomly) generated groundwater level data. The approximate return period of a severe drought was estimated to be:

- Well House Inn 1 in 35-year
- Riverhead 1 in 175-year

For peak DO (PDO), July was selected as the month of peak demand based on historic records of demand as well as the modelled groundwater levels.

The next stage of the assessment involves applying scaling factors to describe the relationship between the rest water level of the appropriate critical period observation borehole and the groundwater sources. The output of this process is a set of non-pumping water levels for each source under the WDHR and 1 in 200-year event conditions. The drought curve for each source can then be shifted to this different starting point and the Minimum DO (MDO) calculated from where the curve meets the source constraint, i.e. licence, pump capacity, pump cut out or Deepest Advisable Pumping Water level (DAPWL).

The results of the critical constraint to MDO and PDO, compared against the last assessment, is given in Table 4. There are a number of sources where the constraint has changed. In some cases, this has resulted in a significant change in DO, for example, following the 2012 drought it was found the pump low level cut-out at Purley is lower than previously assessed, and therefore PDO has increased. DO for Fetcham Springs is not included in the table as it is related to spring flow.

Table 4: DO Critical Constraint Factor

Groundwater source	MDO critical constraint (WRMP14)	MDO critical constraint (dWRMP19)	PDO critical constraint (WRMP14)	PDO critical constraint (dWRMP19)
Cheam	DAPWL	DAPWL	DAPWL	Pump capacity
Cheam Park	DAPWL	DAPWL	DAPWL	DAPWL
Springclose Lane	Pump capacity	Pump capacity	Pump capacity	Pump capacity
Langley Park	Pump capacity	Pump capacity	Pump capacity	Pump capacity
Nonsuch Park	Licence	Licence	Licence	Licence
Sutton	Pump cut-out	DAPWL	Pump cut-out	DAPWL
Sutton Court Rd	Pump cut-out	Pump cut-out	Pump capacity	Pump cut-out
Chipstead	Pump capacity	Pump capacity	Pump capacity	Pump capacity
Holly Lane	Licence	Pump capacity	Pump capacity	Pump capacity
Woodmansterne	DAPWL	DAPWL	DAPWL	DAPWL
Smitham	Licence	Licence	Licence	Licence
Hackbridge & Goatbridge	Licence	Licence	Licence	Licence
Oaks	Licence	DAPWL	DAPWL	Pump capacity
Woodcote	Pump capacity	Pump capacity	Pump capacity	Pump capacity
Kenley	Licence	Pump capacity	Pump capacity	Pump capacity
Purley	Licence	Pump capacity	Pump cut-off	Pump capacity
Fetcham Boreholes	Pump capacity	DAPWL	Pump capacity	Pump capacity
Elmer & Young St	Licence	Licence	Licence	Licence
Leatherhead	Licence	Licence	Licence	Pump capacity
Dorking	Licence	Licence	Licence	Licence
Buckland	Water quality	Water quality	Water quality	Water quality
Clifton's Lane	DAPWL	DAPWL	DAPWL	DAPWL
Warwick Wold	DAPWL	DAPWL	DAPWL	DAPWL
Brewer Street	Pump capacity	Pump cut-off	Pump capacity	Pump cut-off
Bletchingley	Licence	Pump cut-off	Licence	Licence
North Park	Licence	Licence	Pump capacity	Licence
Godstone	Licence	Licence	Licence	Licence
Flower Lane	Licence	DAPWL	Pump cut-off	DAPWL
Water Lane	Pump cut-off	Pump capacity	Pump cut-off	Pump capacity
South Green	Licence	Licence	Licence	Licence
Westwood	DAPWL	DAPWL	DAPWL	DAPWL

The total DO for groundwater sources is shown in Table 5. This cannot be directly compared against the last assessment as the 2013 values relate to a 1 in 50-year drought event, whilst the 2017 values are based on WDHR and 1 in 200-year event. There is a 1.5% increase in MDO and a 1.5% increase in PDO between the 2013 assessment and the current WDHR values. This is only slightly lower in the 1 in 200-year assessment.

Table 5: Groundwater source DO

AMP	Design Drought	MDO (Ml/d)	PDO (Ml/d)
WRMP14	1 in 50-year event	186.7	237.9
Draft WRMP19	Worst Drought on Historic Record	189.6	269.1
Draft WRMP19	1 in 200-year event	188.7	265.5

4.1.2 Surface water sources

We operate one river abstraction from the River Eden, which is used to fill Bough Beech Reservoir during the autumn and winter months only (September to April). The constraint on DO is the availability of water in the river during drought years. This relates to the Dry Year Annual Average (DYAA) scenario. A Dry Year Critical Period (DYCP) scenario is not applicable as any seasonal increase in demand is met from available storage, however a PDO can be derived by multiplying the DO for DYAA by the peak (July) demand factor.

The volume available from the River Eden at the abstraction point is calculated using a CatchMOD rainfall-runoff model. A CatchMOD model was also developed for the Mill Stream which feeds directly into the reservoir, although this is minor in comparison to the abstracted levels. The model used in 2013 has been updated to include rainfall and PET data from 2005 to 2017, which was added to the data from 1920 to 2005, so that 97 years of data was utilised.

For the WDHR design drought, 2005/06 was selected, corresponding to that used for groundwater sources. Frequency analysis suggests this event approximates to a 1 in 100-year drought. Stochastically generated rainfall and PET data from a selected sequence of 78 years (including a 1 in 200-year event) was used to determine DO for a severe drought. This corresponded to the sequence used in the groundwater pumped parameter model.

Abstraction is then simulated using an Aquator Model. This is a component-based modelling software that includes a representation of the water supply network. It allows source constraints to be applied to individual components, such as reservoir control curves, and for the inclusion of daily flow time series. Since the previous WRMP, the final phase of upgrading treatment works capacity has been completed, resulting in a maximum of 55 Ml/d. Reservoir levels were simulated for an extended period of 99 years to ensure the drought trigger curves used in the draft Drought Plan 2017 were still appropriate following the changes to capacity.

To simulate seasonal demand profile the 2013 year was selected as the most recent typical dry year demand, with the peak monthly demand factor in July of 1.21.

The results of the DO assessment for Bough Beech, and how these compare against the previous assessment, are given in Table 6. For MDO, there has been a 10.7% reduction between the 2013 assessment and the WDHR. For the 1 in 200-year event scenario, MDO declines significantly, by 62.3%. In the last plan, peak DO was assumed to equate to the works capacity, and therefore is not comparable to the current assessment. Again, DO is much lower in a severe drought during the peak.

Table 6: Bough Beech DO

AMP	Design Drought	MDO (Ml/d)	PDO (Ml/d)
WRMP14	1 in 50-year event	28.9	50.0
Draft WRMP19	Worst Drought on Historic Record	26.1	31.6
Draft WRMP19	1 in 200-year event	17.8	21.5

4.1.3 Impacts of Levels of Service (Drought Orders) on DO

We have calculated Deployable Output on the basis of the Levels of Service (LoS) set out in Section 3.7. However, a decrease in the LoS, i.e. if we were to plan on the basis of more frequent drought orders to restrict water use, would slow the natural decline in groundwater and surface water levels but would not result in an actual recovery in levels by itself. Consequently, a temporary reduction in abstraction will generally not result in an immediate increase in DO.

Over the long-term, reduced abstraction associated with more frequent demand restrictions will affect the drought condition rest water level by adjusting the aquifer water balance, but assessing this requires a detailed understanding of the relationship between aquifer unit water balance and temporal groundwater levels. Such an understanding can only really be developed with a distributed groundwater model. Although such a model was not utilised for this plan, we will reassess the feasibility and need for this approach for the next plan, WRMP24.

For WRMP14, we undertook a preliminary appraisal of how a change in LoS would affect DO. We found that for the majority of sources, a change in LoS is unlikely to have an impact on the DO as they are constrained by licence or infrastructure. This remains the same in the current assessment. Where the availability of water (yield) constrains DO then usually the effect of changing LoS is to change stream or spring flow. For our surface water source at Bough Beech, it was determined through the Aquator Model that the application of the current LoS increased Average DO by around 0.8 Ml/d in comparison to having no demand restrictions. It is considered that these values remain applicable to the current plan.

4.1.4 Sustainable Abstraction

In collaboration with the Environment Agency we have assessed our abstractions to ensure compliance with the requirements of the River Basin Management Plans (see Section 2.3.5). The EA have produced a WRPG supplementary guidance on this in June 2017. The requirements are summarised below:

- Where abstraction is deemed to be causing harm or at risk of causing harm to the environment, companies must carry out an investigation on the impacts of their abstraction
- This list of sources is provided in the form of the Water Industry National Environment Programme (WINEP), previously referred to as NEP. The latest version (Phase 4) was issued at the end of March 2019.
- For each source listed in the WINEP, the EA have identified the primary 'driver' for the categorisation, and also the level of certainty on the assessment
- Where action is required to reduce damage or the risk of damage to the environment, measures range from a licence change (referred to as a sustainability change or reduction) to mitigation measures such as river restoration.

There were eight sources across two catchments where the driver was identified as being flow (others relate to water quality, biosecurity or invasive non-native species). Since Phase 2 the certainty of the River Wandle scheme has increased from amber to green. These are summarised in Table 7.

Table 7: NEP Programmes

Catchment	No of Sources	Certainty	Action Required	Date Required
Darent	1	Amber	Adaptive management	22/12/2024
Wandle	7	Green	Adaptive management	22/12/2024

For those sources under an amber classification (indicative), the EA state the amount licenced should be included as an adjustment to deployable output and the effects considered through scenario analysis. However, it is assumed this does not apply where the action required is Adaptive Management, which relates to measures such as river restoration. Therefore we have not completed an adjustment to deployable output.

The sources listed for the Darent and Wandle catchments were included in previous NEPs. We have carrying out investigations on both these catchments in collaboration with the other water companies involved, namely Thames Water and South East Water.

The Upper Darent low flow investigation report was issued in February 2018. It did not conclude that abstraction at our boreholes at Westwood, near the headwaters of the river, was linked to low flows. Discussions with the Environment Agency, Thames Water and South East Water are ongoing to finalise the investigation report and determine the actions needed.

On low flows in the River Wandle, we are expecting to finalise and issue the options investigation report with Thames Water in April 2019. We have included provision to carry out river restoration work on the Croydon branch of the Wandle in the Business Plan, working in partnership with Thames Water. We are working closely with the Wandle Catchment Partnership to identify how the Good Ecological Potential of the Carshalton Branch of the Wandle can be maintained, i.e. following the requirement to ensure 'no deterioration', following this designation in 2015. We are also implementing measures to reduce the risk of failure on the augmentation system from Goatbridge to the Upper Wandle at Carshalton.

The Phase 3 release included two sources in the Lower Mole and Rythe catchment and two groundwater sources at Fetcham and Leatherhead, which were derived from the supply options included in the draft plan. These options were not selected in the final plan, however we intend to carry out the necessary investigations to assess the impact on WFD objectives should these options be required in WRMP24.

We are expecting that the Phase 5 release will include the requirement for an investigation into low flows in the River Hogsmill, also in conjunction with Thames Water. We have included a cost estimate to carry out both the investigation and the potential work required in our Business Plan for completion by 2025.

In relation to the duty to prevent deterioration, we will assess the final plan to determine if there are any planned increases to abstraction. This does not include changes to meet year-to-year fluctuations resulting from outage or weather.

We have considered measures to improve fish and eel passage to meet the Eels (England and Wales) Regulations 2009. In accordance with the requirements of the PR14 NEP, we installed an eel screen at our river intake at Goatbridge (which was classified as high risk) in March 2017. We commissioned a feasibility study to be carried out on installing measures at the intake site from the River Eden at Chiddingstone, which is classified as medium risk. We are currently formalising an exemption for this site so that the project is delivered alongside other proposed maintenance works in the 2025-2030 period. These measures do not impact on our supply forecasts.

We recognise the benefit of taking a Catchment Based Approach (CaBa), working collaboratively with other organisations to improvement our water environments, and are committed to being actively part of the catchment partnerships in areas that we impact on due to our abstractions.

We are also required to take account of the impact on any transfers on water body objectives. This is discussed further in Section 4.1.7.

4.1.5 Invasive Non-Native Species (INNS)

We are required to assess whether our current or future abstractions will risk spreading INNS. Potential pathways could be from raw water transfers or changes to existing impoundments such as weirs. This risk will be assessed in deciding the final plan (Section 0), although it is not expected to be significant.

As required under the WINEP Phase 3 release, we will be carrying out a company-wide investigation to develop a strategy to reduce the risks of INNS, including from non-water transfers.

4.1.6 Impacts of Climate Change on supply

As detailed in the WPRG, we have carried out an assessment to quantify the impact on climate change on the availability of water supplies and therefore DO. Full details on the methodology used and results obtained is given in Section 4 of Appendix A.

The first stage is to complete a Basic Vulnerability Assessment to climate change. This showed that the vulnerability was ‘Low’. This has not changed from the previous assessment in 2013.

Climate change modelling was carried out by HR Wallingford, using the Future Flows Climate scenarios under a medium emissions scenario for the 2080s for the River Eden catchment. This dataset consists of 11 equally likely scenarios of climate to 2098. Monthly climate change factors for rainfall and PET were calculated for the 2080s. These factors were then used to perturb the historical climate record and were input into the CatchMOD rainfall-runoff model of the River Eden. From this, 11 climate change river flow series were produced, from which 11 sets of monthly flow factors were generated.

The results demonstrate a tendency, due to climate change, towards reduced flows in the summer, autumn and early winter. There is a large variation in flows in the late winter and early spring although many of the scenarios indicate reduced flows between September and April. Therefore there is the potential to adversely impact the winter refill of Bough Beech reservoir and correspondingly the water resource availability and drought resilience of this part of the system.

For groundwaters, the climate change factors generated using the Future Flows climate scenarios were used to perturb the historic climate record (areal rainfall and PET for South London) for input into the lumped parameter models for the Well House Inn and Riverhead observation boreholes. It is a recognised issue in climate change impact studies that lengthy historic climate records, such as used in this Aquator modelling which extends from 1920 to 2017, already include a climate change signal; however the benefit of the increased record length, and the capture of more natural variability, is considered to outweigh this.
The factors were used to perturb the stochastic climate record for the 1 in 200-year event, as identified by frequency analysis. From this, 11 climate change

groundwater level series were produced, from which the average scenario or central estimate was extracted for use in the DO assessment. The minimum and the maximum scenarios or estimates of uncertainty were extracted for use in the headroom assessment.

The results of the climate change assessments, for both drought scenarios, are summarised in Table 8.

Table 8: DO with climate change impacts (with change in brackets) for 2080s

Source Type	WDHR MDO (Ml/d)	WDHR PDO (Ml/d)	1 in 200-yr MDO (Ml/d)	1 in 200-yr PDO (Ml/d)
Groundwater	188.9 (-0.7)	268.3 (-0.8)	188.2 (-0.4)	261.6 (-3.7)
Bough Beech	18.4 (-7.3)	22.3 (-8.8)	21.6 (+3.6)	26.1 (+4.4)
All sources*	207.7	291.2	209.6	287.7

* The total does not exactly equal groundwater + Bough Beech due to rounding

The most significant impacts are on peak deployable output scenario at Bough Beech under the WDHR scenario. Groundwater resources, especially chalk sources, are more resilient to changes in climate as levels gradually rise or fall over several seasons or years. Whilst it may seem surprising that there are positive impacts on Bough Beech under the 1 in 200-year scenario, during the abstraction period (September to April) flows actually increase, with reduced summer flows having no impact on DO.

These impacts are then scaled back to each five-year period in line with the guidance. We test the sensitivity of our climate change estimates in Section 10.3.

The initial vulnerability assessment was then re-examined in light of the results, by using a magnitude against sensitivity plot, as shown in Figure 3. This showed the classification of vulnerability remains unchanged at Low.

An allowance for uncertainty in the climate change forecasts is included in the headroom assessment, detailed in Section 4.6.

4.1.7 Raw Water Transfers

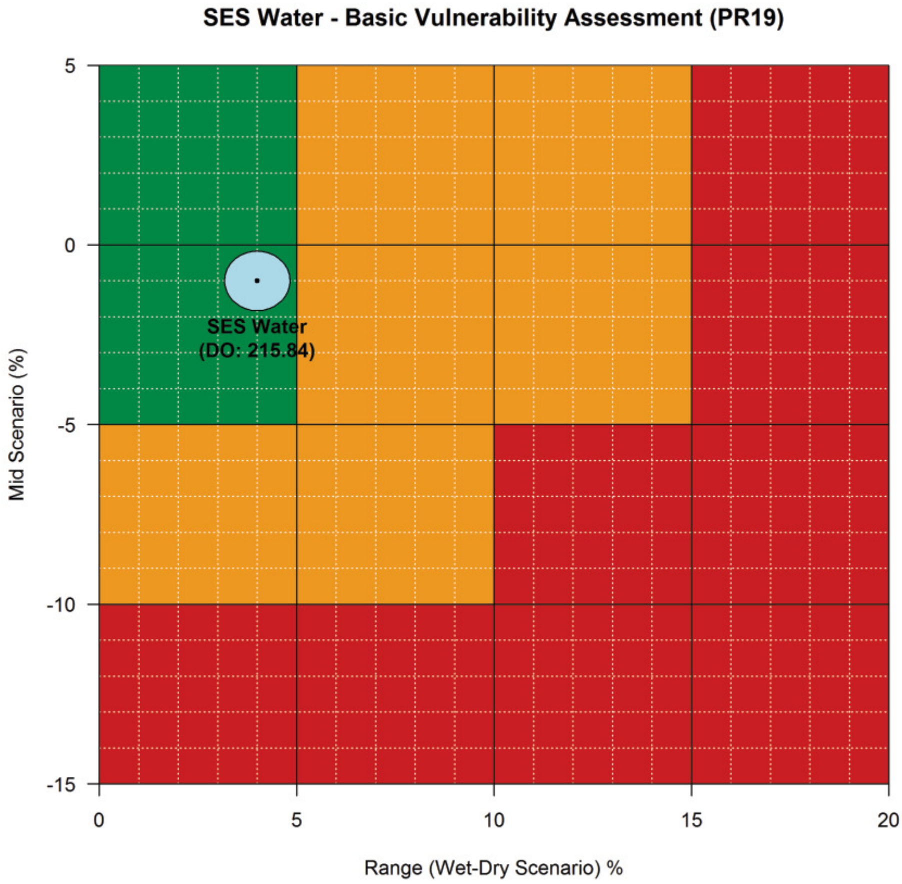
There are no raw water transfers in the current WRMP, and therefore this factor is not included in the DO calculation.

4.1.8 Drinking Water Quality

The WRPG require that companies include in their plans measures to support the objectives for drinking water protected areas, with a view to reducing the level of treatment required. This may also benefit deployable output.

In July 2017 we carried out a Drinking Water Protected Area WFD Risk Assessment of our source waters. This was used to inform the water quality related measures in the WINEP, in particular in Source Protection Zones.

Figure 3: Climate Change Vulnerability Assessment



In general, our sources are of a very good quality. The most significant challenge is that of metaldehyde, a pesticide used by farmers in the Eden catchment to reduce slug numbers. We have taken a catchment management approach for a number of years to reduce the levels in the mill streams which feed the reservoir, alongside abstraction management to avoid filling the reservoir from the Eden when metaldehyde levels peak in the autumn 'first flush'. This combined approach has resulted in no exceedances of the required quality standard since 2009. The WINEP includes a requirement to investigate options to manage a range of pesticides, including metaldehyde, and phosphorus, at Bough Beech.

Other measures include investigating proposals to manage nitrates, bacteria and solvents at a catchment level in the North Downs Chalk and Lower Greensand catchments.

The majority of these measures are required to be complete by the end of 2024, and will be used to inform WRMP24 and/or WRMP29.

4.1.9 Summary of DO

Since DO is unaffected by raw water transfers or measures relating to drinking water quality, the values are that calculated following the climate change assessment, as detailed in Table 8. Table 9 shows how the overall values compare with the previous assessment for WRMP14.

Table 9: Baseline DO compared to WRMP14

Source Type	MDO (Ml/d)	PDO (Ml/d)	1 in 200-yr MDO (Ml/d)	1 in 200-yr PDO (Ml/d)
Final Plan WRMP14 (at 2040)	209.7	290.9		
dWRMP19 (at 2080)	207.3	290.6	209.8	287.7
Difference	-2.4	-0.3		

The levels are not strictly comparable since each assessment used a different drought scenario, i.e. a 1 in 50-year design drought was applied in 2014 whereas in the current plan the WDHR was used. However, it can be seen that the overall results are broadly similar, even though the current plan is over an extended time period. This is a result of the increase in DO calculated for this plan. An assessment of a 1 in 200-year scenario was not included in the WRMP14 analysis.

4.2 Raw water and treatment works losses

We have updated estimates on the amount of water lost between each abstraction point and the point that the water leaves the treatment works for this plan. Previous values were from analysis completed in 2009. Details of this assessment is given in Appendix B, with the results are summarised below.

4.2.1 Raw water losses

Raw water losses are those between the point of abstraction and the WTW, assumed to be mainly due to leakage on raw water mains. These were re-assessed based on a review of meter records, with total losses calculated to be 2.5 Ml/d. This compares against a value of 2.9 Ml/d in WRMP14.

The losses figures have been applied to both the average and peak planning cases within the Draft WRMP. It has also been assumed that the figures will remain constant throughout the planning period, on the basis that there are no planned upgrades at this stage. However, for the Business Plan we have assessed burst records on raw water mains, as well as trunk and distribution mains, to model where mains replacement is required and have identified around 7km of replacement is needed up to 2035, of which 3km has been included in the 2020-2025 plan.

4.3 Water treatment works losses

These are losses that occur through the works, including leakage from pipes and structures, non-recovery of washwater, water lost through sludge exports and operational use such as sampling. It is calculated by using the difference in metered flow between the WTW inlet flow meters and the WTW output flow meters (known as DI meters). As we supply process water from the distribution mains (i.e. downstream of the DI meters), these flows must be taken into account in the analysis.

The results of the assessment for both average and peak conditions are compared to the values in WRMP14, as shown in Table 10. The increase is considered to be due to improved data and not an actual increase in losses. There is a significant variation in losses between treatment works. To address this, we plan to replace works inlet meters on a targeted basis using the results of a calibration-testing programme, starting in 2018/19, and to monitor results on a monthly basis.

Table 10: Water Treatment Works losses

Plan	Average losses (Ml/d)	Peak losses (Ml/d)
WRMP14	1.0	1.2
WRMP19	4.95	4.95

It has been assumed that these losses will remain constant throughout the planning period.

4.4 Outage

An outage is a short-term loss of deployable output, with short-term defined as three months or less. These must be accounted for within the supply forecast. Outage can be considered as either planned or unplanned. Planned outages typically result from the need to maintain the serviceability of source works, including inspection works, planned maintenance activities, and refurbishment or repair of plant that lead to a temporary loss of water supply. Unplanned outages are interruptions to supply caused by unforeseen events including pollution events, power failures, and system and equipment failures.

The outage allowances have been derived with reference to the WRPG using the principles set out within the UKWIR (1995) report *Outage Allowances for Water Resource Planning*. The approach has involved assessment of each WTW in terms of potential outage type, duration, magnitude and frequency. From this, a modelling technique (Monte Carlo simulation) has been applied to produce probability distributions of the events so an outage allowances can be calculated. Full details of the approach adopted and the outage results are provided by a separate technical report shown in Appendix C.

The outage assessment was based on a review of historical outage events. The on-site storage of treated water at each works is taken into account when reviewing the data. Where further detail was required on individual events, this was discussed with operational personnel.

A risk assessment model was created to derive outage estimates for both average and peak demand periods. Planned outage events such as routine maintenance works to treatment works are normally undertaken outside of the peak period to limit impact on available supplies; therefore, planned outages were excluded from the peak outage assessment. Most unplanned events are due to power cuts. For this plan, the winter shutdown of Godstone WTW for maintenance purposes was included (this was not included in the WRMP14 outage assessment).

The Monte Carlo model provided outage estimates for both dry year average and dry year peak periods for a range of different percentile (%ile) values. The 95%ile represents the level of outage that would only be exceeded once every 20 years, or that there is a 5% likelihood of the outage level being exceeded. This is the level used in the outage allowance for this plan.

The results of the assessment are given in Table 11. It shows there has been an increase in average outage, mainly due to the inclusion of Godstone winter shutdown, although it is a lower percentage of overall DO. Conversely, there has been a decrease in peak outage.

Table 11: Outage Allowances

Plan	DYAA Outage (Ml/d)	DYCP Outage (Ml/d)	DYAA Outage (% DO)	DYCP Outage (% DO)
WRMP14	5.07	2.27	5.2	1.7
WRMP19	8.10	3.61	3.75	1.22

We do not consider it necessary to include any options to reduce outage to resolve a supply-demand deficit for water resources planning, and have assumed that the outage allowances remain constant throughout the planning period. However, in the Business Plan for PR19, to improve resilience we have made provision to maintain our treatment works so that unplanned outage is kept to be realistic minimum (of 2.3% of peak week production capacity) by 2025, and to reduce the period of shutdown at Godstone WTW over the winter.

4.5 Water Available for Use (WAFU)

The results of the assessments of DO, climate change, raw water and treatment works losses can be combined to give a value of WAFU, as shown in Table 12. This represents the supply forecast.

Table 12: Water Available for Use (by 2080)

Scenario	DO (with climate change)	Raw water & WTW losses	Outage	Exports	WAFU
DYAA (WDHR)	207.74	7.45	8.10	2.50	189.69
DYAA (1 in 200-yr)	209.64	7.45	8.10	2.25	191.84
DYCP (WDHR)	291.15	7.45	3.65	5.00	275.05
DYCP (1 in 200-yr)	287.68	7.45	3.65	9.00	267.58

We have included the transfer to South East Water as an export from 2042. The other minor bulk supplies are treated as part of the demand forecast.

4.6 Allowing for Uncertainty (Headroom)

Headroom is defined in the WRPG as a 'buffer for uncertainty between supply and demand designed to cater for specified uncertainties'. Its purpose is to allow for variations in the supply and demand forecasts. A full analysis of headroom is given in Appendix D, with the results summarised in this section.

Nine uncertainty factors are combined to calculate headroom allowance for supply:

S1 Vulnerable Surface water licences
S2 Vulnerable Groundwater licences
S3 Time Limited Licences
S4 Bulk Imports
S5 Gradual Pollution
S6 Accuracy of Supply-Side Data
S8 Impact of Climate Change on Deployable Output
S9 New Sources

As with the WRMP14 headroom assessment, a Monte Carlo simulation is used to model the variance probability of each factor using known data and other information. Factors S1 to S4 have not been included in the analysis, as we do not have any licences classified as vulnerable or time-limited, nor do we have any bulk imports. For gradual pollution (S5), for this plan we have assessed confined chalk sources as a separate group to the unconfined group. The risk of pollution to greensand sources has been reduced from a maximum per five-year period from 20% to 5%. Based on the latest WINEP, the main risks identified are bacteria/parasites (e.g. cryptosporidium), nitrates and pesticides.

The accuracy of supply-side data (S6) is now assessed on a 95% probability basis, instead of a % of DO. The method for S8 and S9 is largely unchanged from the previous assessment.

When combined with the headroom allowances for the demand factors (as discussed in Section 5.8), the overall results are as given in Table 13. These are based on the WDHR scenario. The level of acceptable risk was determined to be 95% probability at 2020, falling to 85% by 2080. A higher level of risk is more acceptable in the future as there is more time to adapt to any changes in DO or demand. The WPRG promotes the use of this 'glide-path' approach.

Table 13: Target Headroom based on Uncertainty Analysis

Scenario	85% probability	95% probability
DYAA (Ml/d)	12.11	16.50
DYCP (Ml/d)	15.19	21.35

The effect of applying these results is shown in Figures 4 and 5.

Figure 4: Composition of DYAA Target Headroom (Ml/d)

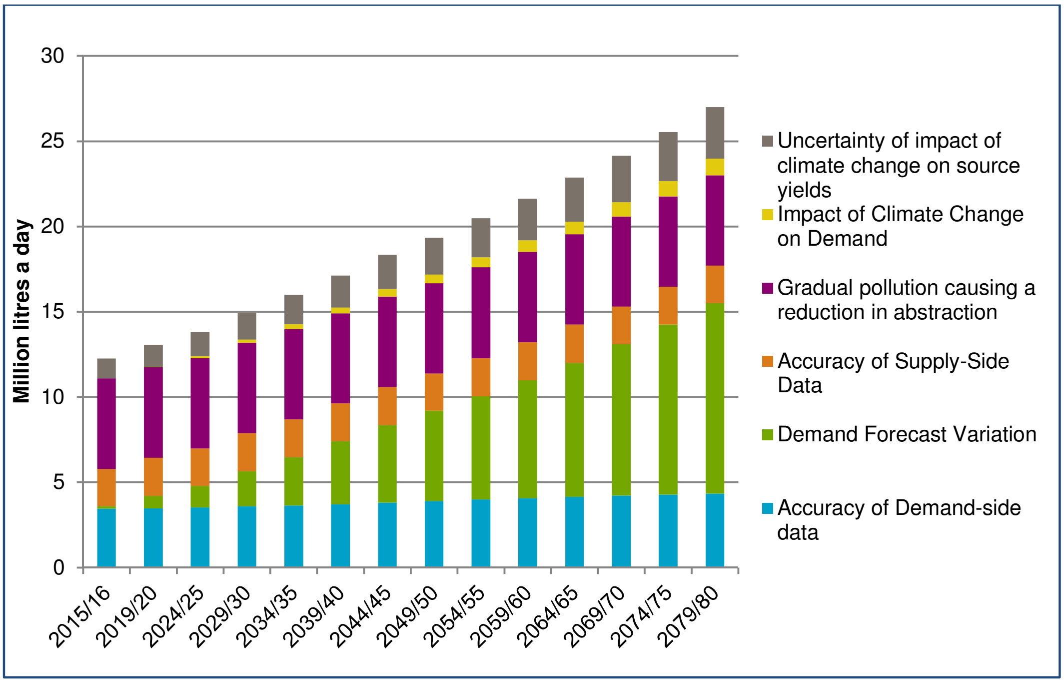
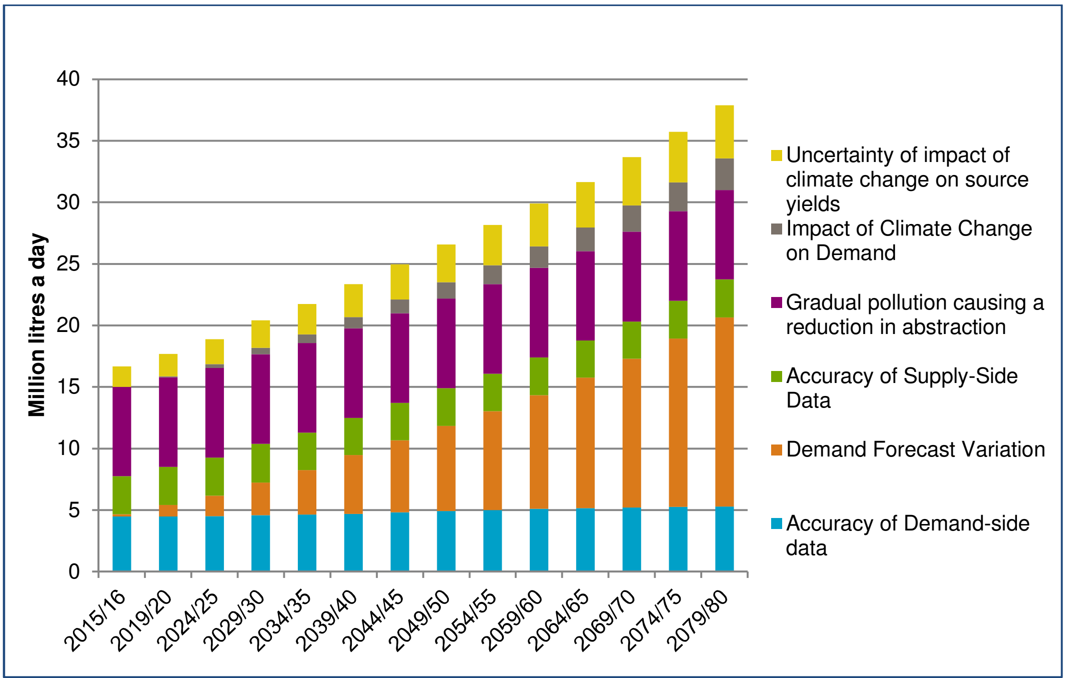


Figure 5: Composition of DYCP Target Headroom (Ml/d)



The headroom allowances at the start and end of the planning period is given in Table 14. In WRMP14 the headroom assessment resulted in a value of 19.8 Ml/d under average conditions and 28.1 Ml/d under peak conditions by 2040. This was equal to 10% of WAFU. In the current plan, headroom is a maximum of 5.6% of WAFU. Therefore there has been a significant reduction in the headroom allowances since the last assessment.

Table 14: Target Headroom Allowance (WDHR)

Scenario	DYAA 2015/16	DYAA 2079/80	DYCP 2015/16	DYCP 2079/80
Risk percentile (%)	95th	85th	95th	85th
Target Headroom (Ml/d)	8.23	12.11	10.93	15.19
% WAFU	3.8	5.6	3.6	5.1

Headroom was also assessed for the 1 in 200-year drought scenario using the same methodology (Table 15). The main difference was the impact of climate change on source yields, which reduced headroom allowances for average conditions but increased the values for peak conditions.

Table 15: Target Headroom Allowance (1 in 200-year)

Scenario	DYAA 2015/16	DYAA 2079/80	DYCP 2015/16	DYCP 2079/80
Risk percentile (%)	95th	85th	95th	85th
Target Headroom (Ml/d)	8.07	11.69	11.07	16.61
% WAFU	3.8	5.6	3.6	5.1

Section Summary – Supply Forecast

We assessed the level of water available for use (WAFU) by calculating the deployable output of our sources and taking into account losses from outage, leakage from raw water mains and treatment works usage. We considered two scenarios – the Worst Drought on Historic Record and a simulated 1 in 200-year drought severity, and assessed the impacts of climate change under these scenarios. The WAFU under average conditions is calculated to be between 190 and 192 Ml/d.

We have detailed the measures we are taking in response to the obligations we have under the Water Framework Directive, including the Water Industry National Environment Programme, to support the sustainability of our abstractions.

We have assessed the level of uncertainty of each component of the supply forecast under average and critical period conditions to calculate a headroom allowance. This resulted in a target headroom of 8 Ml/d at the start of the period increasing to 17 Ml/d by 2080 under average conditions. Uncertainties in the demand forecast accounts for most of this increase.

5.0 Demand Forecast

This section sets outs current and forecast demand under normal year and dry year planning scenarios, including an assessment of peak demand in a dry year. Demand is equal to Distribution Input (DI), which is the level of water put into the distribution network from the water treatment works with a slight adjustment to account for changes in service reservoir levels.

DI is calculated according to the following formula:

DI = *Household Demand + Non-Household Demand + Leakage + Distribution System Operational Use + Water Taken Unbilled + Exports*

As with the supply forecast, DI is adjusted to take account of the impacts of climate change, and is based on design drought scenarios.

Each of these components is discussed in Sections 5.2 to 5.6. We also carry out an assessment of the impact of our Levels of Service on demand (Section 5.7) and model uncertainties to determine the demand-side headroom allowance (Section 5.8).

The demand from exports has been based on average consumption from the small bulk supplies to SSE and Southern Water (totalling 0.1 Ml/d).

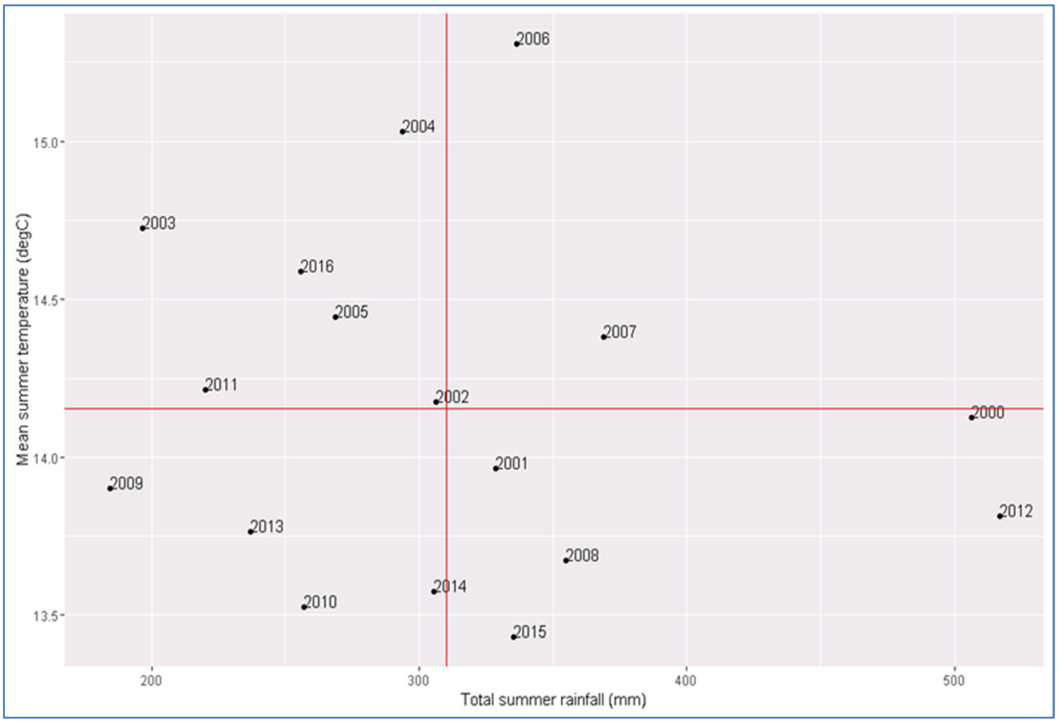
5.1 Defining Normal Year, Dry Year and Critical Peak Demand

In order to forecast future demand, we explore the relationship between DI and climatic factors to inform our assessment of ‘normal’ and ‘dry’ years. The methodology used is taken from the UKWIR report *Household Consumption Forecasting.* Further details are provided in Appendix E2, Section 6.

Rainfall and temperature can have a strong influence on customer demand for water. During the summer months, rainfall reduces customer demand from outside activities. Conversely, drought conditions accompanied by sustained periods of high temperatures, particularly over weekends and bank holidays, can lead to rapid increases in demand, particularly for garden watering.

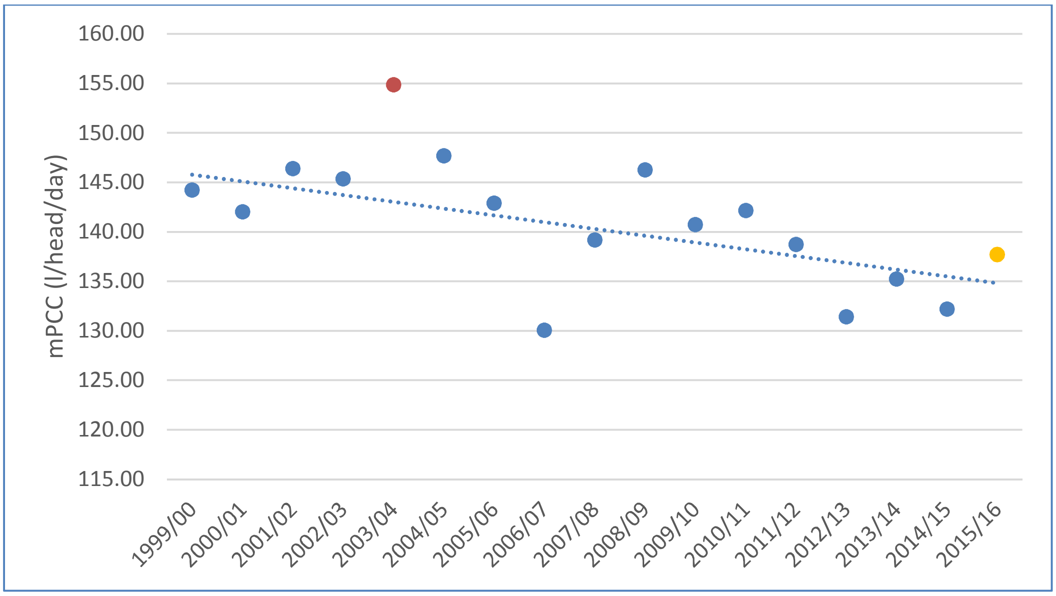
The first stage to determine the NYAA, DYAA and DYCP factors is to assess recent summer temperature and rainfall data using a quadrant plot, as shown in Figure 6. A judgement is made as to which is the hottest and driest year in the top left quadrant; in the case of this assessment 2003/04, 2004/05 and 2011/12 appear the strongest.

Figure 6: Quadrant plot for determining the dry year



Stage two is to analyse the Per Capita (Person) Consumption (PCC) trends, as shown in Figure 7. Note that the PCC calculation method used in the plan is different to the current reported method. Measured customer values are deemed to be more accurate and less variable in comparison to unmeasured customers, although unmeasured consumption is also assessed. Based on this, 2003/04 stands out as the year that responds the strongest out of the three possible dry year selections discussed above. The dry year factor is calculated by removing the dry year, then calculating a trend line through the remaining points. The dry year factor is the reported figure divided by the modelled figure.

Figure 7: Reported PCC – measured properties **(dry year in red, base year in yellow)**



This results in a ‘dry year factor’ of 1.08, i.e. demand is 8% higher in a dry year. In WRMP14, the dry year factor was calculated to be 1.10% (also based on 2003/04). The reduction in this value could be related to higher rates of metered customers (which has increased by around 2-3% each year since 2005) having the effect of suppressing peak usage in recent years.

Measured normal year factor is 0.98 and unmeasured normal year factor is 1.02. In the WRMP14 forecast, no normal year adjustment factor was applied.

The WRPG requires companies to assess the ability of their sources to meet peaks in demand as well as those experienced on an annual average basis. The remainder of this section details the process we have used to define a peak period and calculate the appropriate peak factor to apply to normal year annual average demands. This is used to calculate demand for the critical period supply-demand balance.

Critical period calculations are done in accordance to the methodology stated in UKWIR 06/WR/01/7. From the daily Distribution Input data a weekly rolling mean, peak week and annual average demand are calculated. A long-term annual average is then calculated from all of the years in the time series, and the critical period peak week factor is the maximum peak week within one of the dry years (i.e. in the top left quadrant). For this plan, the peak week was selected from 2003/04, with a peak factor of 1.492 (49.2%). This is similar to the value used in WRMP14 of 1.50. The updated figure is a reflection of a minor change in methodology to use a long term annual average rather than a single annual average in the dry year.

A summary of the NYAA, DYAA and CP factors is given in Table 6. Application of these factors to the household demand forecast is detailed in Appendix C.

Table 16: Summary of factors applied in the household forecast

Factor	WRMP19	WRMP14
Normal to Dry year factor (all households)	8.3%	10%
Base to Normal year factor (measured households)	-2.1%	0
Base to Normal year factor (unmeasured households)	1.8%	0
Normal to Critical period factor (all households)	49.2%	50%

5.2 Household Forecast

Household consumption is forecast by multiplying the projected population with the forecast per capita consumption in each year of the planning period, starting from the base year (2015/16). The methodology and results is described in detail in Appendix E2, with a summary provided in the following sections.

5.2.1 Population and Properties

We commissioned Experian to forecast household population and properties (dwelling) numbers as part of a club project with other water companies in the south east. Their report is attached in Appendix E1. They followed the guidance set out in the UKWIR report *Population, Household Property and Occupancy Forecasting* (2016). They produced four sets of forecasts with outputs provided at census level (ward) output and water resource zone level:

- Trend based (based on official statistics)
- Plan-based (based on Local Authority Plans)
- Econometric (taking account of economic factors)
- Hybrid (combination of plan and econometric forecasts)

Forecasts were produced to 2044/45, with trends extrapolated from this point to the end of the planning period.

The trend-based forecast is based on census and population projections published by the Office for National Statistics (ONS). Vacant properties are estimated using council tax vacancy rates. Occupancy rates are calculated using average household size data from the Department for Communities and Local Government (DCLG).

For the plan-based forecasts, Experian contacted every local authority to request their latest adopted or draft plan on housing growth. The response rate in our supply area was 80%. Where a response was not obtained, information published online was used, as shown in Figure 8. The vacant property rates derived from the trend-based forecast was also used in the plan-based forecast.

Figure 8: Local Authority Plan Response & Status

Status	Local authority response	Local Plan Status	Data source	Published/ adopted date
Bromley	Yes	Draft	Proposed submission draft local plan and five year housing land supply paper November 2016	Nov-16
Crawley	No	Emerging	The Crawley Borough Local Plan 2015 – 2030, HOUSING IMPLEMENTATION STRATEGY	Nov-14
Croydon	Yes	Published	Updated Croydon Housing Trajectory for the Croydon Local Plan Proposed Submission	Sep-16
Elmbridge	Yes	Adopted	Annual Monitoring Report 2016	Jul-11
Epsom and Ewell	No	Adopted	Figures from dated plan no longer representative. Trend used.	Jul-07
Guildford	Yes	Published	Land Availability Assessment (LAA) 2016	May-16
Horsham	Yes	Adopted	Housing Authority Monitoring Report Mid Yearly Update May 2016	Nov-15
Merton	No	Adopted	London Plan	Jul-11
Mid Sussex	Yes	Submitted	Housing Implemention Plan August 2016	Aug-16
Mole Valley	Yes	Adopted	Annual Monitoring Report 2014/15	May-15
Reigate and Banstead	Yes	Adopted	Core Strategy	Jul-14
Sevenoaks	Yes	Emerging	Kent and Medway Growth and Infrastructure Framework Refresh June 2016 - New dwelling completions	Jun-16
Sutton	Yes	Draft	Council Housing Monitoring Returns & the Draft Sutton Local Plan	Sep-16
Tandridge	Yes	Emerging	Housing Supply Statement 2016 and Tandridge Strategic Housing Market Assessment (2015)	Jun-16
Wealden	No	Adopted	AMR 2013-14	Feb-13

The econometric forecast takes into account the link between economic growth and household property growth, on the basis that upward trends can be constrained by market conditions. Trend-based occupancy rates are applied to the economic household forecast to derive a population forecast.

The hybrid approach takes the mid-point between the econometric and plan-based household forecast. This is on the basis that rates of housing development will be greatest in local authority areas with the most accommodating planning system, but limited at the broader level according the economic conditions. The hybrid population forecast is derived by applying the occupancy rate from the econometric forecast.

The results of the projections (to 2045) are shown in Figure 9 and 10. It can be seen that the trend-based plan results in the higher projections of both properties and population, 12% higher than the plan-based forecast by 2045. The econometric and hybrid forecasts are closely matched. We have selected the econometric forecast as the best projection to use in the household demand forecast. This was confirmed comparing actual growth in the past 5 years with that predicted using the model.

Figure 9: Household projection comparison

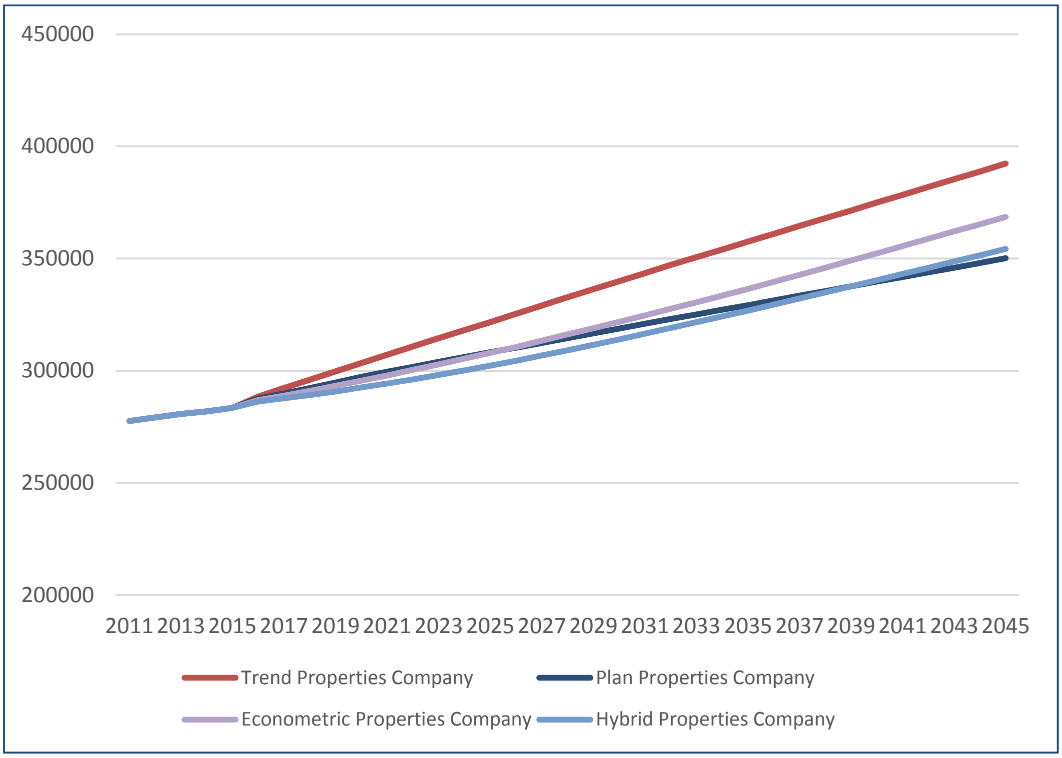
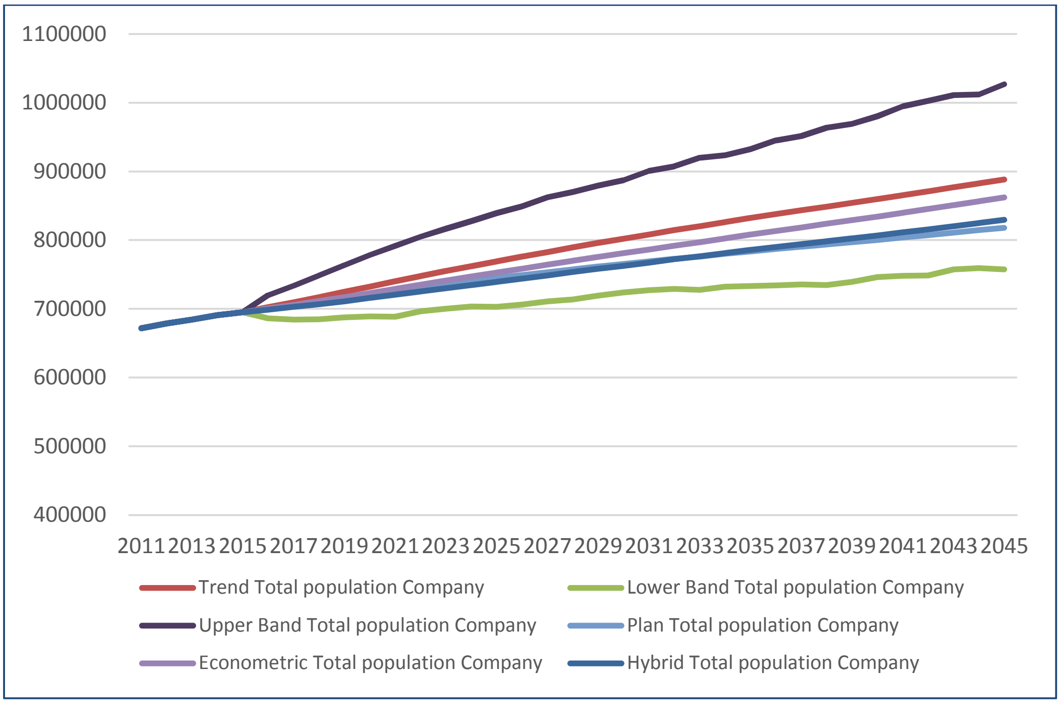


Figure 10: Population projection comparison

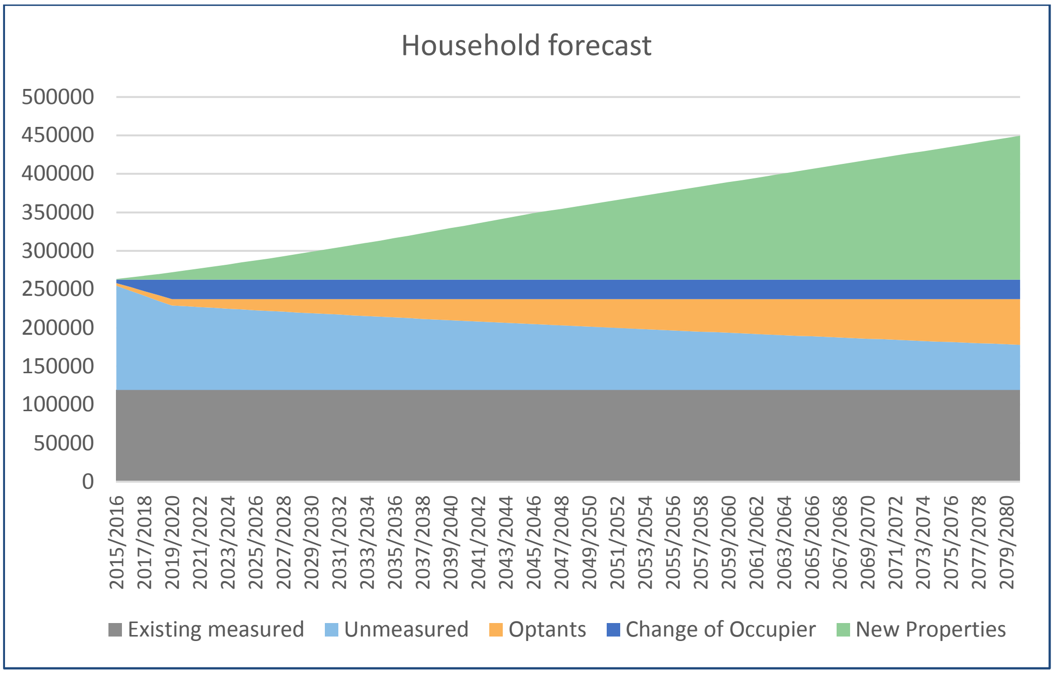


The projected figures are then aligned to our reported base year customer numbers. An adjustment is made to account for those properties not captured on our customer database, for example where individual dwellings are not billed separately. To ensure the population numbers used in the household demand forecast matches that derived from the Experian analysis (of 684,456 in 2015/16), a higher occupancy rate has to be applied.

We commissioned Artesia to segregate the population and property numbers into measured (metered) and unmeasured customers. The base-year measured population is 312,907 and unmeasured population is 371,550. When aligned to our customer numbers in the base-year, occupancy is 2.44 for measured customers and 2.74 for unmeasured customers. This is slightly higher than the rates applied in the 2014 plan.

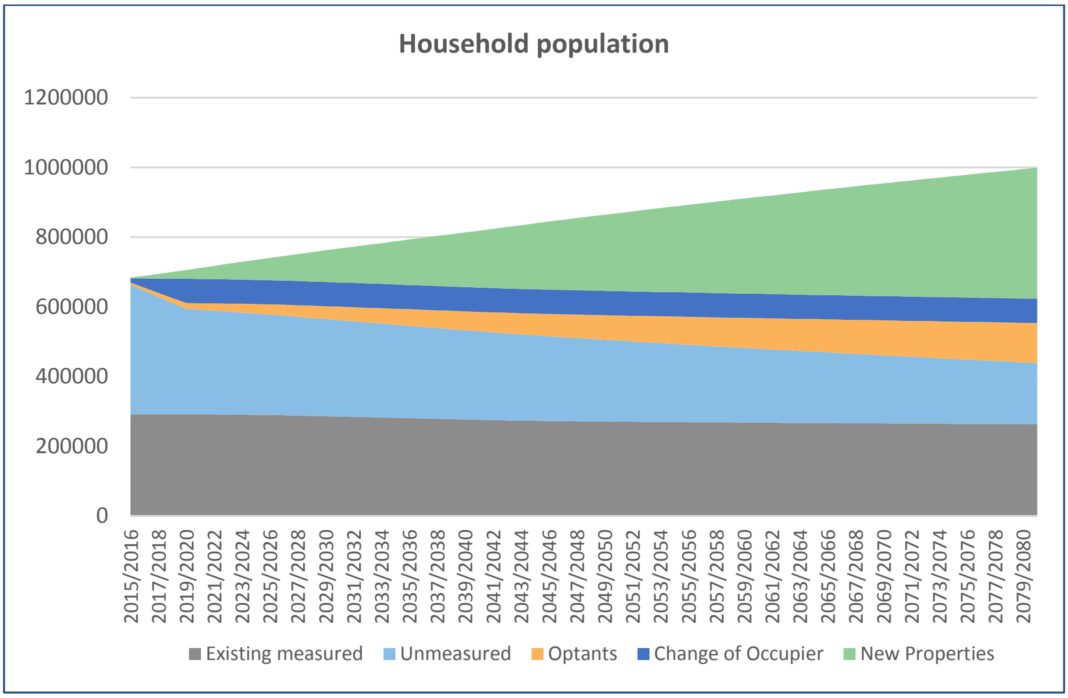
When extrapolated to the end of the planning period, the household forecast is as shown in Figure 11. Total number of households is expected to increase from 263,451 to 446,691, a 70% increase over the 60-year period. The graph also shows how the numbers are proportioned according to their metering status. By the end of the period an additional 187,186 new properties are forecast to be connected, all of which will be metered. The number of properties that will 'switch' from an unmeasured to measured status (through either our change of occupancy or optant metering programmes) is predicted to reach 84,531 by 2080 under the baseline scenario.

Figure 11: Household Forecast



The same approach is used to forecast population to 2080 as shown in Figure 12, with the total population expected to rise to just under 1 million by 2080 at 995,381, representing an increase of 41%. Population growth is lower than property growth due to a decline in occupancy rates (from 2.59 to 2.23) over the planning period.

Figure 12: Population Forecast



5.2.2 Household Consumption

The second part of the household demand forecast is to consider factors that affect consumption trends on an individual property and person (capita) basis. We commissioned Artesia to compete this analysis for this plan. Following the UKWIR guidance on household consumption forecasting, they selected an approach using a scoring matrix to compare different methods. This is detailed in Section 2 of Appendix E2. This showed the optimum methods were micro-components, macro-components and regression analysis. Regression analysis was discounted as there was insufficient company-specific data available. They opted to use the micro-component approach as sufficient data was available and it is more advanced than using macro-components. This was deemed suitable based for a company with a low level of concern in its problem characterisation analysis (as detailed in Section 3.3).

To establish a baseline consumption at a household level, Per Capita Consumption (PCC) from the water balance analysis for the base year is multiplied by the reported occupancy figures. Since 2015 we have carried out two methods to calculate the water balance, the traditional method and the Mean Likelihood Estimate (MLE) method. The traditional method is used for reporting purposes, whereas the MLE method is industry standard. We previously committed to switch to using MLE for reporting purposes from 2020. This also aligns with the guidance issued by Ofwat on consistent methodology for PR19. Therefore, we have used the MLE method in this plan.

This resulted in a measured household consumption of 338.7 litres per property per day, with unmeasured households using 424.6 litres per property per day.

To forecast future trends, total consumption must be divided into its components and each forecast by combining values for ownership, volume per use and frequency of use. The main components are toilet flushing, personal washing, clothes washing, dishwashing, external use and miscellaneous internal use including plumbing losses, although these are sub-divided where necessary for the forecast.

In brief, we used the following data sources:

- National studies (such as the UKWIR study using the Siloette system and WRc study using Identiflow) to provide measured information on water use per component on a limited number of properties
- Customer surveys such as our online water savings calculator to provide estimates of water use per component on a large number of properties
- Information from Defra's Market Transformation Programme (MTP) to provide predictions of water use for different appliances based on the effects of changes in technology, policy and behaviour trends.

5.2.3 Property Segmentation

Since the metering status of a household property has a significant influence on consumption, we segment the properties into the categories given in Figure 12. This is partly due to the difference in occupancy rates between the categories, as customers that opt to have a meter tend to be lower in occupancy (hence they benefit from switching from a charge based on a fixed rate per property). This has the effect of reducing occupancy in metered households, and correspondingly increasing the occupancy rate of properties remaining as unmeasured.

It is predicted that the rate of increase in the number of meter optants and change of occupier metered properties will reduce significantly over the next five years, as the pool of unmeasured properties declines. It is expected that the proportion of metered customers will increase from around 60% in 2020 to 70% by 2025 and 93% by the end of the period. As some properties cannot be metered due to their plumbing arrangements, reaching 100% will only be achieved once all these properties are replaced which is difficult to forecast.

Micro-component analysis is completed for both measured and unmeasured properties, taking into account forecast trends and the baseline level of water efficiency programmes set at the level of 0.09 Ml/d each year as used in WRMP14.

5.2.4 Impacts of Climate Change

Climate change impacts on consumption have been calculated in accordance with the UKWIR report *Impact of Climate Change on Water Demand* (2013). This is summarised below, with additional detail provided in Appendix E2, Section 5.8.

Median percentage climate change impacts on household demand at 2040 relative to 2012 have been published for each river basin within the UK. Our supply area sits entirely within the Thames basin.

The dry year annual average demand was forecast to increase by 0.88% over that period due to climate change. As the base year is now 2015/16 and the final forecast year is 2079/80 the percentage change is shifted along and projected to the 2079/80 planning year as there has been no further evidence since the previous report. As the forecast period is longer, the final percentage is larger with a predicted impact by 2079/80 of 2.0% for the DYAA scenario. Under a critical period scenario the percentage increases to 5.5%. When the critical period is selected, the appropriate climate change factor is applied in a linear fashion across the forecast period.

The additional demand from climate change is added to the external use micro-component only.

The micro-component trends, with climate change added, are given in Figures 13 and 14. This shows consumption from toilets is expected to decline significantly over the next 10 years, whereas there is an increase in shower and bath usage over the same period. Other components are relatively stable.

Figure 13: Micro-components per household (dry year)

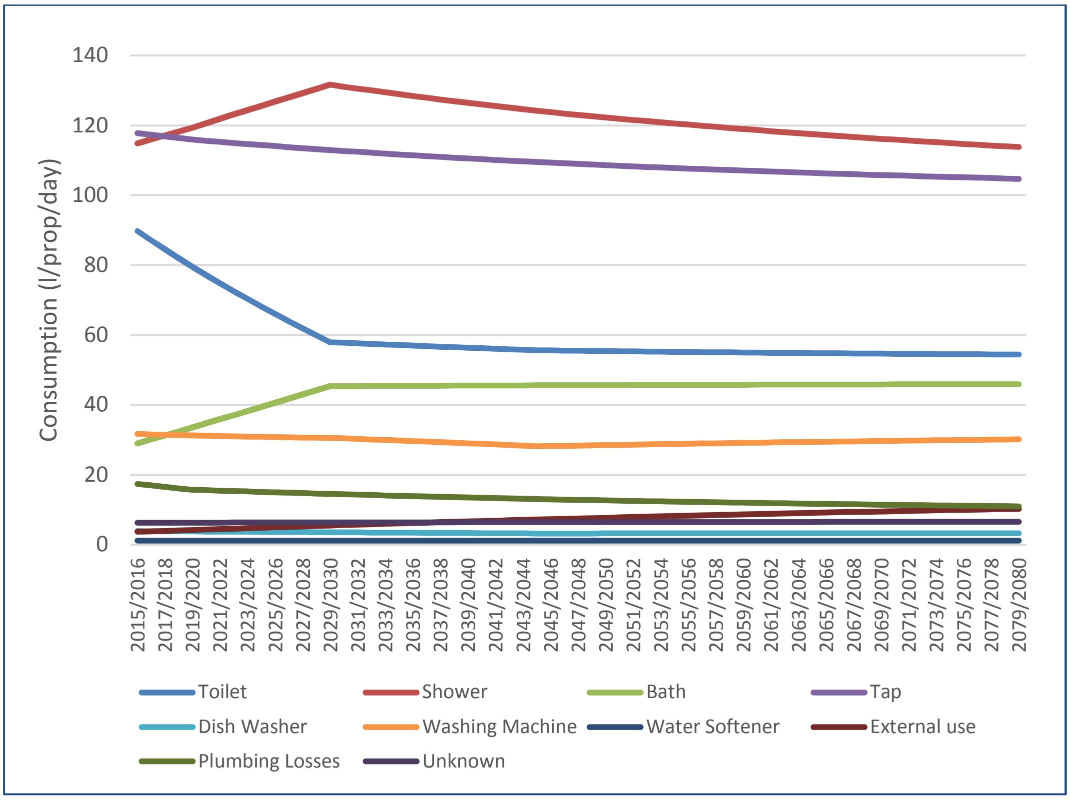
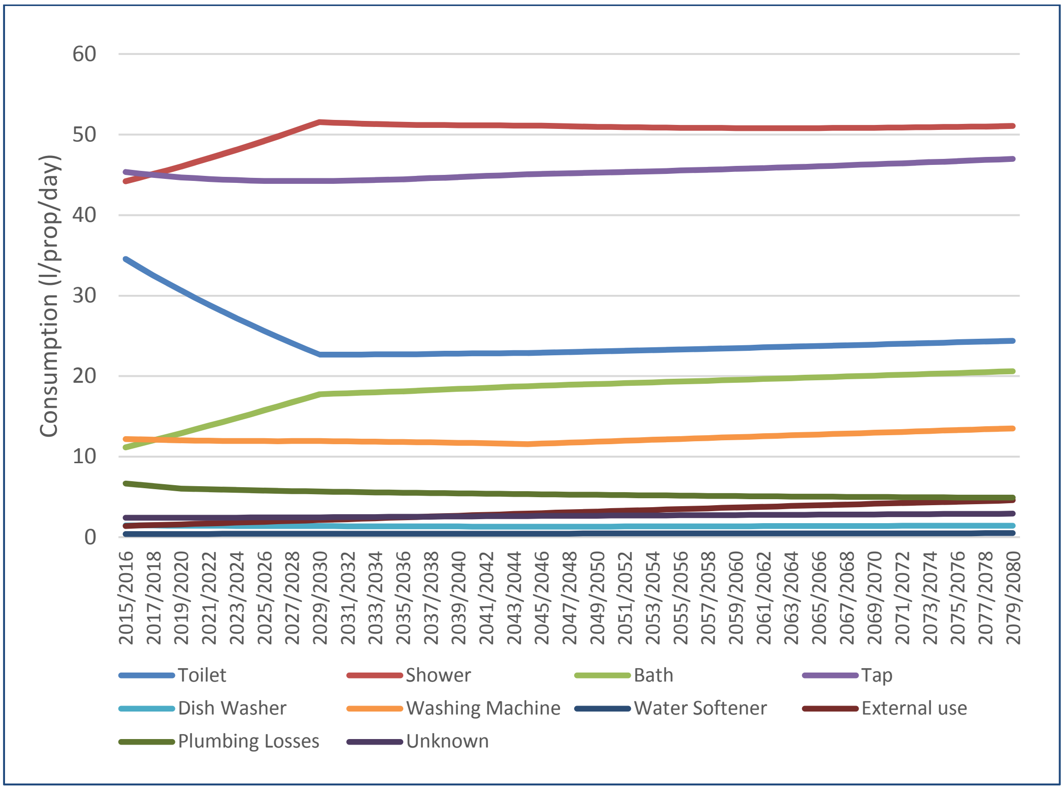


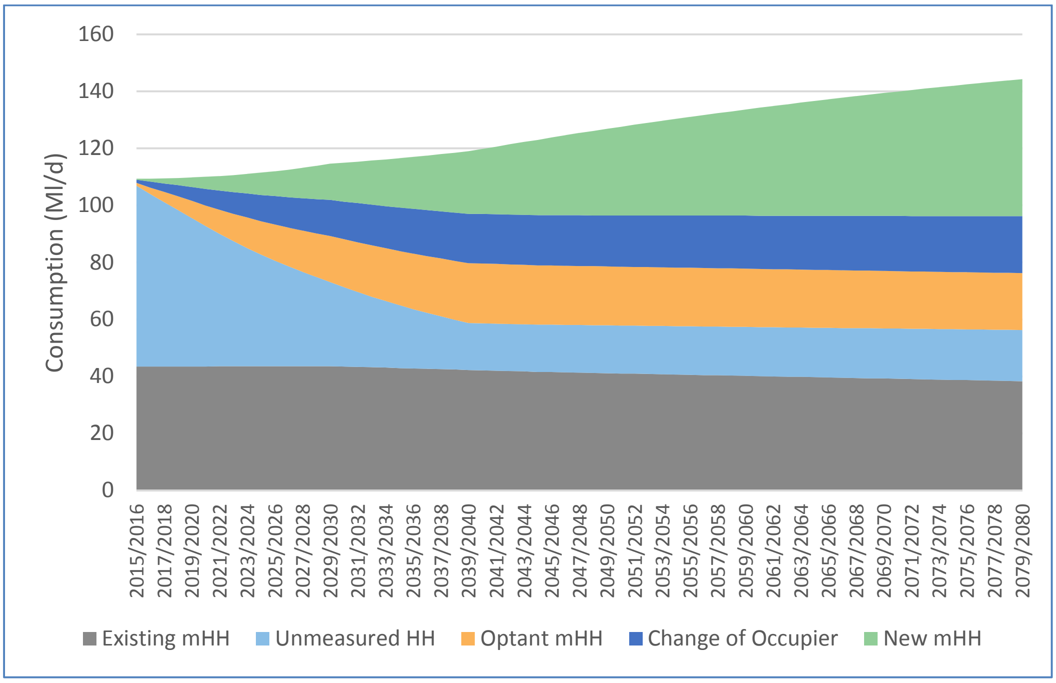
Figure 14: Micro-components per capita (dry year)



5.2.5 Household Demand Forecast

By combining the property and population forecasts with the data from the micro-component consumption analysis, we have forecast average dry year household demand to increase from 109.4 Ml/d in 2015/16 to 144.3 Ml/d in 2079/80, as shown in Figure 15. This represents a rise of 32%.

Figure 15: Baseline Household Consumption: Dry Year



We can also view consumption by PCC in both a normal year and a dry year. These are displayed in Figures 16 and 17. The reduction in PCC explains why overall household consumption rises at a much lower rate than housing growth.

The overall normal year PCC declines from 147.6 to 135.8 litres per person per day, whereas dry year PCC starts at 159.8 and drops to 144.9 litres per person per day over the period.

Figure 16: Baseline Per Capita Consumption (Normal Year)

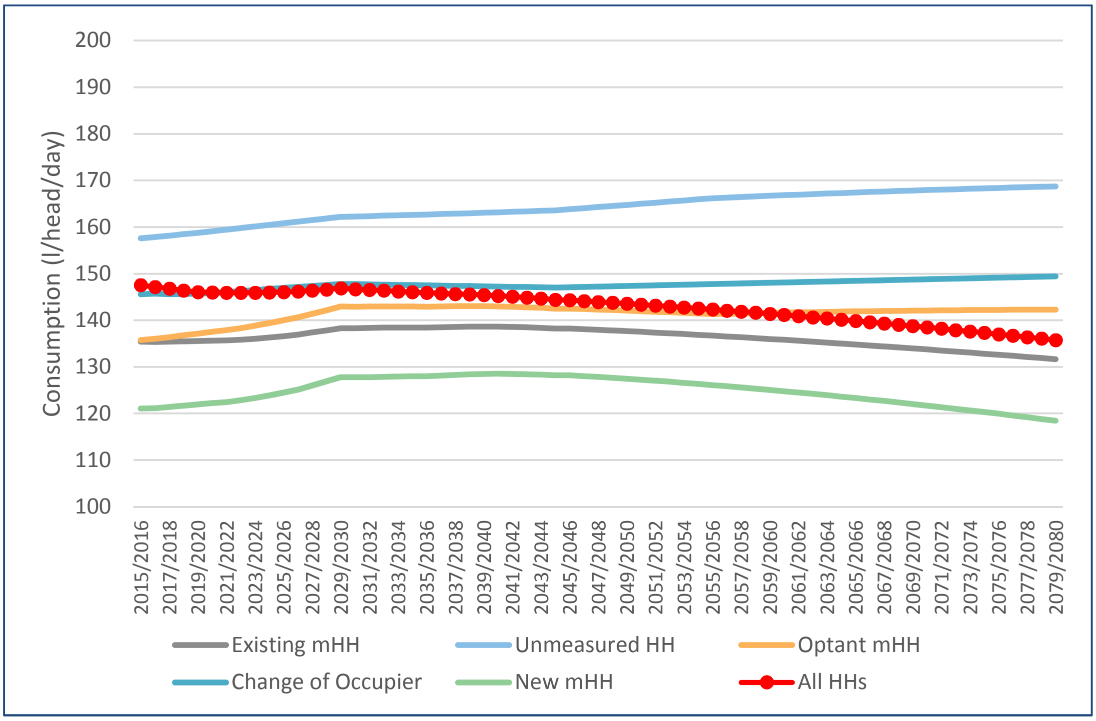
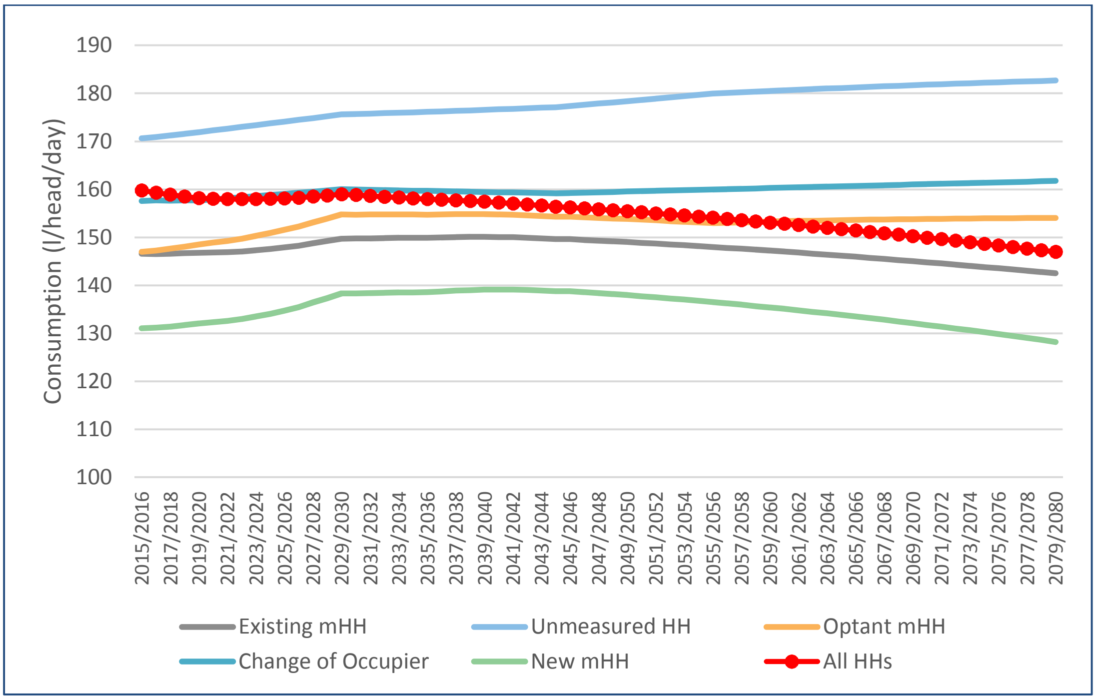
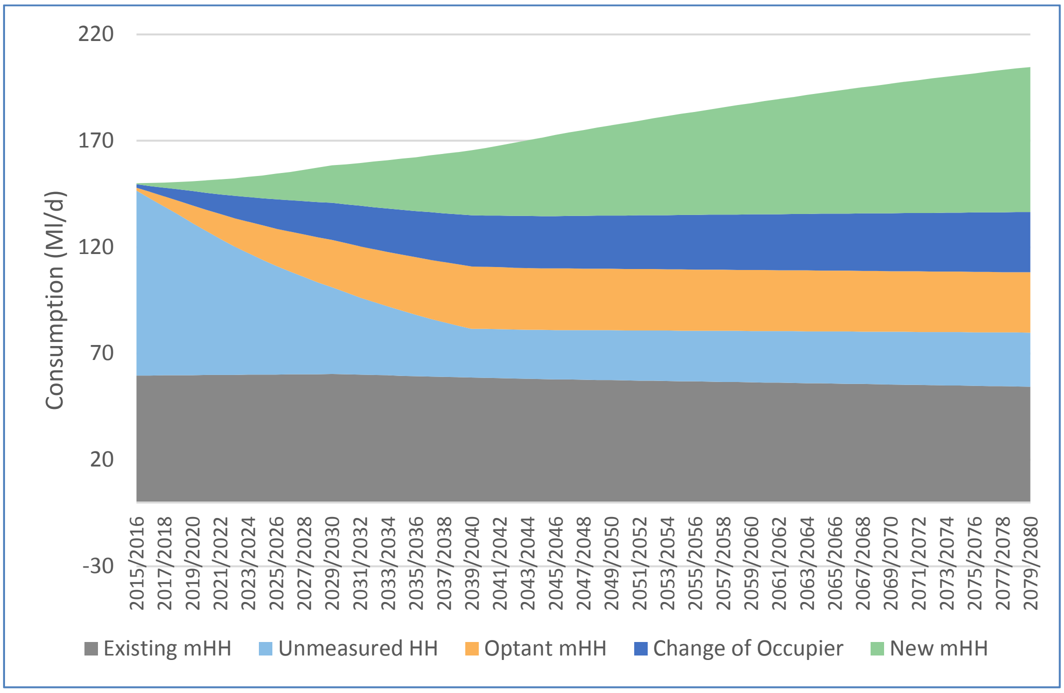


Figure 17: Baseline Per Capita Consumption (Dry Year)



We have also forecast household demand during the peak period, using the factors detailed in Section 5.1, as shown in Figure 18. This results in a peak demand of 207.8 Ml/d by 2080.

Figure 18: Baseline Household Consumption: Dry Year Critical Period



5.3 Non-household Demand

In the previous WRMP, analysis of historical non-household consumption data found no clear trend in overall non-household consumption. Although employment in South East England was generally expected to grow, at the time there was considerable uncertainty regarding the effects of the economic downturn. We therefore took the approach of maintaining non-household consumption at virtually the same levels throughout the planning period, reaching 25.09 Ml/d by 2039/40 in the Final Plan.

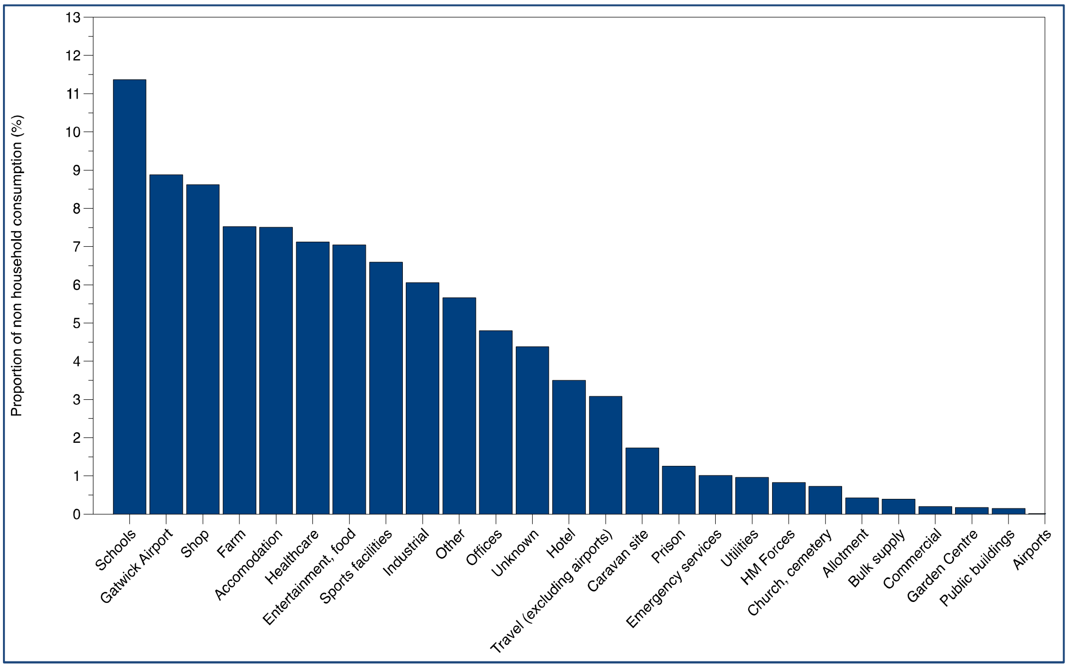
The first stage of the new forecast is to group consumption into categories based on the last full year of data (2016/17). This is shown in Figure 19.

The largest category is schools, the second largest Gatwick Airport, after that shops, farms and accommodation (domestic and managed flats). A large part of the non-household consumption is associated with the general population (e.g. schools, healthcare, entertainment, food, sports.) as opposed to industrial use.

In the absence of consumption trends by category, the forecast was based on four components that had good quality historical data since 2000.

- Measured non-household consumption in the East Surrey water supply area (minus Gatwick)
- Measured non-household consumption in the Sutton water supply area
- Measured non-household consumption in Gatwick Airport
- Unmeasured non-household consumption

Figure 19: Non-household use by category



The East Surrey (minus Gatwick) area consumption produces a reasonable linear model with ONS unemployment data with a lag of one year. The final forecast shows a decline over the planning period from 15.75 to 15.5 Ml/d.

The Sutton area consumption has an upward time-series linear trend, assumed to be related to growth in the services sector. This upward trend has been used to forecast the Sutton area consumption for the first five years of the plan. After this date, the consumption remains flat. The increase is from 9.16 to 9.49 Ml/d.

Gatwick (2.04 Ml/d) and the unmeasured non-household consumption (0.92 Ml/d) are assumed to remain constant over the forecast period.

We have considered the impact of market reform on non-household consumption and concluded that it is unlikely to be significant, based on the efficiency programmes we have carried out since 2010. We have audited businesses, schools, nursing homes and other non-households on an ongoing basis, both on request and as part of inspections for compliance against the Water Fittings Regulations. We provide advice and water saving devices. We have also carried out visits using market data to select properties that are deemed to have a usage above the average for that property type. From this, we have concluded that most properties that can make significant savings have already done so. However, we have included an ongoing baseline level of water efficiency in the forecast.

The overall forecast for non-household consumption, with upper and lower limits, is shown graphically in Figure 20 and also in Table 16.

Figure 20: Non-household consumption forecast with upper and lower limits

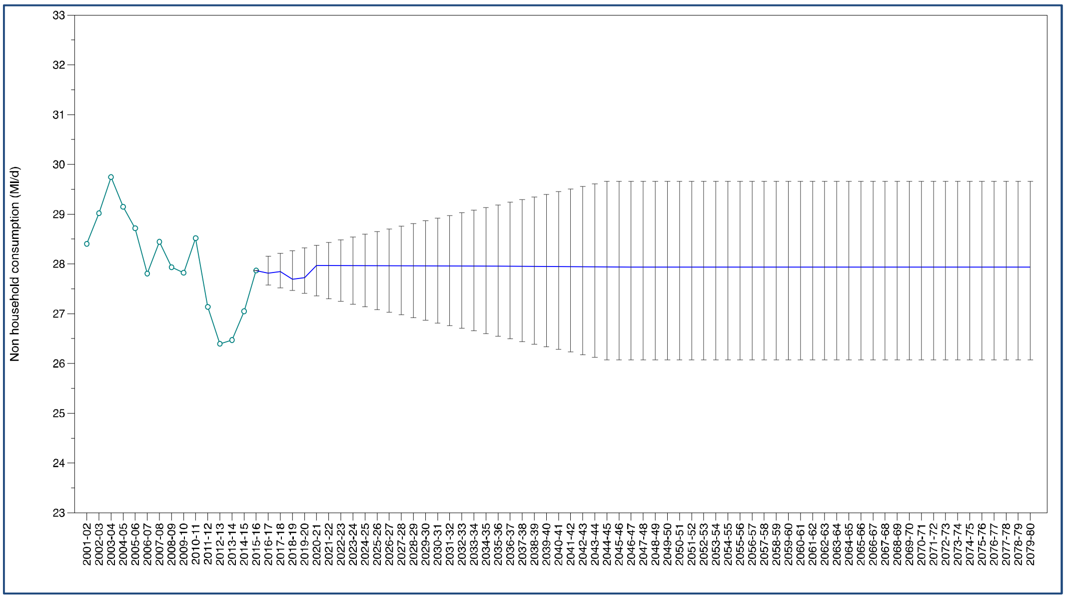


Table 16: Summary of Non-Household Consumption

Year	Central forecast (Ml/d)	Upper forecast (Ml/d)	Lower forecast (Ml/d)
2015/16 (Base year)	27.87	27.87	27.87
2020/21	27.97	28.38	27.36
2025/26	27.96	28.65	27.08
2030/31	27.96	28.92	26.81
2035/36	27.95	29.19	26.55
2040/41	27.95	29.45	26.28
2045/46	27.94	29.66	26.07
2079/80	27.94	29.66	26.07

5.4 Leakage

5.4.1 Current leakage level

We estimate leakage in the distribution system by monitoring 302 discrete District Metered Areas (DMAs) using GPRS loggers. Each logger records average flow data every 15 minutes, which are transmitted hourly to a data server. The data forms a daily profile, including a minimum night flow that can be used as an indication of leakage in the DMA. Additionally, pressure data for each logger site are transmitted and used for operational purposes.

Approximately 95% of data loggers are available for leakage calculation each day. This level of coverage gives us a high level of confidence in our assessment. The leakage calculation is based upon a long and established methodology. Bespoke software is used to collect district meter data and estimate levels of leakage.

One of the biggest challenges we face when estimating leakage is distinguishing between leakage and increased demand at night during the summer months due to sprinkler or irrigation usage, which is common in our supply area. Up to 2016/17, we assumed a leakage level during the summer months based on average levels. The reported level of leakage in the past 10 years is shown in Table 17.

As expected, leakage is influenced by weather conditions with levels increasing during cold spells and also during rapid thaw periods. As an example, 2012/13 was a benign year with winter temperatures only dropping below freezing for 37 days (as measured at Bough Beech), compared to an average of 61 days, and therefore the leakage was low in that year at 23.74 Ml/d. In cold winters, we have to invest additional funds in Active Leakage Control (ALC) in order to meet the target.

Table 17: Leakage levels since 2007/08

Year	Leakage (Ml/d)	Target (Ml/d
2007/08	24.28	24.5
2008/09	24.48	24.5
2009/10	24.20	24.5
2010/11	24.50	24.5
2011/12	23.56	24.5
2012/13	23.74	24.5
2013/14	23.93	24.5
2014/15	24.17	24.5
2015/16	24.17	24.4
2016/17	24.34	24.3
2017/18	24.16	24.2
Average (all years)	*24.14*	*n/a*
Average (past 3 years)	*24.22*	*n/a*

Our leakage target for the AMP6 period is a gradual decline from 24.5 Ml/d in 2015/16 to 24.0 Ml/d in 2019/20, a reduction of 0.1 Ml/d per year. Our approach to leakage control involves a combination of ALC, pressure management and mains replacement. We also assess leakage from service reservoirs, for example through the use of drop tests during maintenance work, and trunk mains. The options available to reduce leakage in the future is discussed as part of the options assessment in Section 7.2.

5.4.2 Consistency of Leakage Reporting

Since 2016 water companies have been working together, co-ordinated by Water UK, to improve the consistency of definitions of key performance measures, so that performance can be compared between companies more easily. This work is supported by Ofwat, the Environment Agency, Natural Resources Wales and the Consumer Council for Water.

Companies need to make changes to their current reporting to align with the new reporting definitions, and for some of these changes it will take some time to have robust data. One of the measures of performance this applies to is leakage. For this plan, we have used the existing methods of reporting leakage since the value under the consistent methodology is not available for the base year and we do not currently have estimates which are sufficiently robust to use in the planning calculations. We have already made good progress, and will continue to implement the measures required to achieve full compliance with the methodology by April 2020, such as improving our night use allowances for households and non-households. We have submitted details of the actions we plan to take in the Shadow Reporting Commentaries to Ofwat in July 2018. The change in reporting of leakage does not affect the actual amount of water lost through leakage.

5.4.3 Baseline leakage forecast

As shown in Table 17, our current leakage level is 24.16 Ml/d and the average of the last three years is 24.22 Ml/d.

However, as we made a commitment to achieve 24.0 Ml/d by the end of the period (2019/20), in our baseline demand forecast we have set leakage to remain at this level throughout the planning period. Although there is an increase in housing, it is assumed we will be able to manage our network without allowing leakage to rise, partly as this will be offset by an increase in metering penetration which is expected to reduce supply pipe leakage. We assume unmeasured properties have an average of 40 litres per property per day lost through supply pipes, against an average for measured properties of 20 litres per property per day. We evaluated these assumptions by benchmarking these levels against other companies and by analysing data from leak repair records. It was concluded these assumptions were reasonable, and therefore the same estimates of supply pipe leakage have been used in this plan.

Options for varying our leakage management policy in order to target a lower level of leakage are considered as part of the options appraisal (Section 0). The economic modelling and programme appraisal undertaken to derive our preferred final planning programme considers whether options for leakage reduction are necessary and justifiable, including taking account of financial, social and environmental and carbon costs and benefits, as well as other wider factors including guidance issued by regulators and the results of customer engagement on our PR19 business plan. New leakage targets for the AMP7 period will be set by Ofwat as part of its Final Determination in 2019.

To assist with this appraisal, we commissioned Artesia to review our Sustainable Economic Level of Leakage (SELL), the level at which the financial costs of further leakage reduction are equal to the financial benefits of the water saved. This compares the costs of leakage detection and repair versus the marginal cost of supplying water. This is contrasted with the minimum achievable leakage (known as MAbL) for each DMA. The new SELL was calculated to be 23.5 Ml/d, or 89 litres per property per day. This is lower than the previous level used in WRMP14 (calculated for PR09) of 27.3 Ml/d. This is mainly due to the change in using MAbL instead of the minimum achieved leakage (MAL) in each DMA. The revised level of SELL has been used in the appraisal of leakage reduction options. This lower level has the effect of making leakage options more cost beneficial and therefore they are more likely to be selected to address a supply demand deficit than in WRMP14.

Leakage is divided into company-side losses (termed distribution losses) and customer-side leakage (CSL). As customer-side leakage is counted as part of the household and non-household demand, only the distribution losses component is used in the demand forecast. Distribution losses decline from 15.95 Ml/d at the start of the period to 13.62 Ml/d by 2080. This is due to an increase in CSL (as property numbers increase), so that overall leakage is constant at 24.00 Ml/d.

5.5 Distribution System Operational Use (DSOU)

In WRMP14 a figure of 0.22 Ml/d was used for DSOU, based on an estimation of water used for flushing purposes. In 2015, a more thorough assessment was carried out to take account of the water used for process water at WTWs (for chlorination, ammoniation and sulphonation) as well as reservoir cleaning. The revised methodology was used from 2015/16. The results for 2016/17 is shown in Table 18.

Table 18: Distribution System Operational Use - 2016/17

Component	Consumption (Ml/d)
Process Water at WTW	2.529
Reservoir cleaning & maintenance	0.104
Mains flushing for water quality	0.014
New mains commissioning	0.004
TOTAL	2.651

A slightly lower figure of 2.64 Ml/d has been used in the baseline demand forecast. It is assumed that DSOU does not vary throughout the planning period, on the basis that the main components (process water and reservoir cleaning & maintenance) are fixed, i.e. they do not change in proportion to DI. We are also trialling approaches such as robotic cleaning of service reservoirs that, if successful, would reduce the need to take them out of service periodically.

5.6 Water Taken Unbilled

This component has also been revised for this plan following a more detailed review of its calculation. In WRMP14, WTU was estimated at a level of 0.43 Ml/d, largely based on the use of standpipes hired to third parties. In 2016/17, usage from unbilled properties was added, i.e. properties classed as void (unoccupied) on our billing system but actually occupied. This can be estimated from a comparison between the number of properties registered as unoccupied on council tax records (from the Experian datasets) and the number of billed household properties. This accounts for 1.14 Ml/d of the 1.74 Ml/d assessed as total WTU for this plan. The remaining volume is from standpipe hire, use of hydrant by fire authorities, and consumption unaccounted for by water meters slowing or stopping.

This figure is considered to remain constant throughout the planning period, despite an increase in property numbers, due to improvements in data collection and technology.

5.7 Impact of Levels of Service (Drought Orders) on Demand

Data regarding water savings achieved by sprinkler and full hosepipe bans were collected during the implementation of demand restrictions between 1996 and 2007. It was found that sprinkler bans produced savings at peak demand when accompanied by an intensive media campaign. A saving of up to 1.5% at average and 3.5% at peak, i.e. June to September inclusive, could be expected, based upon the difference between actual demand and that expected based on the climatic conditions experienced in 2005/06. As stated in UKWIR (2007), "*the magnitude of reduction in any year depends on the demand that would have been expected in that year had restrictions and other measures not been imposed*".

It was found that the introduction of full hosepipe bans provided a further suppression of demand, saving up to 4% at average and up to 6% at peak (inclusive of savings from sprinkler bans). While these figures may not be directly comparable to the activities defined by the new legislation in Temporary Use Bans (see 4.1.3), they offer an indicative measure of the effectiveness of these restrictions.

It is estimated that an additional demand saving of approximately 8.5% could be expected with a full drought order ban being implemented (UKWIR, 2007), over and above savings achieved by the temporary water use restrictions. This information was calculated as part of the UKWIR (2007) study that modelled the effects of demand restrictions during droughts: SES Water specific data from the 2003-2006 drought quoted in this study suggested that a saving of between 10% and 17% at average and 20% at peak could be expected in the past with the non-essential use ban (inclusive of sprinkler and hosepipe bans). The additional 8.5% (13.5% cumulatively) is taken from the mid-point between average savings, which are considered to be those most impacted by a drought order to restrict non-essential use. These savings should be taken as estimates due to likely variance in temperatures and therefore antecedent levels of demand.

5.8 Allowing for Uncertainty (Headroom)

The allowance for uncertainty from the supply forecast is discussed in Section 4.6, with full details for both supply and demand provided in Appendix D.

There are four uncertainty factors relating to demand:

D1 Accuracy of Sub-component Demand Data
D2 Demand Forecast Variation
D3 Impact of Climate Change on Demand
D4 Demand Management Measures

In summary, for D1, it was assumed that there was a 95% probability that values are within 3%. This is a change from WRMP14 where a normal distribution of +/-2% was used. This component is stable throughout the period.

The variation in demand forecast (D2) was taken as the triangular distribution between the lower, central and upper demand household and non-household demand forecasts. This factor accounts for an increasing proportion of headroom towards the end of the planning period.

Uncertainty on climate change (D3) was based on the triangular distribution between the different scenarios – low (10th percentile), central (50th percentile) and high (90th percentile). This factor is a small but increasing component of headroom by 2080.

Uncertainty on demand management options (D4) are included following the options appraisal and selection.

Dry year demand from each component is given in Table 19.

Table 19: Baseline Demand Forecast (DYAA)

Component	Demand at 2020/21 (Ml/d)	Demand at 2079/80 (Ml/d)
Household demand	109.99	154.24
Non-household demand	27.63	27.94
Distribution Losses	15.82	13.55
Water Taken Unbilled	1.74	1.74
Distribution System Operational Use	2.64	2.64
TOTAL	**166.00**	**200.24**

Section Summary – Demand Forecast

We have selected 2003/04 to be representative of a dry year, with a dry year factor of 1.08 and a critical peak factor of 1.49.

We have forecast the properties in our supply area to reach 446,691 by 2079/80, a 64% increase over the 60-year period. The population is expected to increase by 41% to just under one million by 2079/80. There is a decline in forecast occupancy rates from 2.59 to 2.23 over the planning period.

Household consumption is forecast using micro-component analysis and metering segmentation. Metering is forecast to increase to 70% by 2025 and 93% by 2080 under baseline conditions. Normal year PCC declines from 147.6 in the base year to 135.8 (litres per person per day), whereas dry year PCC starts at 159.8 in the base year and drops to 144.9 by 2080.

Climate change increases external use by 2% by 2080 on average and 5.5% in peak conditions.

Non-household demand is largely stable and is forecast to maintain at current levels.

Baseline leakage is maintained at the 2019/20 target level. Minor components (Water taken unbilled and Distribution System Operational Use) have been re-assessed and found to be of more significance than previously calculated. These volumes are forecast to be stable across the planning period

6.0 Baseline Supply-Demand Balance

This section compares the supply and demand forecasts, including headroom, to determine whether resources are projected to be in surplus or deficit at any point in the planning period. The two scenarios assessed within the forecasts are Dry Year Annual Average (DYAA) and Dry Year Critical Period (DYCP). The supply-demand balance for each scenario is displayed in the following sections.

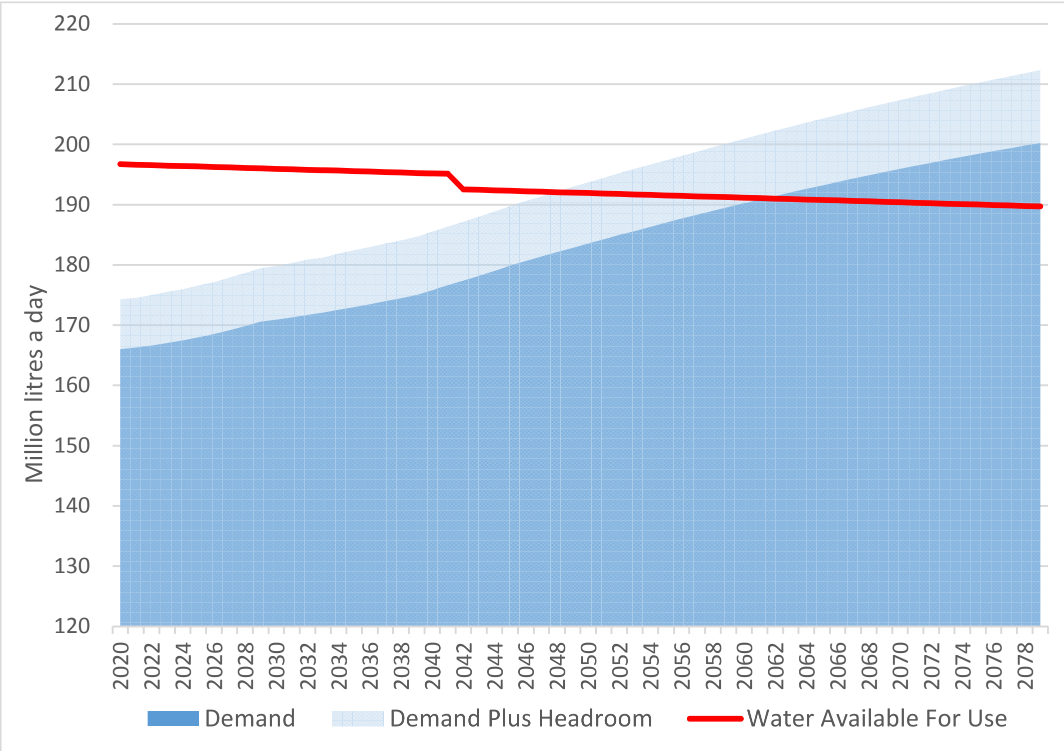
For each scenario, the balance under both design droughts are compared, that is the Worst Drought on Historic Record (WDHR) and the 1 in 200-year drought risk.

6.1 Dry Year Annual Average

The results of the balance under the WDHR scenario is shown in Figure 21. This shows we have a surplus until 2048/49. By the end of the period, the deficit has increased to 22.7 Ml/d.

With the 1 in 200-year scenario, the point at which demand plus headroom exceeds supply is in the year 2047/48. The deficit by 2080 is calculated to be 20.2 Ml/d.

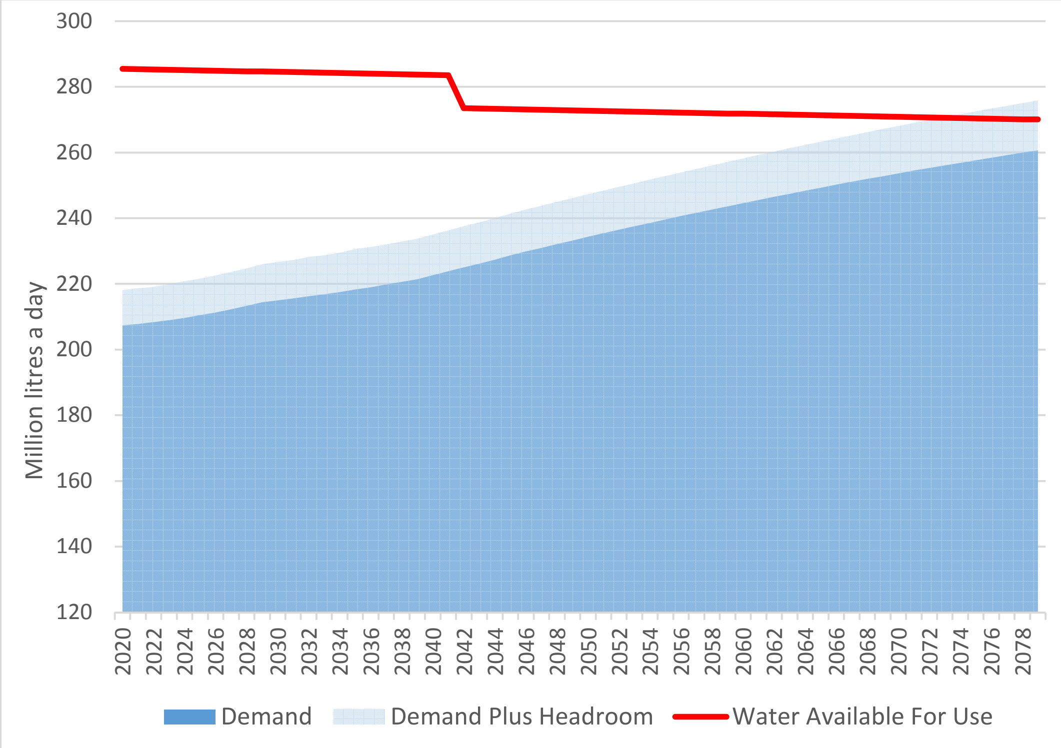
Figure 21: Water Available for Use (DYAA - WDHR)



6.2 Dry Year Critical Period

As shown in Figure 22, in the WDHR critical period scenario there is a surplus until 2072, with the deficit by 2080 at 5.9 Ml/d. For the 1 in 200-year scenario this deficit increases to 9.8 Ml/d by 2080.

Figure 22: Water Available for Use (DYCP - WDHR)



6.3 Planning Scenario

Since the Annual Average is the more challenging of the two scenarios, it is used as the basis for the next stage in the process, options analysis. That is, the planning problem that we need to resolve in this plan is the 22.7 Ml/d deficit.

We have continued to assess the 1 in 200-year drought scenario as a comparator to the WDHR in order test the sensitivity of the plan to different inputs.

The final plan will ensure we are resilient to both the worst drought on historic record and a 1 in 200 year modelled event. As detailed in Appendix A, this includes both a 2 dry winter event and a 3 dry winter event.

Section Summary: Baseline Supply-Demand Balance
We have selected the annual average as our planning scenario since it is more challenging then the critical period scenario.

We have a deficit in supplies from 2048/49 which increases to 22.7 Ml/d by the end of the planning period.

7.0 Future Options

This section sets out the process we have followed to develop potential options that could resolve our supply-demand deficit or those in neighbouring water companies and therefore benefit the region as a whole. We have also considered options that improve resilience and/or benefit the environment in terms of reduced abstraction.

The WRPG requires companies to develop options on a staged basis, starting with an unconstrained list of all possible options. These are then screened using defined criteria to produce a set of feasible (or constrained) options. This removes options which have an unacceptable environmental impact, a high risk of failure or an insufficient yield or demand reduction. The feasible options are then developed to determine costs and assess environmental and social impacts, so that they can be modelled to produce the required solution to the planning problem.

7.1 General Considerations

During the process of developing potential options, we have taken into account a range of factors, including those outlined in the following sections.

7.1.1 Government policy

In May 2016 Defra issued its *Guiding principles for water resources planning.* In this, they state that they expect water companies to:

- Take a long-term, strategic approach to protecting and enhancing resilient water supplies
- Consider every option to meet future public water supply needs
- Protect and enhance the environment, acting collaboratively
- Promote efficient water use and reduce leakage

This approach was supported by the draft PR19 methodology issued by Ofwat in July 2017, which included an expectation that companies would reduce leakage significantly and that they should consider whether their water resources were resilient to 1 in 200-year drought level.

7.1.2 Customer preferences

We recognise the importance of establishing customer priorities in terms of both willingness to pay for future investment and how we should plan for the future taking into account social and environmental impacts.

As discussed in Section 9.2, we have carried out research on these areas on a phased basis. We have established what customers care most about and have found out the extent to which they are willing to pay for improvements in service.

We have carried out a stakeholder review of our draft plan, involving our Customer Scrutiny Panel (CSP) and the Environment Agency. The results have shaped the options selected in the preferred plan, as detailed in Section 8.2.4.

7.1.3 Resilience

We have based our forecasts on both the Worst Drought on Historic Record and a 1 in 200-year drought risk. This allows us to create a preferred plan which addresses the need to be resilient to challenging but plausible future droughts. We have also considered whether the options selected contribute to increasing resilience in other ways, such as:

- Reducing outage
- Reducing flooding risk
- Increasing the capacity of water to be transferred around the network, which assists our ability to manage treatment works outage and network events including major burst mains and freeze-thaw events
- Developing transfers between third parties or other water companies
- Improving raw water quality or reducing the impact of poor water quality
- Encouraging consumers to understand the impacts of water use on the local environment to promote water efficiency especially in times of need
- Contributing to the resilience of aquatic ecosystems to reduce the impact of drought or other risks such as pollution events

7.1.4 Third Party Options

We have investigated the options that could be available from outside the company to either increase supplies or reduce demand. To invite solutions from third parties we published a Periodic Indicative Notice in the Official Journal of the European Union (OJEU) using the *Achilles* on-line procurement platform in June 2016. This was linked to a *Planning for the future* page on our website that remains available to view. Third parties were encouraged to respond by the end of November 2016, although we stated that submissions could be given beyond this point. Only one response was obtained, which related to the provision of bottled water under emergency conditions. This was not considered a viable option to be put forward in relation to water resources planning.

Secondly, as part of the supply-side options work the potential for licence trading within our area of supply was assessed. This is detailed further in Section 7.2.1.

We have also considered bulk transfers of either raw or treated water as part of the WRSE modelling work. The results of this project are discussed in Section 10.2.7.

In March 2018 we published the Market Information Tables on our website to allow third parties to compare our planned options against alternative solutions. In September 2018 we will update these tables to align with the revised plan, and we will also publish our Bid Assessment Framework which details how bid applications should be made and our criteria to evaluate these options.

7.1.5 Upstream Competition

Ofwat have been working with the industry to form their view on how competition on water resources could be introduced. A regulated market is not expected to be in place before the WRMPs are finalised and published in 2019. Once the framework for this market is established, we will consider how this will affect the next revision of plans in 2024.

7.1.6 Demand Management Recommendations

In April 2018 the National Infrastructure Commission (NIC) published its report ‘Preparing for a Drier Future’ which set out recommendations in relation to household consumption and leakage, as well as transfer capacities. It stated that a per capita consumption of 118 litres/person/day and a 50% reduction in leakage by 2050 should be achieved.

In the same month Ofwat commissioned a paper on the ‘Long Term Potential for Deep Reductions in Household Water Demand’. This concluded potential savings of 50 to 70 litres per person per day could be achieved in the next 50 years. It is acknowledged that these savings can only be achieved if actions outside of the water industry are taken, such as labelling of water-consuming products.

7.2 Unconstrained Options and Screening

We considered options to enhance supplies or reduce demand separately. We followed the guidance set out in the UKWIR *Water Resources Tools Project* which includes a list of generic options that should be considered. We also re-assessed all feasible options from WRMP14.

7.2.1 Supply-side options

We commissioned the consultancy AECOM to identify any additional schemes that may be able to provide water supplies for average and/or peak conditions. Their technical report describing this assessment is included in Appendix G.

These options were separated into those relating to:

- abstraction at new or existing sites, and those where new or additional treatment would result in an increase in yield
- treatment options
- pipeline transfer and bulk supplies

In the new groundwater and surface water category, three new groundwater abstraction possibilities in the Mole catchment and potential to trade with licence holders across the Mole, Wandle and Eden catchments were identified. In addition, an assessment of unused headroom of all groundwater sources was carried out by comparing licenced and actual abstraction over the last six years, and sources with a significant headroom added as potential options to assess in terms of constraints. A two-stage screening process was completed using the criteria given in Table 20.

For treatment and pipeline/bulk supply options, the screening criteria was similar to that for groundwater and surface water options, but with those factors not considered relevant removed. This is given in Table 7 and Table 9 of Appendix G.

7.2.2 Demand-side options

We commissioned the consultancy Artesia to identify any additional schemes that may be able to reduce demand.

The total number of options in the unconstrained list was:

- Leakage – 6 options
- Water efficiency – 16 options
- Tariffs – 13 options
- Metering – 9 options
- Rainwater harvesting or greywater recycling – 9 options

These options were screened using the criteria shown in Table 21.

In response to the development of our performance commitments in our Business Plan, we created new leakage, metering and water efficiency options which could achieve further demand reductions. We tested these options as part of our customer engagement programme to find out if they were generally accepted.

7.3 Feasible Option Appraisal

This section explains the results of the screening process and the methodology and outcome of the appraisal of the selected options. Appendix H contains full details of this within the *Constrained Options Appraisal* report from AECOM, with the results summarised in the following sections.

7.3.1 Supply-side options

The screening of groundwater and surface water options (shown in Table 22) identified the catchment trading options received the highest scores because there are no significant impediments from a licensing or WFD perspective, as no additional water is proposed to be taken from the catchments. These sources already have proven yields and all infrastructure is in place. However, these options have not been carried forward to the feasible options stage as negotiations with the licence holders would need to be conducted and the outcomes agreed with the Environment Agency. This will be completed in preparation for the draft WRMP24.

The general scheme for removal of constraints and optimisation of the management of a source with headroom has only been screened to the initial stage because each source would require secondary screening individually. In principle, these schemes are making use of water already licensed and so would also be expected to score highly.

The new options identified in the lower Mole, middle Mole, and upper Mole catchments score highly because they make use of water that the Environment Agency has identified as available for abstraction as it is surplus to environmental needs. Therefore there are no regulatory impediments and with existing infrastructure nearby throughout the Mole catchment, infrastructure technical difficulties, cost and sustainability rank highly.

Table 20: Groundwater and Surface Water Options Screening Criteria Scoring

Criteria	Issues to consider and scoring
Initial Screening	
CAMS status	If no water available, put 2 for peak scheme, 1 for average. If water available 3 for any scheme
WFD status	If Good then 3 for any scheme, if moderate then 2 for peak scheme, 1 to average, 1 to any scheme for water body at Poor status
WFD Risk of Deterioration	If not at risk then 3, if at risk then 1 to average and 2 to peak. If on sustainable catchments list and also at risk then 1 for any scheme
Risk to Designated Sites	If groundwater dependent sites and CAMS status water available then 3 as assumed headroom above gwdte needs. If no water or restricted water available then average 1, peak scheme 2. if no designated sites or sites not groundwater dependent then 3. Or pipeline route through site (score 1), or long route around possible (score 2), or no sites in vicinity (score 3)
if score of 1 for any of the above then potentially screen out, otherwise continue to secondary screening	
Secondary Screening	
Customers	Customers opinions with type of source, groundwater or surface water preferences. Or are there active local groups for river restoration? Score 3 if no information, 2 if preference is not for this option type, 1 if there are active groups opposing abstraction or promoting local environmental improvements (e.g high environmental awareness)
Other water companies	Is there any risk of impact to other water companies, eg does increased abstraction affect other abstraction downstream? High risk (abstraction nearby) score 1, abstraction in catchment=2, no abstraction or singificant distance=3
Yield uncertainty	Is the yield well understood, eg existing site or well known aquifer properties (score 3). Or a new aquifer block not well known (score 1 or 2 on judgement)
Water Quality	WRMP14 raised concerns about landfill pollution to LGS sources. If scheme is LGS source near old landfill score 2, otherwise 3 if no landfill, 3 for chalk schemes and LGS confined schemes. If scheme source area has known pollution problems then score 1
DO of scheme	Is the yield high or low? (e.g. less than 2 Mld score 1, 2-5 Mld, score 2, over 5 Mld score 3). A higher score means the scheme is significant to meeting the supply-demand deficit
Flexibility	Is this option a one-off or stand-alone (score 1), could it be enlarged, used with other schemes (score 3) ? Needs to consider capacity of network and treatment works to accept additional water from scheme
Technical Difficulty	Is the option very complex to implement or significant impediments such as multiple dependencies to bring to fruition, is yield high to make it worthwhile? Highly complex score 1, straight forward, score 3, in between score 2
Sustainability	Is option material, energy or carbon intensive? High score 1, low score 3.
Social Impact (people and places)	Would the scheme enhance community, jobs or green space? Would it damage existing green spaces? Or no effect? Score 3 unless negative
Social Impact (flood Resilience)	Would scheme improve flood resilience, eg groundwater scheme in gw flooding prone area, or surface water scheme abstracting winter high flows? If yes score 3, neutral or some potential to improve flooding outcomes score 2, if possibly detrimental score 1
Social Impact (drought resilience)	Would scheme improve drought resiilence thus reducing risk of drought permits, hoespipe bans etc. Score 3 for ASR scheme, 2 for groundwater, 1 for surface water
Landscape and Heritage	Would scheme damage heritage sites or general landscapes? Score 3 unless negative

Table 21: Demand-side option screening criteria

Criteria	Description	For example	Scoring
Yield uncertainty	What is the risk and uncertainty of the option delivering its estimated yield/water saving?	How assured is the yield? How likely is it that the yield estimated for the option is actually achieved?	Scale: 1 (Very certain) to 5 (Very uncertain)
Lead Time	What is the time required to become fully commissioned or to deliver the water savings?	A water efficiency scheme may be delivered within a few months, a compulsory metering programme may require planning over a whole AMP	Scale: 1 (short lead time several months) to 5 (long lead time 5 years or more (an AMP cycle))
Flexibility	Has the adaptability of an option be reflected?	Can an option be enlarged in the future, or be combined with other schemes	Scale: 1 (very flexible) to 5 (very inflexible)
Security of Supply	How robust is the overall scheme?	The likelihood of yield / water savings varying over time e.g. reduction efficacy of water efficiency initiatives or 'bounce back' from metering	Scale: 1 (Very secure) to 5 (Very insecure)
Environmental impact	Will the option result in environmental impacts?	Impacts on biodiversity, landscape, heritage. Use of materials, generation of waste or pollution.	Very positive (1) positive (2) neutral (3) negative (4) very negative (5) impacts
Sustainability	What is the impact of the option on wider sustainability?	The scheme's impacts on energy use, social effects, carbon footprint etc.	Scale: 1 (very sustainable) to 5 (very unsustainable)
Promotability	Will customers support the option?	Is the option socially acceptable? Will customers think that it's a good idea?	Scale: 1 (very acceptable) to 5 (not acceptable at all)
Suitability	How well the option meets the assumed planning problem?	Will the option provide the correct amount of water at the right time (in terms of seasonality)	Scale: 1 (very suitable) to 5 (very unsuitable)
Technical difficulty	How difficult the option is to deliver?	To reflect the technical complexity, engineering practicability and difficulty of implementation	Scale: 1 (very simple and not difficult) to 5 (very difficult)

In terms of existing options from WRMP14, the Bishopsford Road extension scored highly as this is part of the Wandle artificial recharge scheme which is considered sustainable and has no environmental impacts of concern to the Environment Agency. Fetcham borehole scores highly as there is water available, and the infrastructure is largely in place. Outwood Lane identifies a peak scheme in this area and the Environment Agency confirmed there were no significant concerns with short term abstraction at peak times. This scheme also has unused average headroom within licence so offers average and peak resource potential with all infrastructure already in place. Similarly R28 (Kenley and Purley) offers increases in peak and average deployable output with limited infrastructure requirements, and is within the existing licence so raises no significant regulatory issues.

Bough Beech reservoir increased capacity is the only surface water resource option and scored favourably due to water availability and the resilience offered, and environmental improvements made possible by rerouting the inflowing streams. However, it did not score as highly as groundwater options due to the significantly greater material and carbon inputs, and technical difficulty.

For treatment options (Table 23), three options were found to be feasible, once those which are mutually exclusive (R9, R10, R11) were filtered so that only the highest scoring option (R10) is taken through to the costing stage. One new option was added to those previously assessed, which considers the delivery of additional water to Westwood and/or Godstone from local boreholes where treatment would need to be applied to improve water quality.

For transfers and bulk supplies (Table 24), those options from WRMP14 relating to the transfer of supplies between the Sutton WRZ and East Surrey WRZ were discounted during the screening process. A new transfer from Thames Water (from Shalford WRZ) was considered but discounted due to insufficient supplies being available. One new option was added to those identified in WRMP14, relating to the transfer of raw water to Westwood and/or Godstone.

All the supply-side feasible (constrained) options are summarised in Table 25.

Table 22: Groundwater and Surface Water Options Scoring Summary (Feasible Options shaded in blue)

		Yield Benefit			
Code	Name	ADO	PDO	Initial Screening	Total Score
N1	Mole catchment 3rd party licence trading	3	3	12	45
N3	Eden catchment 3rd party licence trading	3	3	12	44
R22	Outwood Lane	3.4	5	12	44
R5	New borehole (Mole Valley Chalk) - Fetcham Springs	4.78	3.148	9	43
N2	Wandle catchment 3rd party licence trading	1	1	12	42
N6	New Middle Mole Abstraction source	40	40	11	42
R21	North Downs Confined Chalk AR extension 2 (new borehole on SE side of Football Club)	2.16	5	9	42
R28	Lowering pumps at Kenley and Purley	3.4-4.7 ?	14.5	11	42
R6	New borehole (Lower Greensand) - Chalk Pit Lane mains connection	3.4	3.4	10	41
N4	Leatherhead licence increase	2	2	11	40
N5	New Lower Mole Abstraction source	17	17	11	40
N7	Leatherhead new boreholes	20	0	11	39
R1	Raising of Bough Beech reservoir	4.9	0	10	38
R23	Duckpit Wood replacement borehole (not Chalk Pit Lane)	1.37	2.14	10	38
R3	North Downs Unconfined Chalk AR (recharge at Eyhurst Park, Kingswood)	0	5	10	38
R4	North Downs LGS ASR (recharge at Eyhurst Park, Kingswood)		2.5	11	38
R7	Enhance borehole output (Lower Greensand) - Water Lane increase in pump capacity & pesticide treatment	2.95	1.85	10	37
R2	North Downs Confined Chalk AR extension 1 (Bishopsford Road)	0	5	0	33
N9	Removal of constraints and or optimisation of WRZ source use	19	0	10	

Table 23: Treatment Options Scoring Summary (Feasible Options shaded in blue)

		Yield Benefit		
Code	Name	ADO	PDO	Total Score
P1	Increase Bough Beech WTW capacity from 50Ml/d to 70Ml/d - Items 1, 2 & 3	-0.6	20	21
P1b	Increase Bough Beech WTW capacity from 50Ml/d to 70Ml/d - Items 1 & 2	-0.6	20	21
P1c	Increase Bough Beech WTW capacity from 50Ml/d to 70Ml/d - Items 1	-0.6	20	21
R8	Upgrade WTW (Lower Greensand) - The Clears ammonia and pesticide treatment	1.6	2.57	18
R26	Secombe Centre UV	2.07	4.54	18
R24	Duckpit Wood hydrogen sulphide treatment	0	0.77	17
R25	Pains Hill Springs refurb including UV	1.37	1.37	17

Table 24: Transfer and Bulk Supply Options Scoring Summary **(Feasible Options shaded in blue)**

Code	Name	Yield Benefit ADO	Yield Benefit PDO	Total Score
R13	12Ml/d transfer from Sutton WRZ (Langley Park/North Looe Reservoirs) to East Surrey WRZ (Buckland)	12	12	34
R12-Reverse	20Ml/d transfer from East Surrey WRZ (Outwood PS) to Sutton WRZ (Langley Park/North Looe Reservoirs)	20	20	34
R13-Reverse	12Ml/d transfer from East Surrey WRZ (Outwood PS) to Sutton WRZ (Langley Park/North Looe Reservoirs)	12	12	34
R2	North Downs Confined Chalk AR extension 1 (Bishopsford Road). This scheme connects the existing licensed borehole into the WTW A East Main at Source 14	0	5	33
R12	20Ml/d transfer from Sutton WRZ (Langley Park/North Looe Reservoirs) to East Surrey WRZ (Outwood PS)	20	20	33
R10	15Ml/d bulk supply from Thames Water (London WRZ) to SESW (Sutton WRZ) at Merton	15	15	32
R11	5Ml/d bulk supply from Thames Water (London WRZ) to SESW (Sutton WRZ) at Merton (maximum existing capacity requiring no mains upgrade works)	5	5	31
R15	10Ml/d bulk supply from SEW RZ2 (Maidenbower/Whitely Hill) to East Surrey WRZ (Outwood PS)	10	10	31
R16	10Ml/d bulk supply from Thames Water (Shalford WTW, Guildford WRZ) to SESW (Effingham SR, East Surrey WRZ)	10	10	31
n/a 2	10Ml/d bulk supply from SESW East Surrey WRZ (Outwood PS) to SEW RZ2 (Maidenbower/Whitely Hill)	-10	-10	31
N8	Pipeline linking Pains Hill, Duckpit Wood and Chalk Pit Lane to existing treatment works at Westwood and Godstone	1.37	2.14	31
R9	30Ml/d bulk supply from Thames Water (London WRZ) to SESW (Sutton WRZ) at Merton	30	30	30
R14	5Ml/d bulk supply from SEW RZ2 (Maidenbower/Whitely Hill) to East Surrey WRZ (Outwood PS)	5	5	30
n/a 1	5Ml/d bulk supply from SESW East Surrey WRZ (Outwood PS) to SEW RZ2 (Maidenbower/Whitely Hill)	-5	-5	30
n/a 4	10Mld (ADO) & 15Ml/d (PDO) Bough Beech to Blackhurst (SEW) treated water transfer (1)	-10	-15	29
n/a 5	10Mld (ADO) & 15Ml/d (PDO) Bough Beech to Blackhurst (SEW) treated water transfer (2)	-10	-15	29
n/a 8	10Ml/d (ADO) & 15Ml/d (PDO) Bough Beech to Riverhill (SEW) treated water transfer	-10	-15	29
n/a 3	5Mld (ADO or PDO) Bough Beech to Blackhurst (SEW) treated water transfer	-5	-5	28
n/a 6	1.5Mld (ADO) & 5Ml/d (PDO) Release from Bough Beech to Forstall (R. Medway, SEW)	-1.8	0	0
n/a 7	3Mld (ADO) & 10Ml/d (PDO) Release from Bough Beech to Forstall (R. Medway, SEW)	-3.6	0	0

Table 25: Supply Side Options Constrained List

Code	Name
R22	Outwood Lane
R5	New borehole (Mole Valley Chalk) - Fetcham Springs
N6	New Middle Mole Abstraction source
R21	North Downs Confined Chalk AR extension 2 (new borehole on SE side of Football Club)
R28	Lowering pumps at Kenley and Purley
N4	Leatherhead licence increase
N5	New Lower Mole Abstraction source
R1	Raising of Bough Beech reservoir
P1c	Increase Bough Beech WTW capacity from 50Ml/d to 70Ml/d - Items 1
R8	Upgrade WTW (Lower Greensand) - The Clears ammonia and pesticide treatment
R26	Secombe Centre UV
R13	12Ml/d transfer from Sutton WRZ (Langley Park/North Looe Reservoirs) to East Surrey WRZ (Buckland)
R12-Reverse	20Ml/d transfer from East Surrey WRZ (Outwood PS) to Sutton WRZ (Langley Park/North Looe Reservoirs)
R13-Reverse	12Ml/d transfer from East Surrey WRZ (Outwood PS) to Sutton WRZ (Langley Park/North Looe Reservoirs)
R2	North Downs Confined Chalk AR extension 1 (Bishopsford Road). This scheme connects the existing licensed borehole into the WTW A East Main at Source 14
R12	20Ml/d transfer from Sutton WRZ (Langley Park/North Looe Reservoirs) to East Surrey WRZ (Outwood PS)
R10	15Ml/d bulk supply from Thames Water (London WRZ) to SESW (Sutton WRZ) at Merton
R15	10Ml/d bulk supply from SEW RZ2 (Maidenbower/Whitely Hill) to East Surrey WRZ (Outwood PS)
R16	10Ml/d bulk supply from Thames Water (Shalford WTW, Guildford WRZ) to SESW (Effingham SR, East Surrey WRZ)
n/a 2	10Ml/d bulk supply from SESW East Surrey WRZ (Outwood PS) to SEW RZ2 (Maidenbower/Whitely Hill)
N8	Pipeline linking Pains Hill, Duckpit Wood and Chalk Pit Lane to existing treatment works at Westwood and Godstone

7.3.2 Demand-side options

The aim of the screening process applied to demand-side options was to obtain a wide range of possible solutions to be considered in the modelling stage. These options must be additional to those planned as part of baseline activities to reduce consumption and leakage. Table 26 lists all the feasible options identified, and shows which were taken forward for Cost Benefit Analysis (CBA). The remaining options either did not have sufficient evidence to allow a quantitative approach to be used, or were evaluated as being less robust than similar measures. Further detail on the methods used and the results obtained is also given in Appendix H.

Two options, mains renewal and compulsory metering, were not selected from the screening, but were added at a later stage following the stakeholder engagement. The mains renewal option is in additional to that currently based under baseline. The options were further developed post-publication of the draft plan to align with the Business Plan proposals.

In the leakage category, the feasible options show there is scope to reduce leakage via a range of methods. We could use innovative detection techniques (Active Leakage Control (ALC) Efficiency), increase the effort involved to find and fix leaks (ALC effort), be more efficient in finding and fixing leaks (improved repair and maintenance (R&M) activities), and/or increase mains renewal where this is targeted using model outputs of burst and leak locations in the network.

Table 26: Demand-Side Feasible Options

#	Option name	Score	CBA assessed?
Leakage			
073	Increasing ALC effort. Increase leakage find and fix budget by 'x' percent	17	Yes
302	Improved R&M efficiency	17	Yes
178	Raw water and WTW leakage reduction	19	No
301	Increasing ALC efficiency (detection and location)	20	Yes
303	Enhanced pressure management	21	Yes
399	Mains renewal[1]		Yes
Metering			
311	Smart metering of selected households	16	Yes
113	Smart metering of all households	20	Yes
113a	Compulsory metering (AMR) of all households[1]	20	Yes
312	Smart metering of selected non-households	20	No
Rainwater/greywater harvesting			
124	Installation of rainwater harvesting in new build non-households	21	No
Tariffs			
038	Special tariff for sprinkler users	20	No
015	Increasing volumetric charges	21	No
Water Efficiency			
019	Household water efficiency programme (Company led, self-install)	18	Yes
020	Household water efficiency programme (Company led, plumber installed)	18	Yes
305	Domestic retrofit programme targeting high consumers	19	Yes
021	Household water efficiency programme (Partnering approach, home visit)	19	Yes
022	Non-household water efficiency programme (Company led, self-install)	19	Yes
308	Targeting leaking WCs, taps and showers	19	Yes
157	Dual flush toilet retrofits (company funded)	20	Yes
307	Variable infrastructure charge	20	Yes

[1] Options added at a later stage following SES Water request

Enhanced pressure management is also included, although there is limited scope to gain savings from this activity as our network is already at a near-optimum level of pressure control using a network of Pressure Reducing Valves (PRVs) at the inlets to most DMAs.

Following the publication of the draft plan and customer feedback on our Business Plan proposals, we developed our leakage strategy to gain further savings, of 15% by 2025 and 56% by 2045. Further details are to be found in Appendix H.

The best metering options were found to be those involving smart metering (of selected or all households) or compulsory metering. The savings from standard (dumb or AMR) meters are based on findings from Southern Water and South East Water following their compulsory metering programmes, and is set at 14.5%. Smart meters are those where the consumer is given feedback on their consumption on a near real-time basis, using an internet-based system. The savings from smart meters is estimated to be an additional 1.5% (on top of the 14.5%) based on evidence from Anglian Water's in-home display project. This is a conservative estimate as further savings are likely if the consumption data can be provided to a tablet or smart phone, as this is more accessible than a display unit.

The option on compulsory metering of all unmeasured households is based on achieving this within five years (to a maximum level of 95%). We are permitted to carry out compulsory metering under the rights are granted by section 144B of the Water Industry Act 1991 and the Water Industry (Prescribed Conditions) Regulations 1999 as amended in 2007. This states that water companies are entitled to meter 'when the premises to be metered are located in an area which has been determined by the Secretary of State to be an area of serious water stress and are included in a metering programme specified in the relevant company's water resources management plan'. Our entire supply area is within the area designated as being water stressed by the EA. For our draft plan we created Option MET-555 which was based on achieving 80% by 2025 and 90% by 2030, with an additional option of 90% by 2025 and 95% by 2030 added as part of the Business Plan proposal alignment.

The option to install rainwater harvesting systems in new non-households was not assessed further as there was insufficient evidence on the number of eligible properties that would be built or the savings to be gained.

All seven water efficiency options were progressed to the CBA modelling stage. Savings were based on a number of assumptions, including a lifetime of five years for installed devices taking into account likely replacement rates. Uptake rates were based on our experience from packs distributed to customers by post and home visit programmes carried out in recent years. Savings from the installation of each device were taken from those used in our Water Savings Calculator and from the industry evidence base, which predominantly uses data from Essex & Suffolk Water programmes.

Water efficiency options were developed into a package of measures which could achieve the Business Plan PCC targets solely or in combination with an increased metering roll-out.

The variable infrastructure charge option is where we would offer discounts to developers on the cost of connecting to our network where the homes are built to a higher level of water efficiency. This would be based on the rating of fittings against the Bathroom Manufacturers Association's Water Label or by building to an enhanced level as defined by Part G of the Building Regulations, and/or the installation of rainwater harvesting or greywater recycling.

7.3.3 Costing of Options

Appendix H sets out the methods to assess the costs versus benefits of feasible options. This includes the following:

- Option yield (at peak and average)
- Capital and operational costs (fixed and variable)
- Social and environmental costs (one off and annual)
- Carbon emitted and carbon costs (one off and annual)
- Estimates of the whole life costs of each option, including capital maintenance
- High level assessment of potential environmental impacts during construction and operation, including Water Framework Directive (WFD) status and Habitats Directive sites
- An indicative development programme taking into account the need for any further studies and site investigations to aid the scheme design, environmental impact assessments, detailed design, and construction
- An understanding of any potential dependencies between options, or options that should only be taken forward if a similar solution is not implemented.

The WRMP process requires Economics of Balancing Supply and Demand (EBSD) costing as per the WRPG which includes the following elements: Capital (Capex), Operational (Opex) fixed and variable, environment and social (E&S) cost, carbon cost, and carbon quantity, for each scheme.

For supply-side options, we have carried out a calculation of Capex and Opex costs using industry standard typical costs for each type of option. This is considered most appropriate for the purposes of WRMP modelling, where the intention is to compare total Capex and Opex costs over the lifetime of a scheme's asset to arrive at a least cost investment programme. The most expensive options were the raising of Bough Beech reservoir (R1), Middle Mole abstraction (N6) and the Thames Water bulk supply at Merton (R10).

For the demand-side options, unit costs and rates were updated to align with costs submitted for the Business Plan, including marketing costs where relevant.

The aim of the environmental and social (E&S) assessment is to capture and value significant residual impacts in relation to the natural environment as well as human impacts on landscape, heritage, business and recreation. The process involved a qualitative assessment to identify the likely significance of identified impacts, followed by a quantitative assessment using the *Benefits Assessment Guidance (BAG)* issued by the Environment Agency in 2004 as well as the WRPG. A qualitative ecosystems services appraisal was conducted to allow a consistent and integrated approach. As with Capex, the same costs were used for similar schemes rather than being estimated individually. An assessment was made on the impact of the scheme locally in terms of the water being removed from the environment and any loss of habitat, as well as regionally in terms of carbon from pumping, treatment or construction. For water efficiency options, the carbon reduction from hot water savings was also incorporated.

For supply-side options, the highest E&S costs were those which propose to take more water from the environment in a sensitive location, such as groundwater that provides baseflow to a nearby river. For the raising of Bough Beech reservoir, although there will be negative impacts during construction, this is offset by the creation of new habitat. Schemes in the confined chalk have lower environmental impacts. Most demand options have a positive E&S cost due to lower abstraction and therefore less energy is required for pumping and treatment.

7.3.4 Changes to existing abstraction licences

As discussed in Section 4.1.4, we have planned on the basis that there are no planned or likely changes to existing licences due to sustainability changes as assessed by the EA. Therefore, we have not carried out any cost benefit analysis on reducing current levels of abstraction from specific sources.

However, we have considered the views of stakeholders, including the EA and South East Rivers Trust, when deciding the preferred draft plan (see Section 8.2.4) and the environmental impacts of the chosen options (see Section 10.2.5).

Section Summary – Future Options

We carried out a staged approach to decide on potential options to either increase supplies or reduce demand, including third party solutions. The unconstrained options list was screened to produce a shortlist of feasible options for the next stage of assessment.

13 supply-side and 16 demand-side options were considered feasible and we calculated costs, including capex, opex, social, environmental and carbon for each option. We carried out a qualitative ecosystems services appraisal. The results were used in the programme appraisal.

8.0 Programme Appraisal

The next stage in the WRMP involves creating a range of programmes that can be compared on a systematic basis against the initial considerations, with the plan tested using different scenarios to assess the robustness and suitability of the options selected.

8.1 Modelling

The aim of the initial stage is to find the best way of balancing supply and demand from the set of feasible options. We employed DecisionLab to carry out this work under the direction of our consultants AECOM. The approach being used for this plan is an Economics of Balancing Supply and Demand (EBSD) aggregated approach, similar to the WRSE model used in programme appraisal at a regional level in PR14. This is summarised below, and detailed further in Appendix H.

The EBSD model used is highly flexible, and can be customised to suit water companies' needs and has been used for several water company WRMPs. We selected this approach as it is tried and trusted, it meets regulatory requirements and uses the same or similar data requirements to that needed for the WRSE regional model.

The model produces a programme of investments over the planning period to meet the defined planning challenge. The optimal solution will generally consist of multiple options activated in different start years which combine to give the overall least cost solution. All the models use an annual time step. Different planning conditions that may arise within year are accounted for by using planning scenarios - Dry Year Annual Average (DYAA) and Dry Year Critical Period (DYCP).

The optimisation routine finds the combination of decisions which together minimise the discounted cost of the investment programme whilst ensuring a positive supply-demand balance in both DYAA and DYCP. This is the least cost solution. The discounted costs are found using a function called Net Present Value (NPV); this computation converts future cash flows to a present-day value. Costs incurred far into the future are most heavily discounted. This encourages the model to delay expenditure in the optimised plan.

As described in Section 7.3.3, there are three cost types considered by the model:

- Capex – initial and renewals
- Opex – fixed and variable
- Monetised Carbon

The assessment period over which the costs are derived is 80 years, longer than the planning period of 60 years. This allows the selection of larger schemes even towards the end of the planning period.

Some options are not required to meet demand, but to meet headroom. These are classified as 'not utilised' in the model run outputs.

8.2 Initial Programme Runs

In addition to the least cost solution, the EBSD model was run under alternative programmes to see which options the model would select if the choice was limited in order to favour a certain approach or to incorporate a set target. The aim is to find the best value plan taking into account future uncertainties and priorities.

This iterative approach promotes understanding of the drivers behind the modelling outcomes, such as costs, time frames for implementation of an option, and the yield benefit in the context of the rising demand profile with time.

Initially three scenarios were agreed:

- Least Cost
- Environmental considerations
- Level of Service

The Environmental Considerations run was undertaken by ‘forcing’ the model not to select options which had the highest detrimental environmental impacts. WFD screening, SEA screening, and discussions around sustainable catchments with the EA identified that three options (R22, R28, R8) were in catchments flagged by the EA as potentially requiring measures to achieve Good Ecological Status or could put future status at risk. The EA advice was that these options could be taken forward because impacts were predicted for long into the future, but the scenario was run to test what the model would select if these options were not available.

Levels of service scenario run was conducted to test the options chosen if the frequency of temporary use bans (hosepipe or sprinkler bans) was increased from 1 in 10 years to 1 in 20 years. This is tested by increasing peak demand and making the same options available to close the deficit. By reducing the amount of demand suppressed through restrictions, this run can also be considered as a programme that adds resilience.

Each scenario was run under the worst drought in the historic record (WDHR) and a hypothetical 1 in 200-year drought. These scenario runs would enable us to decide on the best programme of measures to suit their business from the range of programmes generated by EBSD modelling. All runs are based on the Annual Average scenario since there is a surplus in the Critical Period scenario throughout the planning period.

8.2.1 Least Cost Programme

This is the baseline run since the model is allowed to select any option to satisfy demand plus headroom for the least cost.

The supply-demand balance for this programme run, under the Dry Year Annual Average WDHR scenario, is shown in Figure 23. The list of the options selected and whether they are utilised is given in Table 27. Delivery year refers to the year the option is implemented. Initially demand management options are selected, with a number of supply-side options selected in the last 20 years leading to incremental rises in WAFU.

Figure 23: Least Cost Supply-Demand Balance (DYAA - WDHR scenario)

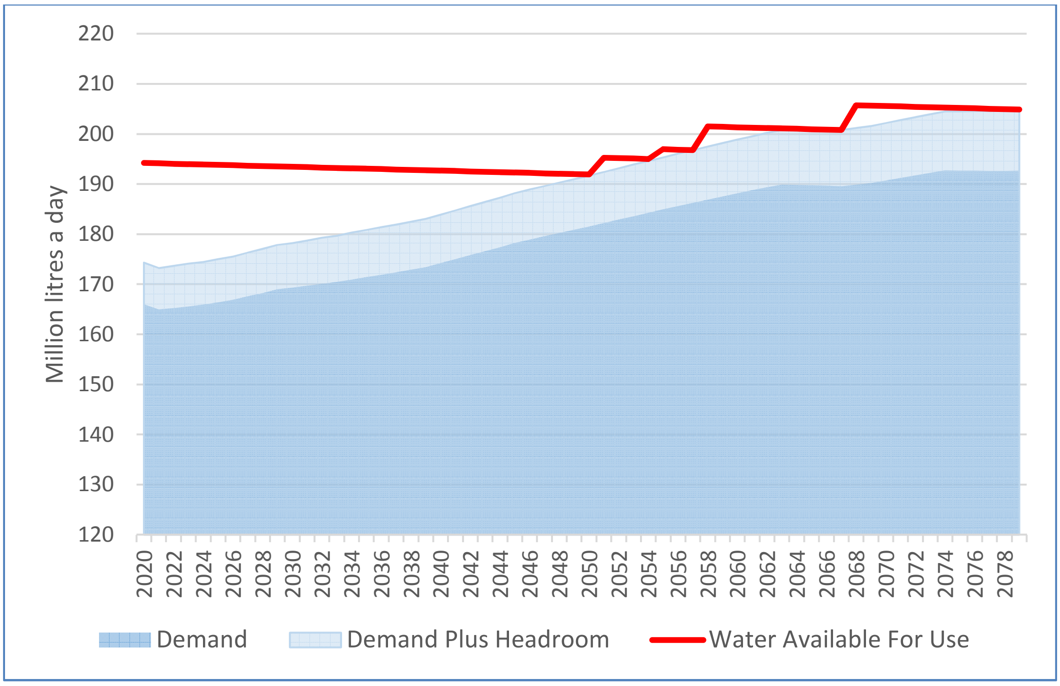


Table 27: Least Cost Selected Options (WDHR scenario)

Option	Delivery Year	Is Option Utilised?
LEA-399a: Mains renewal	2021	Yes
LEA-303: Enhanced pressure management	2021	Yes
MET-311: Smart metering of selected households	2046	Yes
NGW-R22: Outwood Lane pump capacity increase	2051	Yes
NGW-N4: Leatherhead licence increase	2055	No
NGW-R5: New borehole (Mole Valley Chalk) - Fetcham Springs	2058	No
LEA-302c: Improve RM efficiency	2063	Yes
LEA-301a: Improve ALC efficiency	2063	Yes
WEF-308: Campaign targeting domestic customers with high consumption - leaking toilets	2063	Yes
WEF-307: Variable infrastructure charge	2065	Yes
WEF-157: Dual flush toilets retrofit	2065	Yes
NGW-N5: New Lower Mole Abstraction source	2068	No
LEA-073f: Increased ALC effort	2075	Yes
WEF-022: Non HH WEFF company led self-install	2075	Yes
WEF-305: Domestic retrofit targeting high consumers	2075	Yes

Although there is a surplus in the first half of the planning period, the model selects two demand side options in the first year as this it is more cost effective to do this; the overall cost for these options are negative over the 60 years as pumping and treatment is reduced. Smart metering on selected households, water efficiency options and a number of leakage reduction measures are selected later in the plan, along with two supply-side options to meet rising demand. The total cost was calculated to be £2.2M for the WDHR scenario.

Those options in bold are also selected in the 1 in 200-year drought scenario. The other options are not required as the WAFU is slightly higher in this scenario and so the deficit is smaller.

8.2.2 Environmental Considerations Programme

This run resolved the supply-demand balance deficit in a similar way to the least cost scenario as only two runs were excluded, of which only one (Outwood Lane) was selected in the least cost programme. The model replaced this option with additional leakage reduction options selected at earlier points, as shown in Figure 24 and Table 28. The different levels of each option, for example ALC effort, are coded as separate options (a, b etc.). The overall cost of the programme was £8.0M under the WDHR scenario.

Figure 24: Environmental Considerations Supply-Demand Balance (DYAA - WDHR scenario)

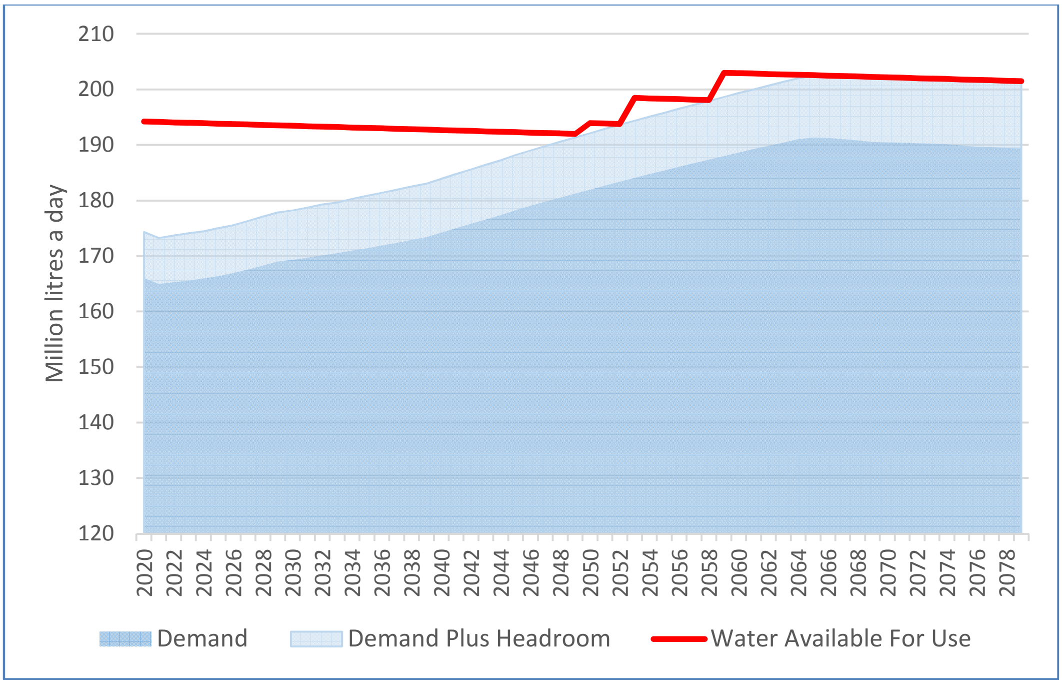


Table 28: Environmental Considerations Selected Options (WDHR scenario)

Option	Delivery Year	Is Option Utilised?
LEA-399a: Mains renewal	2021	Yes
LEA-303: Enhanced pressure management	2021	Yes
NGW-N4: Leatherhead licence increase	2050	Yes
NGW-R5: New borehole (Mole Valley Chalk) - Fetcham Springs	2053	No
NGW-N5: New Lower Mole Abstraction source	2059	No
WEF-022: Non HH WEFF company led self-install	2064	Yes
LEA-073g: Increased ALC effort_g	2065	Yes
LEA-301a: Improve ALC efficiency_a	2065	Yes
WEF-157: Dual flush toilets retrofit	2065	Yes
WEF-308: Campaign targeting domestic customers with high consumption - leaking toilets	2065	Yes
LEA-073c: Increased ALC effort_c	2067	Yes
LEA-073f: Increased ALC effort_f	2075	Yes
WEF-305: Domestic retrofit targeting high consumers	2075	Yes
LEA-302a: Improve RM efficiency_a	2077	Yes

8.2.3 Levels of Service Programme

In this programme, the reduced frequency of TUB usage restrictions being applied (from a 10% risk to a 5% risk) results in a higher level of average annual demand (an additional 7 Ml/d), so more options are needed to satisfy the deficit (as shown in Figure 25 and Table 29).

Figure 25: Levels of Service Supply-Demand Balance (DYAA - WDHR scenario)

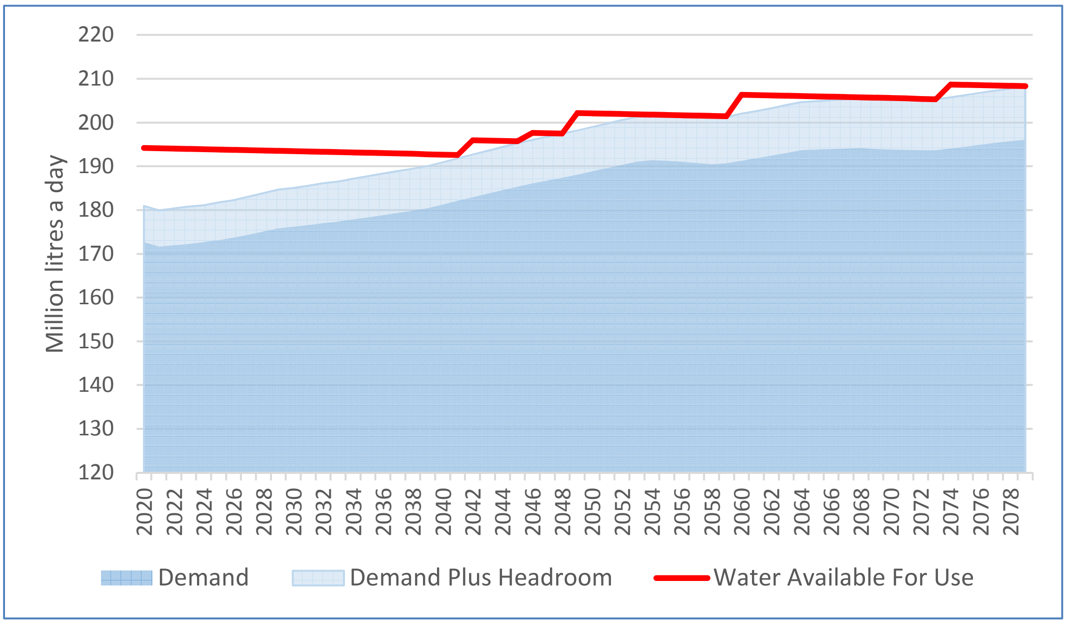


Table 29: Levels of Service Selected Options (WDHR scenario)

Option	Delivery Year	Is Option Utilised?
LEA-399a: Mains renewal	2021	Yes
LEA-303: Enhanced pressure management	2021	Yes
NGW-R22: Outwood Lane pump capacity increase	2042	Yes
WEF-022: Non HH WEFF company led self-install	2044	Yes
MET-311: Smart metering of selected households	2045	Yes
NGW-N4: Leatherhead licence increase	2046	Yes
NGW-R5: New borehole (Mole Valley Chalk) - Fetcham Springs	2049	Yes
LEA-302c: Improve RM efficiency_c	2053	Yes
LEA-301b: Improve ALC efficiency_b	2054	Yes
LEA-073f: Increased ALC effort_f	2055	Yes
WEF-307: Variable infrastructure charge	2058	Yes
NGW-N5: New Lower Mole Abstraction source	2060	Yes
LEA-073g: Increased ALC effort_g	2064	Yes
LEA-073c: Increased ALC effort_c	2065	Yes
WEF-157: Dual flush toilets retrofit	2065	Yes
WEF-308: Campaign targeting domestic customers with high consumption - leaking toilets	2065	Yes
NGW-R28: Lowering pumps at Kenley and Purley	2074	No
WEF-305: Domestic retrofit targeting high consumers	2075	Yes

Supply-side options are required at an earlier stage, with Outwood Lane pump capacity increase selected in 2042. This programme was costed at £25.9M (WDHR), around three times more than the environmental considerations programme.

Additional demand management options are selected in this programme related to leakage control and water efficiency. In the 1 in 200-year scenario, one leakage and one water efficiency option were not required.

8.2.4 Stakeholder Programme

In August 2017, a workshop was held at our Bough Beech WTW to discuss potential options to either reduce demand or increase supplies. Members of the CSP, regulators and other stakeholders were invited to take part. The session involved participants choosing sufficient options to solve the supply-demand deficit. Further details on the results of this session is given in Section 8.2.4.

The aim of the workshop was to present the planning problem, i.e. the supply-demand deficit, and ask attendees to select options to solve the gap. Information on the relative costs and benefits were given for each option. We considered this innovative approach would truly gain insight into our stakeholder's priorities in an interactive way. The findings are given in Appendix I.

The results showed that there was a strong preference for demand-side options, with the full range of leakage and water efficiency options being selected alongside smart metering. Attendees agreed that smart metering should be introduced as quickly as possible, although concerns regarding data protection would have to be addressed. From the supply-side options there was less of a consensus, with stakeholders selecting different groundwater, treatment and surface water options, guided by the relative environmental impacts and costs provided. The bulk supply from Thames Water was not selected, as stakeholders expressed concern that this supply may not be reliable in the event of the drought affecting the whole region. The need to be resilient to future events and be able to adapt to future improvements in technology was also expressed.

After considering the outputs of the stakeholder engagement work, in conjunction with preliminary customer priority research and the direction set by the government and regulators, a further programme run was created which was based on the following requirements:

- Leakage should be reduced by at least 15% above the 2020 level
- Metering penetration should reach 80% by 2025 (around 10% above baseline) and 90% by 2030 (named as Option MET-555)
- Smart meters should be installed to selected households to achieve 10% coverage by 2025 (included in Option MET-555)
- To address the remaining deficit, only options preferred by stakeholders could be selected - leaving a smaller selection of supply options with all demand options available to the model.

The result of this programme run is shown in Figure 26 and Table 30. The overall costs over the 60 years is £82.7M under the WDHR scenario.

The model selected some of the leakage options (mains renewal and pressure management) in the first 5 years, with improved repair and maintenance efficiency effort in 2070. In the 1 in 200-year drought risk scenario, improved ALC efficiency was selected instead of lowering of pumps at Kenley and Purley. The leakage options were selected in order to satisfy the requirement to reduce leakage by 15% according to the data provided.

Figure 26: Stakeholder Supply-Demand Balance (DYAA - WDHR scenario)

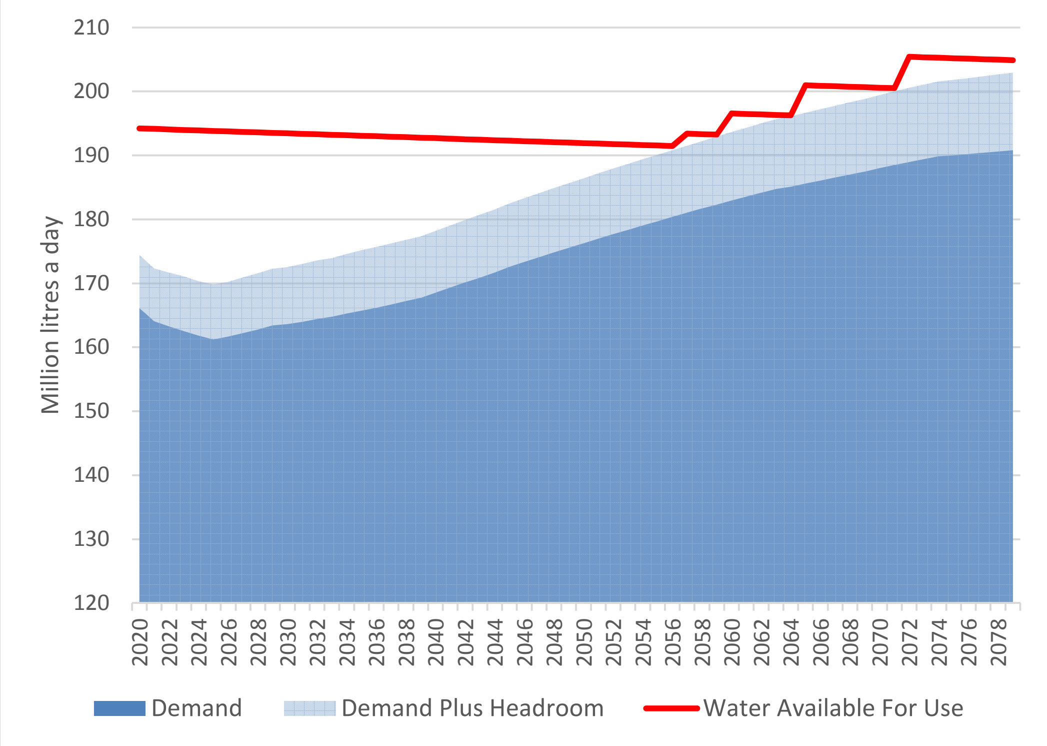


Table 30: Stakeholder Selected Options (WDHR scenario)

Option	Delivery Year	Is Option Utilised?
LEA-399d: Mains renewal	2021	Yes
LEA-303: Enhanced pressure management	2021	Yes
MET-555: Compulsory smart metering – high meter penetration	2021	Yes
NGW-N4: Leatherhead licence increase	2055	Yes
NGW-R5: New borehole (Mole Valley Chalk) - Fetcham Springs	2057	Yes
NGW-N5: New Lower Mole Abstraction source	2064	Yes
WEF-308: Campaign targeting domestic customers with high consumption - leaking toilets	2065	Yes
LEA-302c: Improve RM efficiency	2070	Yes
WEF-307: Variable infrastructure charge	2070	Yes
NGW-R28: Lowering pumps at Kenley and Purley	2072	No
WEF-022: Non Household company led self-install	2075	Yes
WEF-021: Household WEFF programme partnering approach home visit	2075	Yes
WEF-305: Domestic retrofit targeting high consumers	2075	Yes

8.2.5 Stakeholder Programme with South East Water Transfer

The WRSE model, discussed further in Section 10.2.7, produced a revised set of model outputs in January 2018 following some refinements to the option inputs. This included a transfer to South East Water from Bough Beech WTW to their service reservoir at Riverhill, near Sevenoaks, selected from 2035. The model was run using a transfer of 10 Ml/d at average and peak.

The model was not able to satisfy the transfer requirement under average conditions beyond 2055. Therefore, we agreed with South East Water that the transfer would be reduced to an average of 2.5 Ml/d. with the peak maintained at 10 Ml/d since this could be met for the duration of the plan. As seen in Figure 27, the transfer reduces the Water Available for Use from 2035. Note that the date and volume of the transfer was revised in April 2018 (see Section 10.1).

This has the effect of bringing forward the supply-side options at Leatherhead and Fetcham Springs by one year, with a slightly different set of demand management options from 2060 to 2080. The model also selects the pipeline from Pains Hill, Duckpit Wood and Chalkpit Lane in preference to Lowering Pumps at Kenley and Purley. This supply option is the only significant difference between our plan and the WRSE model central scenario outputs, i.e. there is good alignment between our company plan and the regional model results issued at this time. In this model run we also amended the leakage and metering options so they started in 2020/2021. The cost of this programme is £93.1M.

The model selected the same options under the 1 in 200 year scenario.

Figure 27: Stakeholder Supply-Demand Balance (DYAA - WDHR scenario) with transfer to South East Water (Riverhill)

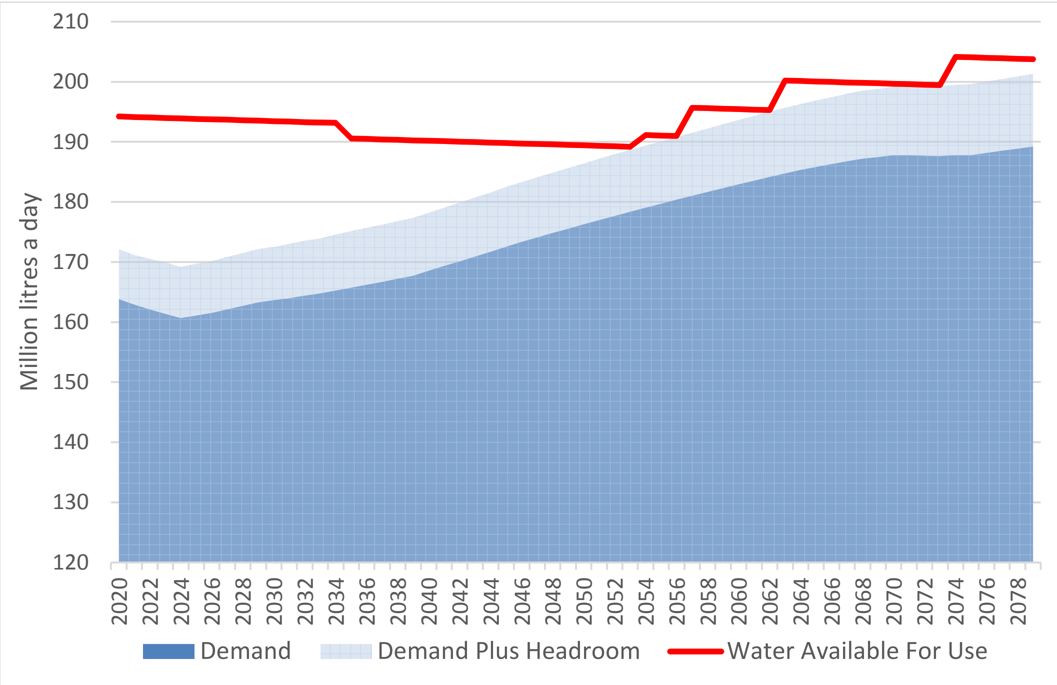


Table 31: Stakeholder with South East Water Transfer Selected Options (WDHR scenario)

Option	Delivery Year	Is Option Utilised?
LEA-399d: Mains renewal	2020	Yes
LEA-303: Enhanced pressure management	2020	Yes
MET-555: Compulsory smart metering – high meter penetration	2020	Yes
NGW-N4: Leatherhead licence increase	2054	Yes
NGW-R5: New borehole (Mole Valley Chalk) - Fetcham Springs	2057	No
NGW-N5: New Lower Mole Abstraction source	2063	No
WEF-308: Campaign targeting domestic customers with high consumption - leaking toilets	2065	Yes
WEF-307: Variable infrastructure charge	2069	Yes
WEF-157: Dual flush toilets retrofit	2069	Yes
LEA-302c: Improve RM efficiency c	2070	Yes
LEA-301a: Improve ALC efficiency a	2071	Yes
RTR-N8: Pipeline linking Pains Hill, Duckpit Wood & Chalkpit Lane to Westwood and Godstone	2074	No
WEF-022: Non Household company led self-install	2075	Yes
WEF-305: Domestic retrofit targeting high consumers	2075	Yes

This programme was then tested against the PR19 key priorities of affordability, innovation, customer service and resilience. We also carried out a Strategic Environmental Assessment of the preferred plan, to assess the potential impacts of the options selected and identify any monitoring measures required.

The programme summarised in Table 31 was considered to meet our requirements and therefore formed the basis of our preferred draft water resources management plan issued for consultation.

Section Summary – Programme Appraisal

We used a model which assessed the costs of each option and selected those needed to satisfy the supply-demand deficit for each year of the plan. Some options are only selected to meet the headroom requirements and are therefore not expected to be utilised.

We ran a number of runs to test the effects of constraining the model against the baseline least cost programme, taking into account environmental considerations and stakeholder inputs. This resulted in a preferred programme of 14 demand and supply options, plus a strategic transfer to South East Water, costing £93.1 M, which was taken forward for public consultation.

9.0 Consultation on the Preferred Plan

9.1 Publication of the Draft WRMP

We published our Draft WRMP for public consultation on 5 March, with the consultation period ending on 25 May 2018. We created a document (attached as Appendix M) which was designed to summarise the main elements of our plan and invite feedback on key areas using set questions. We also offered face-to-face briefings to key stakeholders including local authorities and environmental groups.

We carried out a joint consultation workshop with Southern Water, Affinity Water, Portsmouth Water and South East Water on 18 April 2018. This event attracted a good level of attendance from organisations with interest in water resources planning across the region and allowed those present to compare the approaches between companies as well as understand how the regional modelling work carried out by WRSE has shaped the individual company plans.

We received 128 responses to the consultation, 86 from individual customers. The majority of respondents were supportive of our proposals, with high levels of support for leakage and water efficiency measures. Details of the representations is given in our Statement of Response (SoR) published alongside the draft and revised draft plans. We notified all parties who have made representations that the SoR was available to view on our website. It includes:

- An explanation of how we have considered representations received
- An outline of any changes we have made to the plan and the reasons for making these changes
- A clear explanation of how the changes affect parts or the whole of the plan
- Any changes in timing and schemes selected to maintain a balance of supply and demand
- An explanation where we have not made changes

The Secretary of State considered the Statement of Response and directed us to publish our revised draft plan as a Final WRMP on 23 July 2019.

Our Business Plan contains our proposals for 2020 to 2025. Ofwat will make a final determination of price limits late in 2019, which will determine what investments companies will be able to make during this period.

9.2 Customer Engagement

As part of our Business Plan preparation, of which the WRMP forms an integral part, we engaged with customers and stakeholders to understand their preferences, priorities and willingness-to-pay (WtP) for our expenditure and investment proposals. This programme, branded as 'Talk on Water', occurred alongside the WRMP planning process and is used to inform both plans. Further detail on the engagement process and results are given in Chapter 1 of the Business Plan.

The first stage of this consultation process, '*Listen, learn and inform*' started with a series of deliberative workshops, designed and facilitated by specialist consultants with input from SES Water staff. These were held over April and May 2017. In relation to water resources, the results indicated that customers expect us to:

- Invest in our infrastructure for current and future generations to provide a reliable and resilient service
- Provide advice and devices that help them use water wisely
- Provide a high quality product and charge fairly for it
- Use digital technology to provide information on consumption

There was a range in attitudes to water, which can be classified as being 'cost conscious', 'water conscious' or 'water blind', depending on whether the customer was responsive to saving money, helping the environment, or neither. On leakage, most customers felt leakage should be reduced when seen without any context in terms of the costs of improving levels. Customers also wanted us to go further in embracing smart technology, recycle more water and provide a range of support to help them cut their usage, and to be future-focused to address climate change and environmental concerns. These results were used to inform the draft plan submitted for consultation.

The second stage of the customer consultation process '*Test and review*' comprised of an online panel, in-depth stakeholder interviews and co-creative workshops, involving both household and non-household customers. This research took place over autumn/winter 2017. In areas relating to water resources management, customers told us that they care about water quality, supply interruptions, reducing the risk of droughts, metering and education. In many of these areas they stated they were willing to pay to see an improvement in service:

- Service improvements to protect all homes from the risk of supply failures
- Reducing supply interruptions and leakage
- Wider roll-out of the metering programme
- Our local contact centre
- Education and water efficiency

The results of this phase of work was used to determine the questions set out in the consultation document.

We undertook the third phase of customer research in spring 2018, '*Seeing the full picture*', to understand in detail the views of our customers in relation to specific proposals in our Business Plan (and draft WRMP), and to test the acceptability of the plans in full.

In summary, customers told us that:

- Having a reliable supply of water is essential
- They expect us to do more to reduce leakage (12% reduction by 2025 was not enough)
- They want us to invest in making our service more resilient
- They want help to reduce demand and metering is an acceptable way to do this
- Educating customers and future customers about the value of water is important to them
- They want us to use new technology to deliver a better service
- We should protect and enhance the local environment

This feedback has shaped our plans in terms of setting targets and performance commitments on supply interruptions, leakage, metering, per capita consumption, the roll-out of smart meters and networks, reducing carbon emissions, investing to improve our local rivers and increasing the biodiversity of the land we own. This is discussed further in Section 10.0.

Section Summary – Public Consultation

We issued our preferred plan for consultation in March 2018 for 12 weeks. We received 128 responses, with the majority of respondents supportive of our proposals. Our response to each of the comments is set out in our Statement of Response, which was published alongside the revised draft plan.

Alongside the consultation we have carried out extensive customer research to seek feedback on our Business Plan proposals including those in our draft WRMP, with a focus on the 2020-2045 period. Customers told us that they wanted us to go further to reduce leakage and household consumption, and to invest in a resilience water supply for the future. This view was supported by many of the individuals and organisations that responded to the consultation.

10.0 Final Water Resources Strategy

10.1 Overview

In response to the feedback received from customers, government and regulators we have significantly enhanced our plans on managing demand, especially in the first part of the planning period. The engagement programme has established a clear expectation that taking steps to reduce consumption and leakage should feature prominently in our proposals, even where there is not a supply-demand deficit. We have also taken account of the recommendations set out in the National Infrastructure Commission report 'Preparing for a drier future' published in April 2018.

As set out in our Business Plan, in the next five years (by 2025), we plan to:

- Accelerate our metering programme – including an element of smart metering - to increase the proportion of our customers who pay for their usage through a meter from 60% to 90%
- Enhance our water efficiency programme, with the aim of reducing average consumption by a further four litres per person per day
- Enhance our activity to detect, find and fix leaks – doing more, and taking less time to complete repairs – to reduce leakage by around 5%
- Make further improvements to the way we manage pressure in our network – by minimising transience, a major cause of pipe stress and fatigue, and normalising average pressures to be more constant – to deliver an additional 5% reduction in leakage
- Accelerate the replacement of our poorest integrity water mains by adopting innovative condition-based maintenance techniques to facilitate better targeting to deliver a further 5% reduction in leakage

These programmes will result in an average PCC of 134 (a reduction of 7.3% comparison to 2019/20), and a leakage reduction of 15% in comparison to 2019/20. Beyond this point, we will deliver an ongoing focus on water efficiency, metering and leakage control to achieve an average PCC of 118 and a leakage reduction (in comparison to 2020 levels) of over 50% by 2045. Beyond 2045 leakage is held at the same level, with PCC reducing slightly to the end of the period due to baseline water efficiency impacts.

Our plan is based on needing to implement temporary use bans every 10 years and non-essential use bans every 20 years. This frequency cannot be directly related to drought severity as the need for restrictions will depend on the season and other factors. This level of service is stable throughout the plan.

We have revised the date of the bulk transfer to South East Water (from Bough Beech to Riverhill) to 2042 to align with the requirements of their Final WRMP. This reduces the Water Available For Use by 2.5 Ml/d in average conditions and 9 Ml/d at peak.

The revised plan is shown in Figures 28 and 29, with the options listed in Table 32.

Figure 28: Final Plan Supply-Demand Balance (DYAA - WDHR scenario)

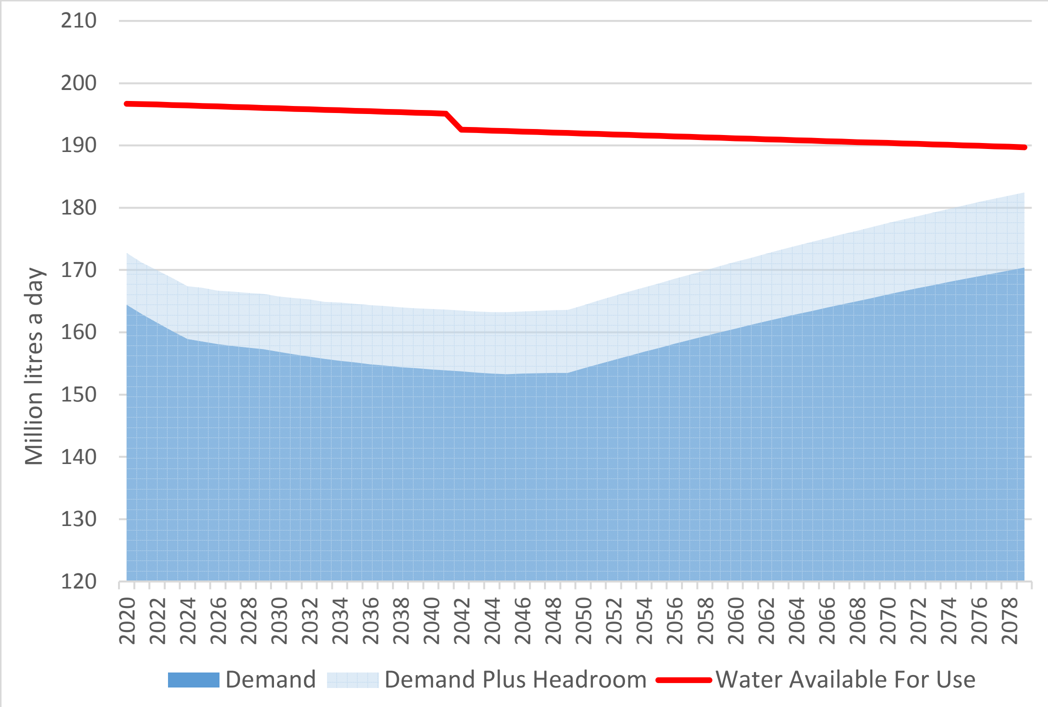
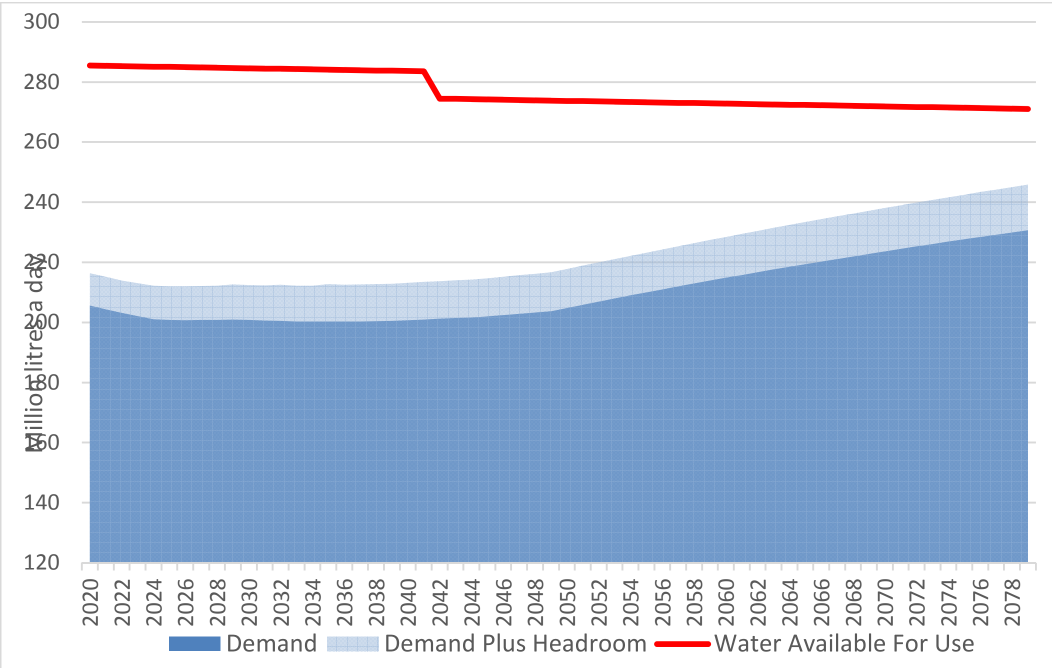


Figure 29: Final Plan Supply-Demand Balance (DYCP - WDHR scenario)



The effect of the demand management options is to reduce demand below current levels, despite a growth in properties, to 2050, with a surplus at the end of the planning period of 7.4 Ml/d. Under the critical period scenario, there is a surplus of 25.2 Ml/d at 2080.

Table 32: Preferred Plan Selected Options (WDHR Scenario)

Option	Delivery Year	Is Option Utilised?
SESW-LEA-900: Leakage Strategy (Bundle 1)	2020	Yes
SESW-WEF-700b-ph1: Water Efficiency Option 1b (phase 1)	2020	Yes
SESW-MET-600: Compulsory metering AMI - enhanced higher meter penetration	2020	Yes
SESW-TAR-800b: Tariffs (scenario b)	2045	Yes
SESW-WEF-700b-ph2: Water Efficiency Option 1b (phase 2)	2045	Yes

The same options were selected in the 1 in 200-year scenario. Due to the selection of options to control leakage, increase water efficiency and enhance our metering penetration, the supply-side options included in the draft plan are no longer required to meet a supply-demand deficit. The overall cost of the plan is £170.2M over the 60 years.

In the following sections we assess the plan against our key priorities, test it against different scenarios and consider its environmental impacts. Further details on the options and how we will manage the programme is given in Section 10.4.

10.2 Key Priorities

10.2.1 Affordability

Since our proposed plan is not the least cost solution, we recognise the need to have our customers' support so that it can be justified in terms of the benefits gained in the short and long-term. These include greater resilience to droughts and unplanned outages, a reduced impact on the environment (from more healthy rivers and a reduced carbon footprint) and, for metered customers, access to more information on their consumption so that they can have greater control over the size of their water and sewerage bills. The preferred programme achieves these benefits by focussing on increasing the available surplus (especially in the first half of the period) and taking a significant step to reduce demand including usage by householders and leakage taking place within the home. This helps to offset the costs of the demand management measures proposed.

We appreciate that a key part of gaining support is being able to clearly explain the need for investment, in terms of what the scale of the problem is and the different ways it can be addressed to meet the needs of current and future customers. We have done this through the use of communications using a variety of media channels and by conducting research with consumers from different groups.

The increase on bills needed to fund the options selected to be implemented during AMP7 (2020-2025) has been determined as part of the Business Plan submission. Customers have shown support for the demand management options selected through our willingness to pay research.

The programme includes a compulsory metering option which we plan will affect between 10-20% of customers. Whilst many of these customers will benefit from having a meter installed, we appreciate that some will have an increase in their bills, with a small proportion (such as those with a large family or medical needs) finding their bill will increase significantly. We plan to evaluate compulsory metering programmes carried out by our neighbouring water companies so that we can learn from their experiences. We want to find out which approaches work well, and how they have supported customers who may become worse off financially. For example, we will link the compulsory metering programme with our current home water efficiency check programme, and work with groups such as Age Concern and Citizens Advice to identify those customers who are financially vulnerable and in most need of assistance.

10.2.2 Resilience

Our previous WRMP and Business Plan had a clear focus on increasing resilience. This was partly driven from the recognition that we needed to be able to better withstand shock events following the flooding of our Kenley WTW in 2014. This led to a target (ODI) in our Business Plan 2014 to be able to supply all customers from more than one treatment works by 2030 by increasing the level of inter-connectivity between zones and upgrading key pumping stations. This target continues to be a performance commitment in our Business Plan proposals for PR19.

With the addition of the more challenging demand management options, the revised model results showed that the supply-side options included in the draft plan (which were needed beyond 2050) were no longer required to address the supply-demand deficit. However, we propose to carry out feasibility studies and environmental assessments on these options (summarised in Section 10.2.5) during the early part of the next Business Plan period to inform options selection for WRMP24. This will address concerns from those respondents to our consultation that these options could have a detrimental effect on local wildlife habitats, European Protected Species or ancient woodlands. These options may be needed if forecasts of population growth and climate change are revised upwards, or if the predicted yields from demand management options are not realised. We have included these in our revised Strategic Environmental Assessment and Habitats Regulations Assessment (summarised in Section 10.2.5 and described in detail in Appendices J and K) only because they may be required from WRMP24 onwards. They are not required in the current plan.

We have also provided additional information in the revised plan on our level of drought resilience and how this links with our level of service. In our draft plan we explained that we had based our plan on the Worst Drought in Historic Record scenario since this was more challenging (in terms of deployable output) than the modelled 1 in 200-year event once the effects of climate change are taken into account. This led to some respondents to the consultation interpreting this as meaning our plan was not resilient to a severe (1 in 200-year) drought, which is not the case. In Appendix A, we have added more detail on the characteristics of the droughts selected, in terms of their duration and severity (when compared to long term average rainfall) and we have also considered the sensitivity of Bough Beech to climate change estimates in Section 10.3.

Increasing the gap between supply and demand adds to the resilience of our system since we are then more likely to be able to accommodate either an unplanned increase in demand or a reduction in supply. We also perceive that if customers understand that we are striving to reduce leakage as well as giving them all the help they need to use water efficiently, they will be more receptive to the need to reduce demand in a drought period. Working collaboratively with our customers and other stakeholders increases our resilience to a range of events. An example of this is working with farmers in the Eden catchment to reduce metaldehyde levels from slug pellets. By minimising spikes in the concentration of this pesticide we can reduce our reliance that it can be removed by treatment.

Finally, our plan improves the resilience of the region as a whole since it includes a transfer to South East Water. It also aligns with the solutions put forward by the *Water UK Long Term Planning Framework* published in 2016, which stressed the need for regional resilience, adaptive planning and demand management.

10.2.3 Innovation

We know that by looking for innovative solutions we can drive up standards and find better ways of working efficiently and effectively. This applies to water resources planning despite the need to have a high degree of confidence in the outcomes.

Since the early 1990s we have not increased the amount of water we supply despite an increase in property numbers of about 0.7% a year. This has been achieved largely through advances in leakage control and a rise in metering.

The programme selected contains options that are likely to lead to new approaches being developed. For example, on smart metering we are carrying out a trial on household properties in 2018/19 so that we can identify the optimum technology, including a software platform which will engage consumers in identifying where they can make savings on an ongoing basis. We expect smart meters to drive down customer-side leakage and encourage consumers to purchase more water efficient fittings in their homes.

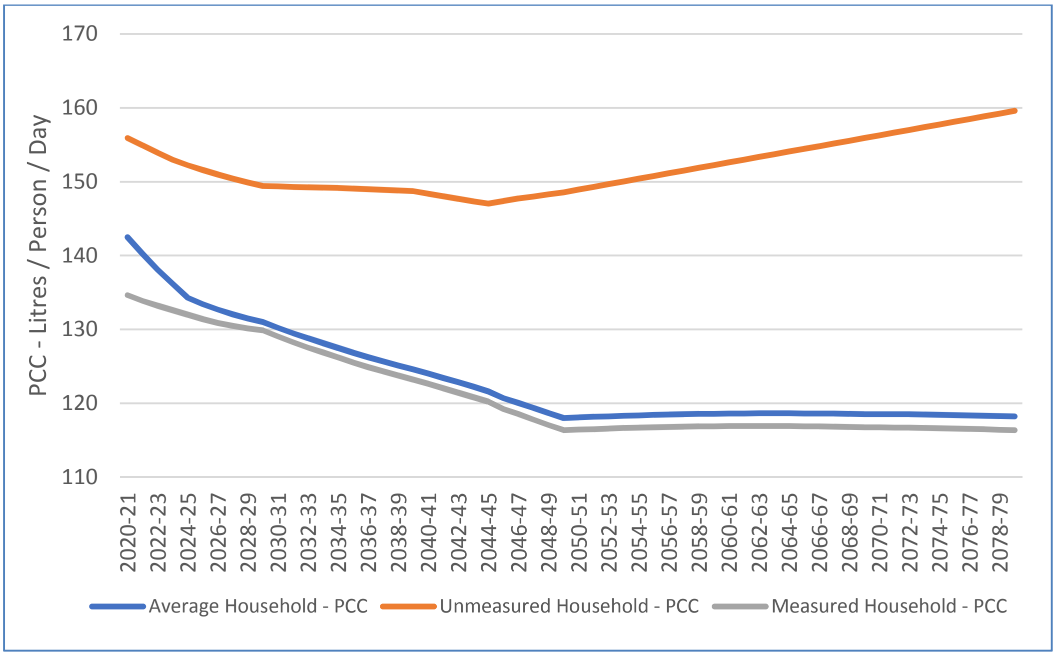
10.2.4 Reducing demand

We need to make a step-change in demand reduction measures if we are to reduce overall consumption sufficiently to outweigh the forecast increase in population to any degree. To achieve sustained reductions, we need to be supported by action from outside the water industry, including central and local government. Further details on our demand management programmes is given in Section 10.4.

Per capita consumption in our supply area, currently at around 147 litres per person per day, is above the national average. The proposed programme is expected to reduce PCC from 144.9 litres per person per day in 2019/20 to 134.3 in 2025 and

118.0 from 2050 onwards. This is shown in Figure 33. Note these figures are expressed in terms of an average year to align with our Business Plan performance commitments, whereas the values in the WRMP tables are given as the expected consumption in a Dry Year, which is around 8% higher than an average year.

Figure 33: PCC trend over the planning period (Average Year)



Further advances could be achieved (i.e. towards the government's aspiration of 110 l/p/d or lower), for example if smart metering is expanded or if technology evolves in other ways to facilitate changes in consumer awareness or in leakage control. Driving down household usage is a significant challenge given that consumption is as much as result of consumer behaviour as it is the type of fittings installed. This is particularly the case in the critical period when a hot and dry spell can drive up demand by 40%, as occurred in June and July 2018.

Our metering strategy gives us a clear opportunity to engage more with consumers so that we can continue to reduce usage. We have assessed the costs and benefits of increasing our metering penetration on a compulsory basis, and have determined that achieving a level of 90% by 2025 and 95% by 2030 is the optimum way to achieve our PCC targets. This will require around 10-20% of customers to be metered on a compulsory basis by 2025. We will integrate the water efficiency and metering programmes to achieve the most benefit from both schemes.

We have also put forward a target that at least 10% of customers will have a smart meter by 2025. We are currently selecting suppliers and contractors to carry out a trial so that we select the best technology in terms of cost, reliability, and quality of data. Beyond 2025, we expect that we will fit smart meters as standard in both our fixed rate to meter and meter replacement programme, providing the cost-benefit analysis shows it is effective to do so and we have the support of our customers.

The programme also includes measures which targets improved water efficiency in non-households. We have worked with a range of businesses over the past ten years to reduce consumption, including at schools, nursing homes, offices and farms. We will continue this approach through engaging with the retailers operating in our supply area.

Leakage is the other key area of demand where improving performance has clear support from customers, stakeholders and regulators. We are proposing to take the ambitious challenge of reducing leakage by 15% between 2020 and 2025, with further reductions in the following four AMP periods resulting in a reduction of over 50% in comparison to the 2020 level. This is in addition to the reduction being made in this AMP period of 0.5 Ml/d, or around 2%. This is despite the increase in the size of our mains network and number of connections.

10.2.5 Environmental Impacts

We have carried out a Strategic Environmental Assessment on the resilience options. This is given in Appendices J to L. The summary assessment findings are given below.

Summary assessment for demand schemes

The assessment found that the demand schemes are not likely to have any significant positive or negative effects against SEA Objectives. The demand management schemes will help to reduce demand and therefore reduce pressure on water resources. In summary, the assessment found the following:

- There is likely to be a minor negative effect in the short term on communities and households. The demand options have the potential to result in some disturbance to communities in the short term through the installation of meters, water efficient devices and works to fix leaks. Good construction practices and detailed pre-works consultation would help to reduce construction impacts.
- The demand management options will help to reduce demand and therefore reduce pressure on water resources. This could have a minor positive effect on water levels in the medium to long term.
- The demand options will require travel to properties in order to install meters and water efficient devices. In the longer term there is the potential for a carbon saving associated with the reduced water requirement. However, there will be a minor negative effect in the short term. Careful operation of schemes will help to maximise efficiencies and minimise travel.
- There is the potential for some disturbance to transport routes in the short term. Careful operation of the schemes will minimise disturbance to transport routes.
- Further work will be required at the implementation stage to assess the environmental risks associated with leakage schemes once specific sites are known.

Summary assessment for resilience supply schemes

Whilst there are no supply-side options in the plan, four supply schemes have undergone environmental screening as a scoping exercise for future planning purposes. These are SESW-RTR-N8 (Pipeline linking Pains Hill, Duckpit Wood and Chalk Pit Lane to existing treatment works at Westwood and Godstone), SESW-NGW-N5 (New Lower Mole Abstraction source), SESW-NGW-N4 (Leatherhead licence increase) and SESW-NGW-R5 (New borehole (Mole Valley Chalk) -Fetcham Springs). It is our intention to progress with these assessments, in conjunction with the Environment Agency and, where relevant, Natural England and the South East Rivers Trust, in preparation for option assessments in the draft WRMP24 plan.

SESW-RTR-N8 (Pipeline linking Pains Hill, Duckpit Wood and Chalk Pit Lane to existing treatment works at Westwood and Godstone)

This option comprises a pipeline linking boreholes at Pains Hill, Duckpit Wood and Chalk Pit Lane to treatment works at Westwood and Godstone. The option makes use of existing spare capacity at Godstone WTW.

This option was found to have the potential for a major short term negative effect on biodiversity during construction as it requires the installation of a pipeline which passes through an Ancient Woodland. There will be potential for permanent loss of some Ancient Woodland and short term disturbance to a number of Ancient Woodland sites during construction. There is also additionally potential for disturbance to local habitats and species. The assessment recommends that the pipeline route should avoid the Ancient Woodland to the north of Duckpit Wood close to the M25. It also recommends that further more detailed ecological survey work will be required to inform the precise route of the pipeline and any specific mitigation required.

Given the relatively large construction (12 km pipeline) the assessment predicted that the construction phase would require the importation of resources and would lead to increased emissions due to use of plant and vehicles. As a result of the construction phase, embodied carbon is high. Once in operation there would be minimal impacts in terms of greenhouse gas emissions. It is recommended that low carbon construction methods are used and energy efficient equipment utilised during operation.

The assessment identifies the potential for construction impacts on predominantly local transport routes. However, there is also the potential for construction impacts to the A25 which links to the A22 and Junction 6 of the M25. It is assumed that there will be no disturbance to the M25. It is likely that good construction practices will help to reduce the residual effect so it is not significant.

The construction of the new pipeline is likely to be visible from a number of listed buildings, including a Grade I listed building. It also passes close to a Registered Park and Garden. Potential for a short-term, temporary negative effect during construction. Pipeline will be buried operation so it is predicted that there will be a residual neutral effect in the long term.

The new pipeline passes through the Surrey Hills AONB so the assessment predicts the potential for impacts in the short-term during construction. If required, further studies will be undertaken to generate detailed information about the option across a range of topics including the effects on long range views. These studies will be used to identify and inform the optimal design and the detailed mitigation measures required to minimise any potential effect. The SEA recommends that prior to construction, a landscape mitigation strategy should be developed and integrated into construction method statements to minimise the adverse effects of the construction phase to the protected landscape. The strategy will include details such as locating construction facilities sensitively; the location of existing and any proposed planting, the import and storage of equipment and materials, and the nature of post-construction hard and soft landscaping works. Good construction practice will be employed to minimise the potential visual disturbance and impacts. The new infrastructure will be appropriately designed to help blend in with the existing landscape, and include appropriate screening

NGW-N5: New Lower Mole Abstraction source

This option will identify a new source location for groundwater abstraction from the Chalk or surface water abstraction (or river terrace gravels). In this context, the option requires a pipeline to be installed for treatment at Elmer WTW where there is existing capacity.

With regard to biodiversity features which may be affected by the option, there is an Ancient Woodland within the identified area of search for the borehole. There is potential for negative effects if Ancient Woodland is removed or damaged. However, as long as the Ancient Woodland is avoided during construction there should not be any significant impacts. Further more detailed ecological survey work will be required to determine the extent of this effect. Survey work will also help to inform the precise location of the borehole and route of the pipeline as well as any specific mitigation required.

It is not predicted that the construction of the borehole, pumps and pipeline would have a significant impact on the River Mole itself. It is assumed that the pipeline would follow existing roads and good construction practices will ensure that impacts are avoided or minimised. The pipeline should, where possible, avoid the Ancient Woodland in the search area.

The construction phase could create short term negative effects on population and communities through noise, dust and disruption to traffic. There are also likely to be related short term negative effects on designated recreational facilities. In the long term no change to the baseline is predicted as the pipeline will be buried.

With regards to effects on agricultural land, it is predicted that there is potential for disturbance to soil and loss of a small amount of greenfield land during construction. This may result in short term minor negative effects. The land take is expected to be minimal. It is assumed that the pipeline route will follow existing roads where possible and therefore minimise disturbance to soil.

The option may also have a minor positive effect with regards to flood risk in the medium to long term because the option will only abstract water during high flows which has the potential to improve outcomes in groundwater flooding.

The pipeline route is expected to follow existing highways infrastructure where possible. As such, there is potential for construction impacts to the A25 which links to the A22 and Junction 6 of the M25. As such, this may have a minor short term negative effect on air quality. Good construction practices will help limit impacts.

The construction of the new pipeline is likely to be visible from at least one listed building. As such, there is the potential for short-term, temporary negative effects on heritage assets during construction. The pipeline will however be buried, as such it is predicted that there will be a residual neutral effect during operation.

NGW-N4: Leatherhead licence increase
This scheme proposes to increase the Leatherhead licence by 2 Ml/d in order to take water available at least 50% of the time in the CAMS policy. The water will be treated at Elmer WTW as per the existing source where there is existing capacity.

The scheme makes use of existing infrastructure and will also make use of existing unused licence headroom for third party licence holders. As such, no new water will be abstracted from the catchment above that of the existing CAMS licence.

Screening work identified that Bookham Common and Mole Gap to Reigate Escarpment SSSIs are within 2km of the abstraction. However, it is not considered that additional abstraction from this location would have a detrimental impact on these habitats not being situated along the River Mole but on chalk slope and plateau environments. In light of these considerations, it is not predicted that this option will have any minor, moderate, or major negative effects on any SEA objectives.

The catchment is noted as being susceptible to flooding; however, no significant groundwater flooding has been recorded to date. The option will only abstract water during high flows and there is therefore potential to improve outcomes in groundwater flooding over the medium to long term.

As discussed the scheme will make use of existing unused licence headroom for 3rd party licence holders, and as such, no new water will be abstracted from the catchment above that of the existing CAMS licence. Consequently there is an opportunity for local improvements to meet the WFD objectives if abstraction in the River Eden is reduced higher in the catchment and taken lower in catchment where it has a higher flow. In terms of meeting WFD objectives, it is predicted that this scheme will have a minor positive effect over the medium to long term.

SESW-NGW-R5: New borehole (Mole Valley Chalk) - Fetcham Springs
The peak deployable output of the Fetcham Spring/Boreholes source could potentially be increased by 3.15Ml/d to the peak licence by the installation of new

boreholes which would allow abstraction above the current potential yield of the source. This option comprises the installation of a collector well and radiating horizontal boreholes to intercept natural springflow, and minimise drawdown, thereby reducing the environmental impact on natural groundwater flow to the River Mole.

There is the potential for temporary impacts during construction such as noise and dust which may have a minor short term negative effect on local communities and disrupt public footpaths which run close to the option.

Local habitats along the site comprise amenity open grassland space, patches of trees and woodland scrub, aquatic features (the Mill Pond). Construction works associated with this option may have a minor negative effect on biodiversity in the short term as they may perturb undisturbed areas and cause damage to plants and vegetation, and disrupt the presence and habitats of nesting birds and other local wildlife including protected species.

Over the medium to long term the option would increase abstraction within licence limits. However, the abstraction may take chalk groundwater that would otherwise flow into the Mill Pond as upwelling springflow, and the Mill Stream that flows round the northern side of the pond and then joins the River Mole. It could negatively impact on the River Mole Local Nature reserve which is nearby and its associated aquatic biodiversity. There is also the potential for the reduced springflows to negatively impact on the adjacent Mill Pond and its associated aquatic biodiversity. As such, the option may have moderate negative effects on biodiversity over the medium to long term.

The abstraction associated with the option may also have minor negative effects over the short term, and moderate negative effects over the medium to long term on fisheries through reductions in springflow to the River Mole. This reduction in springflow will also have moderate negative effects in the medium to long term on the water flow and water quality of the River Mole. Furthermore, this may have a minor negative effect over the medium to long term on the ability to meet WFD objectives, and will also have minor negative effects in the short to medium term on greenhouse gas emission reduction.

Short term minor negative effects may also be experienced during construction phase on landscape character and the potential for construction to impact on hidden or as yet undiscovered archaeology during excavation.

Monitoring
The SEA proposes the key mitigation measures and/or further investigation would be needed to reduce the significance of any negative environmental impacts of the schemes. These will be explored further in the detailed feasibility studies to be carried out before 2022. The key measures are summarised below, with more information included in Table 6.2 of Appendix K.

- Identify route options for proposed pipelines to avoid the Ancient Woodland and minimise environmental impacts

- Develop a landscape mitigation strategy where the pipeline passes through the Surrey Hills AONB
- Detail good construction practices to minimise temporary impacts (noise, dust and closure of public footpaths) and to that will ensure there are no residual impacts of the schemes
- Investigate the hydrological impacts of the proposed additional abstractions in the Mole catchment and determine appropriate mitigation in the form of timing and volume of abstraction (such as a Hands-Off Flow requirement), in order to maintain WFD status and objectives.

Intra-plan cumulative impacts assessment
Intra-plan refers to the potential cumulative effects arising as a result of interactions between schemes proposed within our draft plan.

The supply-side schemes are not within 5km so there is no risk of interactions during construction. The schemes do not fall within any of the same high value receptors.

There is a potential risk for two of the supply-side options to interact as they fall within the same WFD catchment. SESW-NGW-N5 (New Lower Mole Abstraction source), SESW-NGW-N4 (Leatherhead licence increase) and SESW-NGW-R5 (New borehole (Mole Valley Chalk) -Fetcham Springs).

SESW-NGW-N4 (Leatherhead licence increase) proposes to increase the Leatherhead licence by 2 Ml/d in order to take water available at least 50% of the time in the CAMS policy. The water will be treated at Elmer as per the existing source where there is existing capacity. SESW-NGW-N5 (New Lower Mole Abstraction source) will make use of available water (excludes summer period) in the licensing policy, so while there is the potential for a cumulative effect on the river flow lower down from all the abstraction upstream (Fetcham), the recent actual flows must be above environmental flow for at least half the year to make the water available. Furthermore, SESW-NGW-R5 (New borehole (Mole Valley Chalk) -Fetcham Springs) includes the installation of a collector well and radiating horizontal boreholes to intercept natural springflow, and minimise drawdown, thereby reducing the environmental impact on natural groundwater flow to the River Mole.

Taking the above into account it is considered that there is a low risk for cumulative effects on the Mole WFD catchment. Despite this, we plan to carry out further investigation and a more detailed assessment, if necessary, and discuss the outcomes with the Environment Agency to ensure compliance with the WFD.

Regional cumulative impacts assessment
In addition to the SEA carried out by the company, the WRSE examined the potential cumulative (or in-combination) effects of the options being considered by the member companies, in partnership with Natural England. This is the first time that a collaborative appraisal of the potential for cumulative environmental impacts has been undertaken on a regional scale by water companies.

The WRSE commissioned the consultancy Ricardo, to undertake this work. After having developed a robust methodology, Ricardo first looked at the WRMPs produced for the Periodic Review 2014, and determined that no significant issues had been overlooked. Ricardo used the methodology to scrutinise the feasible options under consideration by the WRSE member companies for their draft WRMPs for 2019. Ricardo updated this work in the summer of 2018.

The assessment found that there is potential for cumulative effects on particular receptors and catchments. However, the study identified that none of the schemes proposed in our plan are likely to interact with schemes proposed in other WRMPs to have a cumulative effect. The assessment found that there is no to low risk for cumulative negative effects (inter-plan) arising as a result of interactions with other, plans, programmes and projects.

10.2.6 Water Framework Directive

As discussed previously, we are required to ensure that our plan supports the objectives of the WFD, including the obligation to prevent deterioration. We consider that the proposed plan supports the objectives in the following ways:

- We are reducing demand from households, non-households and leakage so that abstraction impacts are reduced
- Where further abstraction may be necessary beyond 2060, we will use existing sources, unless the feasibility studies carried out prior to WRMP24 identifies that additional schemes should be included, in which case we will take action to mitigate the impacts. We have discussed potential impacts with the EA.
- We will carry out adaptive management identified in the WINEP options appraisal in the Wandle, and Darent catchments to reduce the impacts of our abstractions, in accordance with the timescales agreed with the EA
- We will carry out an investigation into low flows on the river Hogsmill in accordance with the timescales agreed with the EA
- Our plan does not increase the risk of spreading invasive of non-native species (INNS)

10.2.7 WRSE

Over previous cycles of work, the WRSE has developed and used its own bespoke EBSD optimisation model as a key tool to help find the least cost solutions for customers and the environment in the South East of England. The model's results have formed the basis of the WRSE regional strategy over successive years, which companies then use to inform and guide their own long-term water resource plans.

For 2019 the WRSE has used the same model as the core approach to examine water resources but with amendments to be more strategic, looking further into the future (2020 to 2080). Looking further ahead helps to make better decisions in the long run in terms of the type and scale of options may be needed.

Another critical amendment is that the model is being used in conjunction with "Info Gap" advanced decision-making approach, to reflect latest developments in the water industry that calls for the need to 'stress test' model outputs to determine how the selected portfolios of options are resilient for a range of possible futures, not just the one modelled.

There have been two phases of the EBSD optimisation modelling work allowing member organisations to continuously inform our knowledge and better our understanding. This work was undertaken by Jacobs (previously CH2M) who completed this modelling work on behalf of the group.

The initial model incorporated over 1000 potential options into the EBSD optimisation model from all member water companies, covering demand management, resource developments and transfer schemes to allow the model to select from very wide range of choices. The purpose of this phase of modelling was to take a broad, extensive examination of all the options that have been outlined or defined but not yet implemented, taking a ‘blank sheet’ approach, to see what might be useful to meeting future water demand.

Initially twelve different possible future scenarios were scrutinised, based on different combinations of the key influencing factors affects the demand and supply of water, including population, the type of droughts that we might experience in the future, and whether abstraction will be reduced to protect the environment and water quality. This was expanded to 16 scenarios in June 2018. Each scenario would require a different amount of water in the future, and the EBSD optimisation model created a *portfolio* of options that together would meet the demand.

The results showed that some options were always chosen for every scenario modelled; others were sometimes chosen; and a number were never chosen. Examining why some options are always chosen helps us to understand what schemes might be ‘no regret’ developments for the future.

The choice of options selected by the model shows where and what schemes might the best choices, at a regional level, to develop and provide water to other areas of the region. The importance of these schemes might not otherwise be realised from single water company plan looking at a specific area. The results also highlighted which water resource zones were more vulnerable than others, indicating that it would be beneficial to increase the connectivity of the water supply network to allow transfers to take place could help move water around the region. The stress testing of certain portfolios of options, showed that some fared better than others when assessed for their resilience in meeting conditions that are more demanding or difficult than their original scenario design. This helps us to understand what might be the *best value* choice of groups of options to implement, given the uncertainties of some key factors driving water demand, such as climate change and population.

After the completion of the above phase, further modelling was undertaken to take advantage of datasets that had been updated, such as population forecasts and potential abstraction reductions. For this modelling exercise, the options were restricted to only those which have been screened as feasible by each water company, and which were being considered for inclusion in the draft WRMPs; a total of 1410. This number includes new options or schemes that had been just developed by the water companies, and had not been included in the previous modelling phase. The purpose of this phase of modelling was to use only those options which had been subject to examination to ensure their feasibility, from an environmental or water volume perspective, and assess which would be selected by the optimisation model in its search for a regional solution to future water demand by 2080. The list of options was further updated in June 2018, increasing to a total of 1664.

The WRSE first explored the possible water demand to 2080 from over 140 scenarios to explore the full range of possible futures and resulting water deficits. This ‘capacity analysis’ has given insights into the vulnerabilities across the region on a water resource zone-by-zone basis, and identified which zones require transfers to solve their deficits and which zones have surplus that can be shared.

Optimisation modelling was performed on the 16 scenarios, as detailed in Table 33, to see what groups of options were the best choice to satisfy the deficit, and to test their resilience. The scenarios are based on a medium population forecast and incorporate known sustainability changes, but differ according to the severity of the droughts (severe or extreme), whether water companies can take more water from the environment during drought episodes using permits and orders, whether unconfirmed sustainability changes have been included, and whether regional targets for the reduction of leakage (of either 30% or 50% by 2050), and PCC (a reduction in water consumption to 110 litres per person per day by 2050) are included. These differences in scenario composition result in different levels of water deficit by the year 2080, as shown in Table 33, reflecting the challenging nature of possible future conditions.

The modelling outputs show that of the 1664 options considered, 56 were chosen for all 16 scenarios examined; 474 were chosen for some scenarios; and 1132 options were never chosen. Demand management, transfer options and source options all play a role in every scenario, with the precise mix depending on each scenario. The costs of the solution to each scenario ranges from £6 Billion to £15 Billion to satisfy the water deficit in 2079-2080. The cost per scenario depends on the volume that needs to be satisfied and the options chosen for it by the optimisation model.

Table 33: WRSE Scenarios

Scenario	Type of drought	Uncertain sustainability reductions?	Allows drought permits and orders?	Regional PCC targets?	Regional leakage targets?	SDB by 2079-80 (Ml/d)
1	Severe	50%	Yes	Yes	50%	-148.26
2	Extreme	50%	Yes	Yes	50%	-266.22
3	Extreme	100%	Yes	Yes	50%	-370.77
4	Severe	50%	No	Yes	50%	-578.53
5	Severe	50%	No	Yes	50%	-668.12
6	Extreme	50%	No	Yes	50%	-813.57
7	Extreme	100%	Yes	No	50%	-846.48
8	Extreme	100%	No	Yes	50%	-918.12
9	Extreme	100%	Yes	No	30%	-846.48
10	Extreme	100%	No	No	50%	-1393.83
11	Extreme	50%	No	No	30%	-1289.28
12	Extreme	100%	No	No	30%	-1393.83
13	Severe	50%	No	Yes	30%	-578.53
14	Severe	100%	No	Yes	30%	-683.09
15	Severe	100%	Yes	No	30%	-728.53
16	Severe	50%	No	No	30%	-1054.25

The outputs of this modelling work have been used to inform a regional strategy for the WRSE area, based around the Scenario 5, which is considered the central planning case. This is based on medium population growth, droughts that become severe in nature, where water companies are not permitted to abstract more water from the environment during drought episodes and with high level regional targets.

The deficit arising from Scenario 5 by 2079-2080 is 668 Ml/d. Of the solution, costing around £6 Billion, approximately 92% of the volume needed comes from source development, including a number of desalination plants, effluent re-use, and new and extended reservoirs. The scenarios with regional targets, or based on extreme droughts, requires a significant proportion of options related to demand management. Some transfers are required under all scenarios.

The model runs in August 2018 selected a transfer from Bough Beech to South East Water at Riverhill in 14 of the 16 scenarios. SES Water demand management measures were selected in Scenarios 7, 9, 10, 11, 12, 15 & 16, including smart metering and a home water efficiency retrofit programme. Our plan is largely aligned with these results.

We will continue working collaboratively with the group, which is expected to evolve over the next five years to increase co-ordination and strengthen the regional planning approach. We have included in our Business Plan funds to enable the WRSE to progress an enhanced agenda with the objectives of developing a single water resources plan for the region and becoming a trading hub to promote the water resources market.

10.3 Testing the Plan

As previously discussed, the plan is based on quantifying factors which are subject to a range of uncertainties. We consider at this stage whether we would reach a different conclusion in a range of possible futures.

Firstly we considered whether the design drought selected has affected the outcome of the options analysis. It was found that the planning against the Worst Drought on Historic Record was slightly more challenging than the 1 in 200-year scenario. However, the deployable output in the critical (peak) period was slightly lower in the 1 in 200-year scenario. The options selected were found to be identical in both drought scenarios.

The Environment Agency expressed concerns on the influence of climate change on the deployable output of Bough Beech. Therefore we conducted a ‘sensitivity run’ to test the effect of using higher climate change impacts, by reducing DO from 21.9 Ml/d to between 15.9-17.8 Ml/d. It was found that the model selected the same options since the impact was not sufficient to negate the surplus in supply.

The largest component of the uncertainty analysis is demand from households, due to the range in property and population forecasts. We have chosen to base our plan on the econometric projections produced by Experian. Using the upper forecast would have increased household demand by 9 Ml/d by 2045, whereas the lower forecast results in demand being reduced by 17 Ml/d. Under the upper forecast we would have a deficit in supply of around 2Ml/d by 2080. The plan is sufficiently flexible to be able to adapt to changes in these forecasts. We will review the forecasts on an annual basis as part of the Annual Review process.

Consideration was given to whether the plan was sufficiently resilient to non-drought events, including flooding, pollution and winter leakage (freeze thaw) events. We are increasing our ability to manage risks which result in the outage of a water source or treatment works by increasing the connectivity and capacity of our network so that all customers can be supplied by one than one works by 2030. This is detailed in our Business Plan for PR19. This flexibility also allows us to increase or decrease works output if the raw water quality is restricting the capacity to treat supplies, for example due to an algal bloom, or maintain supplies in the event of a burst on a trunk main or multiple bursts on distribution mains.

We have based the savings from the demand-side options proposed on the best evidence available from the industry. It is acknowledged that savings from metering and water efficiency programmes may be more or less that used in the analysis. On balance, it is considered that by planning a range of demand management measures the risk of not achieving the target savings is reduced. We also consider that in some cases, such as smart metering, we have been conservative with our estimates. We will monitor the results of the programmes to manage the risk of not meeting the demand forecast.

We have based our leakage calculations for this draft plan on our current methodology. We have started to collate the data necessary to comply with the new guidance outlined in the *Consistency of Reporting Performance Measures (UKWIR 2017).* Initial findings show our estimate of leakage is more likely to decrease from the current level than increase. The leakage estimate affects the water balance and therefore the calculation of household consumption. For example, a reduction of 5% increases unmeasured PCC by 1.3% and measured PCC by 0.1%, based on data from 2016/17. If this reduced leakage level was applied in the options analysis, the model would be more likely to select metering and water efficiency options. As we have already selected these options, we are reasonably confident that applying the new methodology would not have resulted in a different preferred programme.

We also considered our plan in relation to environmental objectives under the Water Framework Directive. We do not currently have any certain or uncertain sustainability changes to our abstraction licences. However, should these arise in later phases of the WINEP, we consider our plan could be adapted to meet these circumstances, providing the changes are not substantial.

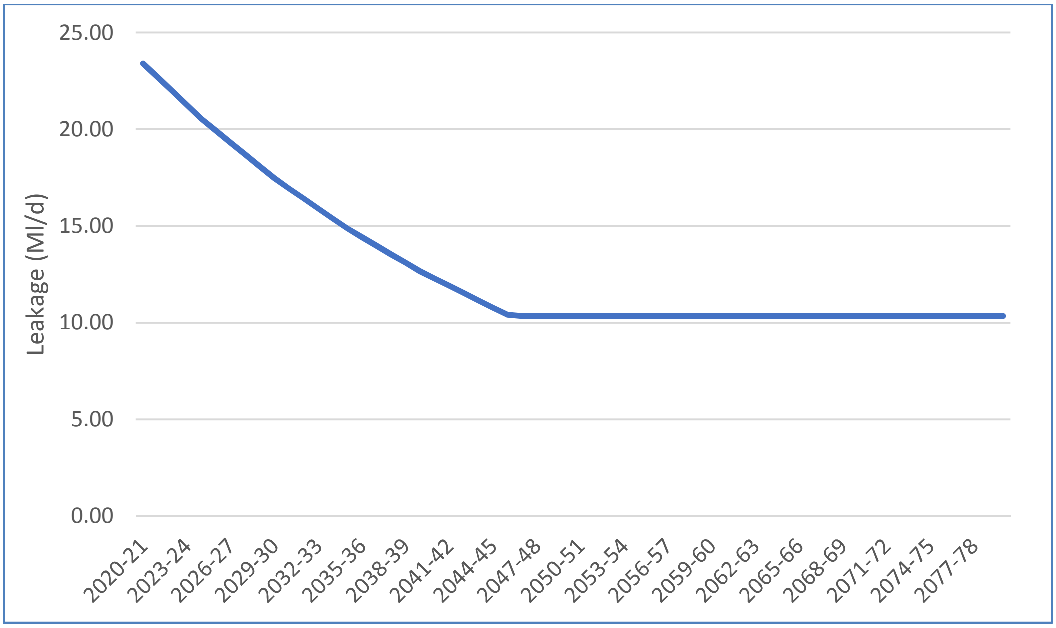
10.4 Preferred Final Plan

In this section, we provide further detail on the options selected from the economic modelling and programme appraisal.

10.4.1 Leakage

Our plan includes a reduction of 15% in each AMP from 2020 to 2045, which equates to a change in leakage from 24 Ml/d at the start of the plan to 10 ML/d by 2045. This represents a reduction from 14.5% to 6.3% of distribution input under annual average conditions. We plan to maintain the lower level to the end of the planning period. This is shown graphically in Figure 31.

Figure 31: Leakage Reduction



We plan to deliver this reduction through a combination of replacing our oldest, leakiest mains more quickly, helping to reduce the level of leakage from customers' pipes, increasing both the level and speed of leak detection and repair on our network (known as Active Leakage Control) and managing pressures better to create a more stable network so that it is less likely to cause bursts and leaks.

We also plan to increase our mains renewal rate from 0.6% to 1.0% per year from 2020. Modelling has shown this could result in a leakage saving of 5% per AMP.

We intend to embrace new technologies and processes to improve our performance and efficiency. Some examples include:

- Fixed Network Noise Logging
- Review of our policy on customer-side leakage
- Reduce leak run times from an average of 12 days to 8 days

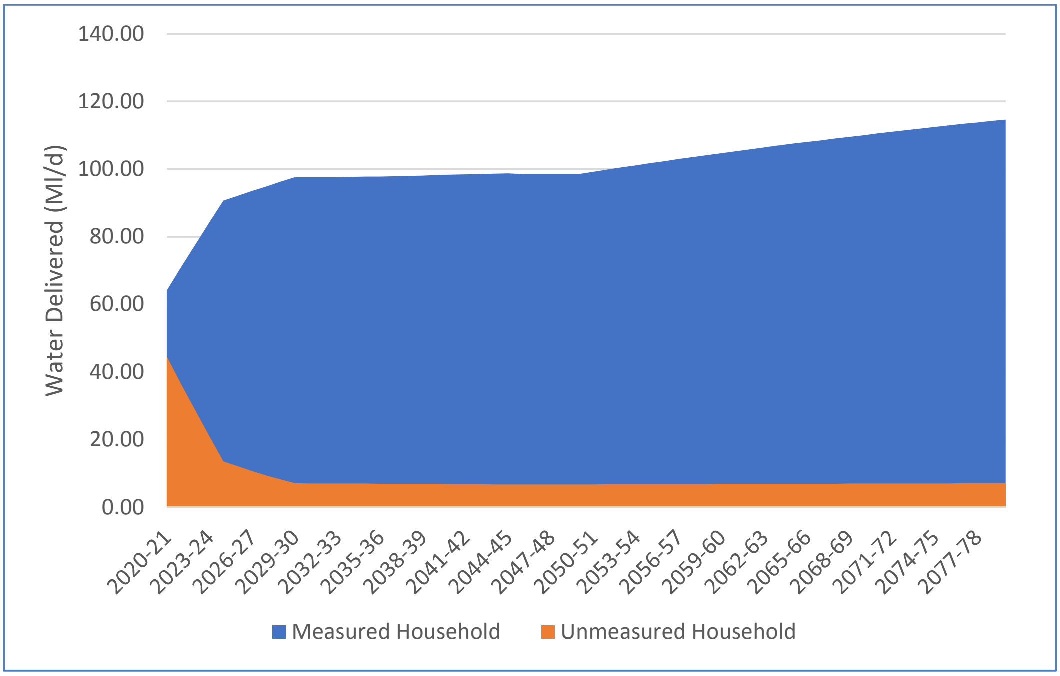
10.4.2 Metering

We have planned that 90% of properties will be charged on a metered basis by 2025, reaching 95% by 2030 and 97% by 2080. Figure 32 shows the effect on metering on water delivered. For the first five years, this will require around 71,000 meters to be installed (excluding new properties) over four times the number expected under baseline. These additional meters will need to be installed under an 'enhanced optant' or compulsory programme. The enhanced optant programme is where we install meters and then encourage the customers to switch to paying on a metered basis by providing a comparison of their actual metered consumption against the costs of staying on an unmetered tariff. As we have started this programme in 2018/19 we will be able to refine our approach to maximise the rate of switching by the start of the new plan.

The number of customers which will need to be included in a compulsory programme with depend on the take-up from the enhanced optant scheme. We will allow a period of transition of two years after the installation of the meter before charging on a compulsory basis is enforced. This allows the customer time to adjust their habits to control their bill.

We also plan that 10% of customers will have access to their consumption on a near real-time basis through the installation of a smart meter by April 2025. This equates to nearly 28,000 meters. We have calculated that these customers with reduce their consumption by around 16% in comparison to being on an unmeasured tariff.

Figure 32: Household Water Delivered by Meter Status (Average Year)



The programme will be developed from the pilot schemes being rolled out in 2019/20. Smart meters will be installed on an area-by-area basis aligned with the availability of the physical infrastructure that transmits the readings. The programme will include new properties, meter optants and change of occupancy customers within these areas. Beyond 2025, we expect that we will install smart meters as standard, providing the cost-benefit analysis shows it is effective to do so and we have the support of customers. If this is the case, by 2030 a further 40,000 smart meters will be in place, resulting in 24% customers having access to data from a smart meter.

10.4.3 Water Efficiency

Water efficiency forms a key part of our demand management strategy alongside leakage reduction and increasing the level of household metering. There is a clear steer from regulators and stakeholders that a declining per capita consumption (PCC) is pivotal to the management of water resources, especially given the future pressures of population growth and climate change.

Water efficiency expenditure is divided into three areas, those which relate to behaviour change (including education programme and outreach activities), installation projects (both customer- and company-led) and research projects. Our water efficiency programme has a dual benefit in that it enhances our supply-demand balance and therefore our resilience to periods of drought, and also allows us to engage with consumers to help them reduce their bills (water, sewerage and energy) by being more in control of their usage.

Our current programme is based on achieving a saving of one litre per property per day (equating to 0.4 litres per person per day). For this plan we are proposing to increase the level of activity so that we achieve two litres per property per day (a PCC reduction of 0.8 litres per year) over the 2020-2025 period. The level of water efficiency savings reverts to one litre per property from 2025.

We plan to increase water efficiency through a combination of home audits, education programme and events, distribution of water-saving devices and local campaigns, such as the *TapChat* initiative which we carried out in partnership with the environmental charity Hubbub. These programmes will start in 2020. We will align the metering roll-out to our Home Water Efficiency Checks programme, with visits targeted to households with high consumption or who are most affected financially by having a compulsory meter installed.

The model also selected a tariffs option in 2045 to achieve the final reduction needed to reach the PCC target of 118 by 2050. Clearly we will need to carry out research on the options available to maximise impact and seek consumer feedback. Having a high rate of metering and a significant proportion of smart meters by this point will aid the introduction of a differential tariffs as customers will receive more timely feedback on the impacts of their behaviour.

We recognise from work carried out in the industry and other sectors that consumption patterns and trends can be influenced by the approach taken. We will continue to work with a range of organisations, including Waterwise to support their *Water Efficiency Strategy,* other water companies in the South East to promote measures which benefit from a regional approach, as well as local authorities, environmental groups and housing associations. Research is needed to understand in depth how messages can be targeted at different groups and to expand our knowledge of how water is used in the home. We plan to carry out detailed analysis on the savings achieved from each programme so we can select initiatives based on evidence of their impacts, and determine the longevity of these savings which is equally important.

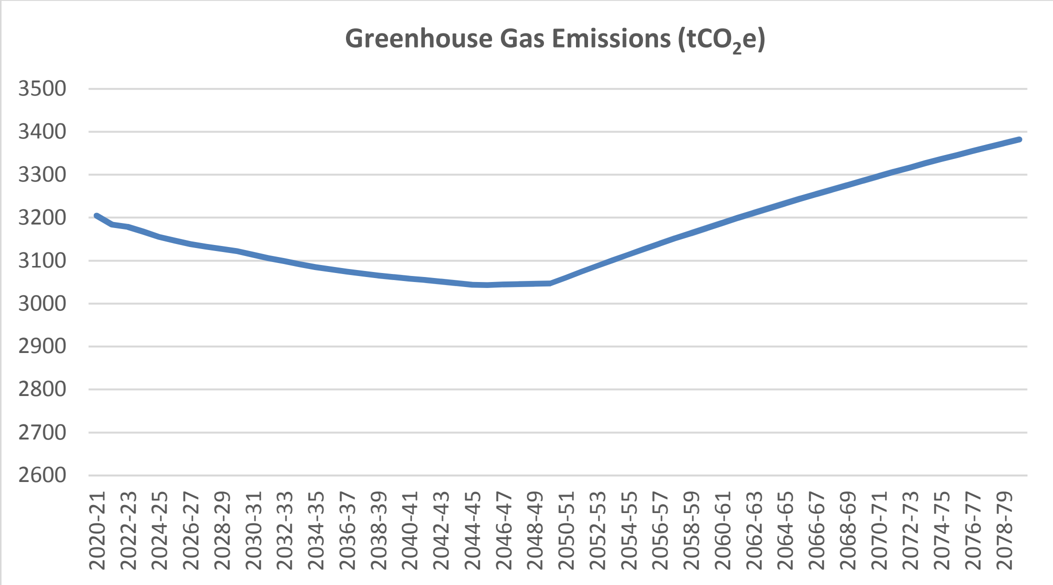
We are also looking to implement a variable infrastructure charge on new developments to incentivise developers to go further than building regulations requirements, and encourage the installation of rainwater harvesting and greywater recycling.

For non-household water efficiency, we will assess the best approach to implementing an efficiency programme under the new market conditions, by working in partnership with Retailers.

10.4.4 Greenhouse gas emissions

Total greenhouse gas (GHG) emissions for the plan in terms of water production are shown in Figure 33. The initial level is 3205 tCO_2e, declining to a minimum of 3043 tCO_2e in 2044/45, then increasing to 3382 tCO_2e at the end of the plan. This trend is explained by the changes in demand.

Figure 33: Greenhouse Gas Emissions



As only demand-side options have been selected, there are no additional emissions likely to arise as a result of the measures detailed in this plan, as shown in Table 34. In fact, the reduction in water abstraction, treatment and network pumping would result in a saving in carbon dioxide emissions. Although the company only uses energy generated from renewable sources, there would be a reduction in hot water usage by customers which would reduce overall greenhouse gas emissions linked to water usage. Other measures included in our Business Plan would also contribute to lower emissions, including the introduction of electric vehicles.

Table 34: Greenhouse Gas Emissions by Option

Selected Option	2020-25	2025-30	2030-35	2035-40	2040-45	2045-50	2050-55	2055-60	2060-65	2065-70	2070-75	2075-80
SESW-LEA-900: Leakage Strategy (Bundle 1)	0	0	**0**	0	0	0	0	0	0	0	0	0
SESW-WEF-700b-ph1: Water Efficiency Option 1b (phase 1)	0	0	**0**	0	0	0	0	0	0	0	0	0
SESW-MET-600: Compulsory metering AMI - enhanced higher meter penetration	0	0	**0**	0	0	0	0	0	0	0	0	0
SESW-TAR-800b: Tariffs (scenario b)	n/a	n/a	**n/a**	n/a	n/a	0	0	0	0	0	0	0
SESW-WEF-700b-ph2: Water Efficiency Option 1b (phase 2)	n/a	n/a	**n/a**	n/a	n/a	0	0	0	0	0	0	0

10.4.5 Climate change impacts

There are no detrimental impacts on climate change of any of the options selected, since we have selected demand-side options only. The plan make us more resilient to climate change impacts, for example by reducing peak demand in summers hotter than have been experienced historically.

10.4.6 Comparison with WRSE modelling

We have worked closely with the WRSE group to ensure consistency in the scenarios selected and options data. Our plan aligns closely to the revised set of model outputs produced in August 2018. Further model outputs issued since this date has not altered the selection of SES options in the regional plan.

10.4.7 Board Approval of the Plan

The Company's Board was presented with the revised draft plan on the 20 August 2018. They confirmed that they supported the proposals, and gave authorisation that the plan could be submitted to Defra. Assurance on those elements of the plan which were part of the Business Plan 2019 (which included all the demand management options selected), was carried out as part of the Business Plan process. The revised draft plan was then published as the final plan in August 2019.

10.5 Next Steps

As outlined above in the section on *Testing the Plan,* we propose further work to monitor progress with household demand uncertainty, the performance of the demand management options, and to assess the feasibility of the potential new abstraction options to inform future planning decisions.

On the compulsory metering option, we plan to work closely with CC Water and other consumer groups to tailor our communications to our customers and develop a strategy to support those most affected by a change in payments. We will investigate the impact of metering on the detection of customer-side leaks, and identify how we can address barriers to the repair of leaks on supply pipes and from internal plumbing.

We also propose to continue with catchment water quality investigations, in particular with respect to metaldehyde in the Eden catchment. We will work with the South East Rivers Trust and the Environment Agency to carry out river restoration measures in the Wandle catchment and develop solutions in other catchments as required in future phases of the WINEP.

We will work with Water UK and the industry to determine the impact of the new leakage and PCC consistent methodology guidance.

On climate change, we expect the revised MET office projections to be released in 2019 will inform our forecasts for WRMP24. We are working with UKWIR on an industry research project to assess how these results can be utilised in the next round of planning. This is a key area that will refine both our supply and demand forecasts, with the outputs also of benefit in assessing our level of operational resilience in the next Drought Plan.

It is also important that we continue to use customer insight to improve the services we provide so that we are responding to customers' needs. We also want to increase their understanding of the impact of weather, such as dry winters, on our resources, and the role they can play to reduce demand to support the measures we intend to take.

Section Summary – Final Water Resources Strategy

Our plan has been significantly revised in response to the public consultation feedback on the Draft WRMP and the customer engagement research carried out on the Business Plan, with the addition of ambitious targets on leakage, metering and household consumption. The model outputs show that these demand management measures are sufficient to solve the deficit in our baseline supply-demand balance without the need for any supply-side options. The plan, at a cost of £170.2M, results in a surplus of over 7 Ml/d under average conditions by 2080.

We assessed the plan against our key priorities of affordability, resilience, innovation and environmental impacts. We consider that to maintain resilience against future uncertainties we should retain the supply-side options selected in the draft preferred plan and carry out feasibility studies early in the next five-year period. This will improve the quality of information to be used in the options appraisal for WRMP24.

We have shown that our plan is consistent with the Water Resources in the South East approach and model outputs, and have tested the plan against different scenarios such as higher population growth. We consider that our plan meets our obligations under the Water Framework Directive and Habitats Regulations.

We have detailed how we plan to carry out the selected options on water efficiency, metering and leakage, and the steps we need to take to improve the certainty of our forecasts and continue to monitor customer views.