FINAL

WATER RESOURCES MANAGEMENT PLAN 2019

November 2019

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Glossary of acronyms

	Term	Meaning
A	ADO	Average deployable output
	ADPW	Average day peak week
	AIC	Average Incremental Cost
	AIM	Abstraction Incentive Mechanism
	AISC	Average Incremental Social Cost
	ALC	Active Leakage Control
	AMP	Asset Management Plan period
	AMP6	The current Asset Management Planning period, running from 2015/16 to 2019/20
	AMP7	The Asset Management Planning period, running from 2020/21 to 2024/25
	AMR	Automated Meter Read
	BAG	Benefits Assessment Guidance
B	BL	Baseline (Plan) (The WRMP excluding all future options)
C	CAP	Customer Advisory Panel
	CAPEX	Capital Expenditure
	CC	Climate change
	CCG	Customer Challenge Group
	CCW	Consumer Council for Water
	CRT	Canal & River Trust
	CSMG	Common Standards Monitoring Guidance
D	DAPWL	Deepest Advisable Pump Water Level
	Defra	Department for Environment, Food and Rural Affairs
	DFSE	Demand Forecasting in the South East
	DI	Distribution Input
	DMA	District Meter Area

	Term	Meaning
	DO	Deployable output
	DSOU	Distribution System Operational Use
	DYAA	Dry year annual average planning scenario
	DYCP	Dry year critical period planning scenario
	DYMDO	Dry year minimum deployable output planning scenario
E	EA	Environment Agency
	EBSD	Economics of Balancing Supply and Demand
F	FBC	Fareham Borough Council
	FP	Final (Plan) i.e. The plan including all options
	fWRMP	Final Water Resources Management Plan
H	HBC	Hampshire Borough Council
	HCC	Havant County Council
	HH	Household customers
	HoF	Hands off Flow
	HRA	Habitats Regulation Assessment
I	IoT	Internet of Things
	IR	Impound Reservoir
L	l/h/d	Litres per head per day
	l/prop/d	Litres per property per day
	LoS	Levels of Service
	LTA	Long Term Average
M	mAOD	Meters Above Ordinance Datum
	MDO	Minimum deployable output
	Ml/d	Megalitres per day
	MNFR	Meter Not For Revenue
	MTP	Market Transformation Program

	Term	Meaning
N	NAVs	New appointments and variations
	NE	Natural England
	NEP	National Environment Programme
	NEUB	Non-Essential Use Ban
	NFR	Not for Revenue
	NHH	Non-household – i.e. commercial and industrial customers
	NIC	National Infrastructure Commission
	NPV	Net Present Value
	NRW	Natural Resources Wales
	NYAA	Normal Year Annual Average planning scenario
O	ODI	Outcome Delivery Incentive
	Ofwat	Office of the Water Services Regulation Authority
	ONS	Office for National Statistics
	OPEX	Operational Expenditure
	OT	Operational Technology
P	PC	Performance Commitment
	PCC	Per capita consumption
	PDO	Peak deployable output
	PET	Potential evapotranspiration
	PHC	Per household consumption
	PR19	Periodic Review 2019
	PRT	Portsmouth Water
	PRV	Pressure reducing valve
	PUSH	Partnership for Urban South Hampshire
R	Ramsar	A wetland of international importance and significance
	RCPC	Rowlands Castle Parish Council

	Term	Meaning
	RSA	Restoring Sustainable Abstraction
S	SAC	Special Area of Conservation
	SDB	Supply demand balance
	SEA	Strategic Environmental Assessment
	SEAA	Severe Drought Annual Average planning scenario
	SECP	Severe Drought Critical Period planning scenario
	SELL	Sustainable Economic Level of Leakage
	SMA	Strategic Metering Area
	SoR	Statement of Response
	SPA	Special Protection Area
	SPORT	Storage and Production Optimisation in Real Time
	SWT	Sussex Wildlife Trust
	tCO_{2e}	Tonnes of Carbon Dioxide equivalents. This unit is the common way to express the global warming potential of various greenhouse gases in terms of the amount of carbon dioxide required to produce the same effect.
T	TLL	Time Limited Licences
	TUB	Temporary Use Ban
	TVBC	Test Valley Borough Council
U	UKCP	UK Climate Projections
	UKWIR	UK Water Industry Research Ltd
	USPL	Underground supply pipe leakage
W	WAFU	Water available for use
	WCSRT	Wessex Chalk Stream & Rivers Trust
	WFD	Water Framework Directive
	WINEP	Water Industry National Environment Programme
	WRMP	Water Resources Management Plan
	WRPG	Water Resource Planning Guidelines, produced and published by the EA

Term	Meaning
WRSE	Water Resources in the South East
WRZ	Water Resource Zone
WSCC	West Sussex County Council
WSW	Water Supply Works
WWTW	Waste Water Treatment Works

1 Executive Summary

1.1 Introduction

Portsmouth Water is a water supply only company with a long tradition of serving Portsmouth and the surrounding area since the Company was established in 1857. Through amalgamation, the Company's supply area has expanded beyond Portsmouth to supply the towns and cities of Gosport, Fareham, Havant, Chichester and Bognor Regis in the south east of Hampshire and West Sussex. On average, the Company distributes around 175 million litres of water each day to over 725,000 customers in nearly 320,000 properties. Portsmouth Water faces a number of challenges over the next 25 years, characterised by anticipated growth in population and property numbers in the Company area, coupled with the effects of climate change and other pressures on its sources such as the need to protect the environment.

Long-term planning for the provision of public water supplies is a vital aspect of maintaining the security of supply to customers whilst respecting the needs of the environment. Water resource planning has been a regular activity for water companies for many decades, and the Government has introduced legislation that requires companies to prepare Water Resources Management Plans (WRMPs) and for public consultation to be carried out. This, Portsmouth Water's Final WRMP 2019 has been prepared in accordance with the statutory guidance and policies issued by the Environment Agency and Defra. It was approved for publication by Defra on 4 November 2019.

In preparing this plan, Portsmouth Water has engaged extensively with customers and stakeholders both prior to publishing its Draft WRMP and during the public consultation period following its publication. The Company takes the views of its customers and stakeholders very seriously and has demonstrated the influence that this engagement process has had on shaping its Final WRMP. In parallel, the plan is closely aligned to the Government's expectations for ensuring resilient water supplies in the long-term enabled by reductions in demand and regional resource sharing through the use of greater bulk supplies to neighbouring companies.

The WRMP 2019 will make a major contribution to long-term resilient water resources in the South East by providing additional bulk supplies to Southern Water (SWS). This will be enabled by a twin-track approach to reduce leakage and lower PCC, and the development of Havant Thicket Winter Storage Reservoir (HTWSR). The reservoir was selected by the Water Resources in the South East (WRSE) modelling as a solution to future potential water shortages in the region. We will be building the reservoir in close collaboration with SWS. We also believe that it is a significant step in achieving the Regulator's vision of a South East strategic Plan and resilient network for water resources in the South East as set out in their joint letter of 9th August 2018 "Building Resilient Water Supplies".

Havant Thicket Winter Storage Reservoir is a £103m construction project, and a collaboration between Portsmouth Water and Southern Water, through the Water Resources in the South East group, to provide resilient water supplies to the region. It supports reduced abstraction on chalk rivers, has an overall biodiversity net gain and will offer a new community leisure facility for the area.

This Plan presents the supply-demand balance throughout the 25-year planning period (2020/21 to 2044/45). It demonstrates the need for investment to maintain the balance between supply and demand over the planning period. It shows the programme of actions Portsmouth Water plan to undertake to ensure the Company can be resilient to a 1 in 200-year drought and support other water companies in the region.

1.2 Key Components of WRMP19

Portsmouth Water has planned on the basis of a single Water Resource Zone (WRZ) that covers its entire supply area. It has produced forecasts for dry year and critical period planning scenarios for a 1 in 200-year drought event.

The Company has worked with customers to set levels of service, and these are consistent between the WRMP and the Drought Plan. The Company's planned level of service over the planning period is set out below:

- > 1 in 20 years for Hosepipe Bans, representing an annual risk of 5%.
- > 1 in 80 years for Non-Essential Use Bans, representing an annual risk of 1.25%.
- > 1 in 200 years for Emergency Drought Orders, representing an annual risk of 0.5%.

In developing its WRMP, the Company has worked closely with the Water Resources in the South East (WRSE) Group which is a sector-wide partnership that selects the best options to solve deficits across the region. The modelling undertaken by the WRSE Group indicated that there is both the scope (through options available to Portsmouth Water) and the need for the Company to provide additional bulk supplies to Southern Water, to assist its neighbour in meeting deficits it faces during the planning period.

The Company's involvement with the WRSE Group has been central in the development of the WRMP, the Havant Thicket Winter Storage Reservoir being considered a significant option to help deliver resilience in South East England.

1.3 Stakeholder and Customer Engagement

Portsmouth Water recognises the importance of effective engagement with its stakeholders to ensure that its WRMP addresses its statutory obligations and has broad support. In addition to collaborating with the WRSE Group as mentioned above, the Company has engaged with key statutory bodies (the Environment Agency and Natural England), the Consumer Council for Water (CCW) and directly with neighbouring water companies.

Engagement has been in two stages:

- Pre-Consultation on the Draft WRMP; and
- Public consultation on the Draft WRMP, undertaken from 5th March to 25th May 2018, which generated 14 representations and over 2,000 responses from members of the public to a non-technical summary of the plan.

The Company has prepared its Final WRMP with due consideration to the queries and challenges received during this process, seeking further meetings and provision of information where necessary. Following a thorough review of the feedback received on its Draft WRMP, the Company prepared a Statement of Response (SoR) document. The SoR sets out Portsmouth Water's response to all representations received, and if/how the plan has been amended to take into account each representation.

Specific outputs of the stakeholder engagement process have been reflected in changes from the Draft to the Final WRMP, particularly in the Company's metering and leakage policy and strategy, in the identification and development of potential bulk supply options, and in how Drought Permits are included in the plan.

Engagement with local authorities has resulted in review and reselection of the access arrangements for Havant Thicket Reservoir to minimise impacts on the local community during construction and through the life of the project. Engagement with environmental Non-Governmental Organisations (NGOs) has helped to shape both the catchment management and biodiversity plans in particular, which protect the long-term future of water resources. They have also asked the Company to consider joint funding of schemes. This is in line with

customers desire to improve the countryside we live in and the Company will establish a grant scheme which will fund suitable, water related schemes.

Customers are at the heart of Portsmouth Water's day-to-day activities and long-term plans. The customer engagement activity undertaken by the Company for this WRMP was designed to enable the Company to understand customers' priorities concerning proposals in the WRMP. The engagement has included targeted qualitative and quantitative research and also incorporates findings from its business as usual activity as well as customer participation on demand management and protection of water resource initiatives. Crucially, these activities do not cease when the WRMP is submitted. There has been an unprecedented level of engagement for this WRMP, as the Company has never before engaged so widely, innovatively, in as much depth, and had so much participation from customers as it has had for this planning process. During the engagement process as a whole, 38,000 customers have been involved in the WRMP and Business Plan process. This includes an unprecedented 2,212 customers who responded to the online survey on 'Your Water and its future', the non-technical public facing document summarising the Draft WRMP published in March 2018. The publication and online survey sought customer views on key issues and choices to address leakage, metering, per capital consumption and the role of the regional solution were explained. As part of the online consultation, customers were invited to complete questions relating specifically to Havant Thicket Reservoir as part of a regional solution and also on the provision of bulk supplies to Southern Water.

The key messages from the customer research are:

- There are high levels of satisfaction with Portsmouth Water's service evidenced across qualitative and quantitative research;
- The top priority is a safe, secure and reliable supply of drinking water;
- The Company has been challenged on leakage ambition to do more than originally proposed;
- There was support for water trading provided Portsmouth Water's customers are not adversely affected by bill increases for the cost of development of Havant Thicket Reservoir;
- Customers value environmental enhancement that goes beyond legal responsibilities;
- There is a desire for the Company to co-create and deliver more water efficiency education;
- There is a wide range of views on metering, and overall customers prefer choice rather than compulsion; and
- Rota cuts are not acceptable even in a 1in 200-year drought.

The above-listed customer views have been taken into account in the programme appraisal stage of the options appraisal, which helps to shape the Company's preferred final plan for maintaining the supply-demand balance.

1.4 Baseline Supply

The majority (88%) of the water supplied by Portsmouth Water to customers is derived from the local chalk aquifer. It is either taken directly from the aquifer from boreholes and wells or captured as it emerges via springs. In addition, the Company has one surface water abstraction. A reassessment of the deployable output (DO) of the Company's 22 sources has been undertaken for the WRMP19, providing the basis for the baseline supply forecasts.

Portsmouth Water has considered the following elements in its baseline supply forecast for the Final WRMP19:

- deployable output anticipated to be available during a 1 in 200-year drought event
- impact of climate change on each source

- sustainability reductions that need to be taken into account
- the impact of any short-term loss of production referred to as 'outage'
- treatment process losses
- bulk supplies to and from the Company area

The bulk supply agreements with Southern Water have been included in the Company's baseline supply forecast and have also been included within Southern Water's preferred programme in its Final WRMP. The existing bulk supply agreements which are available throughout the planning period (April 2020 - March 2045) comprise:

- Southern Water – Sussex North (15 Ml/d)
- Southern Water – Hampshire Southampton East (15 Ml/d).

The future bulk supplies agreed with Southern Water are as follows:

- Southern Water – Hampshire Southampton East (additional 9 Ml/d from 2024/25)
- Southern Water – Hampshire Southampton East (additional 21 Ml/d from 2029/30)

With regards sustainability reductions, the Company will be working with the Environment Agency and Southern Water on the River Itchen common standards investigation to determine the costs, impacts and technical feasibility of reaching or maintaining revised flow targets for the River Itchen. This will also be linked to investigations on biodiversity priorities for the River Itchen. The Company will also be investigating improvements to the hydrological regime to meet Water Framework Directives (WFD) objectives at two sources in AMP7.

1.5 Baseline Demand

Experian was appointed by a group of water companies in the South East to develop detailed property and population forecasts for the planning period 2020-45. In response to representations received during the public consultation, the Company has adopted a plan-based forecast for its Final WRMP. The population and property forecasts have been applied to estimates of base year and forecast per capita consumption for different customer segments.

Portsmouth Water's current metering policy involves encouraging unmeasured customers to opt to have a meter installed (optants). In WRMP14 Portsmouth Water committed to 5,000 meter optants per year. In the first three years of AMP6, despite additional promotional efforts by the Company to increase the uptake of metering, the outturn number of optants has fallen below the target. The Company is not in an area of 'serious water stress', therefore it cannot legally compulsorily meter its customers. However, it recognises the value of metering in reducing consumption.

From 2018/19 Portsmouth Water will seek to attract more customers onto a meter by undertaking a trial of smart meters which are being installed where a meter or meter box already exists. The smart meters will initially provide customers with more information using a dual-billing style approach referred to as 'Metering not for revenue'. Customers will be encouraged to switch to a meter through Portsmouth Water offering comparative bills and water efficiency advice.

In addition to existing baseline metering and the trial of smart metering described above, Portsmouth Water is also considering other metering options for WRMP19. Although the Company cannot compulsory meter all its domestic customers, it does have the right to meter upon a change of occupier and to meter void properties. These options have been considered within the options appraisal process described in section 1.7 of this Executive Summary.

The Company currently undertakes a number of water efficiency activities with the aim of working with customers to help them reduce their consumption, which they have consistently

said they want, the savings from which contribute to base year levels of Per Capita Consumption (PCC) and are therefore incorporated in the baseline PCC forecasts.

Portsmouth Water's assessment is that non-household demand will continue to fall over the planning period, with the long-term trend being reinforced by retailers in the Non-Household Retail Market who are working with their customers to reduce usage further.

Leakage is of significant concern to the Company and its customers; therefore, it has been reviewed in detail for the WRMP. The Company commissioned a consultant to undertake a Sustainable Economic Level of Leakage (SELL) assessment to establish the base year and forecast leakage levels that the Company should be targeting as part of its baseline demand forecast. As a result of the full SELL appraisal, the Company has decided to set an initial leakage reduction target of 7.1Ml/d, reducing leakage from 35 Ml/d down to 27.90 Ml/d by 2025. This will result in a leakage target at SELL by 2025.

The Company anticipates significant improvements in leakage detection and repair efficiency through innovation over the next 40 years and has taken this into account when forecasting the baseline level of leakage, as well as expected growth in properties and increased customer metering. The Company believes that it is reasonable to expect that the increase in leakage from growth in the distribution network will be less than savings made through gains in efficiency. Additionally, it is reasonable to expect that the savings resulting in supply pipe leakage from the metering of customers should be reflected in the leakage forecast. The Company has allowed for these benefits in its baseline leakage forecast which results in a falling leakage forecast over the planning period.

1.6 Baseline Supply-Demand Balance

Portsmouth Water has considered baseline supply and demand forecasts, together with an assessment of target headroom (a buffer between supply and demand that allows for uncertainty and risk) to produce a baseline supply-demand balance. Portsmouth Water's baseline supply-demand balance shows a deficit at both annual average and critical period throughout the planning period.

The deficit is calculated to be 33.3 Ml/d in 2019/20 increasing to 83.6 Ml/d by 2044/45 under the annual average scenario, and 34.8 Ml/d in 2019/20 increasing to 85.8 Ml/d by 2044/45 under the critical period scenario. This indicates that options need to be developed to meet both our customer requirements and bulk supply commitments to Southern Water.

Options will, therefore, need to be developed and implemented to eliminate this deficit. The process by which this is done is the 'options appraisal'.

1.7 Options Appraisal

To determine how to meet the supply-demand balance, an options appraisal was undertaken, in accordance with the Water Resource Planning Guidelines and the recommended best practice guidance. The stages of the process are summarised as follows:

- Firstly an *'unconstrained list'* of options was produced which identified all potential options that could be used to balance supply and demand. Unconstrained options are generated based on technical feasibility, but tend not to be constrained by regulatory restrictions. These options are generated from past and present information available to the Company and take into account the core business functions and government aspirations. The Company's unconstrained option list comprised 183 potential options.
- The viability of these options was then considered by applying *screening criteria* to identify those to take forward for more detailed options appraisal, i.e. as part of the 'feasible' options list. Following the screening, a total of 25 feasible options were identified for Portsmouth Water to consider further.

- The *feasible options* (those shortlisted from the original list of unconstrained options) were then examined further by taking into account financial costs, social and environmental costs, carbon costs, yield and delivery uncertainties.
- The next stage in the process was an *economic appraisal*. The relative economic costs and benefits of all feasible options, to the extent which they have been possible to monetise were analysed using 'current' Economics of Balancing Supply and Demand (EBSD) decision-making approaches to determine the least-cost planning solution. Taking bulk supplies into account in the baseline supply-demand balance indicated that nearly all the feasible options would be required to eliminate the supply-demand deficit and that the options had to be delivered as soon as practically possible. A cross-check of costs, yields and timings was required to show that the economics were not unreasonable. On this basis, within EBSD, it was considered most appropriate to use Average Incremental and Social Cost (AISC) ranking plus 'expert judgement' as the decision-making tool (described in Table 8 of the UKWIR decision Making Process Guidelines).
- To develop a combination of feasible options which balances supply and demand throughout the Company's supply area from 2020/21 to 2044/45, the Company has undertaken a *programme appraisal*. This ensures that the non-monetisable impacts of options (both negative and positive) are taken into account, together with any risks and uncertainties that have not been captured earlier in the options appraisal process. The programme appraisal methodology has been revised since the Draft WRMP19 in response to representations received during the public consultation to improve transparency in the selection of the preferred plan. Except for cost (financial, environmental and social and carbon), the programme appraisal is qualitative, assessing the performance of programmes of options in the following areas:
- Total cost;
- Performance against SEA objectives;
- Programme risk (including yield uncertainty, cost and programme uncertainty, Water Framework Directive and flexibility);
- Alignment with Government policy priorities;
- Customer preferences; and
- Resilience.

The least-cost plan was arrived at by identifying the projected supply-demand deficit after allowance for headroom, each year for 25 years ahead. The options that could be used to meet any deficits were then identified. The options were chosen considering those with the lowest AISCs (least-cost) first. The least-cost plan was then assessed against the above factors, and from this, the preferred final plan was arrived at.

1.8 Testing the Plan

Portsmouth Water have tested its preferred plan through a series of different sensitivity scenarios considered to represent the main areas of uncertainty concerning risk to supply and demand, including the impact of sustainability reduction which may arise from the Investigations being conducted in AMP7

The sensitivity testing has indicated that whilst there is a range of uncertainty in the supply-demand forecast, the preferred plan appears to be robust with respect to changes in population and property forecasts and uncertainty in demand benefits from water efficiency savings. The testing results emphasised the need for the Company's resource side options to be in place, to reduce uncertainties in the yield available from drought restrictions.

The testing results reinforced the fact that many of the options are being driven by the desire for regional resource sharing. The results illustrated that the development of Havant Thicket

Winter Storage Reservoir is a key component of the Company's preferred plan to enable the Company to be able provide a bulk supply to Southern Water. Without this option, Southern Water would be required to find alternative supply options that will be significantly more expensive, and thereby offer much poorer value to their customers.

The sensitivity testing indicated that the preferred plan is less robust to significant reductions in deployable output. In the event of the worst-case scenario of a loss of output from Source A, or a similar scale reduction in DO arising from a combination of sustainability reductions the Company would be unable to meet its bulk supply commitments to Southern Water in full. However, it should be recognised that the Company's plan is based on a 1 in 200-year drought event which is uncertain and the sustainability reductions considered were a worst-case scenario.

The sensitivity testing helped to demonstrate that whilst the Source S drought permit is needed as an option by the Company in the short term, once other options within the preferred plan have been developed, there is potential not to rely on the drought permit. The Environment Agency and Natural England have expressed some concerns regarding the Source S Drought Permit, and the Company would like to avoid the requirement for using the drought permit wherever possible.

1.9 Final Plan

Portsmouth Water's preferred final plan contains options which the Company considers most appropriate to adopt over the next twenty-five year planning period to maintain the balance between water supply and demand.

The Company has based its planning on a 1 in 200-year drought event. This is more appropriate for Portsmouth Water than the worst historic drought on record which is not considered severe enough for Water Resources Planning. The company has considered different return periods and calculated the supply-demand balance or each. This analysis has indicated that although the 1 in 200-year scenario represents the most challenging scenario, the 1 in 80-year event actually contains a similar level of supply-demand risk to the 1 in 200-year event due to the Level of Service constraints included. The analysis undertaken indicates that the options selected under the preferred plan are required under a range of drought conditions and not just in a 1 in 200 -year drought event.

Planning for a 1 in 200-year drought event provides future resilience and, as the Company has committed to providing a bulk supply to Southern Water with water available up to a 1 in 200-year event, it is appropriate to undertake planning based on this event.

As a result of the sensitivity testing, the Company is confident that it has the correct balance of options available to balance supply and demand and manage uncertainties. The Company believes the plan to be robust to minor changes in supply and demand forecasts in the near future and moderate changes as the plan progresses.

Table 1 sets out the options within the Company's preferred final plan and their planned start dates.

Option code	Option name	AMP7 (2020/21-2024/25)	AMP8 (2025/26-2029/30)
CO46	Household water efficiency programme (partnering approach, home visit)	2020–21	
CO46b	Waterwise programme	2020–21	
CO26	Subsidy to customers that purchase water efficient appliances (washing machines and dishwashers, showers and WCs)	2020–21	
RO21a	Source O – Maximising DO	2020–21	
RO23a	Source H – Maximising DO	2020–21	
CO34	Water saving devices – Retrofitting existing toilets	2020–21	
CO06a	Metering on change of occupancy – existing meter pits	2020–21	
DO04a	Fixed network of permanent noise loggers connected to telemetry - Tranche 1	2020–21	
RO24a	Source C – Maximising DO	2020–21	
CO84	Voids metering	2020–21	
CO40	Water saving devices – spray taps	2020–21	
CO43	Water saving devices – trigger nozzles for hoses	2020–21	
CO05	Smart Meter MNFR Trial	2020–21	
CO78	Voluntary restraint and leakage action	2020–21	
CO79	Mandatory restraint	2020–21	
CO80	Imposition of Drought Direction Restrictions (mandatory commercial restraint)	2020–21	
RO68	Source S – Drought Permit	2020–21	
RO22a	Source J – Maximising DO	2024–25	
DO04b	Fixed network of permanent noise loggers connected to telemetry - Tranche 2		2025–26
CO06	Metering on Change of Occupancy - all properties		2025–26
RO13	Havant Thicket Winter Storage Reservoir		2029–30

Table 1 Preferred Final Planning Programme

The relative yields or demand savings gained from each option are summarised graphically in Figure 1 and Figure 2 below.

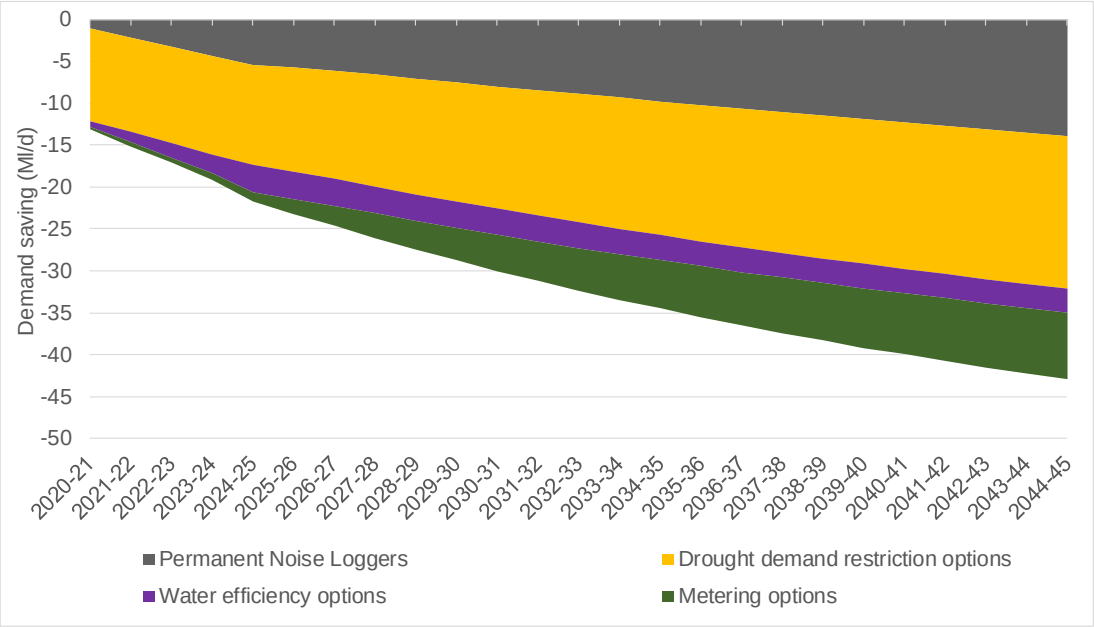


Figure 1 Demand Management (Customer Side and Distribution Side) Option Savings over the Planning Period

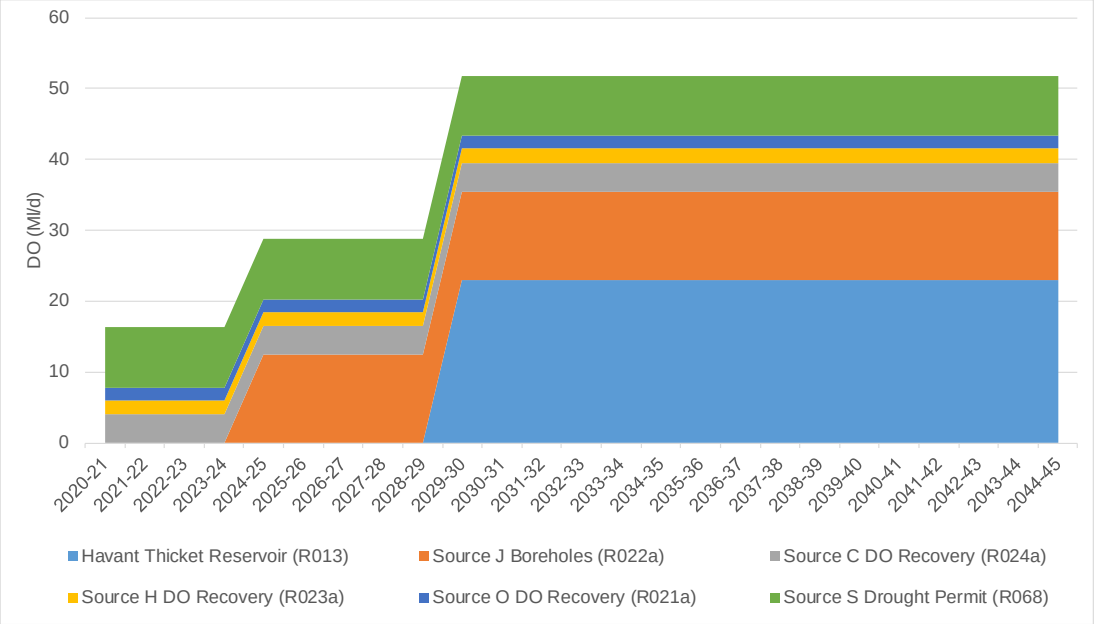


Figure 2 Resource Option Yields over the Planning Period

It can be seen that Havant Thicket Winter Storage Reservoir provides a large proportion of the additional DO required to balance supply and demand from 2029/30 onwards.

The final planning supply-demand balance for the annual average scenario is represented in Figure 3 and the critical period scenario is presented in Figure 4.

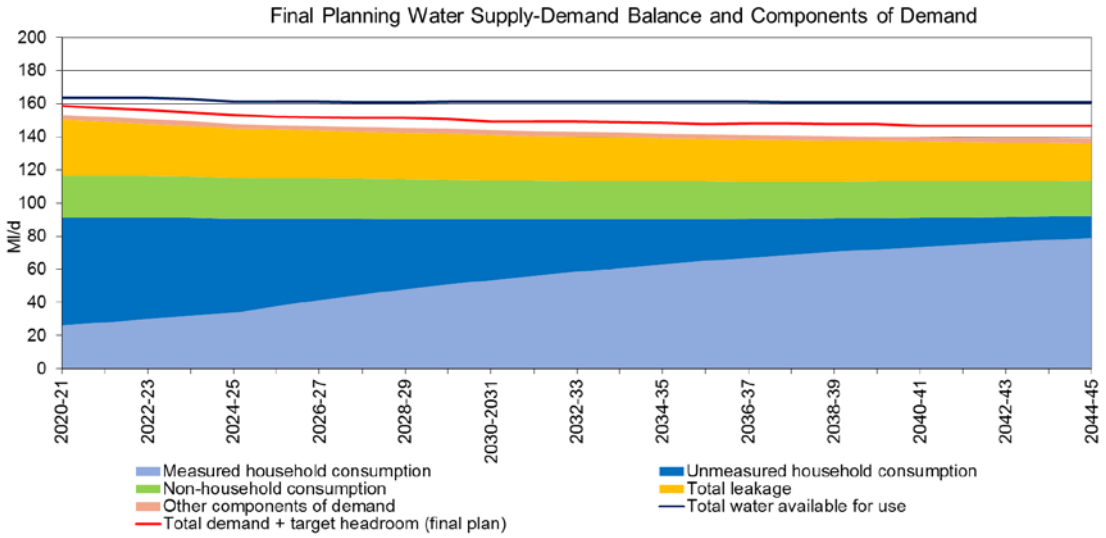


Figure 3 Final Planning Supply-Demand Balance Graph - Annual Average

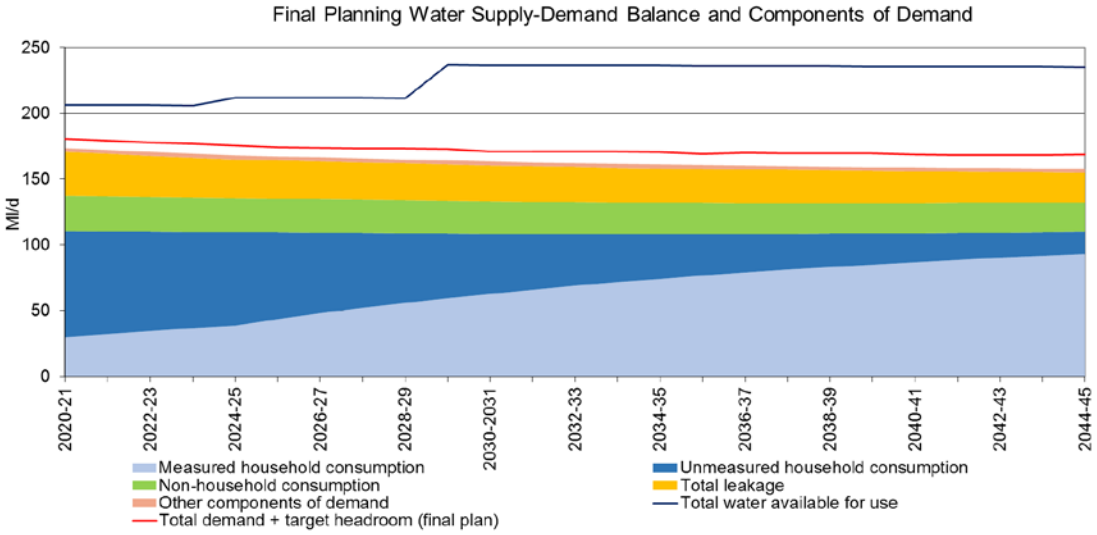


Figure 4 Final Planning Supply-Demand Balance Graph - Critical Period

Implementation of the preferred plan results in a small but increasing surplus in resource over the planning period under the annual average scenario. The surplus is largely generated as a result of the economic and programme appraisal methods which have been utilised to ensure that the smaller demand management measures are included. In addition, the preferred plan includes a number of options which enable the Company to meet Government policy objectives (for example, the 20% reduction in leakage during AMP7, continued ambition to reduce leakage throughout the remainder of the planning period, measures to drive down PCC and ensuring a twin-track approach to balancing supply and demand), and to meet the preferences of its customers. These options have been included in the preferred plan because the Company considers them to be a key part of its future strategy and helps to demonstrate that the Company is 'doing the right thing' for regulators and its customers. In practice, the

demand management measures cannot fully balance supply and demand and resource schemes are required in addition.

The surplus generated helps to provide resilience to a range of risks. Having a small surplus enables the plan to be robust to minor changes in supply and demand forecasts. Furthermore, the availability of a supply-demand surplus under the 1 in 200-year drought scenario means that the Source S Drought Permit, may only be required at the start of the planning period, with dependence on it then decreasing over time. This is beneficial as the Environment Agency and Natural England have expressed concerns regarding the drought permit and potential environmental impacts.

The surplus shown under the critical period scenario is greater than that shown under the annual average scenario. This simply reflects that the difference between PDO and ADO for the supply-side interventions is greater than the difference between the forecast demand in the annual average and critical period scenarios.

The Company's preferred plan has been arrived at through consideration of Company priorities, Government policy priorities and the perceived priorities of its customers. The way it helps to meet those objectives is summarised below.

Twin Track Approach

The preferred plan has a strong focus on demand management measures (leakage, metering and water efficiency) and demonstrates the Company's commitment to a twin-track approach of resource management and customer- and distribution-side options to balance supply and demand.

The Company plans to reduce leakage by installing permanent noise loggers throughout the distribution network and linking these to telemetry. This option takes into account the latest technology and innovation and is based on instant data transmission, from leak noise loggers, back to the company using a custom-built network, based on 'Internet of Things' (IoT) technology. By adopting this option in the Final WRMP, the Company has a more ambitious leakage target. In addition to meeting Ofwat's 15% leakage reduction target over the first five years of the plan, further leakage savings will be delivered throughout the planning period. In total there will be a 20% saving by March 2025 and a further 10% by March 2040.

The Company's metering programme includes change of occupier metering, voids metering and the 'meters not for revenue' smart meter trial programme (which is designed to increase the number of meter optants and will provide valuable information to customers on their usage).

The Company has included an ambitious programme of demand savings based on water efficiency. This includes an extensive household water efficiency programme in which the Company will be working with Waterwise to assist customers in reducing their consumption.

The Company expects, as a result of a combination of its ongoing baseline demand management activities and the metering and water efficiency measures it proposes to undertake, that PCC will fall during the planning period. The Company forecasts that by adopting the preferred final plan, average PCC will fall over the planning period from 142.2 l/h/d to 128.7 l/h/d. These levels are what can be delivered through the options which can be implemented by the Company. However, the Company has an aspiration to see PCC at 100 l/h/d by 2050, but to do this will need to work with developers, local authorities and inset appointees. This will be undertaken as part of the Company's next steps, following submission of WRMP19.

Resource sharing

The baseline supply-demand balance of the preferred plan explicitly assumes the Company will provide bulk supplies to Southern Water. This supports the Government's policy priorities for improved resource sharing, and also takes account of the outcomes of the WRSE modelling work.

The development of Havant Thicket Winter Storage Reservoir is an integral part of the Company's preferred plan. Water for the reservoir will be sourced by transferring any winter excess from the Company's main Source B, to the reservoir by the construction of a dedicated pipeline. Water from the reservoir will be treated at Treatment Works B, before it is transferred westward within the Company's network to supply customers in Gosport and Fareham in particular. These areas are currently supplied with blended water including from Source A. As water from Source A will be used to provide the bulk supply to Southern Water, this will be replaced by the water transferred from Treatment Works B.

Resilience to drought

The options selected in the preferred plan provide supply-demand and DO resilience to a 1 in 200-year drought. The Company is committed to further exploring ways to increase resilience though additional enhancements, such as two-way transfers, to reduce risks from outage and events such as extreme droughts, heatwaves, freeze/thaw and pollution.

Providing opportunities for environmental improvements

The preferred plan is integrated with the SEA Environmental Report and as a result performs well against SEA objectives. In addition, it has been identified that environmental improvements can be delivered in many areas through scheme design, catchment management at biodiversity plans. Development of the Havant Thicket Winter Storage Reservoir provides the biggest opportunities.

Bulk supplies are a major part of this Plan and they are driven by the requirement for Southern Water to significantly reduce its abstraction on the chalk Rivers Test and Itchen, (as set out by the Environment Agency to meet the requirements of the Habitats Directive and Water Framework Directive). We consider that our solution to provide these bulk supplies, is a significantly better environmentally solution than the alternatives.

1.10 Next Steps

After submission of the Water Resource Management Plan (WRMP), the Company proposes to undertake further work to ensure successful delivery of this Plan. This work will include:

- Commence the programme of works for water resource developments in the Final Plan, including Havant Thicket Winter Storage Reservoir
- Workstreams to improve confidence in the Final Plan
- Delivering environmental enhancements including the provision of updates on the progress on the various environmental studies and uncertainties and their implications
- Continued collaboration to achieve regulatory ambitions

The Company will continue to work closely with the EA and other regulators and will inform the EA of progress against its preferred final planning solution through the Annual Review process on its WRMP.

Further information is available in section 10.

1.11 Board Assurance Statement

In preparing this statement, the Board have considered its overall strategy for Water Resources, the views of Customers, Regulators and the Customer Challenge Group as well as reports from third parties, conducting elements of the work and reviewing aspect of it. It has also considered the work of Water Resources in the South East of which the Company is a key member. This work concluded that in most scenarios examined Havant Thicket was a chosen solution for resilience in the South East.

1.11.1 Strategy

The Board agreed its Core Strategy for the Business Plan and the Water Resource Management Plan in autumn 2016 which set the tone for the plan. A central pillar was to play a key role in delivering resilience for the South East by way of bulk supplies to neighbouring companies and to work with those companies to achieve it.

1.11.2 Discussions at the Board

The Board have received numerous papers to understand the process used in compiling the WRMP, to understand customer views, to consider policy and make decisions.

In July 2017 the Board reviewed and discussed a paper which set out the process to be followed and the matters to be considered, including the request for bulk supplies from Sothern and the likely requirement of Havant Thicket. The Board agreed that there should be constant engagement with Ofwat regarding Havant Thicket. This was followed in September 2017 by a discussion and Board approval for the assumptions to be made in the Draft Plan

The Board approved the Draft Plan after considering the options proposed at its November 2017 meeting.

As part of the PR19 business planning process and the WRMP consultation, the Board have considered substantial feedback on matters such as leakage, metering, water efficiency, bulk supplies and Havant Thicket Winter Storage Reservoir. This has been from customers, regulators, NGOs, Local Authorities and the Minister of State.

The Customer Challenge Group also reviewed the process of engagement and findings relating to the WRMP as a standing item on its agenda. At least one independent Non-Executive Director attended every CCG meeting. The CCG challenged the Company very strongly on its leakage and metering options. In terms of leakage, it encouraged the Company to take a more innovative approach. These views were discussed with the Board.

The Board considered the progress on Havant Thicket on several occasions, and after receiving independent reports from PA Consulting regarding the appropriate delivery model and Atkins on the delivery programme, cost and risk, the Board were assured that the timescales and cost assumed in the Plan were robust

1.11.3 Key Policy Decisions and Changes to the WRMP

Following consideration of all the stakeholder responses to the WRMP alongside customer and CCG engagement, the Board discussed and made the following key decisions:

- **Metering**. The Board decided to introduce selective change of occupier metering from 2020 and full change of occupier metering from 2025. It considered whether to introduce this from 2020 but did not feel it had sufficient customer support. It agreed that the Company would make a step change in its approach to promoting the positive benefits of metering to gain support and increase the uptake of metering. This was a significant change to the plan and will increase the amount of water available.

- **Leakage**. The Board decided to further reduce leakage beyond 2025 by at least 5% every 5 years, but with an aspiration for leakage to be 50% lower than it is now by 2050.

1.11.4 Third party Support

- The Board approved the appointment of expert third parties to undertake preparation of certain parts of the WRMP, including the assessment of deployable output, SEA activities and the least cost option assessments.
- The Board asked for and received a peer review of the Statement of Response so that it could be assured that it had dealt with the matters raised
- The Board considered a report from Atkins, the Company's Reporter on the Final Water Resource Management Plan. The report addressed:
    - Checks against Industry Good Practise for Supply and Demand Components
    - Comments on the Design Scenario and the development of the Preferred Plan
    - A review of the plan against comments made by the EA and Ofwat
    - Audit of the tables.

1.11.5 Final Approval

At its meeting on the 9th August 2018, the Board reviewed key elements of the feedback to the consultation on the WRMP and initial responses.

At its meetings on the 30th August 2018 and 11 September 2018, the Board reviewed the Final Plan including the least cost assessment and how the final preferred plan was chosen, and confirmation that it reflected accurately policy decisions taken by the Board. It also considered reports from third parties as described above.

As a result of this process of review and challenge, the Board is satisfied that the plan being presented aligns with customer priorities, represents the most cost-effective and sustainable long-term solution and will make a major contribution to resilient water supplies in the South East in the future.

2 Overview

2.1 Introduction

This section sets out the background to Portsmouth Water's Final Water Resource Management Plan and describes how it links to legislation and other plans. The characteristics of the Water Company supply area are presented, together with the challenges, opportunities and overall approach to providing secure resilient water supplies to customers for the next 25 years.

2.2 Characteristics of Portsmouth Water

Portsmouth Water supplies an area of 868 square kilometres with a population of around 722,000 across West Sussex and Hampshire. The area of supply includes a large expanse of coastline with numerous important habitats that have been designated under European Directives (including the South Downs National Park). As a statutory undertaker, Portsmouth Water has due regard to the purposes of the national park. The Company abstracts an average of around 170 Ml/d from boreholes, natural springs and one river. The Company has no significant raw water storage and consequently is reliant on the recharge of groundwater over the winter period.

Within Portsmouth Water's supply area there are a series of ephemeral and perennial chalk streams and rivers. In addition to their global rarity, chalk streams are diverse ecosystems which support a wide range of native wildlife. Their special status has been recognised by the European Commission's Habitats Directive.

The map below (Figure 5) gives an overview of the sources Portsmouth Water abstract from.

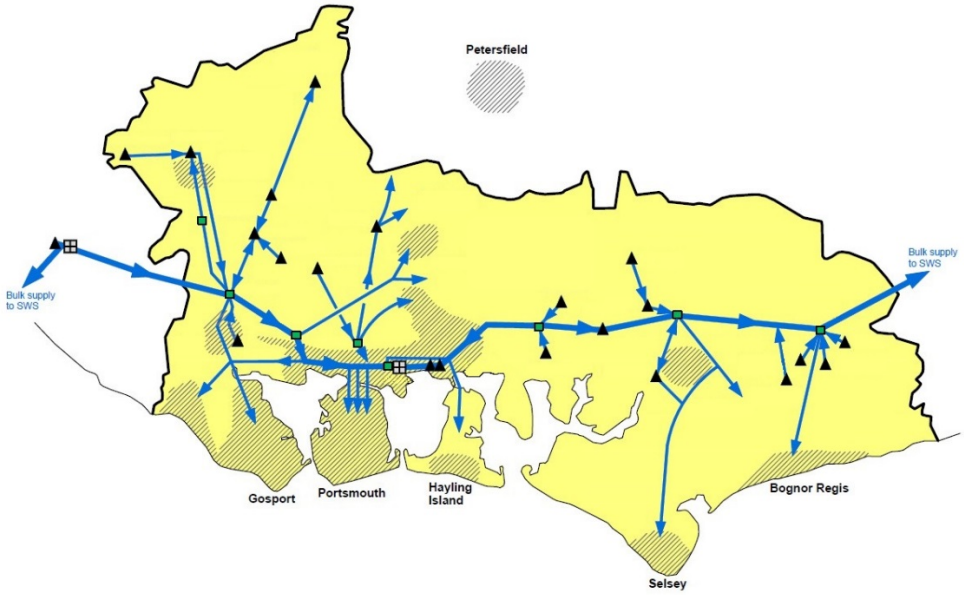


Figure 5 Map of Portsmouth Water Area of Supply

A number of sources are subject to 'group licences' where the licence conditions are limited between sources. The group sources are listed below.

- Source B Springs
- Source C and Source D
- Source F and Source G
- QRST Group (Source Q, Source R, Source S and Source T)

- LMNOP Group (Source L, Source M, Source N, Source O and Source P)

There are also a further six sites that have individual licences.

Over the last few years the Company has undertaken a number of infrastructure reinforcement projects which has resulted in improved connectivity between sources. As a result, Portsmouth Water has a single Water Resource Zone.

2.3 Overview of the Water Resources Management Plan Process

As a statutory water undertaker in England, Portsmouth Water has a duty under Section 37A-D of the Water Industry Act 1991 to prepare and maintain a Water Resources Management Plan every five years.

This document, Portsmouth Water's Water Resources Management Plan (WRMP) for 2019, sets out how the Company plans to maintain the balance between water supply and demand, to ensure it can supply water to people and businesses in its area during the 25 years from 2020/21 to 2044/45.

The key components of the WRMP include:

- An assessment of licensed source yields and supply capacity;
- An assessment of future water demands over the planning period;
- A review of the options available to manage the supply-demand balance; and
- An explanation as to how the Company's preferred plan has been derived from these options.

Portsmouth Water's WRMP contains proposals for how the Company will take account of known challenges being faced in its supply area and the wider South East region, and also sets out the methods that it has used to make allowances for future uncertainties. The Company recognises the need to balance the provision of secure water supplies with the needs of the environment and the affordability of customer bills.

The Company's work with the Water Resources in the South East (WRSE) Group (detailed in section 3.1.1 and outcomes of which are reflected in its preferred plan), demonstrates its commitment to working collaboratively to improve the resilience of water resources in the region. In addition, Portsmouth Water recognises the need for a 'twin-track' approach to managing supply and demand, incorporating both demand management options and supply side options in its preferred plan that will collectively enhance the resilience of its own water resources, reflecting government policy priorities.

In developing its WRMP, the Company has complied with the Water Resources Management Plan Regulations 2007 (Defra, 2007) and the Water Resources Management Plan (England) Direction 2017 (Defra, 2017b). A list of these Directions and where within its Final WRMP the Company has addressed them is provided in Table 2. References in the Direction to a numbered section are to the section so numbered in the Water Industry Act 1991 unless otherwise stated.

Direction	Location in Portsmouth Water's Final WRMP 2019
2.(1) A water undertaker must prepare a water resources management plan for a period of at least 25 years commencing on 1st April 2020.	This relates to the whole document. The Final WRMP covers the period from 1 April 2020 to 31 March 2045.
3.(a) the appraisal methodologies which it used in choosing the measures which it has identified in accordance with section 37A(3)(b) and its reasons for choosing those measures	The Company has followed the approaches specified in both the WRPG (July 2018) and UKWIR WRMP 2019 Methods – decision making process guidance (UKWIR, 2016a). The way the Company has implemented this guidance in the context of choosing the measures it intends to take throughout the planning period (i.e. its preferred final planning programme) is set out in section 7.
(b) for the first 25 years of the planning period, its estimate of the average annual risk, expressed as a percentage, that it may need to impose prohibitions or restrictions on its customers in relation to the use of water under each of the following— (i) section 76; (ii) section 74(2)(b) of the Water Resources Act 1991(b); and (iii) section 75 of the Water Resources Act 1991, and how it expects the annual risk that it may need to impose prohibitions or restrictions on its customers under each of those provisions to change over the course of the planning period as a result of the measures which it has identified in accordance with section 37A(3)(b);	The Company's planned levels of service have been agreed with our customers and are set out in section 2.4. The relationship between levels of service and deployable output is set out in section 4.2. In is not anticipated that there will be any change with regard to the annual risk over the course of the planning period. Evidence that the final planning scenario will meet the agreed level of service is presented in section 9.
(c) the assumptions it has made to determine the estimates of risks under sub-paragraph (b), including but not limited to drought severity;	The annual risk of restrictions is set by the level of service agreed with customers. It has been assumed that the level of risk will not vary with time. A full stochastic risk assessment of supply capability has been undertaken and is described in section 4.2. Section 0 describes how the plan has been tested and section 9.2.1 shows how the preferred final plan will meet the planned level of service.
(d) the emissions of greenhouse gases which are likely to arise as a result of each measure which it has identified in accordance with section 37A(3)(b), unless that information has been reported and published elsewhere and the water resources management plan states where that information is available;	The Company has evaluated carbon emissions for all feasible options in this Final WRMP. The methodology is described in section 7.4.2, with information presented in the Options Costing report (shared with the regulators) and in Appendix P (SEA). The assessment of the likely emissions associated with the final planning scenario is set out in section 9.5.3

Direction	Location in Portsmouth Water's Final WRMP 2019
(e) the assumptions it has made as part of the supply and demand forecasts contained in the water resources management plan in respect of— **(i) the implications of climate change, including in relation to the impact on supply and demand of each measure which it has identified in accordance with section 37A(3)(b);** **(ii) household demand in its area, including in relation to population and housing numbers, except where it does not supply, and will continue not to supply, water to domestic premises; and** **(iii) non-household demand in its area, except where it does not supply, and will continue not to supply, water to non-domestic premises or to an acquiring licensee;**	(i)The Company has assessed the impact of climate change on supply (section 4.3.4), demand (section 5.3.3) and headroom (section 6.2). The Company has considered the impact of climate change on each of its options in the final planning scenario in section 9.5. (ii) The Company's approach to estimating current and future household demand follows the methods in the WRPG and is presented in section 5.3. Population and housing numbers are derived from Local Authority estimates. The Company has used the plan-based forecasts without adjustment. (iii) The Company's approach to estimating current and future non- household demand follows the methods in the WRPG and is described in section 5.4.
(f) its intended programme for the implementation of domestic metering and its estimate of the cost of that programme, including the costs of installation and operation of meters;	Section 5.3.2 sets out the assumptions the Company has made regarding metering in its baseline supply-demand balance (i.e. new properties and optant metering), whilst section 9.4.1.2 sets out its preferred final planning approach to additional metering over the planning period (change of occupancy and void household metering, plus a smart meter trial). The costs of the metering programme are presented in the Options Costing report (shared with the regulators). Summary costs are also included in WRMP Table 5.
(g) its estimate of the number of premises which will become subject to domestic metering during the planning period as a result of— **(i) optant metering;** **(ii) change of occupancy metering;** **(iii) new build metering;** **(iv) compulsory metering; or** **(v) selective metering,** **and its estimate of the impact on demand for water in its area of any increase in the number of premises subject to domestic metering;**	The number of premises which will become subject to domestic metering during the planning period as a result of the different types of metering in the baseline and the final plan are shown in section 9.4.1.2 and in the WRMP Tables. The expected volumetric savings to result from the final planning metering options are presented in Table 70 and in the WRMP Tables.

Direction	Location in Portsmouth Water's Final WRMP 2019
(h) its assessment of the cost-effectiveness of domestic metering as a mechanism for reducing demand for water by comparison with other measures which it might take to meet its obligations under Part III of the Act;	The Company has assessed the cost-effectiveness of metering options available to it (change of occupancy metering, void household metering and smart metering) against other options that could be used to balance supply and demand in the economic appraisal of options, section 7.6 of this plan. Optant metering is already included in the baseline demand forecast, as is new property metering. Costs for these do not therefore form part of the WRMP cost effectiveness assessment in accordance with the Water Resources Planning Guideline (Environment Agency and Natural Resources Wales, 2018).
(i) its intended programme to manage and reduce leakage, including anticipated leakage levels and how those levels have been determined; and	The Company's intended programme to manage and reduce leakage is set out in section 9.4.2.
(j) if leakage levels are expected to increase at any time during the planning period, why any increase is expected.	The Company's leakage levels are not expected to rise during the planning period.

Table 2 Location of the text in the Final WRMP 2019 where the Company has addressed the Water Resources Management Plan (England) Directions 2017

The plan has been developed with reference to the Water Resources Planning Guideline (WRPG) (last updated in July 2018) developed by the Environment Agency, Natural Resources Wales (NRW), Ofwat, Defra and the Welsh Government.

The steps of the statutory process that must be followed in preparing a WRMP are set out in Figure 6.

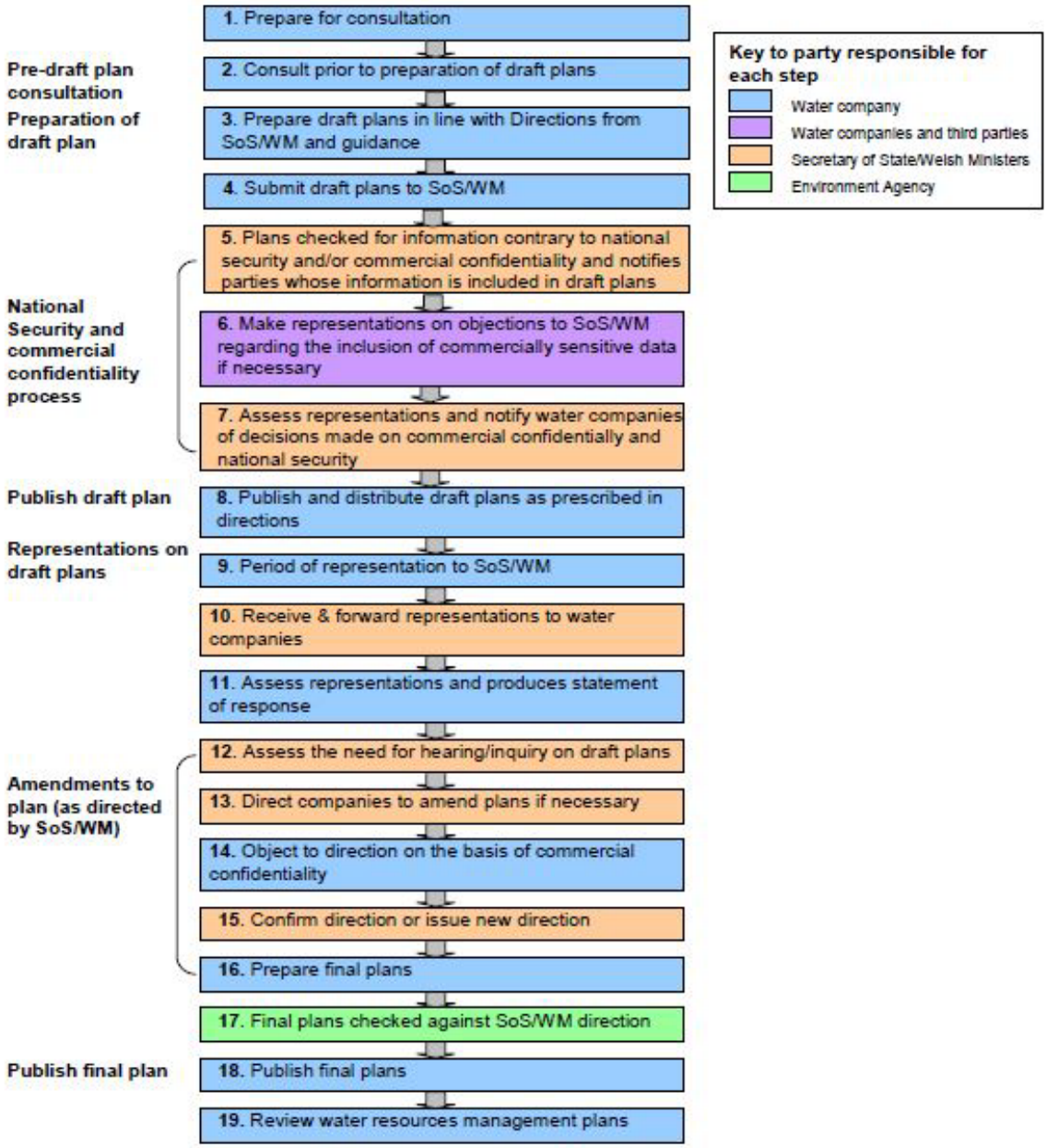


Figure 6 Process for developing a WRMP (Source: WRPG, EA, NRW, Ofwat, Defra and Welsh Government, 2018)

This WRMP is the Company's Final WRMP 2019. It follows the period of public consultation on its Draft WRMP 2019, which was undertaken from 5th March to 25th May 2018. Following a thorough review of the feedback received on its Draft WRMP, the Company has prepared a Statement of Response (SoR) which sets out how it has taken into account comments received on its Final WRMP.[1] The SoR is submitted to Defra and published alongside this Final WRMP. The Secretary of State confirmed the Company may publish its Final WRMP on 4 November 2019.

[1] Note that in response to a letter from Defra dated 19th March 2019, requesting further information, an Addendum to the SoR has been produced.

Section 37A (5) of the Water Industry Act 1991, as amended by the Water Act 2003, requires a water company to review its WRMP and to send a statement to the Secretary of State of its conclusions before each anniversary of the publication date of the Plan. If the annual review indicates a material change of circumstances, the Secretary of State may direct the Company to prepare a revised plan under Section 37A (6). In any event, companies are required to prepare a revised Plan (in accordance with the procedures set out in section 37B of the Act) within five years from the date of publication of their Final WRMP.

2.3.1 Links between the WRMP and Other Portsmouth Water Plans

2.3.1.1 Business Plan

The water resources planning process runs in parallel to the process for setting water company prices, which involves preparation of a Business Plan, presented to Ofwat. The Business Plan and WRMP are inherently linked, with WRMP investment requirements being put forward as part of the Company's overall Business Plan. Portsmouth Water has taken an integrated approach to ensure consistency between the two plans, aided by the provision of regular updates to the Portsmouth Water Customer Challenge Group (described in section 3.1.3).

In addition, the Company has agreed to various Performance Commitments which relate to water resources in its Business Plan, adhering to Ofwat guidance to companies for the Periodic Review 2019 (PR19). These are summarised in section 3.4.5 and are reflected in the demand forecast and options appraisal which form part of this WRMP.

2.3.1.2 Drought Plan

Water companies in England and Wales are also required to prepare and maintain drought plans under Sections 39B and 39C of the Water Industry Act 1991, amended by the Water Act 2003 and clarified most recently in the Drought Plan (England) Direction 2016. The purpose of a Drought Plan is to detail "how the water undertaker will continue, during a period of drought, to discharge its duties to supply adequate quantities of wholesome water, with as little recourse as reasonably possible to drought orders or drought permits". It is, therefore, an operational plan, setting out the measures which the Company plans to implement during drought events of different severities, guided by the position at any time of groundwater levels in relation to specified 'trigger curves'.

The Company published a summary of its latest Draft Drought Plan for consultation between 8th January and 2nd March 2018. The Company received permission from Defra to publish the plan in February 2019, a copy is available on the Portsmouth Water website.

For the WRMP 2019, stronger links have been advocated between WRMPs and Drought Plans. For example, Table 10 in the WRMP Tables requires companies to populate supply-demand balances for different drought scenarios, taking into account the potential benefits of drought orders and/or drought permits that might be available. There are other significant areas of overlap, including the link between the anticipated frequency of implementation of drought management actions and the Company's target levels of service, which also underpin the assessments of deployable output (DO) in the Company's WRMP (presented in section 4.2).

2.3.1.3 River Basin Management Plan

River Basin Management Plans form the framework for delivering the Water Framework Directive and set out how organisations, stakeholders and communities will work together to improve the water environment. The Portsmouth Water supply area falls within South East River Basin District. River Basin Management Plans are updated on a six-yearly cycle. The River Basin Management Plan South East River Basin District (Environment Agency and Defra, 2015) was last updated in 2015, the results from which have informed the Strategic Environmental Assessment (SEA) of this WRMP. The SEA is presented in Appendix P.

2.3.2 Portsmouth Water's Previous WRMP (2014)

The Company published its previous WRMP in August 2014. The WRMP 2014 covered the period from 2015/16 to 2039/40. While the WRMP 2014 did not forecast a deficit in the Company's own supply area, the need for an additional bulk supply of 15Ml/d to Southern Water was identified through the process. This bulk supply will be commissioned in 2019 and is therefore included as part of the baseline supply-demand balance in this WRMP 2019.

In Section 8.2 of its Final WRMP 2014, the Company gave details of its commitment to further work. The commitment was to undertake further work on deployable output and resilience of the plan to drought and climate change and to include stakeholders in a dialogue of this further work. Since the publication of the Final WRMP 2014, Portsmouth Water has reviewed all the components and engaged consultants to re-assess several elements of the supply-demand balance. This work has been shared with the Environment Agency throughout the development of this WRMP 2019. This process, along with the other stakeholder and customer engagement undertaken during preparation of this Final WRMP 2019 is detailed in section 3.

2.3.3 Other Policy and Legislation Influencing the WRMP

In addition to the specific legislation detailed above which governs the WRMP process, there are some other government policies and pieces of legislation which have an influence on aspects of a WRMP.

In the preparation of this WRMP, Portsmouth Water has taken account of the following government policy documents:

- Guiding Principles for Water Resources Planning - For water companies operating wholly or mainly in England (Defra, May 2016). In this document, the government expects WRMPs to address, amongst others, the following key issues:
  - Meaningful engagement and collaboration with regulators, stakeholders and customers;
  - Resilience and management of resources during drought;
  - Provision of quality service to customers; and
  - Protecting and enhancing the environment.
- The Government's strategic priorities and objectives for Ofwat (September 2017), published under the Water Act 2014. This document addresses, amongst others, the following key issues:
  - Securing long-term resilience against a range of hazards in a way which offers the best value for money;
  - Protecting customers; and
  - Making markets work.

Portsmouth Water agrees with and supports the aims set out in these documents and has developed its WRMP 2019 accordingly.

2.3.3.1 Restoring Sustainable Abstraction and the Abstraction Incentive Mechanism

The Environment Agency is responsible for the Restoring Sustainable Abstraction (RSA) programme, which is linked to the European Water Framework Directive (WFD) in that it contributes to work improving WFD water bodies where ecology may be at risk due to unsustainable abstraction. Measures to improve the water environment under the WFD are set out in the River Basin Management Plans produced by the Environment Agency and Defra (mentioned above in section 2.3.1.3). Additionally, the RSA programme aims to address environmentally damaging public water supply abstraction licences.

Water company licences identified as requiring review are set out in the Water Industry National Environment Programme (WINEP). WINEP2 was released in September 2017 and has been followed up by WINEP3 which was released in March 2018. The WINEP sets out the actions that water companies will need to complete to meet their environmental obligations

under the RSA programme. Portsmouth Water's obligations under the WINEP are presented in 4.3.

To complement the RSA programme, Ofwat has developed the Abstraction Incentive Mechanism (AIM). This is designed to encourage water companies to reduce the environmental impact of abstracting water at environmentally sensitive sites during periods of low surface water flows. This will apply to all companies from April 2020 onwards, with financial incentives to increase its impact.

Portsmouth Water has agreed to a bespoke Performance Commitment in its Business Plan relating to sustainable abstraction, which has a financial Outcome Delivery Incentive (ODI). This reflects the high importance Portsmouth Water places on reducing adverse impacts on the water environment by its customers (see section 3.3). The Company is, therefore, continuing with its current AIM site, at Source C and the River Hamble with a reward and penalty, relating to its abstraction at Source C relative to its historical usage volume when the flow in the River Hamble falls below the agreed level (known as its Q95 level).

2.3.3.2 Strategic Environmental Assessment Directive

A Strategic Environmental Assessment (SEA) on this WRMP is required (under the SEA Directive, which has been transposed into UK law by the Environmental Assessment of Plans and Programmes Regulations 2004) 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. The aim of an SEA in the context of a WRMP is to fully integrate environmental considerations into the plan and evaluate their linkages with economic and social considerations.

The SEA on this WRMP 2019 is provided as Appendix P. The outputs are integrated into the options appraisal as part of the programme appraisal process detailed in section 7.

2.3.3.3 Habitats Directive

The Conservation of Habitats and Species Regulations 2017 (the 'Habitats Regulations') are the latest transposition of the European Habitats Directive into UK law. Regulation 63 of the Habitats Regulations states that if a plan or project is *"(a) is likely to have a significant effect on a European site or a European offshore marine site (either alone or in combination with other plans or projects); and (b) is not directly connected with or necessary to the management of the site"* then the competent authority must *"…make an appropriate assessment of the implications for the site in view of that site's conservation objectives"* before the plan is given effect.

The process by which Regulation 63 is met is known as the Habitats Regulations Assessment (HRA). An HRA determines whether there will be any 'likely significant effects' on any European site as a result of a plan's implementation (either on its own or 'in combination' with other plans or projects) and, if so, whether these effects will result in any adverse effects on the site's integrity. Portsmouth Water has a statutory duty to prepare its WRMP and is, therefore, the Competent Authority for any HRA.

The Company's full HRA of its WRMP 2019 is presented in Appendix O.

2.3.3.4 Water Stressed Areas

In 2013 the Environment Agency produced an updated assessment of the level of 'water stress' of all areas of England and Wales. If determined to be in an area of 'serious water stress', a water company is allowed to consider compulsory metering as an option within its WRMP. Despite being in an area of moderate water stress, the Company asked Defra, whether there was a possibility of a change to the legislation to allow it to consider compulsory metering in its plan. This proposal was to enable the Company to provide greater bulk supplies to support the rest of the South East which is predominantly deemed "seriously water stressed". Defra advised this would not be possible for the 2019 plan.

2.3.3.5 Additional Information

In developing its WRMP, Portsmouth Water has also considered information produced by Natural England which relates to the water environment. These include:

- Conservation 21 Strategy (Natural England, 2016), which reflects recent political changes and aims to focus on resilient landscapes and seas;
- Sussex and Kent Focus Areas (Natural England, 2017), which will assist Portsmouth Water to promote joint working with the catchment partnerships; and
- Common Standards Monitoring Guidance (Natural England, 2016).

These have been taken account of when developing and appraising options in the WRMP, as well as in the Company's stakeholder engagement programme.

2.4 Key Components of WRMP19

2.4.1 Water Resource Zones

Water Resource Zones are a key building block for the Water Resource Management Plans. They are defined as:

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.

Over the last few years, the Company has undertaken a number of infrastructure reinforcement projects which has resulted in improved connectivity between sources. As a result, Portsmouth Water has a single Water Resource Zone.

Portsmouth Water's distribution system is now based on a spine main and a series of large treated water storage reservoirs. Perfect integration is not possible, but outlying areas have had links provided to improve the security of supply.

The zone is suitable for reporting levels of service because customers experience the same overall risk of supply failure. This applies under normal, dry year and drought conditions.

More detail about the Water Resource Zone Assessment is set out in Appendix E.

2.4.2 Levels of Service

The Company has worked with customers to set levels of service and these are consistent between the WRMP and the Drought Plan.

The Company's planned level of service over the planning period is set out below:

- 1 in 20 years for Hosepipe Bans, representing an annual risk of 5%.
- 1 in 80 years for Non-Essential Use Bans, representing an annual risk of 1.25%.
- 1 in 200 years for Emergency Drought Orders, representing an annual risk of 0.5%.

Further details of how the Company has engaged customers and stakeholders, and how their views have been taken into account in developing the levels of service are provided in Section 3.

2.4.3 Design Drought

The Company's supply forecast is based on a design drought of 1 in 200 years. In deciding on this design drought, the Company followed the 'UKWIR Risk based planning guidance' (UKWIR, 2016b) and opted to develop a resilience tested plan (risk composition 2) that considered a challenging, but plausible range of droughts.

In addition to the worst historic drought on record, the Company considered the following return periods: 1 in 80, 1 in 125, 1 in 200, and 1 in 500. The return periods were based on

supply-demand failures (see section 4.2 for further detail). The supply-demand balance was calculated for each of the different drought return periods, and the 1 in 200-year event appeared to marginally represent the worst-case situation. There were some uncertainties regarding which event was worst as the supply-demand balance considers a combination of supply side, demand side and drought options and in keeping with the level of service, not all the drought options would be chosen under each of the different return periods selected. For the 1 in 80-year event, neither the Drought Permit or Non-Essential Use Bans would be selected, resulting in less water being available in the supply-demand balance at times than in the 1 in 200-year event. The 1 in 200-year event has been selected and utilised as the design drought for the Final WRMP19. It is a good scenario for planning as the final supply-demand balance appears to be reasonably representative of either the 1 in 80-year or 1 in 200-year event.

Selection of the 1 in 200-year event as a design drought is far more appropriate for Portsmouth Water than the worst historic drought on record which is not considered severe enough for Water Resources Planning. Additionally, the Company has committed to providing a bulk supply to Southern Water with water available up to a 1 in 200-year event, so it is appropriate to undertake planning based on this event.

2.4.4 WRSE and Bulk Supplies

The Company has worked closely with the Water Resources in the South East (WRSE) Group which is a sector-wide partnership that selects the best options to solve deficits across the region (further detail provided in section 3.1.1).

The modelling undertaken by WRSE indicated that there is both the scope (through options available to Portsmouth Water) and the need for the Company to provide additional bulk supplies to Southern Water, to assist its neighbour in meeting deficits it faces during the planning period. The Havant Thicket reservoir is considered a very important option to help deliver resilience in South East England (see section 4.7)

Portsmouth Water has given careful consideration to the WRSE modelling results in preparing its WRMP19. Discussions have been held with Southern Water throughout the preparation of both companies' WRMPs. An agreement was reached that as Southern Water's modelling shows a need for the additional bulk supplies, Portsmouth Water would make these available. Portsmouth Water has agreed in principle to provide the requested bulk supplies to Southern Water.

Providing the agreed bulk supplies to Southern Water means that they effectively form an additional demand. They must, therefore, be added to the Company's own baseline demand to develop a planning solution to maintain the balance between supply and demand.

For the Final WRMP, the volumes of the bulk supplies are included in Portsmouth Water's baseline supply-demand balance and have also been included within Southern Water's preferred programme in their Final WRMP. Including the agreed bulk supplies allows the regional planning solution to be determined.

Portsmouth Water and Southern Water are committed to meeting on a regular basis to discuss ongoing investigations and the delivery of schemes in order to keep each other informed of emerging risks to each company's respective water resources strategies. This bilateral liaison will be in addition to discussions at a regional scale through the WRSE group of companies.

3 Stakeholder and Customer Engagement

3.1 Stakeholder Engagement Groups

Portsmouth Water recognises the importance of effective engagement with its stakeholders to ensure that its WRMP addresses its statutory obligations and has broad support. The Company has used a number of mechanisms to engage with its stakeholders, set out in this section.

3.1.1 Water Resources in the South East (WRSE)

Water Resources in the South East (WRSE) is a sector-wide partnership that selects the best options to solve deficits across the region, promoting a south-east strategy for water. It was formed in 1996 as a direct result of a recommendation from the Monopolies and Mergers Commission which (in reviewing a proposed merger of two small water companies in Kent) suggested there should be better regional co-operation when it came to sharing water. Today, the partnership is still going strong, covering an area of 21,000 km^2 with a population of some 19 million people, and 2 million businesses.

The core membership comprises six water companies (Affinity Water, South East Water, Southern Water, SES Water, Thames Water and Portsmouth Water) working alongside the Environment Agency, Ofwat, the Consumer Council for Water, Natural England, the Department for the Environment, Food and Rural Affairs (Defra), the Canal and River Trust, the Greater London Authority, and other partners.

3.1.1.1 Aim of the WRSE

The aim of WRSE is to identify how best to share the water resources at a regional level. It also looks further afield, working with neighbouring regions of the UK and the relevant water companies to explore inter-regional water transfers.

The work focuses on exploring opportunities across the region for existing and new water resources to be shared in the most efficient and effective way, to provide reliable, sustainable supplies at best value to customers while also protecting the environment. This is because the pressure on water supplies in South East England is expected to increase in the future due to many reasons including climate change, population growth and the need to further protect the environment.

The water supply network within south east England is a complex pattern of different water company areas and water resource zones. This is a result of the historic development and integration of local systems over more than a century, plus the fact that division of the region after privatisation did not necessarily align with catchment or water resource system boundaries. Therefore, the fundamental approach of the WRSE is to ignore water company boundaries, and look across the region, to assess best ways to share available water.

Many of the water resource zones across the South East currently, or in the future, will experience shortfalls in water availability. However, there are also areas that have water that can be shared. By looking at a regional scale one aims to maximise the benefits of sharing of water resources across the area, and in doing so, reduce the need for new water schemes or developments, and reduce existing abstraction.

The planning work helps us to understand which options might be best for the South-East in the long-term (such as strategic schemes that are not necessarily justifiable on a single company basis, but would be beneficial on a regional scale) which will help the region become more resilient to drought, outage and the environment.

With this aim in mind, the WRSE has undertaken different projects covering water and environmental assessments, which are summarised below.

3.1.1.2 Collaborative Work

Examining the potential for environmental impacts across the region

In partnership with Natural England, the WRSE has examined the potential cumulative (or in-combination) effects of the options being considered by the member companies for their Water Resource Management Plans (WRMPs). This is the first time that a collaborative regional 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. Then Ricardo used the methodology to scrutinise the feasible options under consideration by the WRSE member companies for their draft WRMP19 submissions. The assessment found that there is potential for cumulative effects from most WRSE companies, on receptors and catchments. The findings included the potential inter-relationships between schemes and the impact pathway.

Following the customer consultation period some changes have been made to the Company options under consideration. Therefore, the assessment to determine potential cumulative environment impact has been repeated using updated information on company options, to inform the revised WRMP process. The results were provided to companies and Portsmouth Water has considered them within the cumulative impacts section of the Strategic Environment Assessment.

Addressing the future need for water: optimisation modelling

For the WRMP19 planning cycle, the WRSE has been looking over a very long horizon of sixty years (from 2020 to 2080), exploring different factors such as:

- a greater range, and severity, of future droughts
- different population growth forecasts
- greater protection of the environment through reduced abstraction
- effects of poor water quality
- resilience to extreme events
- reducing water demand and leakage rates still further

This is done via several plausible “what if?” scenarios to examine potential future water demand using an optimisation model. An optimisation model seeks to minimise the total economic costs of meeting future water demands for these future scenarios, by selecting a portfolio of options, from a choice available to it that cover both supply and demand management schemes. Using such a model allows the development of strategies to address future water needs; it has been a standard approach of the water industry for many years.

To inform the draft WRMPs, the WRSE group used a bespoke EBSD optimisation model to assess many different possible futures, to see what groups of options were the best choice to satisfy the deficit, and to test their resilience.

Following the close of the consultation period, further regional modelling has been undertaken, exploring more scenarios to assess the feedback from customers. In addition, the scenarios being explored include a range of regional targets to assess the effect of meeting the recommendations from the National Infrastructure Commission and Defra on leakage and per captain consumption concerning option selection.

This work is currently ongoing. Preliminary outputs have been produced and these are being subject to close examination, as per all previous phases, to ensure robust confidence can be placed in the results. When the review period is completed, the findings of the revised modelling work will be used to inform subsequent WRMPs.

3.1.1.3 WRSE in context of Portsmouth Water

The modelling undertaken by WRSE indicated that there is both the scope (through options available to Portsmouth Water) and the need for the Company to provide additional bulk supplies to Southern Water, to assist its neighbour in meeting deficits it faces during the planning period. With specific reference to the following WRSE documents (included as appendices to the Final WRMP), they provided the following commentary:

- *WRSE File 726*: "From Source to Tap" is the non-technical summary of the WRSE work, which summarises the overall findings including highlighting the "big ticket schemes" (schemes that deliver more than 15 million litres of water per day) and showing how the region may look in the future; it includes the new reservoir at Havant Thicket and associated transfers.
- *WRSE File 629*: A technical appraisal of the WRSE water resource modelling work which shows that in eight of the nine future scenarios that have been examined in detail, the Havant Thicket reservoir has been chosen as part of the solution to help meet the demand for water across the region. As such it is considered a very important option to help deliver resilience in south east England.

Portsmouth Water has given careful consideration to these modelling results in preparing its WRMP19. Discussions have been held with Southern Water throughout the preparation of both companies' WRMPs. The agreement was reached that as Southern Water's modelling shows a need for the additional bulk supplies, Portsmouth Water would make these available. Portsmouth Water has agreed in principle to provide the requested bulk supplies to Southern Water. The volumes of the two additional bulk supplies have been included in Portsmouth Water's baseline supply-demand balance, to provide certainty that this water will be available to Southern Water.

Portsmouth Water's commitments to providing bulk supplies to Southern Water demonstrates the Company's strong support of regional water resource sharing where it is shown to be for the benefit of customers and the environment.

Details of the proposed bulk exports regarding volumes and timings are provided in section 4.7.

Further details about how the WRSE Group modelling has been undertaken are provided in Appendix S.

3.1.2 Water Resources Management Plan Stakeholder Group

A WRMP Stakeholder Group was established at WRMP14 with organisations who had made representations or expressed an interest in the Company's previous plan, invited to join the group. The group consisted of the Consumer Council for Water (CCW), Environment Agency, Natural England and Partnership for Urban South Hampshire (PUSH), representing local authorities. The Group met in November 2017 and fed into the development of the Draft Water Resource Management Plan. In particular, the members of the group each provided stakeholders' responses to Pre-Consultation (see section 3.2.1). The majority of the WRMP Stakeholder Group's representatives also sit on Portsmouth Water's Customer Challenge Group and their on-going engagement on the Water Resources Management Plan was subsequently undertaken under the auspices of this group.

3.1.3 Portsmouth Water Customer Challenge Group

As part of PR14, companies were required by Ofwat to have established a Customer Challenge Group (CCG), made of stakeholders drawn from the public, private and voluntary sectors. The CCG is tasked with monitoring the Company's progress against its customer promises and providing a report to Ofwat on its view of how well the Company is engaging with its customers throughout the price setting process and how effectively the Business Plan reflects the views of customers.

Water resources are a key element of this process and have been a standing agenda item at meetings, allowing a dialogue to take place on the various issues arising from the Company's Water Resources Management Plan. Technical expertise on these matters has been provided by a representative of the Environment Agency, who was a permanent member throughout the PR19 CCG engagement, and a representative of Natural England, as well as through an independent Technical Assurance provider from an established engineering consultancy.

The CCG has been directly involved in decisions on the customer and stakeholder engagement strategy as well as how those findings have been utilised by Portsmouth Water. For example, the Group has considered the following:

- relevance and make-up of the sample for the Company's qualitative research on the WRMP;
- how conflicts between different customer feedback should be treated and the associated weighting each element should be given as part of the triangulation process; and
- how customer acceptability has translated into both short-term priorities (the setting of Performance Commitments over the next five years) and longer-term commitments.

The outputs of this work have been reflected in changes from the Draft to the Final WRMP, particularly in metering and leakage policy.

Having considered the outputs of customer engagement, the Group also particularly challenged the Company on its metering strategy, which has resulted in a significant shift from what was proposed in the Draft Plan.

The CCG's detailed findings are summarised in its 'Report on Portsmouth Water's PR19 Business Plan' published in September 2018.

3.1.4 Local Authority Engagement

Portsmouth Water engages with Local Authorities in its area of supply with the aim of developing a consistent set of assumptions between Portsmouth Water's WRMP and Local Authority Plans. The policies aim to avoid unforeseen problems such as water quality risks and the availability of water in a drought as well as promoting water efficiency policies in local plans.

Portsmouth Water has also worked with the Partnership for Urban South Hampshire (PUSH) on the development of an Integrated Water Management Study. This was reflected in the 2014 WRMP and has been updated to take account of the WRMP 2019.

The Company has also consulted on different access arrangements for Havant Thicket Reservoir and selected the northerly route to minimise impacts on the local community during construction and through the life of the project which addresses specifically an issue raised by Rowlands Castle Parish Council.

3.1.5 Contact Plan

Portsmouth Water recognises the importance of giving due consideration to potential bulk supplies and possible solutions to deficits that may be delivered by third parties. Portsmouth Water developed a Contact Plan and it published a document setting out the likely surplus water Portsmouth Water is forecasting over the planning period. We also sought engagement on potential third-party sources but did not receive any responses. The Company has worked closely with other water companies in the region, both through Water Resources in the South East (WRSE) (see section 3.1.1), and through bilateral meetings to determine mutually beneficial trades.

3.2 Stakeholder Consultation

Stakeholder engagement was undertaken in two phases: pre-consultation during development of the Draft Water Resources Management Plan (section 3.2.1) and then consultation on the Draft Plan (section 3.2.2). Section 3.3.2.1 summarises how stakeholders and customers have shaped the WRMP.

3.2.1 Pre-Consultation on Draft WRMP

Prior to preparation of its Draft WRMP, the Company undertook a period of pre-consultation as required by the WRPG. The Company sent a letter to statutory consultees including the Environment Agency, as well as to Natural England, Ofwat and neighbouring water companies. A copy of the letter is shown in Appendix Z, along with copies of the responses received. The letter invited stakeholder views on certain key issues pertinent to Portsmouth Water's Draft WRMP, and also extended an invitation to be included in the Company's WRMP Stakeholder Group.

Portsmouth Water received written responses to their pre-consultation from Defra, the Environment Agency, Ofwat, Natural England and Southern Water.

The Environment Agency, Natural England and Defra noted that they expected the Company to take account of the:

- Collaboration with others
- Customer requirements
- Water Resources Planning Guideline
- Risk Management
- To give due consideration to a range of options including Regional Solutions

The Company's Plan has been prepared giving due consideration to these elements.

The Environment Agency raised some queries and challenges in its response to the pre-consultation. The Company, through further meetings and provision of information, sought to address these issues.

Natural England made reference to Drought Permits and the fact that they did not sit comfortably with protecting the water environment. Portsmouth Water will try to avoid the use of Drought Permits, if possible, but the Drought Plan does make reference to a Source A Drought Order. This is not required to satisfy Portsmouth Water's needs, but it is a short-term measure related to Southern Water's sustainability reduction on the River Itchen and to provide the bulk supply to Southern Water.

3.2.2 Consultation on Draft Plan

The Company held a period of public consultation on its Draft WRMP 2019, which was undertaken from 5th March to 25th May 2018.

In total, there were 15 representations from the following organisations:

- Environment Agency (EA)
- Water Services Regulation Authority (Ofwat)
- Department for Environment, Food and Rural Affairs (Defra)
- Natural England (NE)
- West Sussex County Council (WSCC)
- Hampshire County Council (HCC)
- Partnership for Urban South Hampshire (PUSH)
- Havant Borough Council (HBC)
- Test Valley Borough Council (TVBC)
- Fareham Borough Council (FBC)
- Rowlands Castle Parish Council (RCPC)

- Sussex Wildlife Trust (SWT)
- Wessex Chalk Stream & Rivers Trust (WCSRT)
- Canal & River Trust (CRT)
- Hampshire and Isle of Wight Wildlife Trust (HIWWT)

In addition, there were over 2,000 responses from members of the public to a non-technical summary of the plan, discussed in Section 3.4.

Following a thorough review of the feedback received on its Draft WRMP, the Company prepared a Statement of Response (SoR) document. The Statement of Response sets out Portsmouth Water's response to all representations received. As required by the Act, it details:

- The consideration that was given to those representations
- Any changes made to the Draft WRMP following consideration of those representations and reasons for doing so
- An explanation where changes have not been made as a result of the representations

In addition, it details:

- The consideration given to customer comments made as part of customer engagement
- Any other changes made to the Draft WRMP and the reasons for those changes.

The SoR is submitted to Defra and published alongside this Final WRMP. The next step involves the Secretary of State determining if this Final WRMP should be published, modified or if an examination in public of the plan is needed. Approval was received on 4 November 2019.

3.3 Customer Engagement

Customers are at the heart of Portsmouth Water's day to day activities and long-term plans. Understanding customers' priorities and continuously improving how the Company works to meet changing customer expectations is part of Portsmouth Water's 'business as usual'. This also translates into engagement on shaping and delivering the Company's Water Resource Management Plan.

Ofwat's "Tapped In" report identified a customer participation continuum and provided the following working definition of customer participation in relation to water company services:

The active involvement of customers in the design, production, delivery, consumption, disposal and enjoyment of water, water services and the water environment in the home, at work and in the community.

Sections 3.3.1 and 3.3.2 summarise the customer engagement activity undertaken by Portsmouth Water. The engagement has included targeted qualitative and quantitative research and also incorporates findings from its business as usual activity as well as customer participation on demand management and protection of water resource initiatives (see Table 3). Crucially, these activities do not cease when the Water Resource Management Plan is submitted.

Customer participation continuum	Description	Examples
Listening and understanding	Understanding what is important about water in the lives of different customer groups.	• Customer Advisory Panel which met periodically during WRMP development and designed to create two-way dialogue with an informed set of customers to help inform PW's priorities
Listening and acting	Listening to different customer groups and acting on what is heard in order to achieve business objectives.	• Analysing and acting on 2,212 responses received from online questionnaire on 'Your water and its future', the customer friendly version of Draft WRMP published in March 2018
Engaging and involving	Involvement of customers or their representatives. Making it easy for them to propose specific ideas or solutions to achieve change.	• Working with Customer Challenge Group to develop effective customer engagement and ensure that the WRMP accurately reflects customer priorities
Customer participation	Increasing active customer participation to bring these ideas to life.	• Water efficiency, catchment management and oil spill prevention initiatives

Table 3 Examples of where Portsmouth Water customer participation sits on a continuum

The planning cycle used by Portsmouth Water is shown in Figure 7. For many topics, the Company has frequently cycled through these engagement stages for several iterations as it explored customers' views.

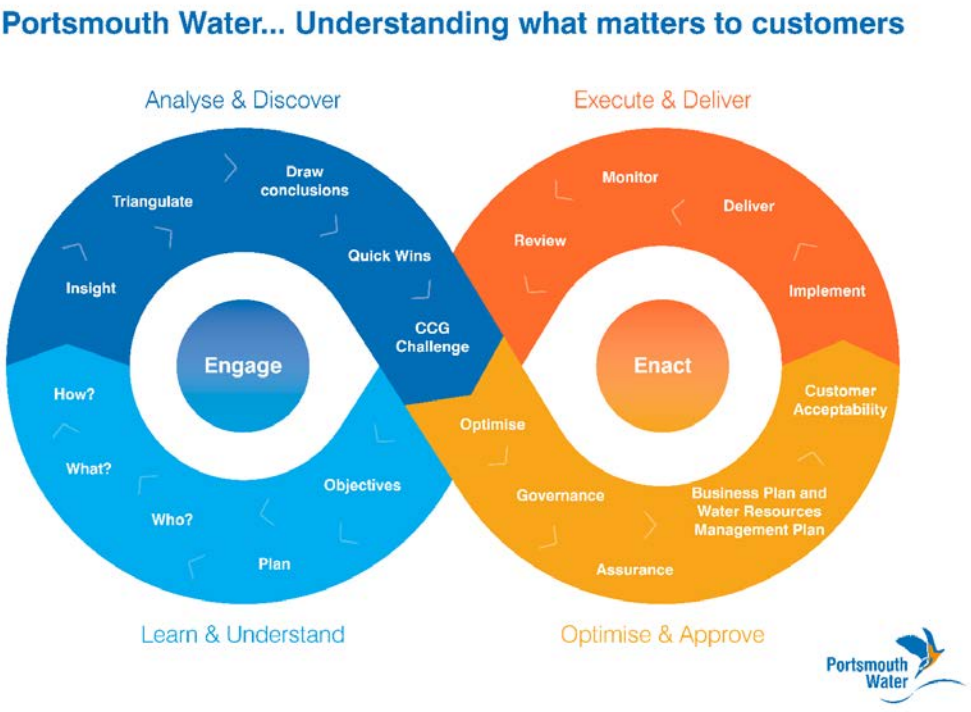


Figure 7 Portsmouth Water planning cycle

Figure 8 summarises the range of topics, customer groups and methods used to gain the insight and that have been utilised to develop Portsmouth Water's Water Resource Management Plan and Business Plan. There is an unprecedented level of engagement for the Company as it has never before engaged so widely, innovatively, in as much depth, and had so much participation from customers as it has for this planning process.

Figure 8 Who, what and how summary of engagement

Triangulating different sources of data has allowed Portsmouth Water to better understand customers' priorities. Where triangulation suggests that one source of data may not be truly representative, it has often been necessary to undertake further work to better understand customer priorities. The Company has used a range of internal and external data sources to triangulate.

3.3.1 Customer Research

Portsmouth Water's annual Institute of Customer Service customer and staff survey, annual Developer Survey, Quarterly SIM survey and ongoing analysis of contacts and complaints and compliments (including social media) are the principal means by which the Company seeks to understand what matters to customers and revise its service offering to meet changing priorities.

While ongoing customer engagement shapes the way that the Company operates, significant additional research and engagement are required for its long-term planning. It is in preparation for the Business Plan, Water Resources Management Plan and Drought Plan there has been a step change in the Company's engagement to gain greater customer insight. This has enabled Portsmouth Water to create ambitious plans that are truly shaped by customers and stakeholders.

Research enables the Company to produce plans that deliver the outcomes that customers' value at an affordable price that they consider represents good value for money. The key activities which have fed into and shaped the WRMP are summarised in Figure 9.

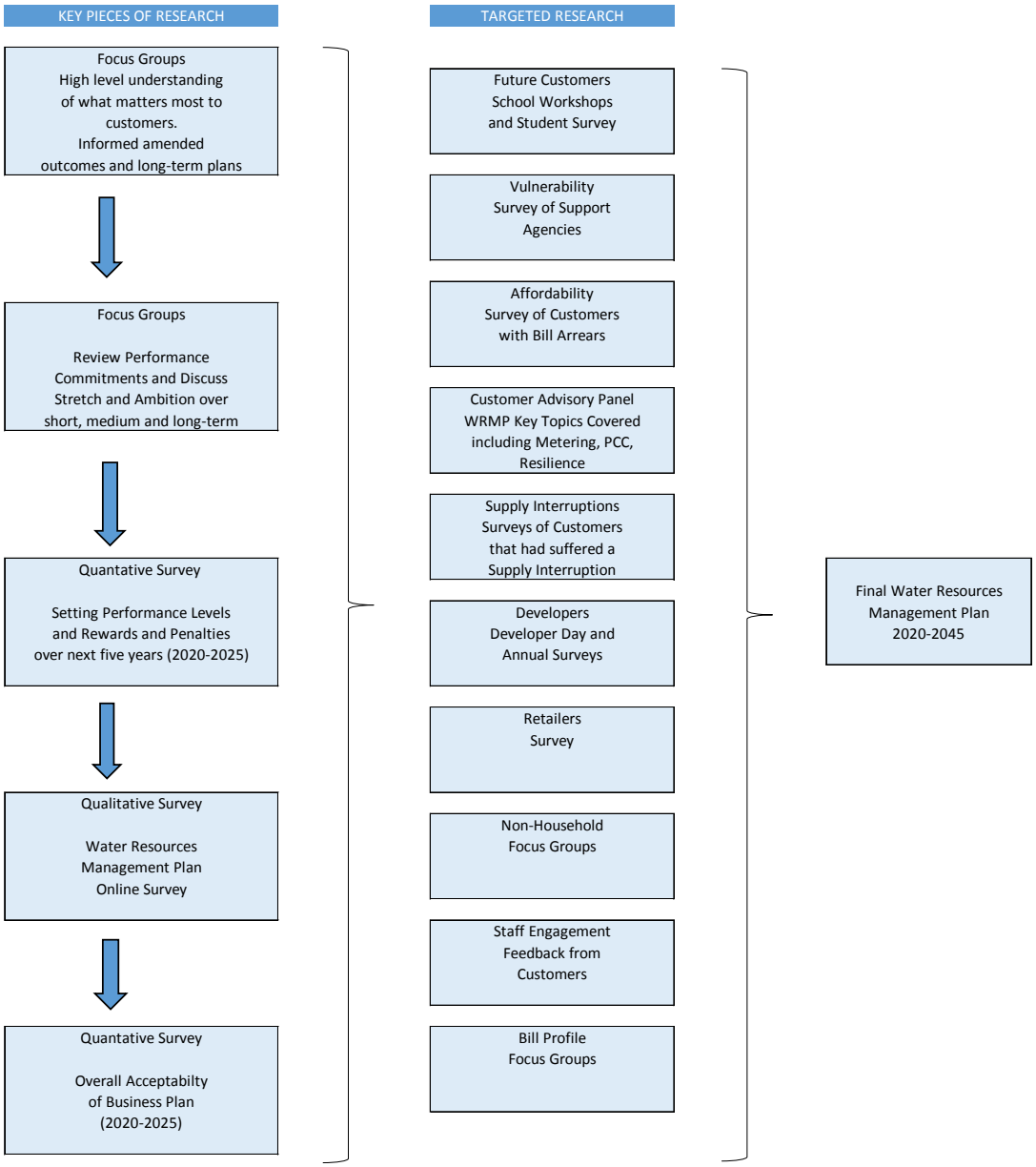


Figure 9 Key engagement activities

During the engagement process as a whole, 38,598 customers have been involved in the WRMP and Business Plan process. This included an unprecedented 2,212 customers who responded to the online survey on 'Your Water and its future', the non-technical public facing document summarising the Draft Water Resource Management Plan (Figure 10) published in March 2018. The publication and online survey sought customer views on key issues and choices to address leakage, metering, per capital consumption and the role of the regional solution was explained. As part of the online consultation, customers were invited to complete questions relating specifically to Havant Thicket Reservoir as part of a regional solution and also on the provision of bulk supplies to Southern Water.

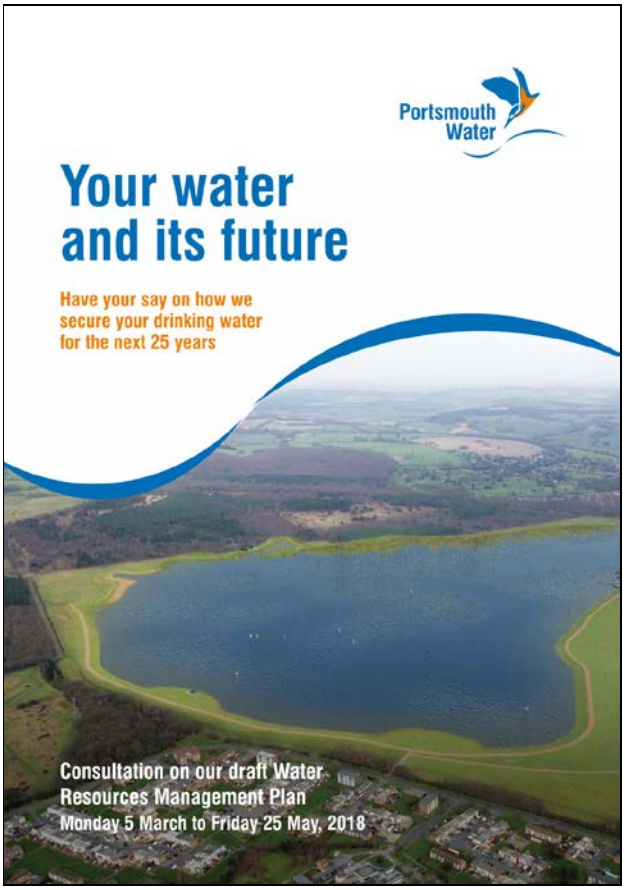


Figure 10 Customer friendly summary of Draft WRMP published in March 2018

Of 2,212 responses, 57% of customers have asked to be kept informed about the water resource plans and the Company is preparing an update to send out to these customers.

Portsmouth Water also engaged consultants to develop valuation work which would allow the quantification of incentive rates for its performance commitments consistent with customer preferences. To meet these objectives a two-phase approach to the customer research was developed:

- Phase 1 – A qualitative phase of focus group research to provide evidence of typical customer views. This initial phase was also designed to provide evidence to assist the design of the quantitative (Phase 2) research.

- During November 2017 a series of 6 focus groups were undertaken to explore these topics with customers. To ensure good coverage across the Portsmouth Water region, the groups were held in a range of locations. In addition, a good cross section of customers, in terms of age and socio-economic group was also achieved. And, although not recruited on the basis of whether they had meters, there was a mix of both metered and unmetered customers.

- Phase 2 – A quantitative phase of survey research conducted with a sample of Portsmouth Water's household customers and residents. This survey was designed to allow the estimation of incentive structures and levels of service supported by Portsmouth Water customers. The survey research was preceded by a test phase to allow testing and refinement of the survey instrument and materials.

- Following a test phase during December 2017 to January 2018 involving cognitive interviews and a hall test, an online survey was launched in late January 2018. A final sample of 630 responses was achieved.

The Phase 2 survey was designed to provide evidence on:

- Customers' relative importance placed on the outcomes proposed by Portsmouth Water
- Customer attitudes towards targets and financial incentives for service performance
- Customer preferences around financial penalties and rewards where Portsmouth Water under- and over-performs relative to its performance commitments for the 2020-25 period

Table 4 shows the measures included in the Phase 2 research, highlighting those that directly relate to the Water Resources Management Plan.

Block 1	Block 2	Block 3
Minutes lost due to supply interruptions Average minutes lost per property per year	**Leakage Levels** - Litres lost per property per year and m3/km/day	**Asset Health - Bursts** Number of burst mains on average per year
Water Quality Compliance Risk Index Score based on DWI methodology	**Asset Health** Number of Customer Contacts re: Orange/Brown/Black Water	**Water Quality Contacts** Number of customer contacts per year
Customer Satisfaction (C-MEX) Score based on Ofwat Methodology	**Affordability** Nr of eligible household customers receiving support Average household customer bills < 0.5% of household income	**Vulnerability** Satisfaction rating by local agencies
Improving river flows through abstraction reductions (AIM) Agreed Projects completed by 2025	**Improving biodiversity in local areas** Agreed Projects completed by 2025	**River restoration measures to enhance habitats for wildlife** Agreed Projects completed by 2025
Per capita consumption Litres per person per day	**Asset Health - Outage** % of capacity lost through unplanned failures	**Drought Resilience** Population at risk of severe restrictions in a 1 in 200 drought

Key:
Directly relate to WRMP
Other PCs, not directly related to WRMP

Table 4 Measures considered in the Phase 2 survey

As part of Business Plan customer engagement, the Company established a Customer Advisory Panel (CAP). This was made up of a representative group of customers, with the same group meeting five times over 18 months to consider a range of different topics and issues. The sessions were facilitated by a third party to encourage the best possible discussion and debate. The Company presented to the CAP on a range of different topics to obtain a wider and deeper understanding of customer views and priorities. It was particularly relevant to the WRMP because it covered topics such as levels of service, metering, bulk supplies and Havant Thicket.

3.3.2 Customer Participation

Listening and engagement is only a starting point. Involving customers and increasing active participation is desired to achieve positive outcomes and promote changes in behaviour. Some of the initiatives that contribute to the effective management of Portsmouth Water's water resources now and in the future are discussed below.

3.3.2.1 Behavioural Change

The Company sees encouraging behavioural change and raising the awareness of the benefits of metering and other changes which save water as on-going activities. Customers say consistently that they would like more information on how much water they use and how they can reduce any wastage. Portsmouth Water's water efficiency programme addresses this requirement. Water savings products are available free of charge. The Company regularly attend fairs, shopping centres and fetes as part of its community events to promote how to use water more efficiently and hand out free water saving devices. This goes hand in hand with providing information about switching to a water meter. There are also pages on the Company website to help customers learn about where their water comes from and how to save water and the Call Centre maximises opportunities when customers call to discuss water efficiency and metering.

3.3.2.2 Saving Water Challenge

The Company also promotes the Saving Water Challenge. This initiative involves customers thinking about their behaviour in regard to their own water use and how they can reduce the amount of water they use in their homes.

3.3.2.3 Working in Partnership

The Company recognises that it can achieve far more working in partnership than working on its own. The Company promotes and engages with organisations like Waterwise and Eco Schools.

3.3.2.4 Catchment Management

The Company has also engaged with environmental NGOs. Their input has helped shaped both the catchment management and biodiversity plans in particular, which protect the long-term future of water resources. They have also asked the Company to consider joint funding of schemes. This is in line with customers desire to improve the countryside we live in and the Company will establish a grant scheme which will fund suitable, water related schemes. The Catchment Management programme will also engage with farmers more generally to ensure that the practices farmers adopt do not have detrimental effect on the raw water that the Company relies on to supply customers. Customers agreed that it was more efficient to work with farmers to ensure raw water quality does not deteriorate rather than invest in more complex treatment processes which are generally more energy intensive.

Portsmouth Water has also set up an innovative scheme to reduce the risk of groundwater pollution from leaks and spills associated with domestic heating oil tanks. The scheme involved an awareness campaign and subsidised oil tank inspections targeted at users of domestic heating oil. Oil spills in the catchment remain a risk to water supplies and this activity will be extended from 2020.

3.4 How Engagement Has Shaped the Plan

The main findings from the customer research and impact on the WRMP have been summarised in this section. The key messages from this work are:

- There are high levels of satisfaction with Portsmouth Water's service evidenced across qualitative and quantitative research
- The top priority is safe, secure and reliable supply of drinking water

- The Company has been challenged on leakage ambition to do more than originally proposed
- There was support for water trading provided Portsmouth Water's customers are not adversely affected by bill increases for the cost of development of Havant Thicket Reservoir
- Customers value environmental enhancement that goes beyond legal responsibilities
- There is a desire for the Company to co-create and deliver more water efficiency education
- There is a wide range of views on metering, discussed below, and overall customers prefer choice rather than compulsion
- Customers do not support rota cuts even in a 1 in 200-year drought

3.4.1 Metering

A great deal of the research on metering strategy was conducted after the draft WRMP was published and produced mixed results concerning support for compulsory metering particularly metering on changes of occupier. The findings are summarised below:

- Historic research going back to WRMP14 showed that customers supported metering where customers would benefit financially from metering, but not any form of compulsion. This was still supported in some of the WRMP19 research, but the picture that emerged was not conclusive.
- The Draft WRMP consultation indicated a high level of support for compulsory metering with over 2,200 responses to the online survey and over 70% supporting the Company metering proposals and in particular the implementation of compulsory metering (see Figure 11).
- Findings from the Customer Advisory Panel (CAP) focus groups conducted by the Company highlighted a range of views, but generally, respondents were less receptive to Change of Occupier or Compulsory metering. One group showed a limited appetite for metering unless it saved money although there was an acknowledgement that metering would help to moderate consumption. Another group generally regarded metering as less of a priority although they were more receptive when presented with options which "de-risked" the take-up of a meter (e.g. dual billing, a two year 'cooling off' period and water company ownership of the customer supply pipe). Another group chose the Not for Revenue metering option to educate customers on their use followed by metering on Change of Occupier and with Compulsory metering across half the supply area the least preferred option (see Figure 12).
- The Student Customer Survey group of respondents supported by a narrow margin customer choice for metering (41%) compared with universal metering (36%) and the remainder having no preference.
- Engagement with school children presented four possible options to meet water resource needs of the future with metering selected as the most popular (47%), followed by development of new resources in the form of a reservoir (32%), more work to address leakage (19%) and developing desalination (2%).
- Non-Household customers supported a Performance Commitment around smart metering, and some respondents favoured compulsory metering of all household customers as a means to reducing consumption.
- Qualitative research on setting our Performance Commitments and targets for 2020-2025 demonstrated support for all the metering plans proposed. Optional metering attracted the highest level of support (72%) with Change of Occupier metering the lowest (63%).

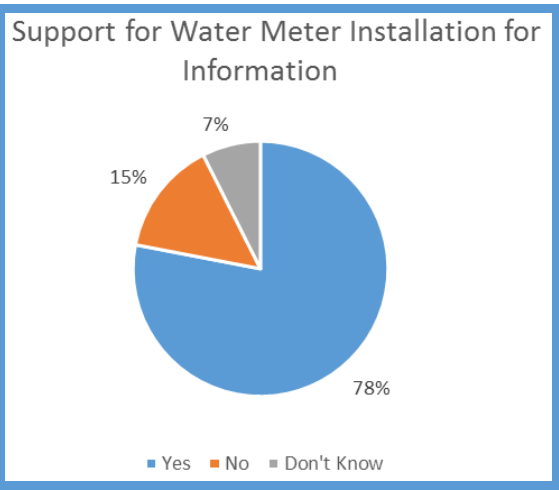
- The Customer Affordability Survey indicated that 60% of customers would install a meter if it would save them money.

Do you support the Company's plans to install water meters to give you more information on how much water you are using?

78% of customers supported plans to install meters for information. This was the most popular metering option in the survey.

Not-for-Revenue Metering has been added to the package of measures designed to balance supply and demand. It will complement, Change-of-Occupancy Metering and Optional Metering.

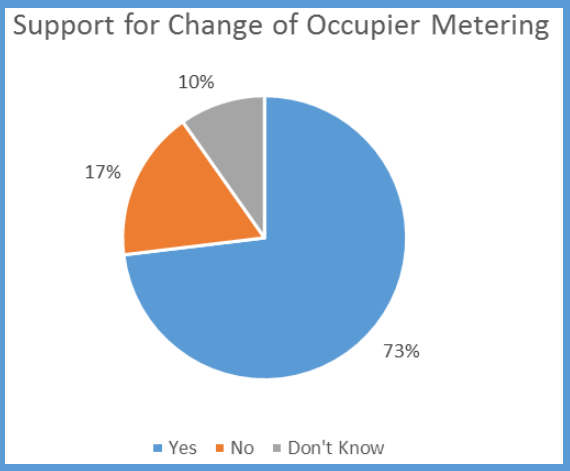
The total number of meters fitted and the demand reduction remains the same.



Would you support the Company installing meters in homes when people move house?

74% of customers supported the plans to install meters when people move house. Although this was the least popular metering strategy, overall customers were in favour of it.

Change of Occupancy Metering has been added to the package of measures designed to balance supply and demand. It will complement Optional Metering and Not for Revenue Metering. The total number of meters fitted and the demand reduction remains the same.



The South East as a region in short of water and most people have water meters – do you think the Company should also install water meters for most people in the supply area?

Although the survey revealed that 74% of customers would support plans to supply meters to most people in the supply area, the comments received were divided on the issue.

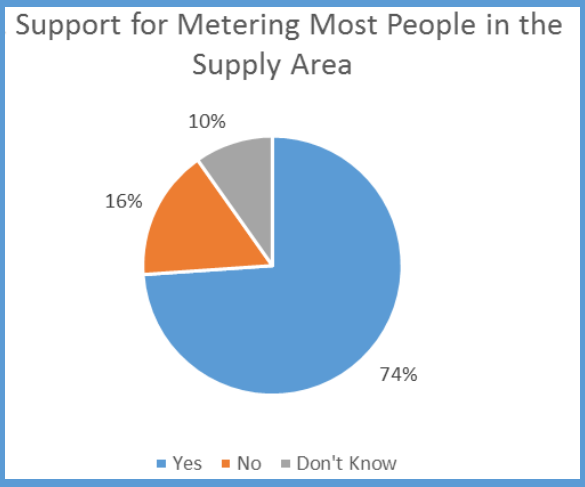


Figure 11 Findings from online survey on Draft WRMP (March to May 2018)

Ranking of uncosted v costed

Participants took part in a **second** qualitative ranking exercise (1-6, where 1 is most preferred option). Findings are by no means statistically reliable, but give a general indication of preference.

Option	Overall (Uncosted)	Overall (Costed)
To educate customers on their use – not for revenue	**1.8**	**1.8**
For all customers who move address	3.6	3.8
When properties are empty for more than 6 months	3.7	3.8
On a selective basis when customers move address	4.1	4.4
On a compulsory basis across the whole supply area	4.5	4.4
On a compulsory basis across half the supply area	4.8	5

Panellists were given information on the cost of each option and asked to rank the options again.

Cost information had very little impact on overall preferences.

Figure 12 Snapshot from findings from Customer Advisory Panel focus group no.4 exploring metering (March 2018)

In assessing the research, the Company considered that there was no research which explicitly addressed whether customers were willing to pay for full change of occupier metering, except in the Customer Advisory Panel, where it was not supported. As a result of customer and stakeholder feedback, including from Regulators, and discussions with the Customer Challenge Group, the Company concluded that it had a mandate to change its policy on change of occupier metering. Selective change of occupier metering will be introduced from 2020 to 2025, which has a relatively low impact on bills, with full change of occupier metering from 2025. To increase customer support for this activity, the Company will promote the merits of metering and test customer opinion more frequently. In this way, the Company has identified the optimal balance between meeting Government ambition, regional strategies and customer priorities not just on metering, but also for other areas in the plan such as water efficiency and reduction in per capita consumption, where there are interdependencies with the approach to metering.

3.4.2 Valuation and Quantification Research Findings

The valuation work, underpinning the quantification of incentive rates consistent with customer preferences, asked respondents to provide a priority ranking of the five categories of outcome that represent the majority of measures in the proposed performance commitment framework for Portsmouth Water. Respondents were asked to rate their top 3 outcomes in terms of importance to them. The ranking responses were modelled to derive the relative importance weight for each of the 5 outcomes; Table 5 presents the results of the statistical analysis.

Outcome	Overall Sample	SEG AB	Age Group 18-29	Age Group 60+
Safe, Secure, and Reliable supply of drinking water	7.0	10.6	1.6	19.7
Long term resilience of supplies for our own customers and to support the South East Region	1.3	1.6	0.91	2.2
Low leakage	2.1	2.5	0.88	4.3
Service Tailored to Individual Needs at a Long Term Affordable Price	1.1	0.8	0.89	2.0
An improved environment, supporting Biodiversity	1.0	1.0	1.0	1.0

N = 630 respondents, Weighted

Table 5 Relative importance of outcomes

The importance scores show that all customers rate safe, secure and reliable drinking water as the most important outcome – it is seen overall as seven times more important than Portsmouth Water improving the environment. The second most important is low leakage, followed by long-term resilience and then customer services and affordable bills.

There are, however, differences across the demographic groups. Safe and Secure is still rated as the most important outcome for the 18-29 group, but the relative importance is notably reduced. Environment is ranked the second highest outcome for this age group. For the older 60+ age group the importance of Safe and Secure is stronger than the average, whereas environmental outcomes have lower relative importance for this group. The more affluent AB group places more relative weight on the Safe and Secure Outcome compared to the average and additionally, for the AB group, the environmental outcomes attract more relative weights than Service and Affordable bills.

The table below shows how the customer valuations were translated into rewards and penalties for the Performance Commitments over the AMP7 period, directly relating to the WRMP:

PC	Measurement	Max penalty (£/property)	Max reward (£/property)	Comment
Per Capita Consumption	l/h/d	-0.06	0.03	Max penalty at 145 l/h/d Max reward at 125 l/h/d
Leakage	l/p/d	-0.26	0.13	Max penalty at 95 l/p/d Max reward at 80 l/p/d
Severe Droughts	Ability to meet a 1 in 200 drought	-2.42	0	Penalty only if customers at risk in 1:200 year drought
AIM	Maintain rivers above Q95	-0.89	0.89	Reward for plan being delivered Penalty for non-delivery
Biodiversity	Maintain sites and grant scheme	-0.29	0.29	Reward for plan being delivered Penalty for non-delivery

Table 6 Translating customer valuations into rewards and penalties

3.4.3 Summary of Customer Insight and Findings

Table 7 provides a summary of the insight gained from the specific customer research activity and its impact on the Final WRMP.

Issue	Change made from Draft to Final WRMP
Customer and stakeholder engagement	The Company has made significant changes to the Final Plan to capture the customer and stakeholder engagement activities that have been and continue to take place. This is summarised in a new chapter. Consequence: There is a clear line of sight between stakeholder and customers' views and how they have shaped the final preferred plan.
Outage	Stakeholder feedback highlighted issues with the methodology for calculating outage in relation to accounting for changes to the supply system in the planning period, the impact of activities to reduce outage and potential double counting of pollution incidents. Consequence: The outage profile over the planning period has changed, and the Final Plan has been amended to provide more visibility on the method of calculation.
Property forecast	The forecast of property growth within the supply area has been revised to take into account comments made by EA and Ofwat. For the Final WRMP, Local Authority plan-based figures have been used. The changes may result in a less even profile for housing growth with a steeper increase in property growth in the early part of the planning period until 2030. Consequence: This change has increased demand requirements slightly in the early part of the planning period but has made little difference regarding the total demand for water over the 25-year planning horizon.

Leakage	Additional leakage options have been included in the Final WRMP and text amended so that leakage options are presented more clearly. For the Final WRMP, in addition to the traditional district metering approach, a more 'innovative' option of permanent noise loggers in a fixed network has been considered. This option uses telemetry to collect data continuously. The new option is selected in the preferred plan in preference to the district metering. Consequence: This change means that the Company has a more ambitious leakage target. In addition to meeting Ofwat's 15% leakage reduction target over the first five years of the plan, further leakage savings will be delivered throughout the planning period. In total there will be a 15% saving by March 2025 and a further 15% by March 2040.
Metering and Per Capita Consumption	The Company's metering programme has been updated as a result of the customer consultation and the views expressed by the Regulators. For the Final Plan, the Company's metering programme comprises a baseline of Optant metering and New Build metering. The preferred plan includes Change of Occupier Metering, voids metering and the 'meters not for revenue' smart meter trial which is designed to increase the number of meter optants and will provide valuable information to customers on their usage. The preferred plan also includes water efficiency schemes which will assist customers in reducing their consumption. Although a programme of compulsory metering cannot currently be implemented, it has been costed, and the effect of implementing such a programme has been considered with the sensitivity testing undertaken on the preferred plan. Consequence: The Company's change of policy on metering will result in lower per capita consumption and a higher level of meter penetration in the early years.
Headroom	EA and Ofwat feedback highlighted double counting of oil spill shutdown events in the headroom and outage calculations and the EA asked the Company to revisit options to reduce uncertainty as well as clarifying its approach on Time Limited Licences (TLL). Consequence: Headroom has significantly reduced as a result of changes made to the calculation. The risk profile has been altered with a 1% fall in headroom probability every year, and oil pollution has been removed as a driver. The text on TLLs has been corrected.
Options appraisal	The Company's option appraisal and programme appraisal process has been updated as a result of comments from the Regulators. The Final WRMP contains revised text that sets out the Company's options appraisal process more clearly and contains more information around how the final plan has been taken through programme appraisal. Consequence: This change helps demonstrate how the preferred plan has been selected and provides evidence that this is the best planning solution.
Havant Thicket Reservoir and Bulk supplies	In light of the comments received by customers and stakeholders, the text in the Final WRMP has been revised to make it clearer how the strategic reservoir option will be used as well as addressing concerns raised on the impact on bills and environmental impacts. Consequence: The changes provide clarity on key drivers and benefits as well as addressing key concerns. It is clearly set out that there should be no direct bill increase because of the impact of the Southern Water trading agreement.

Sensitivity Testing	The Company's sensitivity testing has been revised following comments received from the Regulators. The Final WRMP contains a section which outlines how the sensitivity testing has been undertaken and describes the scenarios considered. The results are presented and discussed in detail. The sensitivity scenarios consider the main areas of uncertainty concerning risk to supply and demand. The sensitivity scenarios include possible future sustainability changes including tighter flow standards on the River Itchen. Consequence: This change helps demonstrate how the preferred plan has been tested and provides evidence that it is a robust planning solution that is resilient to a range of risks.
Directions	A table demonstrating compliance with the Directions has been included. This signposts the location where each Direction has been addressed. Consequence: This change points the reader to relevant sections of text within the Final Plan and demonstrates compliance with the Water Resources Management Plan (England) Direction 2017.

Table 7 Summary of insight and impact from customer research

3.4.4 Changes to the WRMP Plan

Table 8 summarises the main changes that have been made to the Draft WRMP in response to stakeholder and customer engagement as well as the formal representations made to Defra.

Issue	Change made from Draft to Final WRMP
Customer and stakeholder engagement	The Company has made significant changes to the Final Plan to capture the customer and stakeholder engagement activities that have been and continue to take place. This is summarised in a new chapter. Consequence: There is a clear line of sight between stakeholder and customers' views and how they have shaped the final preferred plan.
Property forecast	The forecast of property growth within the supply area has been revised to take into account comments made by EA and Ofwat. For the Final WRMP, Local Authority plan-based figures have been used. The changes may result in a less even profile for housing growth with a steeper increase in property growth in the early part of the planning period until 2030. Consequence: This change has increased demand requirements slightly in the early part of the planning period but has made little difference regarding the total demand for water over the 25-year planning horizon.
Leakage	Additional leakage options have been included in the Final WRMP and text amended so that leakage options are presented more clearly. For the Final WRMP, in addition to the traditional district metering approach, a more 'innovative' option of permanent noise loggers in a fixed network has been considered. This option uses telemetry to collect data continuously. The new option is selected in the preferred plan in preference to the district metering. Consequence: This change means that the Company has a more ambitious leakage target than the previous Draft WRMP. In addition to meeting Ofwat's expectation of 15% leakage reduction target over the first five years of the plan, further leakage savings will be delivered throughout the planning period. In total there will be a 20% saving by March 2025 and a further 10% by March 2040.
Metering and Per Capita Consumption	The Company's metering programme has been updated as a result of the customer consultation and the views expressed by the Regulators. For the Final Plan, the Company's metering programme comprises a baseline of Optant metering and New Build metering. The preferred plan includes Change of Occupier Metering, voids metering and the 'meters not for revenue' smart meter trial which is designed to increase the number of meter optants and will provide valuable information to customers on their usage. The

	preferred plan also includes water efficiency schemes which will assist customers in reducing their consumption. Following comments received from the EA, text has been added to provide further explanation with regards to the two phases of Change of Occupier metering Although a programme of compulsory metering cannot currently be implemented, it has been costed, and the effect of implementing such a programme has been considered with the sensitivity testing undertaken on the preferred plan. Consequence: The Company's change of policy on metering will result in lower per capita consumption and a higher level of meter penetration in the early years and the plan provides more clarity around what the metering options involve.
Options appraisal	The Company's option appraisal and programme appraisal process has been updated as a result of comments from the Regulators. The Final WRMP contains revised text that sets out the Company's options appraisal process more clearly and contains more information around how the final plan has been taken through programme appraisal. Consequence: This change helps demonstrate how the preferred plan has been selected and provides evidence that this is the best planning solution.
Sensitivity Testing	The Company's sensitivity testing has been revised following comments received from the Regulators. The Final WRMP contains a section which outlines how the sensitivity testing has been undertaken and describes why certain scenarios were considered, the likelihood of the scenario and how the Company will manage these risks. The results are presented and discussed in detail. The sensitivity scenarios consider the main areas of uncertainty concerning risk to supply and demand. The sensitivity scenarios include possible future sustainability changes including tighter flow standards on the River Itchen. Consequence: This change helps demonstrate how the preferred plan has been tested and provides evidence that it is a robust planning solution that is resilient to a range of risks.
Havant Thicket Reservoir and Bulk supplies	In light of the comments received by customers and stakeholders, the text in the Final WRMP has been revised to make it clearer how the strategic reservoir option will be used as well as addressing concerns raised on the impact on bills and environmental impacts. Consequence: The changes provide clarity on key drivers and benefits as well as addressing key concerns. It is clearly set out that there should be no direct bill increase because of the impact of the Southern Water trading agreement.
Headroom	EA and Ofwat feedback highlighted double counting of oil spill shutdown events in the headroom and outage calculations and the EA asked the Company to revisit options to reduce uncertainty as well as clarifying its approach on Time Limited Licences (TLL). Consequence: Headroom has significantly reduced as a result of changes made to the calculation. The risk profile has been altered with a 1% fall in headroom probability every year, and oil pollution has been removed as a driver. The text on TLLs has been corrected.
Outage	Stakeholder feedback highlighted issues with the methodology for calculating outage in relation to accounting for changes to the supply system in the planning period, the impact of activities to reduce outage and potential double counting of pollution incidents. EA feedback also highlighted issues with the Company's high level outage in the Draft plan, potentially driving unnecessary investment and impacting resilience and transfers. The outage assessment has therefore been revisited to reflect operational practice during critical supply-demand periods. Consequence: The outage profile over the planning period has changed, and the overall outage values are lower. The Final Plan has been amended to provide more visibility on the method of calculation.
Directions	A table demonstrating compliance with the Directions has been included. This signposts the location where each Direction has been addressed. Additional

	text has been included in the relevant sections to provide further clarity on costs and assumptions to address comments received from the EA relating to Direction 3 e, f and h. Consequence: This change points the reader to relevant sections of text within the Final Plan and demonstrates compliance with the Water Resources Management Plan (England) Direction 2017.

Table 8 Changes made from Draft to Final WRMP

3.4.5 Linkages with PR19

Table 9 highlights the key touch points where the Water Resource Management Plan links into the Outcomes and their associated Performance Commitments (PCs) for 2020 to 2025 in Portsmouth Water's Business Plan submitted in September 2018. The proposed PCs have been consulted on and agreed with stakeholders, customers and their representatives. The targets and any associated incentives will be confirmed by Ofwat in December 2019.

Outcome	Performance Commitments
Safe, secure and reliable supply of drinking water	• Resilience Schemes
Long term resilience of supplies for our own customers and to support the South East region	• Per Capita Consumption • Risk of severe restrictions in a drought • Temporary Usage Bans
Low leakage	• Leakage
An improved environment, supporting Biodiversity	• AIM • Catchment management • Biodiversity

Table 9 Links between WRMP and PR19 Business Plan

4 Supply

4.1 Introduction

The majority (88%) of the water supplied by Portsmouth Water to customers is derived from the local Chalk aquifer. It is either taken directly from the Chalk aquifer from boreholes and wells or captured as it emerges from the Chalk aquifer via springs. In addition, the Company has one surface water abstraction.

This section describes how much water is available for supply. It presents the latest supply calculations, referred to as deployable output (DO) assessments. It also considers factors that could affect DO or influence the water available for supply. The estimates of output available from the sources of supply were fully revised for the WRMP 2019, fulfilling the commitment made in the WRMP14 process. It now reflects a detailed re-assessment of source yields and the variation of deployable output with return period. The key assumptions included in the supply side forecast are outlined briefly below with more detail in the following sections. It covers:

- Deployable Output Assessment
- Sustainability Reductions
- Climate Change
- Outage Assessment
- Process Losses
- Bulk Supply Imports

4.2 Deployable Output Assessment

Portsmouth Water is required to submit deployable output (DO) values to the Environment Agency and Ofwat every five years as part of its WRMP submission. DO is defined by UKWIR's Handbook of source yield methodologies (2014) as:

"the output of a commissioned source of group of sources or of bulk supply as constrained by licence (if applicable), pumping plant and/or well/aquifer properties, raw water mains and/or aqueducts transfer and/or output main, treatment and water quality, for specified conditions and appropriate demand profiles to capture variations in demand over the year"

Portsmouth Water appointed AECOM to carry out a reassessment of the Company's DO for WRMP19. As part of this work, the following activities were carried out:

- Source models were developed to calculate individual source DO values for the worst historic drought on record
- A Water Resource Zone assessment of Deployable Output was undertaken to determine DO values for group licences for the worst historic drought and a range of stochastic droughts.

This section summarises the work that has been undertaken with reference to the detailed technical report (presented in Appendix A) that supports the DO figures.

4.2.1 Previous Deployable Output Assessments

Historic assessments of DO were undertaken by the former Southern Water Authority in 1984. Portsmouth Water undertook a review of DO in 1997 and produced DO assessment diagrams for the majority of sources. These incorporated operational data from the 1970's or 1990's droughts, which were used to define operational drought lines.

The surface water assessment for Source A was based on groundwater modelling data for the period 1970–2002 which was provided by the Environment Agency.

Portsmouth Water's DO was reassessed for the WRMP09 submission (Arup, 2009) by updating DO constraints data and deriving DO assessments for new groundwater sources.

AECOM (incorporating URS) undertook the assessment of Portsmouth Water's DO for the WRMP14 submission (URS, 2013). This was completed in accordance with the Water Resources Planning Guideline (WRPG) October 2012, and the supporting guidance in UKWIR's WR27 DO Report (2012) and A Unified Methodology for the Determination of Deployable Output from Water Sources (2000).

4.2.2 Reassessment of Deployable Output for WRMP19

Portsmouth Water's Deployable Output has been reassessed for WRMP19 considering the WRPG (April 2017), the supporting Drought Plan and the following UKWIR guidance:

- A Unified Methodology for the Determination of Deployable Output from Water Sources (2000).
- WR27 (DO Report) Water Resources Planning Tools (2012)
- Handbook of Source Yield Methodologies (2014)
- WRMP 2019 Methods – Decision Making Process Guidance (2016a)
- WRMP 2019 Methods – Risk Based Planning (2016b).

The Problem Characterisation exercise undertaken suggested that the supply side might be assessed in line with 'Risk Composition 1' within UKWIR (2016b); 'conventional DO or historically based time series'. However, Portsmouth Water decided to explore 'conventional plus event-based DO or time series' in line with 'Risk Composition 2', to consider the implications of alternative/more severe droughts.

The Environment Agency's WRPG (April 2017) indicates that the data in the WRMP should be based on a 'design drought' (for supply). The WRPG also states that the 'design drought' can be the worst on record or a more challenging, but plausible drought. The deployable output assessment undertaken by AECOM on behalf of Portsmouth Water for WRMP19 explores the impact of severe (but plausible) droughts through consideration of stochastic data, in addition to the 'worst historic' drought on record for full details see Appendix A). Portsmouth Water has selected the 1 in 200-year drought as their 'design drought' and have used this as the basis for their supply forecast (see section 4.2.3).

The WRMP19 DO assessment itself has been undertaken in two stages. In the first stage, a DO assessment was undertaken on individual sources. For this work, records of groundwater levels and abstractions were analysed by AECOM. These, along with a review of constraints information were used to predict the reliable supply that could be achieved. Models were developed in order to predict groundwater levels and reliable supplies that might be available in plausible droughts. An existing Environment Agency groundwater model for the supply area was also used to check that the DO values were realistic. The results from this work are summarised in section 4.2.6.

In the second stage, a Water Resources Zone DO assessment was undertaken based on historic and stochastic climate records. This built on the source DO assessment work by including the impact of group licences on DO and introducing restricted and non-restricted demand profiles to allow calculation of ADO. Additionally, it used historic and stochastic climate records to identify the relationship between WRZ DO and WRZ DO return period. It also examined how ADO could be impacted by the shape of demand profiles. The results from this work are summarised in section 4.2.7.

4.2.3 Selection of Worst Historic Drought and Design Drought

4.2.3.1 Worst Historic Drought

To identify key drought years and indicators of minimum levels/flows, monitoring sites with long-term records were examined.

The Company's record from its groundwater monitoring borehole centrally located at Well 'X', dates back to 1932 and provides a long-term record. The WRMP14 DO assessment used Well 'X' as the drought year indicator for all Portsmouth Water groundwater sources (it is also the key drought indicator in the Portsmouth Water drought plan). Figure 13 shows the key drought years from the recent history.

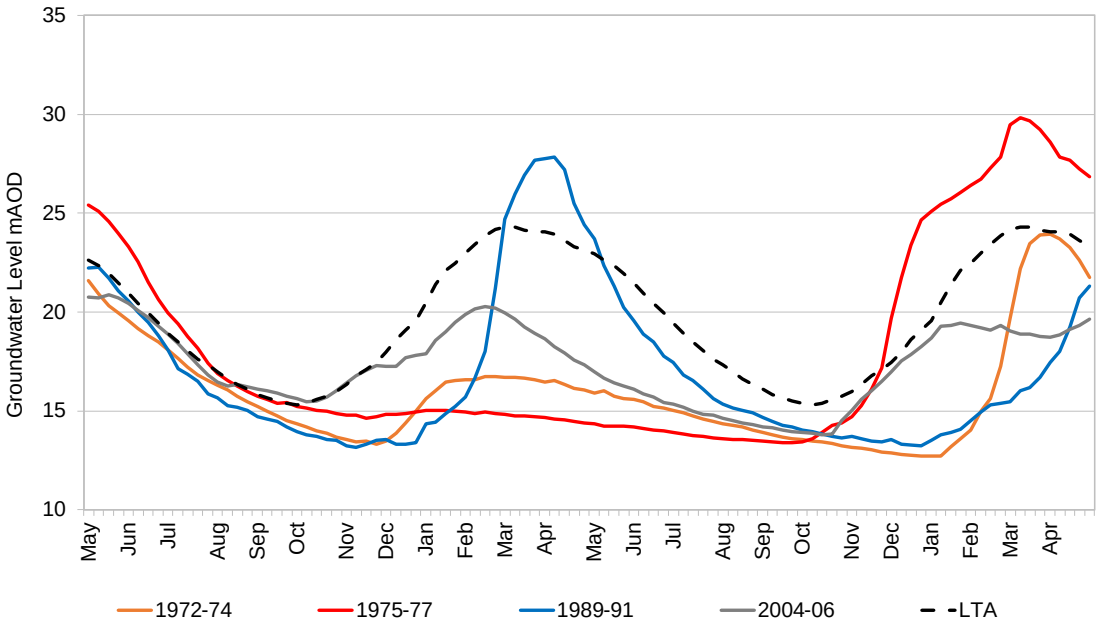


Figure 13 Historic Well 'X' Levels for Portsmouth Water's key drought years

For the WRMP19 DO assessment, lumped parameter models were used to explore the use of Environment Agency observation boreholes at Well 'Z' and Well 'Y'. Although it was considered these offered no significant improvement in the modelling of source DO's, the analysis did show that there was a very strong correlation between annual minima groundwater levels at Well 'X' and Well 'Z' suggesting that groundwater levels in these boreholes are very similar in terms of drought behaviour. Portsmouth Water has used this correlation to consider whether more severe events occurred prior to 1932, when Well 'X' records began. Well 'Z' has observed groundwater level data dating from 1836. From the analysis, it was concluded that although low periods of rainfall and groundwater had been experienced in the past, these had not led to lower groundwater level conditions than recorded in Well 'X' in the drought period 1972–74. For this reason, Portsmouth Water consider the drought period 1972–74 to be the worst on record. As shown in Figure 13, the lowest groundwater levels were observed at end of the recession in 1973 at 12.7 mADO, therefore, the Company considers 1973 to be its worst historic drought on record.

Section 2.3 of Appendix A presents the results of frequency analysis and ranking of drought years. In addition, to identifying 1973 as the most severe drought for groundwater levels, it notes that the modelled River Itchen datasets indicate that 1944 and 1976 were the more severe droughts for surface water flow. As described in section 4.1, most of the water supplied by Portsmouth Water to customers is derived from the local Chalk aquifer, therefore the Company consider it appropriate to select the worst historic drought based on groundwater level records.

4.2.3.2 Single Season and Multi-Season Droughts

To consider the impact of different droughts, Portsmouth Water has reviewed the effect of both single season and multi-season droughts.

Portsmouth Water has no significant raw water storage, but the South Downs Chalk aquifer is very resilient to drought. The most significant single season dry summer in the recent historic record occurred in 1990. The summer of 1990 was very dry but groundwater levels did not reach the low level of 12.7 m AOD which was recorded at the end of 1973. Groundwater levels were below average throughout the summer and autumn without significantly impacting upon source yields. Levels recovered early in 1991, following average rainfall in the winter.

A 'Single Season Drought' is considered unlikely to have a critical effect on the supply/demand balance for Portsmouth Water. Further experience from the dry summers of 1995, 2003 and indeed 2018, when again, drought measures were not required, demonstrates the Company's capability to cope with single season dry summers.

Multi-Season Droughts are defined as two or more consecutive seasons of below average rainfall, and have a greater impact upon the Company's ability to balance demands with available supplies, especially if they are combined with high summer peak demand.

The most serious drought years of 1973, 1976 and 2005 all started with groundwater levels close to the LTA at the end of the summer of the preceding year. As a result of low rainfall during the first winter, limited recharge occurred and groundwater levels were well below average at the beginning of the summer period. Below average rainfall was recorded during the summer and groundwater levels continued to fall, albeit at a much slower rate, due to water being 'drawn from storage' in the chalk aquifer. As the second dry winter developed, groundwater levels reached their lowest levels. In each of these years, groundwater recharge occurred in the spring of the third year following a return to wetter conditions.

4.2.3.3 Design Drought

Portsmouth Water has selected a range of drought severities to investigate the resilience of their WRMP19. The Company has used a water resource zone model to provide estimates of DO (see section 4.2.7). The Water Resource Zone (WRZ) DO is calculated by increasing the simulated demand (distributed through the year according to demand profile factors) in the model to generate supply failures. The return period of the WRZ DO therefore relates to the return period of supply-demand failures, rather than the return period of rainfall or groundwater levels.

In addition to the worst historic drought on record, the Company has considered the drought scenarios set out in Table 10 for its WRMP and its Drought Plan. These scenarios are considered to be challenging but plausible. Emergency planning will be used if the Company experiences an unprecedented event such as loss of a major treatment works from a pollution incident, combined with an extreme drought.

Scenario Name	Description of drought type	Return Period (based on supply demand failures)
'B' Extended Drought	A two-year drought with one dry winter.	1 in 80
'C' Serious Drought	A two-year drought with two dry winters.	1 in 125
'D' Severe Drought	A three-year drought.	1 in 200
'E' Extreme Drought	Greater than three-year drought	1 in 500

Table 10 Drought Scenarios

Portsmouth Water has selected the 1 in 200-year drought as their 'design drought'. This has been selected for the following reasons:

- The worst historic drought on record (identified from observed groundwater levels and hindcasting to 1880) has been identified as 1973.
- The worst historic drought on record is estimated to have a return period (based on supply demand failures) of between 1 in 40 and 1 in 83 years.[2] This is not considered severe enough for Water Resources Planning.
- The Company has committed to providing a bulk supply to Southern Water with water available up to a 1 in 200-year event.

4.2.4 Critical Periods and Planning Scenarios

Portsmouth Water is historically a peak driven company because of its groundwater supplies and lack of raw water storage. The critical period is associated with peak summer demand. For this reason, a critical period scenario (peak summer demand) has been included within the WRMP19 DO assessment (see Appendix A).

The links between planning scenarios and DO in the WRMP19 assessment are:

- The assessment of Average Demand Deployable Output (ADO) is linked to the dry year annual average planning scenario.
- The assessment of the Peak Demand Deployable Output (PDO) is linked to the critical period (peak summer demand) planning scenario.
- The assessment of Minimum Deployable Output (MDO) can be linked to a critical period (minimum groundwater level and river flow) planning scenario. The UKWIR WR27 DO report (2012) defines MDO as 'the deployable output of a source during the minimum resource period and for groundwater sources – this is the minimum water level period'.

In the WRMP19 DO assessment, a scenario based on minimum groundwater level and river flow has been included to allow calculation of MDO, although in most drought years, this condition is not the main constraint.

4.2.5 Level of Service and Drought Plan Links

When drought conditions begin, Portsmouth Water will implement its drought plan. This results in a steady escalation of restrictions on the demand for water, from Temporary Use Bans (TUBs) such as bans on the use of hosepipes to Non-Essential Use Bans (NEUBs, also referred to as ordinary drought orders) that may start to impact businesses in the local area.

As a last resort, water companies may also ask for emergency drought orders (e.g. use of standpipes and rota cuts to reduce the demand for water), although these are part of the Emergency Plan and not the Drought Plan. Portsmouth Water has agreed with its customers the frequency at which demand restrictions might need to be implemented. The agreed Levels of Service (LoS) are as follows:

- Temporary Use Bans > 1 in 20 years
- Ordinary Drought Orders > 1 in 80 years
- Emergency Drought Orders > 1 in 200 years

The DO assessment undertaken for WRMP19 has investigated DO for a range of plausible droughts that are more severe than those experienced in the past. The introduction of a demand profile (considering the critical period) has enabled the results from the DO assessment to be mapped relative to the Company's planned LoS. This provides a link between the WRMP and the drought plan.

[2] The stochastic results (section 4.2.7.5) suggest that the ADO derived for the worst historic drought on record is perhaps representative of a 1 in 50-year event.

The DO assessment results themselves are used within the WRMP process to understand the impact of drought conditions on the supply-demand balance and the required investment costs, with or without demand restrictions and drought permits in place.

4.2.6 Source Deployable Output Assessment

4.2.6.1 Methodology

The Source DO assessment completed by AECOM calculated the individual DO for Portsmouth Water's sources, based on the worst historic drought on record. It considered PDO and MDO but excluded group licences and ADO. The work examined observed groundwater level and flow data, source operational data and source constraints in order to develop individual source DO assessments.

The following activities were undertaken:

- 'Critical period' observation borehole and gauging records were selected as drought indicators – Well 'X' was chosen for groundwater and a gauging station on the River Itchen for surface water.
- Drought years were identified using the historic groundwater level and flow records – autumn 1973 into winter 1974 was identified as the most severe drought on record for groundwater levels and 1944 and 1976 were the most severe droughts on record for surface water flow.
- The historic observed record was extended by hindcasting – a lumped parameter model was used to extend the groundwater level record at Well 'X' back to 1880 and a CatchMOD model was used to hindcast the observed (historic) flow record to 1880.
- Source operational data was reviewed – looking at time series of water levels, abstraction and distribution input.
- Source constraints information was refined – looking at licence, environmental, pump, treatment/water quality, distribution/demand and deepest advisable pumping level/potential yield.
-

Full details of the methodology are presented in Appendix A. Section 4.2.6.2 presents a summary of the individual source PDO and MDO values which were defined as the end result of this process.

4.2.6.2 Individual Source Assessment Results

Source assessment diagrams were used to calculate PDO and MDO for each source:

- The assessment of PDO provides a value of the reliable output (prior to the application of group licence constraints) that could be obtained during the worst drought year on record during the peak summer demand period.
- The assessment of source MDO provides a value of the reliable output (prior to the application of group licence constraints) that could be obtained during the worst drought year on record when water levels and river flows were at their lowest.

As described above (in section 4.2.6.1) the assessment took into account constraints but did not take account of group licences. The assessment was undertaken for the worst historic drought on record which for Portsmouth Water occurred in 1973.

The results for individual source works are shown below in Table 11. Note that MDO can be used as a proxy for ADO in the case of individual source assessments.

Individual Source Deployable Outputs		
Source name	MDO (Minimum groundwater level)	PDO (Peak demand)
Source A	39.2	40.7
Source B	52.5	71.0
Source C	20.5	22.5
Source D	0.7	2.7
Source E	0.5	0.5
Source F	9	12.4
Source G	1.9	3.8
Source H	9.0	9.1
Source I	1.5	2.2
Source J	10.2	10.2
Source K	11.4	12.3
Source L	16.0	16.0
Source M	4.0	6.3
Source N	26.1	35.2
Source O	1.8	5.4
Source P	10.0	10.0
Source Q	12.0	13.0
Source R	12.5	14.0
Source S	2.5	2.5
Source T	8.1	8.8

Table 11 Individual Source Deployable Outputs for the Worst Drought on Record (1973)

Compared to the previous yield assessment for WRMP14 the following key changes have occurred in MDO (proxy for ADO):

- Source K is now available
- Source M DO reduced due to identification of a large cavity (affecting DAPWL)
- Source O DO has decreased due to identification of an adit (affecting DAPWL)
- Source J DO has been reduced due to identification of major fissure flow (affecting DAPWL)
- Source I DO has been reduced because of a new environmental river flow condition on the abstraction licence
- Source H DO has been reduced following reassessment of the environmental river flow condition on the abstraction licence
- Source D has increased due to a datum correction
- Source C DO has decreased due to throttling of the borehole pumps to overcome a turbidity issue
- Source U is now unavailable due to the potential risk of Cryptosporidium.

4.2.7 Resource Zone Assessment

4.2.7.1 Overview

The resource zone assessment undertaken by AECOM, builds on the individual source DO work (outlined in section 4.2.6). The work undertaken uses a water resource zone (WRZ) model to estimate DO's at the Company level for the worst historic drought and for a range of plausible droughts that are more severe than those experienced in the past.

The first set of WRZ model runs calculated DO based on the extended (hindcast) historic record whilst subsequent runs were undertaken using a longer stochastic dataset[3].

An unrestricted company demand profile was derived based on weather demand modelling. AECOM then considered how restricted demand potentially influenced the shape of the unrestricted demand profile and the magnitude of ADO.

The work undertaken therefore provided a reassessment of DO considering (i) unrestricted and restricted demand profiles and (ii) both extended (hindcast) historic and stochastic climate sequences.

4.2.7.2 Water resource zone model

The resource zone DO assessment utilised a water resource zone (WRZ) model which was developed for WRMP14. The WRZ model uses individual source constraints, group licence constraints, resource availability (based on Well 'X' groundwater levels) and various profiles of demand to estimate ADO, PDO and MDO on a daily time step.

The input variables for each simulation run through the WRZ model are:

- Groundwater level record (daily) – either the extended (hindcast) historic record or the baseline stochastic dataset can be used
- Demand profiles (daily time step) – either unrestricted or restricted demand profiles can be used
- User defined choice of scenario (e.g. 1 in 20 year, 1 in 40 year etc.)

The model uses the input groundwater level record. It reads the observation borehole groundwater level on a daily time step and calculates rest water levels for each of the groundwater sources and the amount of water available for abstraction. The model then corrects the abstraction rates if these exceed licence quantities and sums the available abstraction rate for the WRZ.

Using the input demand scenario (in conjunction with the input groundwater level record), the model increases the simulated demand until the available resource fails to meet the demand for a target number of years (for example, fifty failures within the 1,000-year stochastic sequence represents a 1 in 20-year event). The model output is an estimate of DO for the WRZ which corresponds to the chosen scenario.

4.2.7.3 Demand profiles

Portsmouth Water produced a demand profile to represent unrestricted demand using weather demand modelling (see section 5.2.1) The Dry Year Annual Average unrestricted demand profile is shown as blue dashed line in Figure 14. To reflect the typical company demand

[3] Note that the water resource zone model used a 1,000 year stochastic sequence (out of the full 15,600 years of generated data) as this was a manageable length of record with respect to modelling efficiency that still allowed improved characterisation of a 1 in 200 year drought event. In response to a query from the Environment Agency, the 1,000 year sequence used has been validated against the 15,600 years of generated data to show that it is representative. This analysis is presented in a technical note included as part of Appendix A.

profile, the critical period demands established from the weather demand model were added to the profile. This provided the Dry Year Annual Average Critical Period unrestricted demand profile, shown as a solid blue line in Figure 14. Compared to previous assessments (in WRMP14) the demand profile is now less smooth over the year and recognises a minor peak around Easter. It also shows the peak week in August which is later than previous profiles.

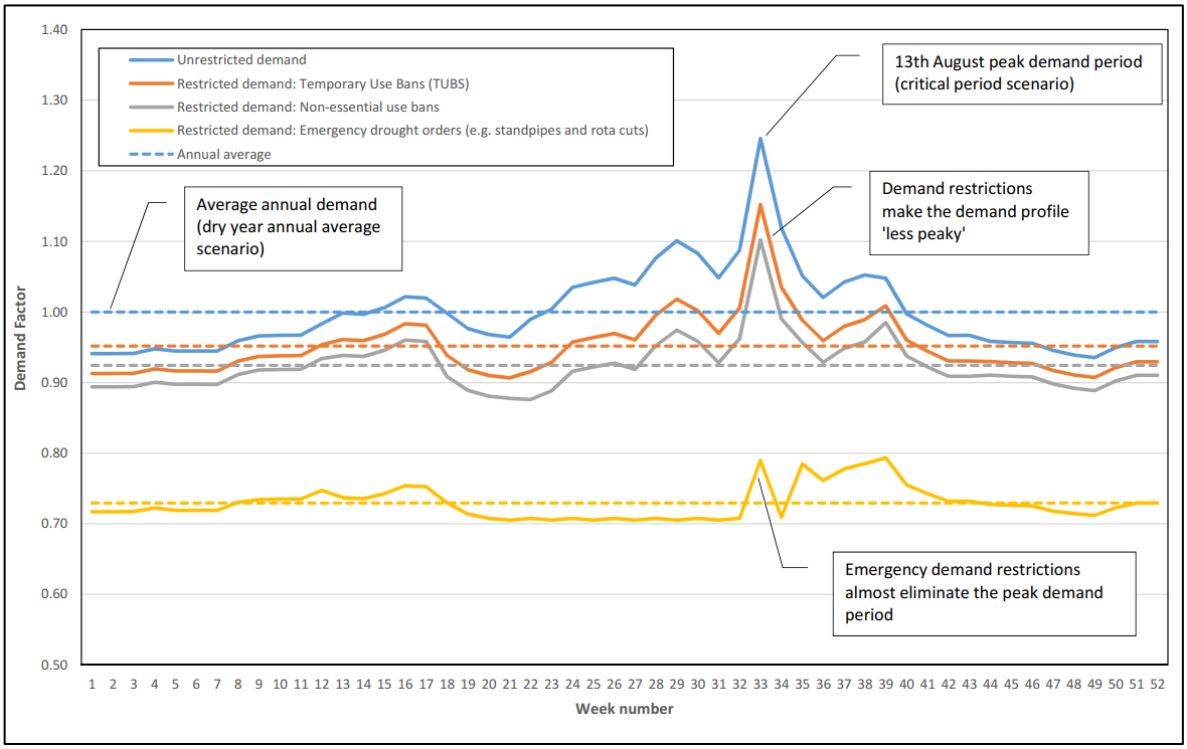


Figure 14 Water Resource Zone Demand Profiles

To investigate restricted demand in the WRZ model, AECOM considered a range of restricted demands including Temporary Use Bans (TUBs) and non-essential use (ordinary) drought orders (shown in orange and grey respectively in Figure 14).[4]

AECOM considered how the demand restrictions would affect the shape of the unrestricted demand DO profile and consequently affect the magnitude of ADO. AECOM concluded that the restricted demand savings are cumulative and they flatten the summer peak demand relative to the average demand. This means that where the WRZ DO is constrained by the peak summer demand critical period, the ADO may increase as a result of using the restricted demand profiles.

Figure 15 shows how the restricted demand profiles relate to ADO, PDO and MDO.

[4] The WRZ model (and the DO assessment) excludes supply side drought permits. These are considered as options within the WRMP process. Emergency Drought Orders are also excluded as these are considered within the Emergency Plan, rather than the WRMP.

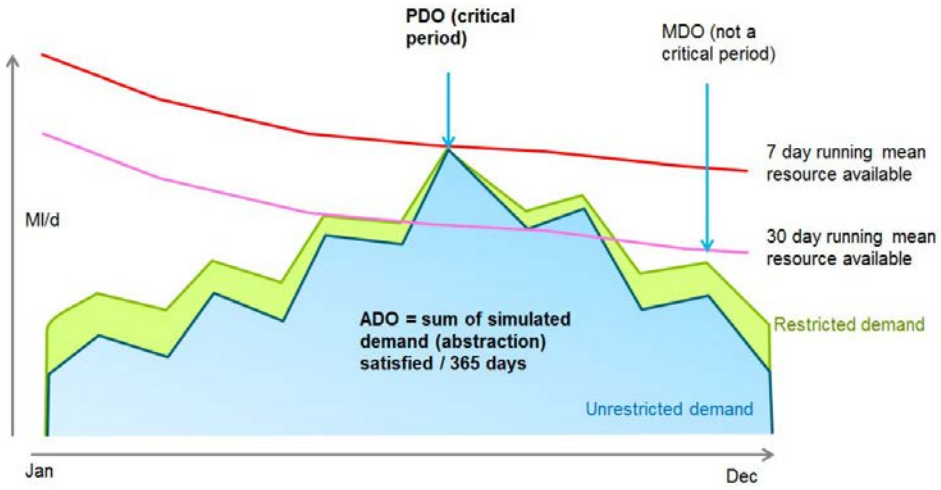


Figure 15 Influence of Demand Profile on Deployable Output

It should be noted that the demand profiles do not impact on modelled groundwater levels within the WRZ models. It is possible that implementation of demand restrictions could help to conserve aquifer storage to some degree, although the effect is believed to be relatively minor.

4.2.7.4 Results for the historic sequence of climate

The first set of WRZ model runs calculated DO based on a 132-year time series of groundwater and river flow. This is the extended historic record, which includes hindcast data back to 1880. The ADO was calculated by increasing the unrestricted demand profile in the WRZ model to generate failures.

The 'worst historic' drought ADO was calculated as 215 Ml/d, the PDO is 267 Ml/d and the MDO is 242 Ml/d; this is based on the use of an unrestricted demand profile.

4.2.7.5 Results for the stochastic sequence of climate

Testing of a longer stochastic time series in the WRZ has been undertaken to provide more certainty in the relationship between WRZ DO and WRZ DO return period.

The creation of a stochastically generated time series was undertaken by HR Wallingford. This work is described in full in Appendix CC. The stochastically generated sequences of precipitation, potential evapotranspiration and river flow were used to generate naturalised river flows for the River Itchen and groundwater levels for Well 'X'.

The ADO was calculated by increasing the unrestricted demand profile in the WRZ model to generate failures. The ADO and the corresponding PDO and MDO are summarised in Table 12 below. Note that following the completion of the DO assessment, further information has come to light regarding Southern Water's discharges to the River Itchen which means that a correction is required to the WRZ results (see section 4.2.7.6). The ADO values presented in Table 12 below match those in Appendix A (Appendix Table 3-2) and are the unadjusted outputs of the WRZ model.

The stochastic results suggest that the ADO derived for the worst historic drought on record (section 4.2.3.1) is perhaps representative of a 1 in 50-year event.

Return Period	PDO (Ml/d)	MDO (Ml/d)	ADO (Ml/d)
1 in 20 year	280	252	227
1 in 40 year	270	237	217
1 in 80 year	263	233	212
1 in 125 year	252	235	203
1 in 200 year	236	222	191
1 in 500 year	238	217	185

Table 12 WRZ DO values for selected return periods (unadjusted output, based on stochastic climate data and unrestricted demand profiles)

The impact of restricted demand profiles was also investigated using the WRZ model. As with ADO, the stochastic results suggest that the PDO derived for the worst historic drought on record is perhaps representative of a 1 in 50-year event.

4.2.7.6 Apportioned DO values

The WRZ DO output from the WRZ model has been apportioned to sources based on simulated rates of abstraction. The apportionment for selected return periods, based on the stochastic climate data and unrestricted demand profiles is presented in Appendix A (Appendix Table 3-4). As noted earlier, following completion of the DO assessment, further information has come to light regarding Southern Water's discharges to the River Itchen which means that a correction is required to the WRZ results.

The deployable output assessment involved liaison with Southern Water over the modelling of naturalised flows in the River Itchen. This included the assumptions made about effluent discharges from one of the Southern Water treatment works, which is upstream from our abstraction. After completion of the DO assessment, Southern Water informed Portsmouth Water that their discharges from treatment works on the River Itchen could be a lot lower in drought events. Rather than re-run all the modelling for the River Itchen, to correct for this, Portsmouth Water has subtracted a nominal 5 Ml/d from the ADO for Source A for each of the scenarios with a return period of 1 in 40 or greater. This reduces the ADO from Source A and also reduces the total Company ADO for some return periods. The adjusted ADO values are shown in Table 13.

Total deployable output is used in Section 6 as part of the overall supply/demand balance.

	1 in 20: Dry	1 in 40: Historic	1 in 80: Extended	1 in 125: Serious	1 in 200: Severe
Source A	36.9	31.6	30.3	30.2	20.0
Source B	53	47.6	46.6	42.4	42.9
Source C	17.3	17.2	16.6	16.5	16.3
Source D	1.1	0.8	0.8	0.6	0.8
Source E	0.4	0.4	0.4	0.4	0.4
Source F	7.2	7.3	7.1	7.2	6.9
Source G	1.5	1.6	1.5	1.5	1.5
Source H	7.7	7.6	7.3	7.3	7.2
Source I	1.5	1.4	1.4	1.3	1.4

Source J	9.1	8.5	8.5	7.8	8.3
Source K	9.6	9.5	9.2	9.1	9.0
Source L	13.7	13.3	12.9	12.5	12.6
Source M	4.5	3.7	3.5	2.8	3.8
Source N	22.2	22.1	21.3	21.1	20.9
Source O	4.1	2.9	2.8	1.6	2.8
Source P	8.4	8.4	8.1	8.0	7.9
Source Q	9.7	9.7	9.7	9.6	9.6
Source R	10.3	10.2	10.2	10.1	10.1
Source S	1.9	2.0	1.9	2.0	1.9
Source T	6.4	6.5	6.5	6.4	6.4
Total	**227**	**212**	**207**	**198**	**191**

Table 13 Average Deployable Output by Source for selected return periods (adjusted output, based on stochastic climate data and unrestricted demand profiles)

The peak week values obtained from the WRZ DO assessment (Appendix A Table 3-4) have not been reduced because the Southern Water treatment discharge input will be greater during the critical period when demand for water is higher. The PDO values are shown in Table 14.

	1 in 20: Dry	1 in 40: Historic	1 in 80: Extended	1 in 125: Serious	1 in 200: Severe
Source A	40.6	40.6	40.6	40.6	39.4
Source B	57.8	52.1	48.7	43.9	39.0
Source C	22.5	22.5	22.5	22.5	21.8
Source D	2.4	2.1	1.9	1.7	1.5
Source E	0.5	0.5	0.5	0.5	0.4
Source F	11.7	11.9	12.1	11.9	8.8
Source G	3.3	3.1	2.9	2.6	2.3
Source H	9.1	9.1	9.1	9.1	8.8
Source I	2.1	2.0	1.9	1.9	1.8
Source J	10.2	10.2	10.2	7.9	7.9
Source K	12.3	12.2	12.2	12.2	13.2
Source L	15.5	15.0	14.7	14.3	13.6
Source M	6.0	4.8	3.9	2.8	2.0
Source N	35.2	35.2	35.2	33.9	30.7
Source O	4.2	2.7	1.7	1.3	1.0
Source P	10.0	10.0	10.0	10.0	10.0
Source Q	12.4	12.1	11.6	11.7	11.2
Source R	13.5	13.1	12.5	12.6	12.0
Source S	2.5	2.5	2.4	2.5	2.4
Source T	8.5	8.4	8.0	8.2	7.8
Total	**280**	**270**	**263**	**252**	**236**

Table 14 Peak Deployable Output by Source for selected return periods (based on stochastic climate data and unrestricted demand profiles)

4.2.8 Future Reviews of Deployable Output

The reassessment of DO for WRMP19 has resulted in a reduction in individual source DOs across a range of drought conditions owing the identification of new constraints including environmental flow constraints and DAPWLs. In addition, PDO and ADO derived from the WRZ DO model have further reduced through adjustment of the peak demand period from July to August.

It is considered that further testing of DOs and different abstraction patterns (spatial and temporal) within the Environment Agency's regional groundwater model may be beneficial to future WRMPs and Drought Plans. In particular, this could be used to explore flows on the River Itchen, taking into account Southern Water's sustainability reductions.

The reassessment of individual source DOs identified some gaps in Portsmouth Water's historic operational records. Portsmouth Water plans to review its monitoring programme to ensure that going forwards, more consistent data is collected to inform future DO assessments.

4.3 Sustainability Reductions

Sustainability reductions, or reductions in abstractions licences which result in reductions in DO, may be required to protect international or national designated conservation sites, to protect locally important but undesignated sites, or to deliver Water Framework Directive (WFD) objectives.

The Company has undertaken several previous environmental investigations, the results of which are summarised in section 4.3.1.

The Environment Agency has provided the Company with a rolling programme of sustainability reduction updates. The most up to date information available has been included during each stage of planning and drafting the Company's WRMP. The latest release of information from the Environment Agency (March 2018) is presented in section 4.3.2.

There are some further investigations which have been identified by the Environment Agency as potential future requirements. These are outlined in section 4.3.3.

Section 4.3.4 describes the way in which sustainability is taken into consideration throughout the Final WRMP.

4.3.1 Previous Environmental Investigations

Portsmouth Water has undertaken several environmental investigations to date under the Habitats Directive and WFD drivers. Options Appraisal work has been undertaken under the National Environment Programme (NEP).

The Habitats Directive and WFD Investigations described in this section were completed in March 2013 and subsequent options appraisals were completed in 2014 and included in the NEP programme. Portsmouth Water has worked with two 'Catchment Partnerships' in its area of supply to help deliver the NEP schemes.

The results of the different environmental investigations that have been undertaken to date are summarised in Table 15, Table 16 and Table 17.

Subject of Investigation	Result of Investigation	Changes Made to Licence	Current Situation
Hamble Estuary	No adverse effects from abstraction	None	No change
Titchfield Haven	No adverse effects from abstraction, although potential for in-	Time limit on Source F Licence until December 2017 (to allow time for further	Augmentation clause became permanent in December 2017

	combination effect with Hill Head Harbour	investigation). Temporary augmentation clause added	resulting in a DO reduction of 2 Ml/d for Source F.
Hill Head Harbour	No adverse effects from abstraction, although potential for in-combination effect with Titchfield Haven	As per Titchfield Haven	As per Titchfield Haven
Fareham Creek	Impacted by abstraction at Source I and Source J.	Source I licence varied in May 2015. Abstraction restricted to 1.5 Ml/d at low flows to ensure fresh water discharges to the harbour.	Low flow restriction in place. DO assessment takes this into account.

Table 15 Summary of Portsmouth Water's Habitats Directive Investigations

Water Body	Result of Investigation	Outcome
River Hamble	River Hamble in relatively good condition. Abstraction from Source C will impact on the North Pond in Bishop's Waltham and the waterbody just downstream	Options for supporting flows in the affected stretch of river were considered under the NEP
River Wallington	Little or no connectivity with groundwater at times of low flow. Impact of abstraction on the ecology of the river considered to be minor. The Lower Wallington would only be impacted under fully licensed conditions and then only in the area of the tidal limit. Low flows are supported by discharges and the licence variation at Source I (May 2015) included a limit on abstraction which will improve flows at the bottom of the catchment.	No further change
River Ems	It was concluded that the River Ems was impacted by abstraction, but an augmentation scheme went some way to mitigate this at low flows. The augmentation was reviewed and a new source of raw water augmentation (Source U) was trialled and brought into use.	Source N and Source U licences were re-issued in April 2016. These licences are time limited to 2028 with the augmentation flow falling to the lower original augmentation flow and location if not renewed.
River Lavant	The River Lavant is naturally 'ephemeral' with periods of no flow in most years. The overall ephemeral nature and extent is not affected by abstraction. The ecological data shows relatively little sensitivity to the duration of wetting and drying with rapid recovery once flow commences.	No change required

Table 16 Summary of Portsmouth Water's WFD Investigations

Options Appraisal	Outcome
Review augmentation on the River Ems and to consider river restoration work	River restoration was considered at two sites. The first site was unsuitable for major restoration due to the presence of water voles. However, the Company assisted with the de-silting of an online pond and funded alterations to two control structures to benefit migrating fish. At the second site, the Company worked with the local Rivers Trust to complete river restoration work. Collaboration with the Rivers Trust ensured that other schemes were developed downstream with other landowners and funding sources. This has provided a real benefit in terms of fish migration on the River Ems. This scheme has been completed and signed off by the EA.
River restoration on the Hamble to support abstraction at Source C	River restoration measures including silt traps, road drainage improvements, hard surface cattle crossings and weir removal were implemented in the summer of 2016 and 2017 in association with the Rivers Trust and the Downs and Harbours Clean Water Partnership. This scheme has also been completed and signed off by the EA.

Table 17 Summary of Portsmouth Water's NEP Options Appraisal work

4.3.2 Latest Sustainability Reduction Information

The Water Industry National Environment Programme (WINEP) was published in September 2017 by the Environment Agency. The Environment Agency initially suggested further investigations were required at Sources A, F, J, L, M, N, O, however the WINEP list has subsequently been revised. The current version is WINEP3 (March 2018).

The Environment Agency notified the Company on 29 March 2018 that three WINEP water resource investigations would be required during AMP7. One has a WFD driver, the other two are associated with conservation objective standards, biodiversity standards and the NERC Act.

Table 18 summarises the information currently available for the WINEP water resource investigations. It should be noted that these are currently proposed investigations and have been classed as 'green' in terms of level of certainty, although the volumes of the potential sustainability reductions are currently unknown and will be determined once the investigations have been completed.

Description	Associated Portsmouth Water abstractions	Potential Sustainability Reduction	Details
Action to investigate and undertake Options Appraisal for improvements to the hydrological regime to meet WFD objectives	Source F	Unknown at present	The EA have asked for an investigation and options appraisal with a completion date of March 2022.
Habitats Directive investigation based on Common Standards Monitoring	Source A	Unknown at present	The EA have asked for an investigation and/or options appraisal to determine the costs, impacts and technical feasibility of reaching or maintaining revised CSMG flow targets for the River Itchen SAC. The EA have suggested that this should be a joint investigation with Southern Water

Guidance (CSMG)			and South East Water with a completion date of March 2022.
Investigations based on biodiversity priorities and the NERC Act	Source A	Unknown at present	Investigation to determine the costs, impacts and technical feasibility of reaching ASB3 in principle salmon rivers (as per Salmon 5 point action plan) The EA have suggested this be linked to the CSMG Investigations.

Table 18 Portsmouth Water Sustainability Reductions (WINEP3)

Further information regarding the WINEP3 water resource investigations is provided below.

4.3.2.1 Source F

The Company considered construction of additional boreholes at Source F as an option to provide additional yield to balance supply and demand. Through consultation with the Environment Agency, the Company were made aware that any increase in abstraction at Source F would likely require a WFD investigation.

Following discussions with the Environment Agency, Option RO23 was screened out of the options appraisal (i.e. was not considered to be a feasible option) In the Draft WRMP based on the presumption against further consumptive abstraction in this part of the catchment. This situation has not changed for the Final WRMP.

4.3.2.2 Source A

The Environment Agency has asked Portsmouth Water to investigate the impact of tighter flow standards on the River Itchen. These flow standards are set out in the 'Common Standards Monitoring Guidance' (CSMG) document (JNCC, 2016). These are not yet a regulatory requirement as they have not been the subject of a Regulatory Impact Assessment.

Portsmouth Water currently think it likely that the impact of tighter flow standards will occur at low flows. The Company are of the opinion that the impact will have the most effect on Southern Water's SRN Source A abstraction which lies upstream from both the Chickenhall WWTW discharge and Portsmouth Water's abstraction at Source A. Using the flow simulation from the DO assessment, the Company's initial estimate is that even under the lowest flow conditions, Portsmouth Water should be able to abstract 20 Ml/d at Source A. However, the Company has investigated the loss of this source as a sensitivity scenario. This is described in section 8.

4.3.3 Other Potential Investigations

The Environment Agency's latest WINEP3 spreadsheet does not contain any information about other potential water resource investigations. However, Source J has been discussed with the Environment Agency.

Source J is currently being investigated for water quality reasons which has resulted in a reduction in yield. In the Options Appraisal process (section 7), the Company has considered two options; RO22 and RO22a. Option RO22 involves the construction of additional boreholes at the site to provide additional yield. Option RO22a involves maximising the DO of the source within existing licence limits by construction of a satellite borehole. Following discussions with the Environment Agency, Option RO22 was screened out of the options appraisal (i.e. was not considered to be a feasible option) based on the presumption against further consumptive abstraction in this part of the catchment. Option RO22a was not screened out on the basis that the existing licence will not be increased. As part of the application process for a licence variation, the Company will need to undertake an assessment of any potential environmental impacts. Source J is associated with the River Wallington which has previously been the subject of a WFD investigation (see Table 16). The Company's assessment for the new licence

variation will be informed by the previous WFD investigation, although the Company recognises that a new environmental assessment will be required. The results from the updated analysis will be discussed and agreed with the Environment Agency.

The Company will work with the Environment Agency and carry out investigations to assess 'risk of deterioration' at their sources and put any necessary measures in place to prevent deterioration before allowing abstraction to increase.

4.3.4 How Sustainability Influences WRMP19

The sustainability of abstraction licences has been taken into consideration during the development of the Final WRMP both through consideration of sustainability reductions and the Strategic Environmental Assessment (SEA) process.

4.3.4.1 Sustainability Reductions

As indicated in Table 18, investigations due to be undertaken in AMP7 may result in sustainability reductions on the Company's abstractions. However, as the Environment Agency has not notified the Company of any volumetric reduction (this is likely to remain unknown until the completion of investigations), the Company has been unable to directly account for the impact of sustainability changes on deployable output to include in WRMP19. The sustainability changes described in the preceding sections have therefore been taken into consideration and used within the testing of the preferred plan (section 8).

As stipulated by the WRPG, the Company has not made an allowance for potential sustainability reductions in its target headroom assessment.

4.3.4.2 Strategic Environment Assessment

Figure **16** illustrates how the SEA, WRMP and HRA preparation processes are integrated. It has been sourced from Strategic Environmental Assessment and Habitats Regulations Assessment – Guidance for Water Resources Management Plans and Drought Plans, UK Water Industry Research (WIR) Limited 2012.

Portsmouth Water's SEA and HRA were undertaken by consultants Wood (previously AMEC Foster Wheeler) and are included in Appendix O and Appendix P, respectively. The SEA contributed to the development of the WRMP19 in two main ways; (i) through the options screening process and options appraisal and (ii) during programme appraisal.

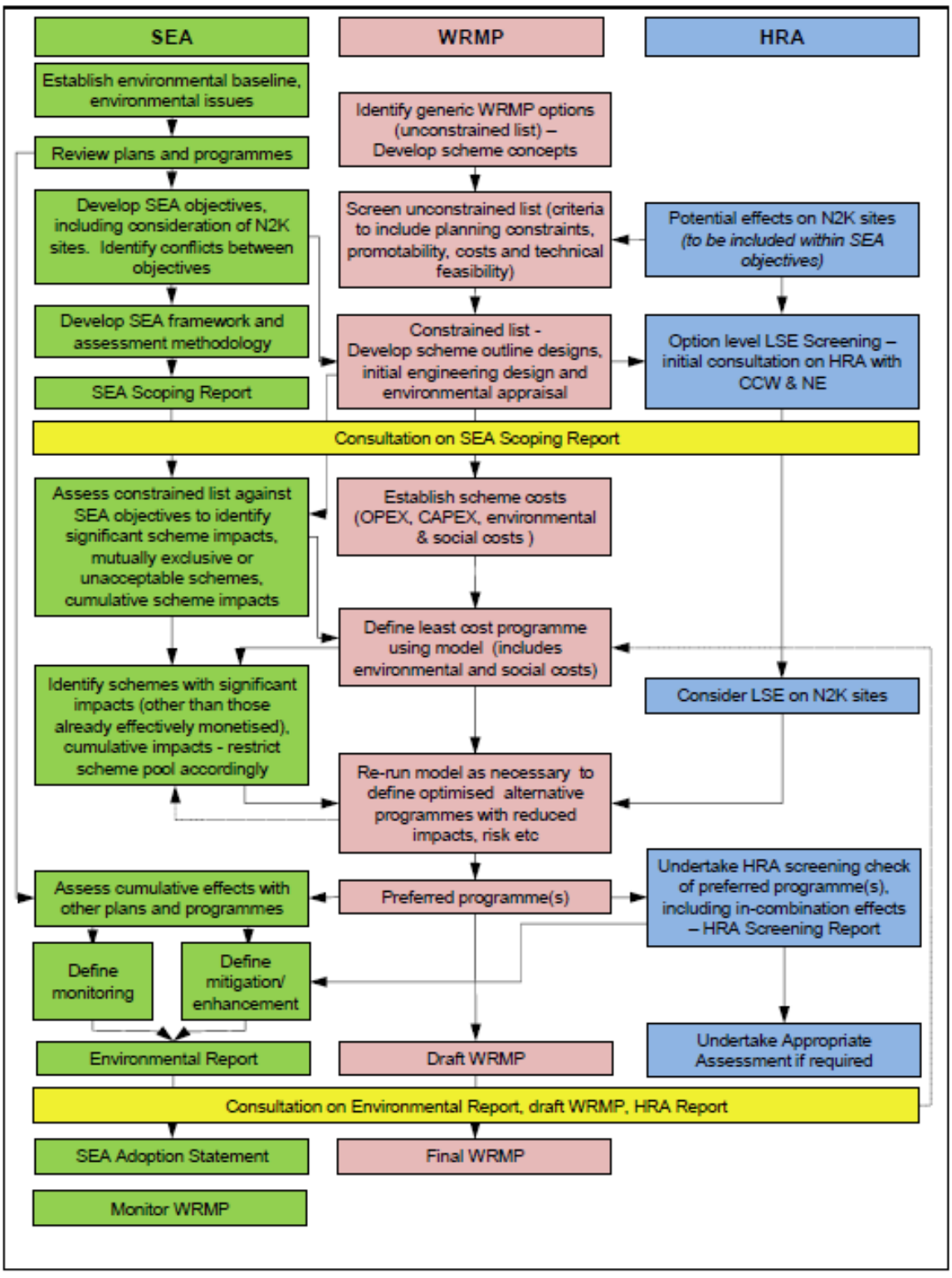


Figure 16 Relationship between the WRMP, SEA and HRA processes

Contribution to Options Screening Process and Options Appraisal

The Strategic Environmental Assessment (SEA) influenced the preparation of the WRMP19 at an early stage through establishing the environmental baseline, identifying environmental problems and considering strategic environmental objectives. The environmental information

contributed to and was used within the Options Appraisal screening process (see section 7.3). Information from the SEA was used to screen the unconstrained list and to provide an environmental appraisal of those options remaining on the feasible options list.

Contribution to Programme Appraisal

The SEA was used to assess the feasible options to identify any significant scheme impacts or cumulative scheme impacts, and this information was used to inform the selection of the preferred options and ensure that these were the best environmental options available (see section *7.7*). The cumulative effect of the preferred plan was considered, together with mitigation and monitoring requirements.

4.4 Climate Change

For the WRMP19, the Company has completely updated its assessment of climate change assessment. The WRMP requires companies to use UKCP09 data and the methodology set out in the UKWIR report 'Climate Change and Water Resources Planning' (2012). In addition to this, new guidance was issued in relation to forecasting river flows in the 2080s.

4.4.1 Vulnerability Assessment

The first stage of the methodology is to assess the vulnerability of the Company's sources to climate change impacts. Portsmouth Water employed AECOM to undertake the overall deployable output assessment and they were assisted by HR Wallingford (HRW) for the climate change work. The climate change vulnerability assessment was based on information already available from previous WRMPs and Drought Plans.

HRW produced a vulnerability assessment summary table (see Appendix C) and this concluded that the overall sensitivity was 'medium'. This implied that a full climate change assessment was not required, but the Company nevertheless took the decision that AECOM as part of their DO assessment, should carry out one.

4.4.2 Climate Change Impacts on Surface Water

For the WRMP19, HRW has used the UKCP09 projections of climate change impacts. The full set of data contains 10,000 projections of weather data, but HRW advised the Company that a subset of 100 results represented the full range of uncertainty in the climate change projections. HRW set out how the sampling approach works and what the results look like for the South East of England (see Appendix C).

To apply the climate change projections to surface water flows, the consultants used a CATCHMOD surface water model developed for the River Itchen at Source A. The Environment Agency provided baseline daily rainfall, potential evaporation and temperature data from 1880 to 2005. This data was 'perturbed' using the monthly UKCP09 factors for the 100 selected samples and the model was run 100 times. A set of 100 river flow time series were generated for the flow gauging sites at Allbrook and Highbridge (which are both upstream of the Company's abstraction) and these were then transposed to Riverside Park using a regression relationship. Riverside Park is the gauging point at the tidal limit which is used to control abstraction at Source A.

Figure 17 presents the potential impact of climate change on flows by 2080 for Allbrook and Highbridge under a 'Medium' emissions scenario.

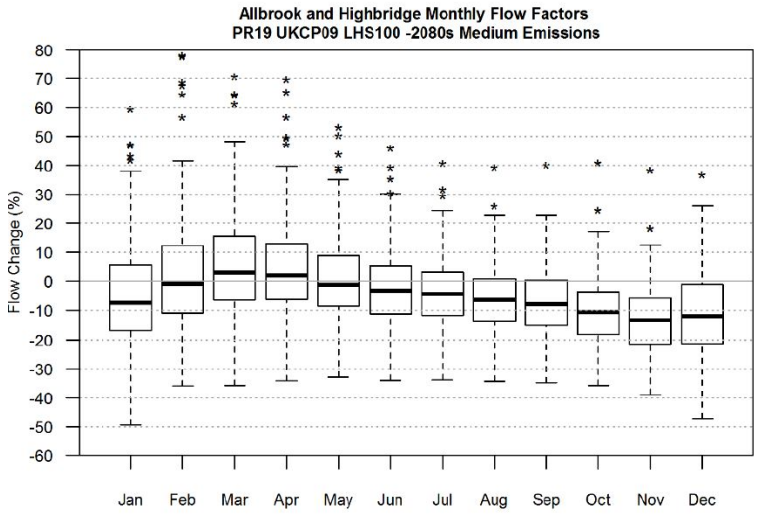


Figure 17 Climate Change Impact on Surface Waters

4.4.3 Climate Change Impacts on Groundwater

AECOM produced a 'Groundwater Level' model which allows groundwater impacts to be assessed in more detail. The subset of 100 climate change projections is used to perturb Well X levels. Portsmouth Water uses Well X to infer groundwater levels across its supply area. The 100 groundwater levels at Well X are inserted into the 'Resource Zone' model, which calculates the potential abstraction rate at each source works. This relatively simple approach to assessing climate change impacts on groundwater has produced results that are consistent with previous modelling. Climate change causes groundwater levels to fall and therefore groundwater yields to fall also.

4.4.4 Combined Climate Change Impacts

When the surface water impacts at Source A are added to the groundwater impacts the combined impact in 2044 is −0.92 Ml/d at average and −2.70 Ml/d at peak.

Year	2019	2024	2029	2034	2039	2044
ADO (Ml/d)	−0.04	−0.21	−0.39	−0.60	−0.75	−0.92
PDO (Ml/d)	−0.2	−0.70	−1.20	−1.70	−2.20	−2.70

Table 19 Climate Change Impact on Average and Peak Deployable Output

The requirement to set out the water balance for drought events, in the WRMP, means that the impact of climate change on rare events needs to be considered. This was not done for the Drought Plan 2018 because it was considered to be an 'operational plan' and specifically excluded climate change. Further work to consider the impact of climate change on rare events will be carried out when updated national climate change forecasts are available in 2019.

4.4.5 Headroom Allowance

The statistical approach to climate change produces a central forecast and a range of uncertainty. This can be used to calculate the impact of climate change on deployable output and feeds into the headroom assessment.

The uncertainty data from HRW has been used to populate the Monte Carlo simulation. Headroom is described more fully in Section 6.2 and in Appendix F.

4.5 Outage Assessment

Outage is defined as a temporary loss of deployable output at a source works. It can relate to planned or unplanned events and covers a wide range of influences from power failure to short term pollution incidents.

4.5.1 Assessment Timescales

For the 2014 Plan, data was analysed for the period 2007–2012. For the WRMP19, the assessment is based on data from 2017–2016. Looking at the previous 10 years ensures that the outage is relevant for the following five-year time step. Over a longer period, outage will continue to be influenced by power failure, system failure and pollution incidents.

4.5.2 Current Guidance

Portsmouth Water employed AECOM to undertake the outage assessment for WRMP19.

The assessment was completed taking into account the following guidance:

- EA and NRW 'Water Resources Planning Guideline' (April 2017)
- UKWIR 'Outage allowances for water resources planning' (1995)
- UKWIR 'WRMP19 methods – risk-based planning' (2016).

The guidance requires companies to pre-consult on the outage methodology if it is different from the UKWIR methodology. Portsmouth Water did not need to pre-consult with all stakeholders but shared its draft report on outage with the Environment Agency.

4.5.3 Methodology

The methodology used is described briefly below. Further detail is provided in the report produced by AECOM (Appendix D).

Historical data have been split into outage categories with magnitudes and durations recorded. A Monte Carlo simulation has then been used to simulate outage in the future, having justified which events are 'legitimate'.

AECOM used a model called @ RISK to carry out the simulation and have commented on the seasonal distribution of outage and the repeatability of results. All Monte Carlo simulations undertaken for this outage assessment have been run for 10,000 iterations, which in practice gives consistent results. The risk percentiles and the relative contributions are set out in Appendix D.

Outage has been calculated with an allowance for the additional DO provided by Havant Thicket Reservoir (R013) and the DO recovery schemes.

4.5.4 Analysis of Recorded Data

Since 2007 Portsmouth Water's operational staff have been maintaining a new record system for actual outage. The outage register is in the form of a spreadsheet which records:

- Start and end date and time
- Site reference
- Percentage of deployable output lost
- Planned or unplanned events
- Short term or long-term shutdown
- Classification and fault code

Since 2012 the Company has been recording outages of less than one day.

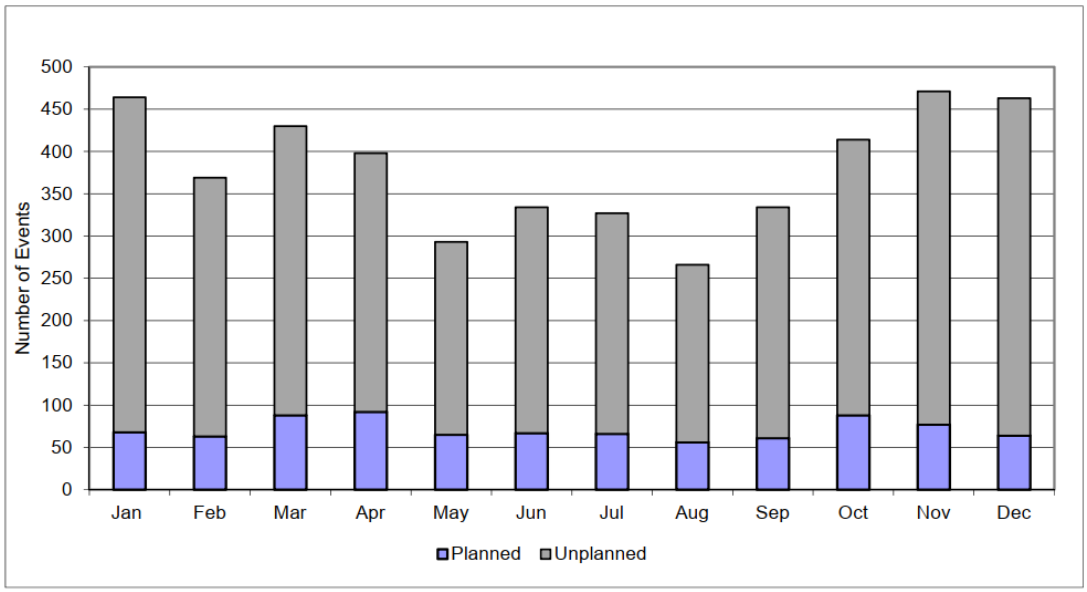


Figure 18 Seasonal Distribution of Recorded Outage Events, 2007 - 2016

Over the ten-year period, there were 4,563 outage events of which 19% were planned and 81% were unplanned. Figure 18 shows the distribution of these events across the months of the year and indicates that a greater proportion of outage events have occurred during the winter months than in the summer. This reflects a policy of scheduling routine maintenance during the winter when demand is generally lower. Unplanned outage events are also less frequent during the summer months. It is important to note that the outage events do not result in interruptions to service to customers in normal years because of the resilience of the works and networks and two to three days storage at the service reservoirs. A number of the recorded events cause a reduction in capacity rather than a loss of works.

4.5.5 Outage Assumptions

The analysis of future outage is based on events that are considered to be 'legitimate'. Many of Portsmouth Water's recorded outage events are not legitimate outage events to assess a suitable outage allowance for the Company's supply/demand balance. The reason for this is that either they did not result in a loss of DO or because the DO lost was not required to meet demand at the time of the shutdown, a reflection of the resilience of the Company. These events are not considered as outage events within the assessment. They are instead classed as strategic operational decisions.

All planned events were excluded from the outage assessment, firstly those in excess of 90 days. Where appropriate these have been considered within the company DO and headroom assessments. This is in line with the UKWIR guidance Outage allowances for water resources planning (1995).

In previous outage assessments planned events below 90 days were included in the DYAA and DYMDO scenarios, with durations capped to represent typical maintenance periods, but excluded from DYCP scenario. However in this assessment planned events are excluded from all three scenarios, as the aim is to calculate an outage allowance to represent drought year conditions and it is assumed that planned events would not be scheduled (or would be postponed) during times of critical supply-demand balance.

In addition, the Source U has an ongoing turbidity issue that is unlikely to be resolved in the current WRMP cycle. Any outage events reported at Source U are due to a longer-term loss in DO rather than true outage events and as such have been removed from the outage events log.

Unplanned events in excess of 90 days have been included within the assessment, but capped at 90 days, in line with the outage assessment guidelines. Event durations in excess of 30 days were reviewed by Portsmouth Water and in some cases adjusted to reflect realistic lead times for correcting the outage event. It is assumed that during drought and/or high demand scenarios, the outage could be addressed more quickly if necessary, within either 30 or 90 days depending on the nature of each specific event.

For the current assessment, the following events have been capped at 30 or 90 days:

- 112-day event at Source O caused by turbidity
- 365-day event at Source F caused by a system failure (Booster pump)
- 345-day event at Source G caused by a system failure (Telemetry)
- 128-day event at Source K caused by a system failure (Membrane)
- 149-day event at the River Itchen Works caused by a system failure (Booster pump)
- 136-day event at Source J caused by a pollution incident (Heating fuel spillage)
- Two events > 1 year each at Source K caused by a pollution incident (Oil)
- 134-day event at Source R caused by a pollution incident (Heating fuel spillage)
- An event > 1 year at Source H caused by a pollution incident (Heating fuel spillage)

Oil pollution events within the catchment occurring for longer than 90 days were considered within the headroom allowance in previous assessments (for WRMP14, and the initial assessment for the draft WRMP19). However, Portsmouth Water acknowledges that the closures to date have been precautionary, an approach which has been possible due to available headroom within the Company's supply-demand balance at the time of recorded events. In the event of future oil spillages occurring in proximity to the Company's groundwater sources at times when the supply-demand balance is critical, due to drought and/or high demand or other factors, long-term source closures would be less likely to be implemented. Monitoring and risk assessment would be undertaken and if necessary additional treatment processes (e.g. carbon tanks) would be installed to maintain a safe supply from the affected source and to limit the period of source closure.

All historic outages relating to oil spill risks will be fully assessed within the Company's outage allowance (and excluded from the headroom assessment) for consistency, and to avoid over-stating the potential impact of precautionary source closures on future supply availability. For the purposes of the outage analysis, the durations of recorded events will be capped at 90 days (dry year annual average and dry year minimum deployable output scenarios) or 14 days (dry year critical period scenario), as it is assumed that measures to monitor and/or treat potential source pollution could be put in place within these timescales. This limits the impact of the precautionary source closures which have occurred to date, on the Company's future supply-demand balance, whilst still making some allowance for potential temporary loss of deployable output due to this factor.

Other adjustments to event durations were made to reflect more realistic response times to outage events during drought conditions and/or periods of high demand or any other time when the supply-demand balance is critical. Any faults with durations of between 10-30 days were reduced to 10 days, durations of events caused by faulty hatch alarms were reduced to zero and durations of intruder alarm events were capped at a maximum of 30 minutes.

For the purposes of this assessment, events with durations of 5 days or more were categorised as long term events, whilst all other events were categorised as short term.

Event magnitudes were reviewed and all short-term events have been assumed to have an outage magnitude of 100% of the source DO. The only exception being three longer term system/turbidity outage events at Source A, Source F and Source O which were modelled separately in the Monte Carlo simulation with partial DO loss (20% of 25% as applicable in each case), to avoid overstating the impact of these on-off events.

To ensure that outage is not overestimated the data were sorted to remove double counted events

4.5.6 Summary of Legitimate Outage Events

A step-by-step audit process was adopted to exclude all events from the assessment which did not meet the Environment Agency's definition of a legitimate outage event, and to amend or re-categorise certain events as outlined in Section 4.5. The process can be summarised as follows:

- Audit 1: Removal of all planned events from master database where "station not required" or similar narrative is listed within the remarks column, along with all outage events from Source U.
- Audit 2: Amendment of master database to cap all unplanned events with durations greater than 90 days to a 90-day maximum, with review of system events above 30 day durations. Events of duration between 10 and 30 days adjusted to 10 days' duration, and intruder alarm events adjusted to a maximum duration of 30 minutes.
- Audit 3: Correction of all negative duration events.
- Audit 4: Removal of outage events with zero DO impact.
- Audit 5: Removal of events with blank Partial Outputs and zero DO loss including faulty hatch alarm events for which the duration was adjusted to zero.
- Audit 6: Removal of double-counted events within the Treatment Works B and Source B outage data.
- Audit 7: All planned events were excluded. Two cryptosporidium events at Source Q and Source R respectively were excluded.

Events in the system and turbidity categories were categorised by duration as short term (<5 days) or long term, to enable short term and long term events to be represented by separate distributions in the outage allowance probability simulation.

Following the above process resulted in a total of 2,480 legitimate outage events from the period April 2007 – end of March 2016 being selected for further analysis. Of these, all were unplanned as planned events are now excluded from the outage allowance. The seasonal distribution of these 2,480 outage events demonstrates that there are still a greater proportion of events occurring in the winter months, with only 1,044 or 42% of the legitimate events occurring during the months of April to September inclusive.

4.5.7 Accounting for Action to Reduce Outage

During AMP6 and in support of the Company's Business Plan, a number of studies and initiatives have been undertaken, including modelling and testing where required, to consider resilience and additional requirement both in the short and long-term.

One study concentrated on potential high impact and single point failures given that one treatment works contributes 45% of supply to customers. A major threat to the Company's treatment works is from oil spills as discussed in section 4.5.5 and so the purpose of the study was to explore the most effective solution to ensure resilience to this risk, and the projects include expenditure to deal with this. The study included extensive modelling and evaluation of the Company's supply system and distribution systems to consider short and long-term resilience to outages. Over 440 scenarios were tested with failure scenarios ranging from single to 6-point failure. The overall conclusion was that no properties were at risk on an average day, however at peak demand some 100,000 customers would be at risk of low pressure for up to 3 hours. A range of options were considered, and the Company's 2020-25 Business Plan includes four projects that will address the risk and improve resilience at peak demand in a normal year at a cost of £2.4m. Whilst these options will increase resilience at peak demand in a normal year, they have not been tested in 1 in 200-year drought.

The Company has considered a range of Catchment Management options to reduce outage in the plan. Catchment Management is a key tool in controlling pollution incidents and the Company is involved in three Catchment Partnerships. These have included initiatives to reduce domestic oil pollution for example through the offer of subsidised surveys of old oil tanks and/or subsidised replacement of oil tanks with plastic double bunded tanks. These initiatives will continue in the next AMP.

In addition, the Company is planning to implement a new system for Storage and Production Optimisation in Real Time (SPORT). The SPORT system will continuously analyse and select the optimum pump combinations from the multiple inter-connected sources to balance reservoirs and meet customer demand. Where outage occurs, the SPORT system will allow automated reset to restart works, and where this is not possible, SPORT will analyse and modify the optimum pump combinations on available pumps. Only where reservoirs cannot be balanced within defined limits will out of hours responses be required.

4.5.8 Results

Outage allowances have been calculated for three scenarios:

- Dry Year Annual Average (DYAA)
- Dry Year Critical Period (DYCP)
- Dry Year Minimum Deployable Output (DYMDO)

An initial assessment of future variations in the outage has also been undertaken to take account of significant planned increases to the Company's supply availability during the 25-year planning period. Future profiles of outage have been determined using the same standard approach but with probability distributions based on the increased deployable output values applicable at each stage of the planning period.

The selected outage values are for a probability of 95%, or exceedance probability of 5%.

Period	DYAA		DCYP		DYMDO	
	Value in Ml/d	As % of DO	Value in Ml/d	As % of DO	Value in Ml/d	As % of DO
2018/19	13.0	5.7%	12.5	4.5%	14.2	5.7%
2019/20 – 2022/23	13.1	5.6%	12.5	4.4%	14.3	5.6%
2023/24 – 2028/29	13.5	5.5%	12.6	4.3%	14.7	5.5%
2029/30 – 2044/45	14.6	5.5%	15.4	4.5%	16.0	5.5%

Table 20 Outage included in WRMP (Ml/d)

Outage is higher than the previous plan because there has been an increased number of legitimate outage events in the most recent period of data and due to the improved recording of events.

At 5.5 % of DYAA and DYMDO deployable output, the Company's outage figures are within the typical range of around 2% - 8% (based on reported dry year annual average scenarios in WRMP14 assessments). Outage has been calculated for each works, but the figures are not cumulative as all sites are not assumed to be unavailable at the same time. The combined probability distributions are provided in the detailed report (Appendix D).[5]

[5] It should be noted that the Company's outage allowance for the Final WRMP19 is not the same measure as the new outage ODI, defined by Ofwat, which is focused on peak week capacity and reflects the health of the assets.

The main contributory factors to the Company's outage assessment are those of system failures and chlorine. The recording of system failure outage events has become more consistent across the sites in recent years contributing to an increase in their frequency.

It should also be noted that event durations of short term system failures are likely to be somewhat longer on average, when compared to other companies. Portsmouth Water currently does not require an operations centre with the facility for remote or automatic restart following system shutdown events, as supplies to customers are very rarely affected. Whilst maintaining an operations centre to monitor events, the Company adopts an approach of either isolation for investigation the following day or a physical site visit to inspect and verify failure reasons in situ before restarting supply.

Outage has been determined to take into account future revised values of DO at certain sources. These are sources at which the DO is anticipated to increase due to planned capital schemes to restore groundwater deployable output and/or new resource schemes (Havant Thicket reservoir). The assessment has indicated that small increases in the Company outage assessment are likely, due to the higher deployable output. The outage is, however, relatively constant when it is considered as a percentage of the Company's overall deployable output.

4.6 Process Losses

Treatment works losses only apply to sources with more complex processes such as rapid gravity filtration and membrane filtration. Portsmouth Water has two works with full conventional treatment and three works with membranes for Cryptosporidium removal. At two works there is a compensation water condition in the licence, but this raw water loss is not included in process losses.

In general, complex treatment works such as Treatment Works A have losses of around 5% of DO. At Treatment Works B, membrane filters have now been replaced with a UV treatment plant and losses have fallen to less than 1%.

Table 21 summarises the process losses assumed for a Dry Year.

Source Works	Treatment	Average (Ml/d)	Peak (Ml/d)
Treatment Works A	Complex	1.9	1.9
Treatment Works B	Complex	0.2	0.2
Source F	Membrane	0.1	0.1
Source K	Membrane	0.1	0.1
Source P	Membrane	0.1	0.1
Total		**2.4**	**2.4**

Table 21 Process Losses

Portsmouth Water does not include treatment works losses in the calculation of DO. Treatment works losses and raw water losses are entered as separate lines in the WRMP Tables. The tables then combine these entries to give the overall process loss.

The River Ems augmentation flow has been removed from the process losses because it has been provided by raw water since 2015. The augmentation is provided by Source U which has been removed from the overall DO assessment.

4.7 Bulk Supplies

The current guidance requires companies to consider a wide range of supply options including bulk transfers to and from other companies as well as third-party suppliers.

Portsmouth Water has been fully involved in the WRSE modelling programme which included bi-directional flows in the existing Southern Water bulk supply and potential future bulk supplies with South East Water.

The existing bulk supply agreements which are available throughout the planning period (April 2020 - March 2045) comprise:

- Southern Water – Sussex North (15 Ml/d)
- Southern Water – Hampshire Southampton East (15 Ml/d).

The currently proposed bulk supplies with Southern Water are as follows:

- Southern Water – Hampshire Southampton East (additional 9 Ml/d from 2024/25)
- Southern Water – Hampshire Southampton East (additional 21 Ml/d from 2029/30)

Further detail regarding the existing and future bulk supply options with Southern Water is provided is sections 4.7.1 and 4.7.2. It should be noted that whilst the requirement for future bulk supplies with South East Water was considered under WRSE, South East Water has confirmed that they no longer require a bulk supply.

4.7.1 Southern Water Sussex North

Portsmouth Water has an existing bulk supply agreement with Southern Water to supply their Sussex North zone. The bulk supply was constructed in 2004 and the agreement was renewed in 2016. Water is pumped from Source S Works to a break pressure tank and from there gravitates to SRN Source D Treatment Works.

The maximum transfer rate is 15.0 Ml/d and this was originally intended to be available only at Minimum Deployable Output during the autumn. Southern Water took the bulk supply for a much longer period in 2004 and into the winter of 2005. Portsmouth Water obtained a licence variation for the QRST Group to help secure the bulk supply. The bulk supply agreement was renewed on the basis that 15.0 Ml/d can be delivered at an average and peak demand. The current bulk supply is not bi-directional.

There is a cross connection between the bulk supply to Sussex North and an existing Southern Water main to Southern Water's Sussex Worthing zone. This connection provides operational flexibility but does not increase the total transfer capacity. When Southern Water is operating their SRN Source C, this connection is not available for bulk supply. As this cross-connection does not affect the transfer capacity between Portsmouth Water and Southern Water, it is not included within Portsmouth Water's WRMP.

4.7.2 Southern Water Hampshire Southampton East

As part of the WRMP14 a second bulk supply was offered to Southern Water from the Source A. Initially this was expected to go via one of Southern Water's service reservoirs, but as the project progressed, it was clear that the bulk supply would be supplied directly from Source A to Southern Water's Hampshire Southampton East Zone. Southern Water has now completed the main and Portsmouth Water has provided a new connection and new pumps within an existing building.

A new bulk supply agreement has been drafted and this is based on the assumption that Portsmouth Water can supply 15.0 Ml/d at all times. This includes average and peak demand up to a 1 in 200-year drought event. The new pipeline offers some increased resilience for Portsmouth Water under normal conditions. This is because in an emergency, it would be possible to discharge water from Southern Water into the contact tank at Source A and for this to be pumped to one of Portsmouth Water's service reservoirs.

Southern Water has experienced problems in its Hampshire Southampton East Zone with respect to meeting their sustainability reductions and their WRMP19 has to consider alternative supply options to meet demand. At the time of producing this Final WRMP19,

Southern Water anticipates that additional bulk supplies from Portsmouth Water will be required. The modelling carried out by Southern Water has selected an enhancement to the current bulk supply and a new bulk supply. The enhancement involves fitting bigger pumps in Portsmouth Water's pumping station but using the same pipeline to Southampton. The pumps are assumed to provide an additional 9 Ml/d bringing the total volume pumped to 24 Ml/d. This supply will be available in 2024/25.

A further new bulk supply would require a new connection to Southern Water's distribution system. This may not be in Southampton but in another area where there is housing growth. The new connection would be sized at 21 Ml/d and would be available in 2029. This bulk supply would increase the total amount of water provided by Portsmouth Water to the Hampshire Southampton East Zone to 45 Ml/d. This volume is the full works capacity at Source A and this water would only be available if Portsmouth Water develop alternative supplies for its customers through construction of the Havant Thicket Winter Storage reservoir.

4.7.3 Third Party Supplies

The Contact Plan (Appendix T) records the potential suppliers that Portsmouth Water considered. No third-party suppliers responded to Portsmouth Water with an offer of supplies.

Portsmouth Water already has two housing developments where a third party delivers the water to the end user. In these cases, Portsmouth Water is retained as the bulk supplier and there is no net reduction in supply. It would be possible for a developer to install effluent re-use and therefore create a nominal surplus for Portsmouth Water to use elsewhere. This has not happened so far.

5 Demand

5.1 Introduction

This section details Portsmouth Water's current and forecast demand for water. It defines and explains the basis of the different demand scenarios used in water resources planning and considers base year and forecast household demand, water efficiency, non-household demand and leakage. The impact of climate change on demand is also considered.

5.1.1 Historic and current demand

Figure 19 shows the Company's historic distribution input (DI) from 1963/64 to 2017/18. It can be seen that there has been a steady decline in DI since 1989. This is attributable to a combination of leakage management, declining non-household demand and greater household water efficiency. Since 2010, there has been a steady fall in DI from 181 Ml/d to a minimum of 167 Ml/d in 2015/16 (which was the base year for the Draft WRMP19), increasing again to 175 Ml/d in 2017/18. This decline is attributed to a fall in commercial demand of 7 Ml/d since 2010 in addition to increased active leakage control, pressure management and household water efficiency.

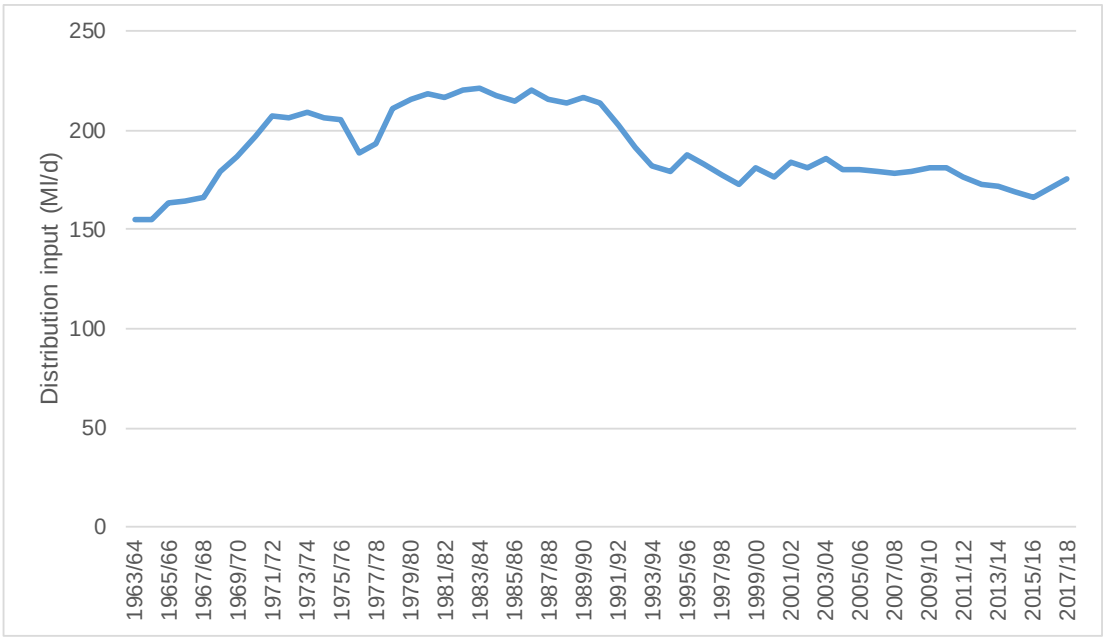


Figure 19 Historic annual average distribution input (Ml/d)

The latest complete financial year for which we have out-turn data, 2017/18, has been chosen as the base year for the Final WRMP to provide as up-to-date as possible a view of demand.

5.1.2 Demand Scenarios

The Water Resources Planning Guideline (Environment Agency and Natural Resources Wales, 2018) requires demand forecasts to be produced for two planning scenarios, namely, dry year annual average (DYAA) and critical period (DYCP). The Company has also developed a forecast for the normal year annual average (NYAA) scenario. These scenarios are defined below.

- *Normal Year Annual Average Demand (NYAA):* The annual average daily value of demand under 'normal' weather conditions. The base year must be assessed as to whether it is a normal year, and if it is found not to be, its demand must be normalised to take account of factors such as weather.

- *Dry Year Annual Average Demand (DYAA):* The annual average value of demand under dry conditions without any drought demand restrictions in place. This demand is presented against the Average Demand Deployable Output (ADO) supply forecast.
- *Dry Year Critical Period Demand (DYCP):* The rolling 7-day average peak week that occurs during the dry year. This demand scenario is presented against the Peak Deployable Output (PDO) supply forecast.

The method by which demands for these different scenarios have been derived is set out in section 5.2.1 below.

5.2 The Base Year

5.2.1 Normalisation of Distribution Input

Demand varies year to year as a result of ongoing trends such as leakage reduction, water efficiency, metering and increasing properties and population. Demand is also affected by weather which has a more immediate effect on consumption and leakage.

Demand normalisation seeks to separate the effects of ongoing trends from the effects of weather so that an estimate can be made of the demand that would have occurred in the base year had 'normal' or 'dry' conditions been experienced.

A weather demand model consistent with that described in the *WRMP19 Methods – Household Consumption Forecasting* (UKWIR, 2015) guidance was developed that allows historical weather data to be run through the base year to determine how base year demand (both annual average and critical period) would change if the weather in year X occurred again in 2017/18.

The model was developed using the following process:

1. Weekly company record of DI from 1997/98 to 2015/16 is combined with rainfall and temperature data (Portsmouth Water has not imposed any demand restrictions during this period, so all years have been included in the analysis).
2. DI is decomposed into a smoothed trend element reflecting changes in the customer base and leakage reduction.
3. A Random Forest regression, an effective non-linear statistical model, is fitted to the trend and weather data.
4. The model is validated against the historical data (see Figure 20).
5. The trend element is held as at 2017/18, whilst historical weather is run back through the model (see Figure 21).
6. The weekly simulated time series is aggregated to annual averages and annual maxima (the maximum 7-day rolling average, or peak week) DI.
7. Statistical distributions are fitted to annual averages and annual maxima.

The 50th percentile is used to represent the Normal Year whilst the 95th percentile is used to represent the Dry Year. The 95th percentile has been selected in order to align with the Company's target Level of Service for demand restrictions (as recommended in the *WRMP19 Methods – Household Consumption Forecasting* (UKWIR, 2015) guidance), which is a 1 in 20-year return period.

Further information on the above stages is provided below.

The *WRMP19 Methods – Household Consumption Forecasting* (UKWIR, 2015) guidance recommends removing leakage from DI before undertaking the above modelling. A weekly time series of leakage for the period was unavailable therefore this could not be done. It is argued, however, that the impact of this is relatively small as the variance of leakage will likely only account for up to 5% of total variance in DI in any week. Additionally, long-term leakage

control will be reflected in the trend element of the models, whilst the leaks from bursts, as a factor of weather, will be captured in the weather variables.

The weather demand model is described in detail in Appendix I, with summary results shown below. Figure 20 shows DI data from the weather demand model fitted to the historic DI data. The results demonstrate a good fit.

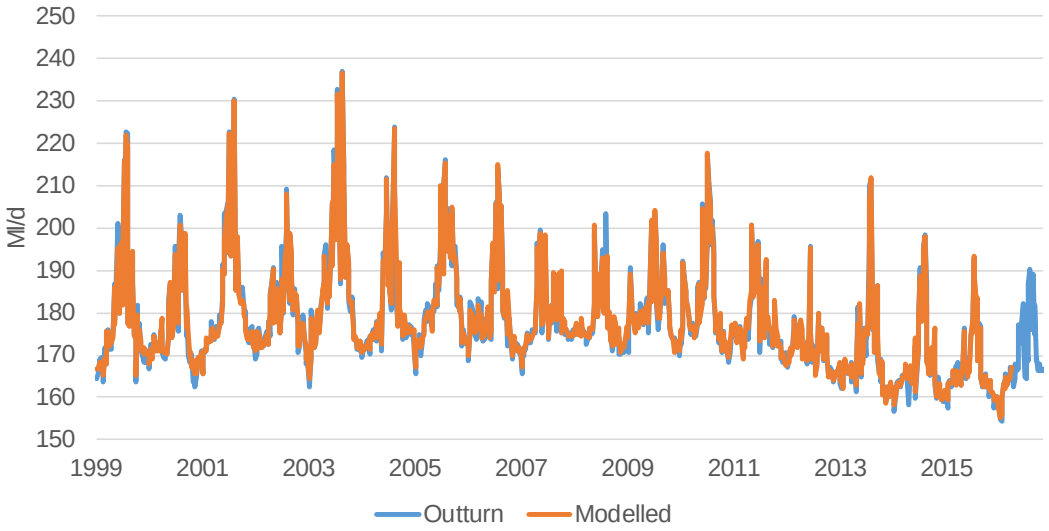


Figure 20 Model fitted to historic distribution input

Figure 21 (below) shows the normalised result from the weather demand model. The blue line represents historic outturn DI, whilst the green line represents the normalised DI data simulated by the regression model. The simulated DI data provides an estimate of what DI would be if that year's weather happened again with the current customer base and behaviours. The simulated DI data is correctly lower than historic levels in the early years of the time period shown (reflecting the decrease observed in DI since the start of the period), but with convergence near the end of the period as the customer base becomes increasingly similar to current.

The above regression analysis was undertaken for the Draft WRMP, which used 2015/16 as the base year. For this Final WRMP, the base year has been updated to 2017/18. Outturn DI for 2017/18 is 8.7 Ml/d higher than 2015/16 (as shown in Figure 19). Approximately 5.5 Ml/d of this increase is attributed to leakage variance, so has been excluded, with the remaining 3.2 Ml/d having been added to the simulated data in all years.

The weather demand model (which uses the regression modelling approach described above) was validated using a 'Comparison of summer and winter consumption' approach as recommended by the *WRMP19 Methods – Household Consumption Forecasting* (UKWIR, 2015) guidance. A similar result was produced from both analyses.

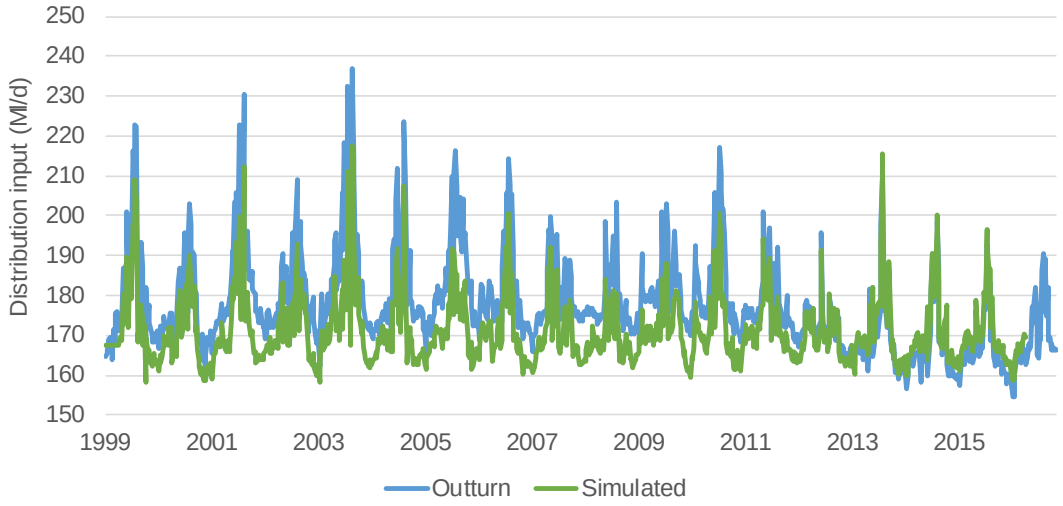


Figure 21 Normalised (simulated) distribution input time series

Annual average daily DI and rolling 7-day average peak week (critical period) DI were then derived from the weekly simulated DI time series shown in Figure 21. These DIs were subsequently analysed using a cumulative distribution function to enable the 50th and 95th percentile DIs from each to be identified. These form the normal year and dry year demands for each of the annual average and critical period scenarios respectively. The results are presented in Table 22.

	Average	Peak
Normal (q50)	171.3	200.7
Dry (q95)	174.1	216.7

Table 22 Estimates of distribution input for NYAA, DYAA and DYCP scenarios

Having estimated the normalised DI for each of the WRMP demand scenarios, it is necessary to break this down into its component parts to enable forecasting to be undertaken on each component over the 25-year planning period. Portsmouth Water has done this using a water balance approach, with separate water balances for normal year and dry year. Table 23 shows the water balance percentages used to break down DI into its component parts, and the resultant volumes for the 2017/18 outturn, the normal year and the dry year.

For the forecasts in this WRMP19, the Company's target leakage level has been used instead of the outturn 2017/18 figure. This target is 30 Ml/d for the period 2015/16 to 2019/20, but, when adjusted for the *Consistency of Reporting Performance Measures* project, this figure is 35 Ml/d.

The outturn uses the 2017/18 DI with the adjusted leakage figure as described above and all other elements also recast. The normal year and dry year water balances use the DI output from the weather/demand model with leakage set to the adjusted leakage target of 35 Ml/d in both instances.

	2017/18 Outturn		Normal Year		Dry Year	
Component	Ml/d	%	Ml/d	%	Ml/d	%
Unmeasured Households	83.5	48.8%	83.7	48.8%	85.2	49.0%
Measured Households	24.5	14.3%	24.5	14.3%	24.9	14.3%

Unmeasured Non-Households	0.9	0.5%	0.9	0.5%	0.9	0.5%
Measured Non-Households	32.8	19.2%	32.8	19.2%	33.5	19.3%
Distribution Losses	26.5	15.5%	26.5	15.5%	26.5	15.3%
Distribution System Operating Losses	0.4	0.3%	0.4	0.3%	0.4	0.2%
Water Taken Legally Unbilled	1.6	0.9%	1.6	0.9%	1.6	0.9%
Water Taken Illegally Unbilled	0.9	0.5%	0.9	0.5%	0.9	0.5%
Total	171	100%	171.3	100%	173.8	100%
***Total Leakage*[6]**	*35.0*	*20.5%*	*35.0*	*20.5%*	*35.0*	*20.2%*

Table 23 Outturn, Normal Year and Dry Year Water Balance

Having estimated the top-down base year demand components to the level of detail shown in Table 23, the customer base was analysed to understand the sub-components of household demand and non-household demand, to further assist in forecasting potential changes that may occur over the planning period. The sections below consider the different types of customer that Portsmouth Water supplies water to, and provide estimates of their water demand.

5.2.2 Customer Segmentation

5.2.2.1 Household Segmentation

Portsmouth Water models household demand at a Per Household Consumption (PHC) level for both measured and unmeasured customers. The Company's model takes account of new properties and movements of population from unmeasured to measured status as a result of metering (Portsmouth Water has an optant policy whereby customers are encouraged to switch to a meter (described in section 5.3.2); it is assumed that some customers are more likely to switch to a meter than others, most likely those with a lower occupancy rate).

To produce measured/unmeasured occupancy rates and to create a profile of customers switching from unmeasured to measured consumption, data was collated from occupancy surveys, ONS demographic data sets and the Company's billing system. Through this process, 62 unique customer types were identified, based on their characteristics under the following categories:

- ONS Demographic Super Groups (8 groups)
- Flat/Non-flat status (2 groups)
- Meter Optant/Non-Meter Optant status (2 groups)

[6] Note that the total leakage has been included in the table as a separate row for reference although it is actually accounted for within the other components of the table.

- New Property (Post 2004)/Existing Property (2 groups)

Table 24 to Table 27 present the measured/unmeasured splits assessed to be present within each of the four categories of household customer.

	Unmeasured	Measured
Constrained City Dwellers	14%	8%
Cosmopolitans	6%	4%
Ethnicity Central	2%	1%
Hard-Pressed Living	21%	12%
Multicultural Metropolitans	3%	1%
Rural Residents	7%	11%
Suburbanites	20%	33%
Urbanites	27%	30%
Total	100%	100%

Table 24 ONS Demographic Super Groups

	Unmeasured	Measured
Non-Flat	85%	82%
Flat	15%	18%

Table 25 Flat/Non-flat status

	Unmeasured	Measured
Non Optant	100%	32%
Meter Optant	0%	68%

Table 26 Meter Optant/Non-Meter Optant status

	Unmeasured	Measured
Existing Property	100%	68%
New Property (Post 2004)	0%	32%

Table 27 New Property/Existing Property Status

5.2.2.2 Non-Household Segmentation

The vast majority of Portsmouth Water's non-household customers have meters installed, therefore are measured customers. To segment these non-household customers to gain a better understanding of their demands both now and in future, a bottom-up approach has been used which classifies non-household properties. Figure 22 shows the proportional split of measured non-household customers into 12 ONS categories. This analysis has been based on the customer base in 2015/16, but this is not considered to be materially different to that observed in 2017/18 so remains applicable for this Final WRMP.

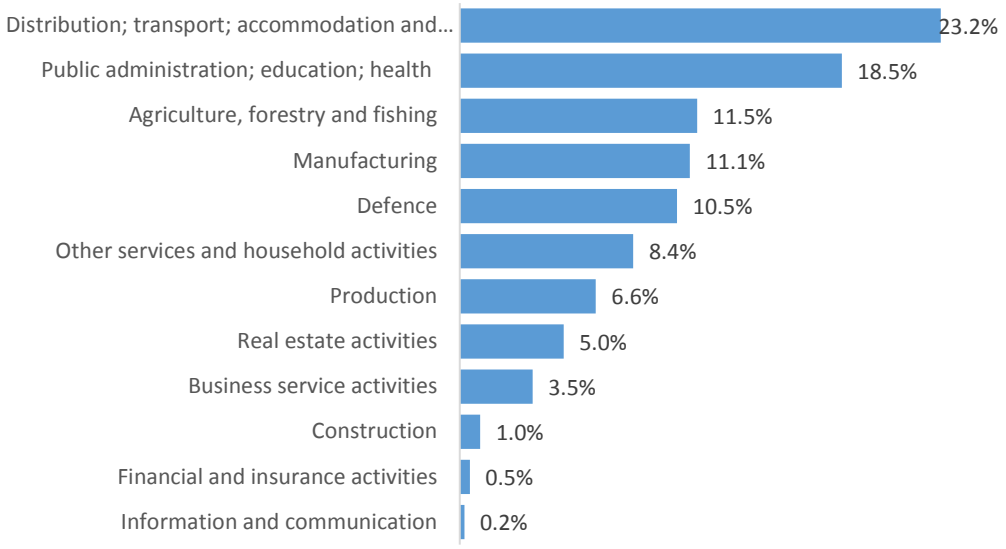


Figure 22 Proportional Split of Non-Household Customers into Segments

5.2.3 Base Year Population, Property and Occupancy Estimates

5.2.3.1 Base Year Household Population

Population and property numbers for WRMP19 were provided by Experian as part of a Demand Forecasting in the South East (DFSE) club project with four other water companies, which ensured consistency across the region and in particular with neighbouring companies South East Water and Southern Water.

The snapshot of population estimates for the year 2015/16 shown in Table 28 indicates that since WRMP14 there has been a relatively small change (a reduction of less than 1%) in the estimation of the Company's household population as a result of the WRMP19 population reassessment.

	WRMP14	WRMP19	Difference
2015/16 Total Household Population	702,777	701,651	−1,126

Table 28 WRMP14/WRMP19 Household Population Estimate Comparison

For the Final WRMP19, the base year (2017/18) household population is 712,420, as shown in Table 29.

	Measured	Unmeasured	Total
2017/18 Household Population	172,760	539,660	712,420

Table 29 Base Year Household Population

5.2.3.2 Base Year Household Properties

The base year number of household properties is taken from the Company's billing system. For the Final WRMP19, total number of household properties in the base year (2017/18) is 293,449, as shown in Table 30.

	Measured	Unmeasured	Total
2017/18 Total Household Properties (Excluding voids)	89,290	204,159	293,449

Table 30 Base Year Household Properties

5.2.3.3 *Base Year Household Occupancy*

Household occupancy is calculated using the Experian 2017/18 population estimate divided by the number of properties in the Company billing system. To derive a split of the Company occupancy between unmeasured and measured properties, Portsmouth Water commissioned an online survey of over 2,600 customers.

From analysis of the customer base, 62 unique groups were identified, as described in section 5.2.2.1. The different groups were then aggregated into measured and unmeasured classifications. The residual difference between the survey occupancy and the Company occupancy provided by Experian was allocated proportionally to the Measured and Unmeasured customer base. The results are shown in Table 31.

Measured	Unmeasured	Company Average
1.93	2.64	2.43

Table 31 Aggregated 2017/18 Occupancy by Measured/Unmeasured Status

5.2.3.4 *Base Year Non-Household Population*

Non-household/communal population refers to residential accommodation such as sheltered accommodation units, student halls of residence, large hostels, hospitals and prisons.

Table 32 provides a snapshot of non-household population estimates for the year 2015/16 for comparison with WRMP14. Comparison between the WRMP14 figures and the revised Experian WRMP19 estimate indicates there is a marginal difference. It should be noted however, that non-household population is not used as a factor in the non-household demand forecast.

	WRMP14	WRMP19	Difference
2015/16 Measured Non-Household Population	12,940	12,574	−366 (−2.8%)
2015/16 Unmeasured Non-Household Population	1,262	1,376	114 (9.0%)

Table 32 WRMP14/WRMP19 Non-Household Population Estimate Comparison

For the Final WRMP19, the base year (2017/18) non-household population is 13,950, as shown in Table 33.

	Measured	Unmeasured	Total
2017/18 Non-Household Population	12,340	1,610	13,950

Table 33 Base Year Non-Household Population

5.2.3.5 *Base Year Non-Household Properties*

In 2015 and 2016 a data cleansing exercise was undertaken to align the Company billing system with the Ofwat guidance on eligibility for the opening of the non-household retail market. This resulted in some relatively small movements between household and non-household classifications. Data from the latest Company billing system has been used for WRMP19.

Figure 23 shows the trend in measured and unmeasured non-household properties since 2010. There has been a steady decline in the number of non-household properties in both groups. The drop in measured properties in 2013/14 is a result of a change in the Company billing system when significant data cleansing occurred.

Other than the drop in measured properties in 2013/14, the effect of the data cleansing activity is largely unapparent as the movement between household and non-households is broadly equal.

It should be noted that cleansing exercise does not appear to have had any significant impact regarding total non-household volumes either. We believe this is explained by the fact that the contestable properties are typically low users.

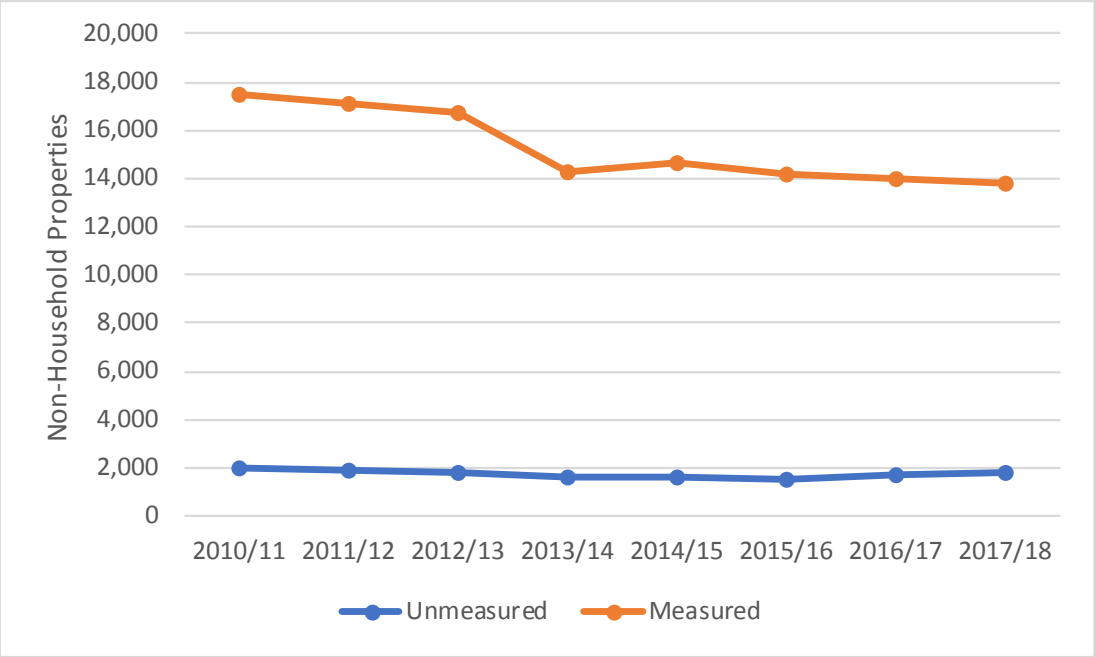


Figure 23 Historic Outturn Non-Household Properties

5.2.4 Base Year Per Capita Consumption (PCC)

As discussed earlier in this section, it is necessary to break down the base year demand into its component parts to assist with forecasting over the planning period. Understanding customer usage is also crucial to designing demand management options that may help customers save water and also help to reduce any supply-demand deficit (feasible customer options are discussed in the options appraisal, section 7.5.2).

One of the important components of household demand is per capita consumption (PCC). Firstly, base year PCC must be estimated for both unmeasured and measured customers.

Portsmouth Water uses its water balance approach described in section 5.2.1 to estimate outturn unmeasured PCC, while outturn measured PCC is more readily calculable from meter readings. Unmeasured PCC showed a steady decrease from 159 l/h/d in 2009/10 to 146 l/h/d in 2015/16 and 2016/17, although it increased again slightly in 2017/18 to 151 l/h/d. Measured

PCC has fluctuated between 110 l/h/d (in 2013/14) and 127 l/h/d (in 2016/17), with the reported value for 2017/18 being 126 l/h/d. Figure 24 displays the trends in unmeasured and measured PCC, with the values being reported in Table 34. It should be noted that these values are not the historically reported PCCs for previous years, but revised PCCs which take account of the change in the water balance as a result of the as a result of the *Consistency of Reporting Performance Measures* (UKWIR, 2017) industry wide leakage convergence project.

To calculate the base year PCCs for the scenarios required by the WRPG, a water balance approach is again taken. The normalised DI produced by the weather-demand model (described in section 5.2.1) is balanced with the bottom up regression model of the sub components of DI. A good balance is provided with an error of just 1%.

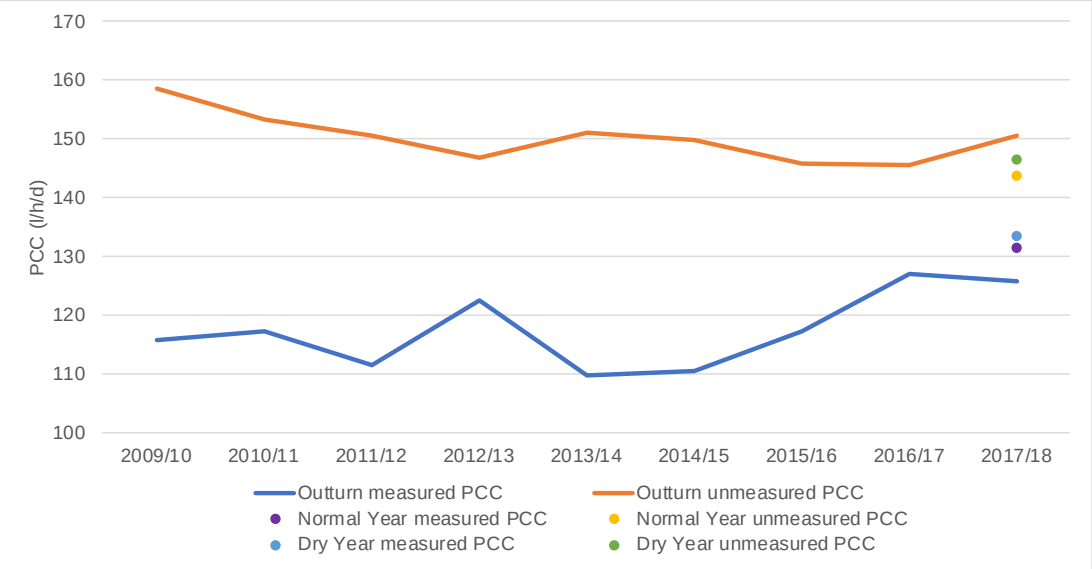


Figure 24 Per Capita Consumption (PCC) graph

Per Capita Consumption type (l/h/d)	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Outturn measured	116	117	112	122	110	111	117	127	126
Outturn unmeasured	159	153	151	147	151	150	146	146	151
Normal Year measured									132
Normal Year unmeasured									144
Dry Year measured									134
Dry Year unmeasured									147

Table 34 Per Capita Consumption (PCC) values

The aforementioned measured and unmeasured PCC values must then be broken down into their constituent micro components. PCC has been apportioned into the different micro components based on the *WRc Compendium of Micro Components* (WRc, 2012). The apportionment for the dry year scenario is shown in Figure 25.

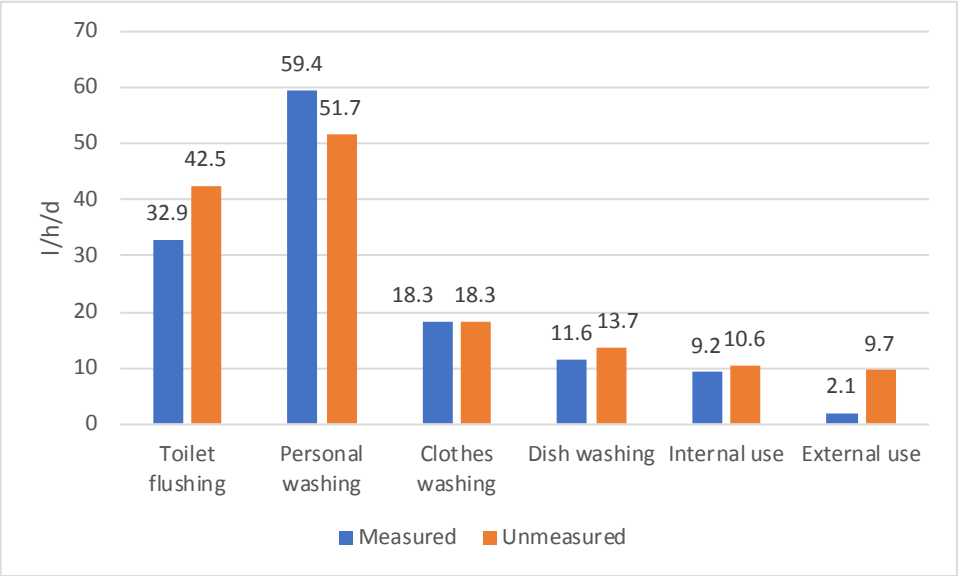


Figure 25 Breakdown of Base Year Per Capita Consumption (PCC)

5.3 Baseline Household Demand Forecast

5.3.1 Household Property and Population Forecast

As noted in 5.2.3, population and property numbers for WRMP19 were provided by Experian as part of a Demand Forecasting in the South East (DFSE) club project with four other water companies, which ensured consistency across the region and in particular with neighbouring companies South East Water and Southern Water. A full copy of the Experian report is available in Appendix G.

For WRMP19 Experian produced a Trend-Based, Plan-Based, Econometric and a Most-likely/Hybrid forecast, as described below:

- **Trend -** represents growth if recent trends (5 to 6 years) in terms of demographic change (births, deaths and migration) and long-term household formation patterns continue into the future
- **Plan Based** - shows the expected growth if local authorities are able to deliver the dwelling targets set out in their plans
- **Econometric** - forecast is designed to determine what growth would be expected once economic factors are taken into account

In WRMP14 a similar approach was taken. The WRMP14 results of the projected population and household estimates against the outturn for the period 2011–2015 are shown in Table 35. The outturn population projection was closest to the trend and most-likely estimations which had an error of 0.1%. Outturn household forecast was closest to the plan and most-likely/hybrid estimation, both with an error of 0.1%.

Forecast	% population growth, 2011–2015	% household growth, 2011–2015
WRMP14 Trend	3.0	3.6
WRMP14 Plan	2.3	2.8
Outturn	2.9	2.7

Table 35 WRMP14 Household Property and Population Projections Compared with Outturn

For the Draft WRMP19, Portsmouth Water applied a trend-based method as it provided a smoother, more reasonable connection profile compared to the recent outturn in new property connections whilst delivering a very similar amount of properties over the forecasted period, as shown in Figure 26. However, for the Final WRMP a different method has been applied, to address comments received during the consultation period. For the Final WRMP, the Company has used the plan-based forecasts without adjustment, to meet the Environment Agency's requirement.

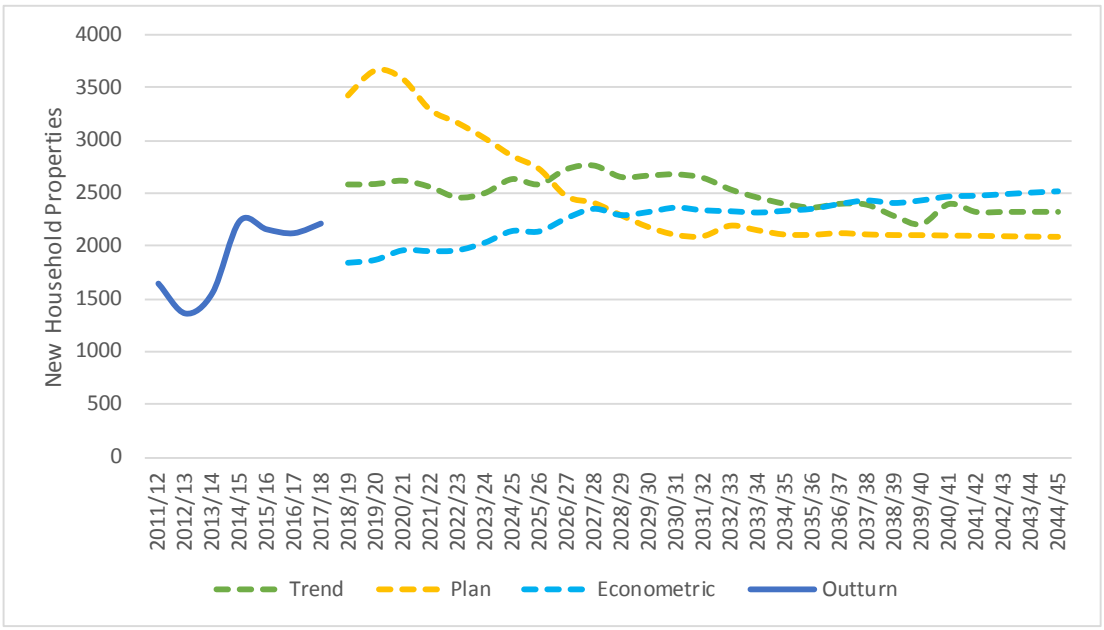


Figure 26 New Household Connections

Figure 27 and Figure 28 show the baseline forecasted household property and population figures for WRMP19 using the Plan-Based approach. Figure 29 shows the baseline household occupancy forecast.

An average of 2,479 new properties are expected per year leading to 66,920 new properties by 2044/45, growth of 23% on 2017/18 household property counts (exc. voids).

Population is expected to increase by 101,180 over the period, a growth of 14% on the 2017/18 population.

New housing is expected to outstrip new population growth in the region resulting in occupancy rates falling from 2.43 in 2017/18 to 2.26 by 2044/45.

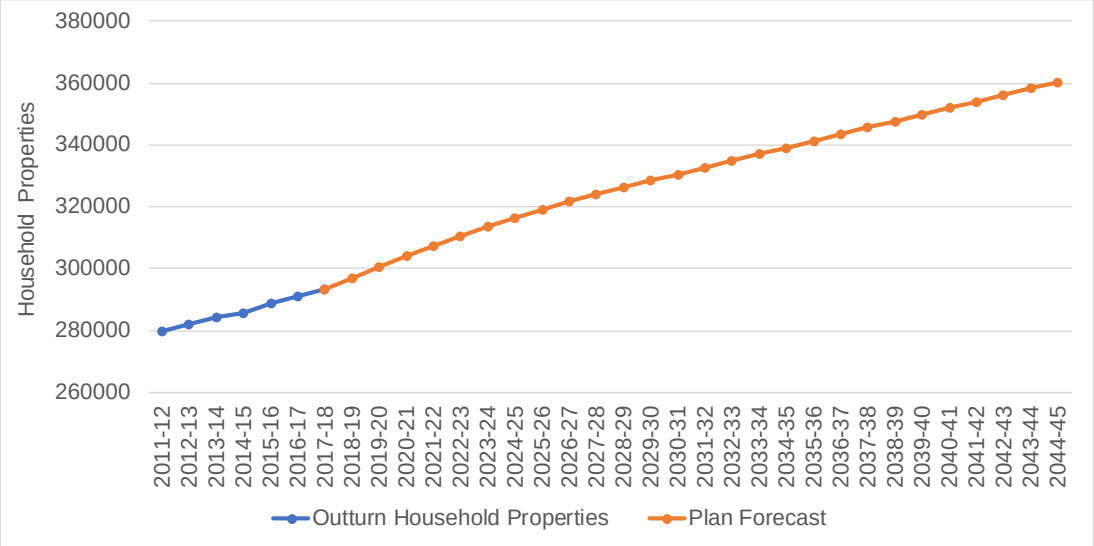


Figure 27 Baseline Household Property Forecast

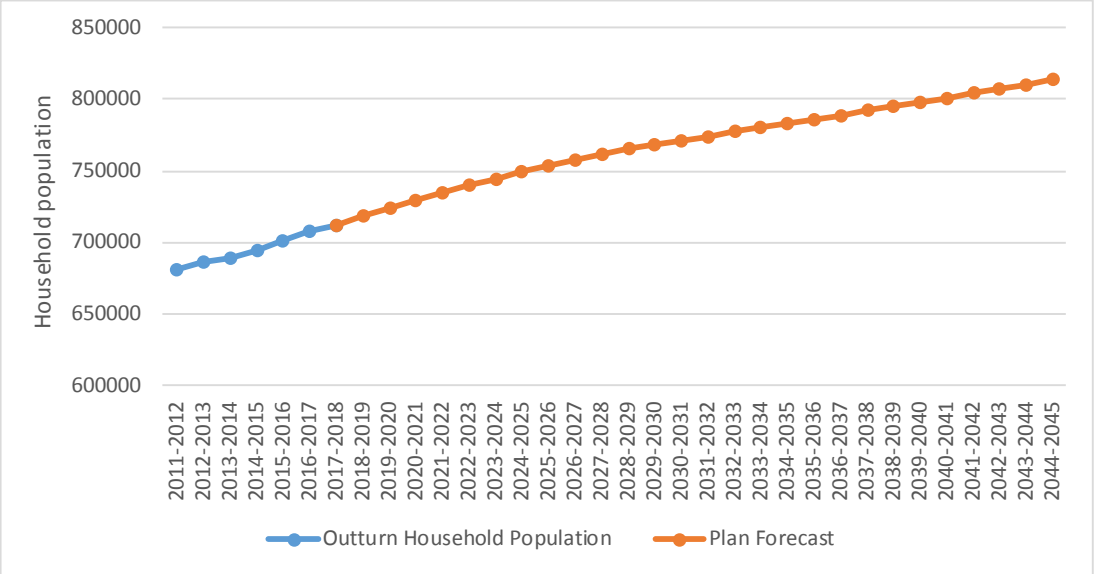


Figure 28 Baseline Household Population Forecast

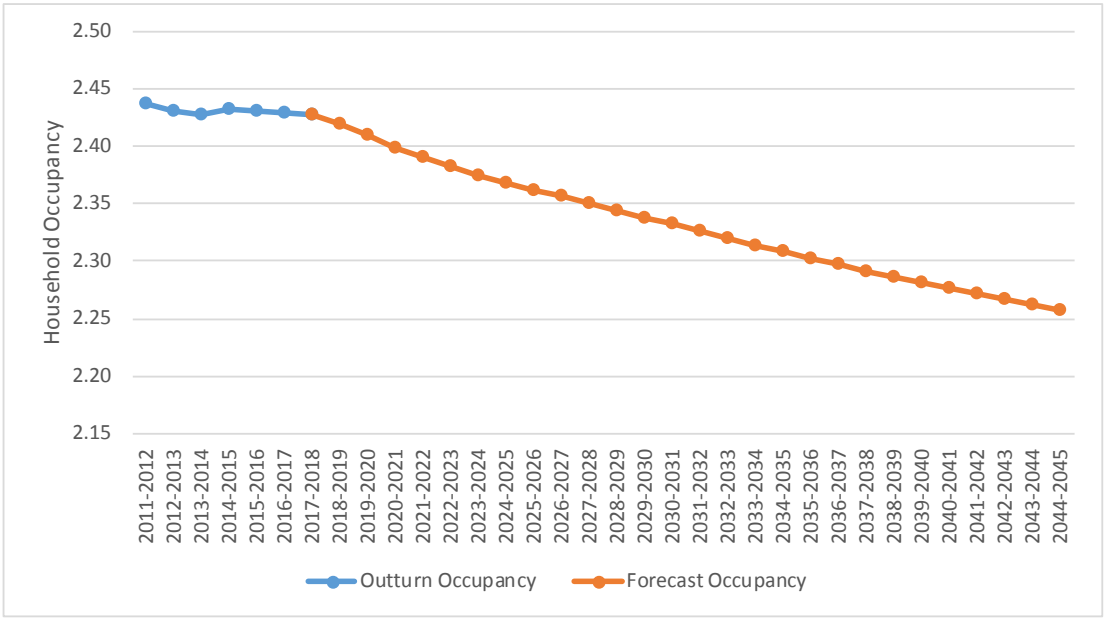


Figure 29 Baseline Household Occupancy Forecast

5.3.2 Baseline Metering Policy

Portsmouth Water currently has an optional metering programme where unmeasured customers are encouraged to switch to a meter using promotional activities. In WRMP14 Portsmouth Water committed to 5,000 meter optants per year. In the first three years of AMP6, despite additional promotional efforts by the Company to increase the uptake of metering, the outturn number of optants has fallen below the target (Figure 30). We have discussed with customers why they do not want to switch to a meter as part of the Business Plan process and have developed a metering strategy which acknowledges their concerns.

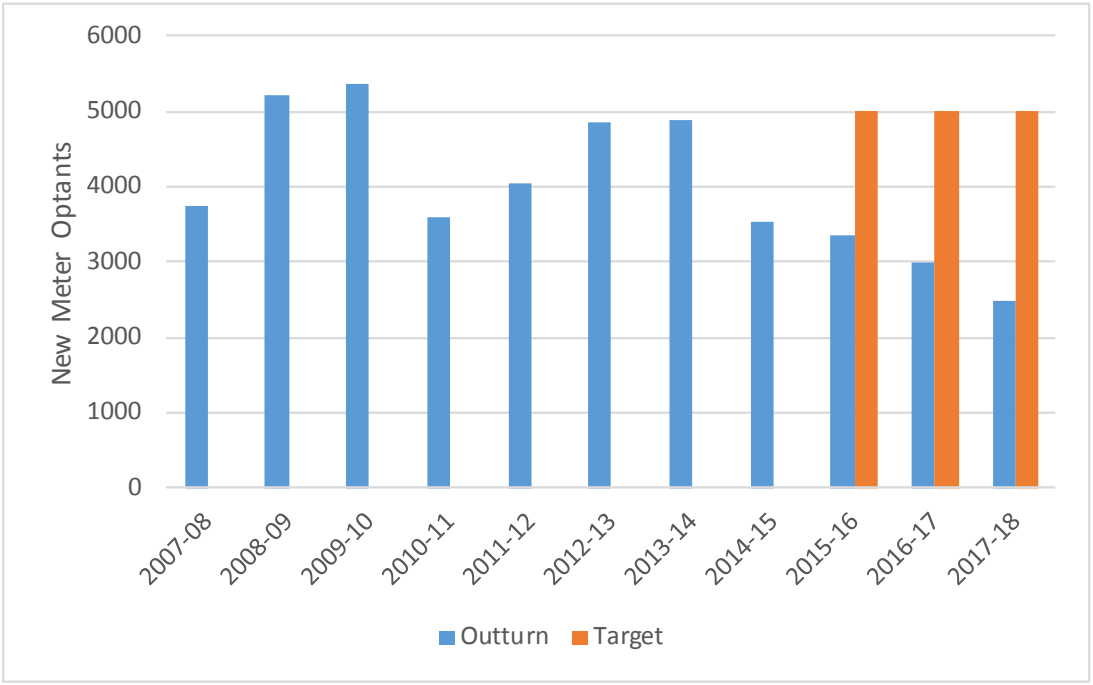


Figure 30 Meter Optants 2007/08 to 2017/18

For WRMP19 the number of meter optants achieved through promotional activities is expected to decline over time, as shown in Figure 31. Other initiatives will be undertaken to increase the number of metered customers. These are described in section 7 (options appraisal) and section 9 (final plan).

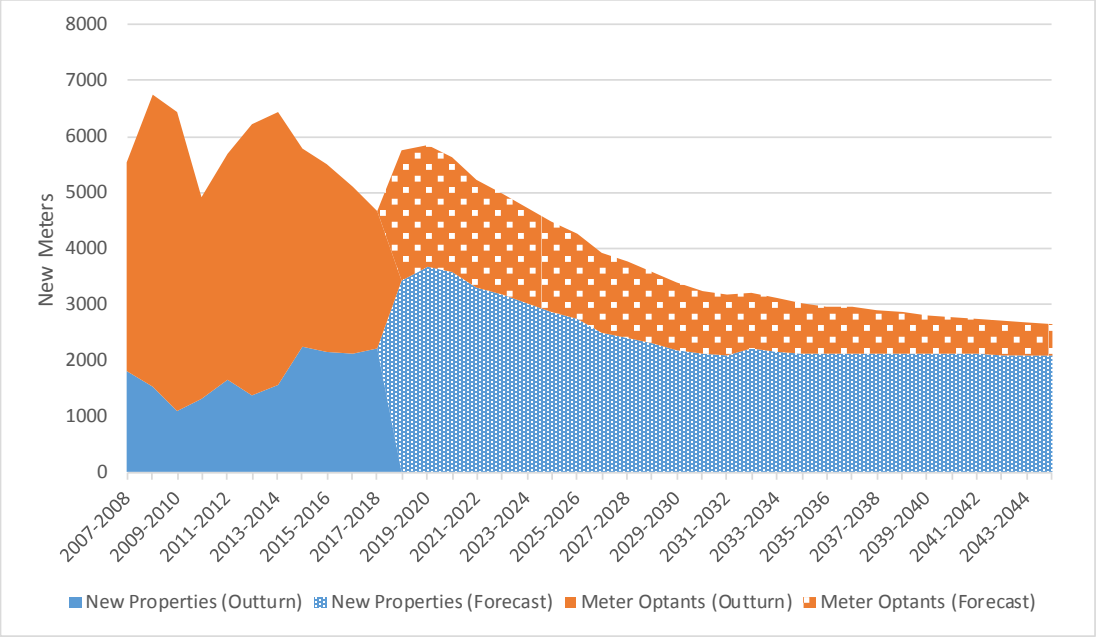


Figure 31 Baseline Metering Forecast

In 2012 the Environment Agency produced a revised assessment of 'Water Stress'. This assessment is referred to in the legislation for compulsory metering and the 2017 Directive requires Water Companies to consider this option if their area of supply is 'Seriously Water Stressed'. Portsmouth Water's area of supply is classed as 'Moderately Water Stressed'.

Despite being in an area of moderate water stress, the Company asked Defra whether there was a possibility of a change to the legislation to allow it to consider compulsory metering in its plan. This proposal was to allow the Company to provide greater bulk supplies to support the rest of the South East which is predominantly deemed "seriously water stressed". Defra advised this would not be possible for the 2019 plan.

Portsmouth Water has been installing meter boxes when conducting mains renewal activity since 1990. There are an estimated 68,000 unmeasured properties with an existing meter box and therefore can cost effectively have a meter installed without the requirement for excavation. From 2018/19 Portsmouth Water will seek to attract more customers onto a meter by undertaking a trial of smart meters which are being installed where a meter or meter box already exists. The smart meters will initially provide customers with more information using a dual-billing style approach referred to as 'Metering not for revenue'. Customers will be encouraged to switch to a meter through Portsmouth Water offering comparative bills and water efficiency advice.

In addition to existing baseline metering and the trial of smart metering described above, Portsmouth Water are also considering other metering options for WRMP19. Although the Company cannot compulsory meter all its domestic customers, it does have the right to meter upon change of occupier and to meter void properties. These options are considered within the options appraisal process described in Section 7.5.2.1.

The costs of metering for the options selected in the final plan are presented in section 7.6 and included in the WRMP Tables. Baseline Metering costs are summarised in Table 36.

	Capex NPV (£000)	Opex NPV (£000)	AISC (p/m3)
Baseline Meter Optants	0.19	0.03	29.18

Table 36 Baseline metering costs

5.3.3 Per Household Consumption (PHC) /Per Capita Consumption (PCC) Forecast

For the Draft WRMP19, a regression-based approach was used to model unmeasured and measured per household consumption (PHC), trialling weather variables and features of the customer base. For the Final WRMP19, Portsmouth Water has opted instead to use a 'variable flow' approach as described in the in the *WRMP19 Methods – Household Consumption Forecasting 15/WR/02/9* (UKWIR, 2015) guidance. The variable flow approach is a method which uses historical data to define variables, but also requires expert judgement and the application of assumptions. The term 'variable flow' refers to how factors modify fixed future assumptions on 'flows' of water into supply.

Portsmouth Water selected to move to the variable flow approach for its Final WRMP19 because it can demonstrate greater transparency of assumptions. Whilst the regression model worked well under simple continued assumptions for metering and movements in the customer base, in its Final WRMP19, the Company is proposing more ambitious levels of metering. With limited Company-specific historical data on metering impacts, there would be considerable uncertainty in using historical data to predict future volumes where they far exceed historical volumes and metering levels. With this uncertainty in mind, the variable flow method provides a mechanism by which transparency of assumptions can be demonstrated outside the restrictions of a statistical-based model.

Factors are used to vary volumes including new properties, baseline meter optants, and future changes to occupancy. Further explanation of the variable flow method and the assumptions underpinning the Company's demand forecast are provided in Appendix I.

In addition to volume factors used to reflect changes in the customer base, percentage changes in micro-components are used to adjust the forecast, referred to as 'Device Replacement'. The volume changes are based upon Defra Market Transformation Program (MTP) baseline changes although some adjustments have been made to moderate the MTP assumptions. .

The forecast has also been adjusted for the potential impacts of climate change on demand. The assumptions for increases in household consumption are derived from the lookup tables provided in the *Impact of Climate Change on Water Demand* report (UKWIR, 2013). The factors are based on those specific to a water company operating in the South East of England. Two adjustments were made to the original factors: the 2012 values were indexed up to the base year 2017/18; and because the original factors only extended to 2040/41, they were linearly forecast to the end of the WRMP19 planning period, 2044/45.

The change in the key components of total household consumption over the planning period resulting from this forecasting exercise are shown in Figure 32.

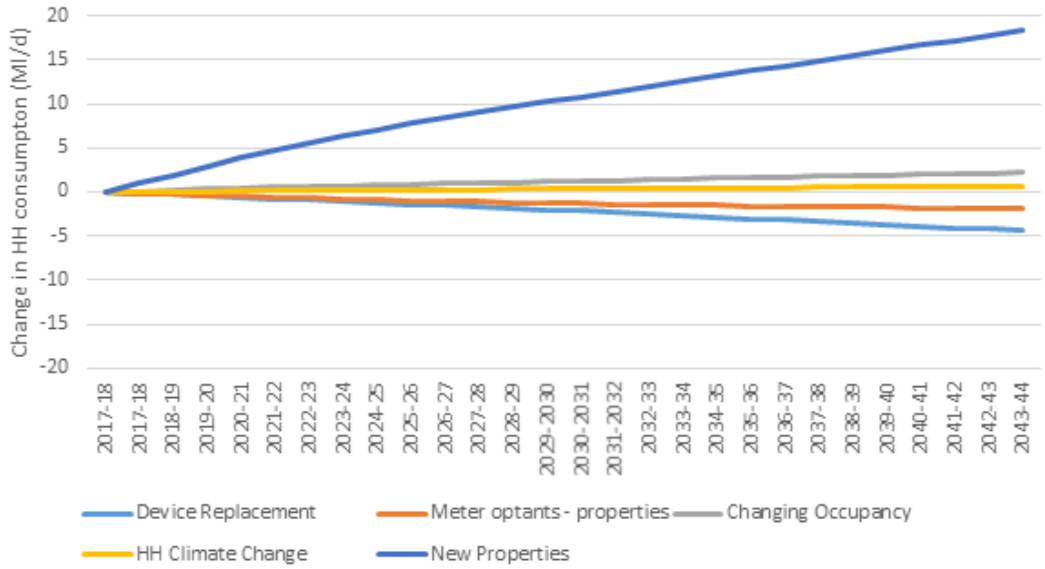


Figure 32 Cumulative change in total household consumption

It can be seen from Figure 32 that the impact of new properties has the greatest influence on baseline demand, creating almost 20 Ml/d of additional demand by 2044/45. A steeper increase is observed at the beginning of the planning period due to a faster rate of development being assumed in the first 10 years of the 'Plan' based forecast (described in section 5.3.1). Falling occupancy rates and the impact of climate change also act to increase demand, but to a far lesser extent. Some reductions in baseline demand are observed over time resulting from the Company's current meter optant policy and also more significantly from the assumed increase in water efficient devices installed by customers as part of the natural device replacement.

The baseline DYAA forecast of PCC (resulting from changes in the customer base, device replacement and climate change adjustments) is presented in Figure 33.

Unmeasured PCC is expected to increase from 146.5 l/h/d in 2017/18 to 151.7 l/h/d by 2044/45. Measured PCC is expected to show a decline from 133.5 l/h/d in 2017/18 to 132 l/h/d in 2044/45. Average PCC falls over time from 143.3 l/h/d in 2017/18 to 142.6 l/h/d in 2044/45.

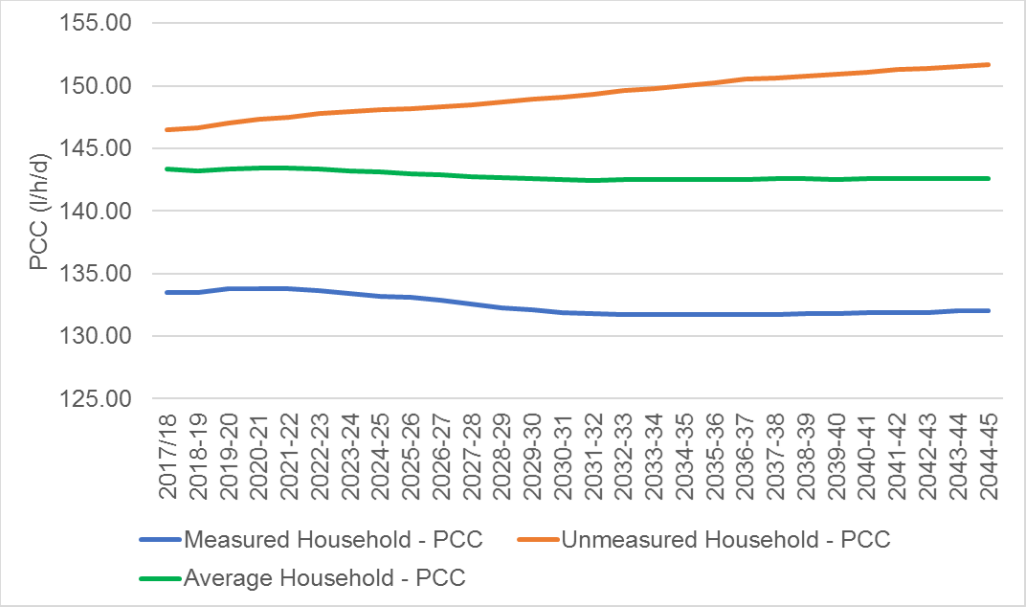


Figure 33 Baseline DYAA Forecast PCC

5.3.4 Water Efficiency

Water companies have a statutory duty to promote the efficient use of water by its customers under section 93A of the Water Act 1991. In the past, water companies were required to set out how they would save one litre of water per property per day as part of a mandatory target set by Ofwat. This mandatory target has now been removed, but Portsmouth Water has maintained its baseline water efficiency programme as part of its statutory duty, and to benefit its customers and the environment.

In its Periodic Review 2019 (PR19) guidance to companies, Ofwat has set out 14 common performance commitments against which it will judge companies' performance. There is a performance commitment governing PCC. This will be met by a combination of the continuation of the Company's baseline water efficiency activities (set out below) and any metering and/or water efficiency options it takes forward as part of its preferred plan following the options appraisal process set out in section 6.3.2.

The Company currently undertakes many water efficiency activities with the aim of working with customers to help them reduce their consumption, which they have consistently said they want, the savings from which contribute to current base year levels of PCC. The activities undertaken are summarised below:

- Water savings products are available free of charge.
- The Company regularly attends fairs, shopping centres and fetes as part of its community events to promote how to use water more efficiently and hands out free water saving devices. This goes hand in hand with providing information about switching to a water meter.
- The Company runs a scheme called the 'Saving Water Challenge', which involves encouraging customers to think about their own water using behaviour and how they can reduce the amount of water they use in their homes. The 'Saving Water Challenge' section of the Portsmouth Water website offers water efficiency advice to assist with this;
- The Company recognises that it can achieve far more working in partnership than working on its own. The Company promotes and engages with organisations like Waterwise and Eco Schools;
- The Call Centre maximises opportunities when customers call to discuss water efficiency and metering;
- The Company has teamed up with the Parks and Leisure Department at Portsmouth City Council to produce a 'Being Water Wise in the Garden' leaflet; and
- Demonstrating at the Company's Head Office in Havant an example of a drought tolerant garden.

As mentioned in section 5.3.3, the household consumption forecast that forms a significant part of the Company's baseline demand forecast has been developed based on assumptions around customers changing their water-using appliances over time, consumption savings that occur when customers opt to have a meter installed and when new properties have meters installed, and climate change adjustments. However, the base year PCC upon which the forecast is based contains an implicit assumption about the current water using habits of Portsmouth Water customers, some of which will have been influenced by baseline water efficiency activities undertaken by the Company. These are therefore assumed to continue throughout the planning period.

It should be noted that where new water efficiency options have been developed as part of the options appraisal (section 7.5.2.2), they promote water saving activities that would allow customers to reduce their consumption over and above what has already been achieved through baseline water efficiency activity. In this way there is no double counting of water efficiency savings.

5.4 Baseline Non-Household Demand Forecast

For the Non-household demand forecast two approaches were applied; a Top-Down and a Bottom-Up linear regression forecast.

Both methods utilise the same data sources; local weather factors (temperature and rainfall) in addition to regional Gross Value-Added data by SIC code which reflect the changes in local economic conditions. The Top-Down model consists of a single model regressed on the total Measured Non-Household volumes for the period 2005 to 2015. The Bottom-Up model consists of 21 sub models for different SIC groups which utilise a subset of economic factors.

The resulting estimates of future Non-household demands are presented in Figure 34. The two forecasts provided differing projections on Non-household demands. The Top-Down forecast shows demand falling rapidly from 35 Ml/d to 24 Ml/d in 2044/45. The Bottom-Up forecast shows Measured Non-household demand to remain flat with a small increase of 0.8 Ml/d by the end of the period. Since both models performed well against the historic data and produce reasonable forecasts, a hybrid approach is adopted for WRMP19, which is simply an average of the two models.

Portsmouth Water has engaged with Castle Water, the largest Non-household retailer in the Company area. Whilst water efficiency activities are planned by Castle Water, the scale of the savings are largely unknown. Reductions as a result of retailer water efficiency activities are not specifically included in the model, however, water efficiency will be somewhat captured within the regression models although not included as a specific factor.

Portsmouth Water has also engaged with the West Sussex Growers Association regarding the growth of horticultural activities in the area of supply. Whilst they expect growth between 5% and 10% per year, this will be met with greater water efficiency activities in addition to some reliance on the Growers' own resources. No additional growth in water demand on top of that implicit within the regression models is assumed over the planning period.

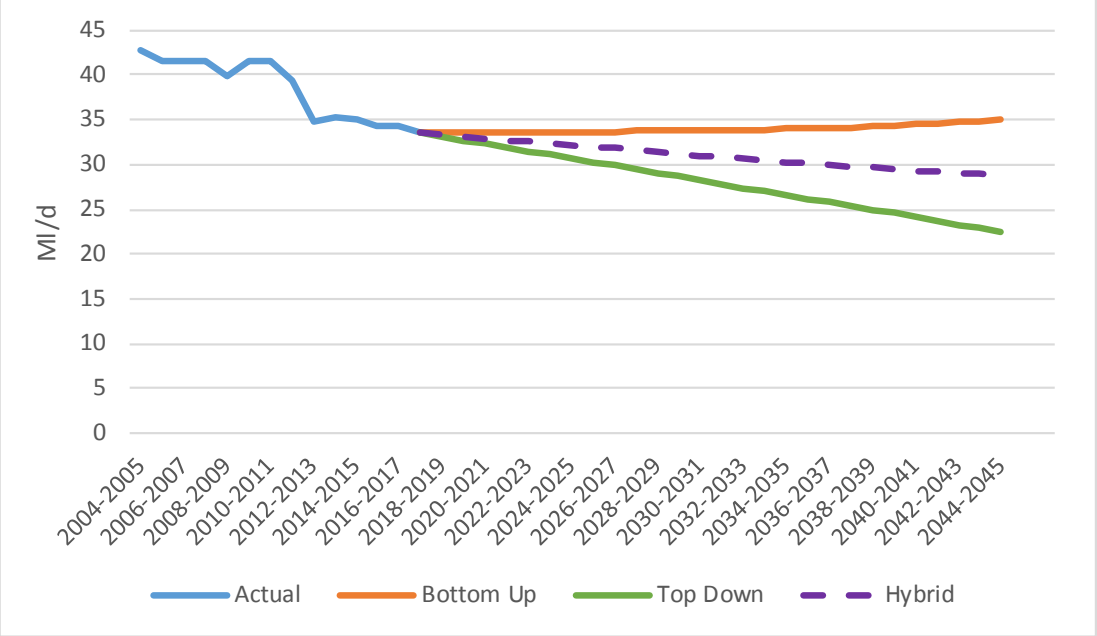


Figure 34 Measured Non-Household Demand Forecast

Unmeasured non-household demand makes up less than 1% of demand and is assumed to stay at the same rate over the planning period.

The UKWIR Impact of Climate Change on Water Demand (UKWIR, 2013) guidance suggests that there is little evidence to suggest that climate change will have an influence on Non-household water demand therefore no increase is applied.

5.5 Baseline Leakage Forecast

Leakage, water abstracted and treated but not delivered to customer's taps, is of significant concern to the Company and its customers. The amount of water lost through leaks in customer's pipes ideally would be zero. However, the reality is that the majority of water lost is as a result of leaks that occur on underground pipes without the water rising to the surface. The leaks that do result in water being visible on the surface are easy to identify and consequently are repaired quickly and are not a significant proportion of the leakage reported by companies.

Portsmouth Water's leakage reduction activities involve identifying and reporting the 'non-visible' leaks through various techniques. These include placing large portions of the network under pressure control to reduce the pressure in the system (which reduces the flow of water from leaks, which stops new leaks developing) active leak detection activities and undertaking mains renewal, replacing old pipes which have recurrent failures.

Portsmouth Water seeks to balance the cost of leakage reduction activities against the cost of the water lost through the leaks. In assessing these costs, the Company considers externalities such as the carbon cost of pumping and treating water, and the benefit to the environment of not abstracting the water. The point at which the costs of the water lost through leakage is equal to the cost of reducing leakage further is known as the sustainable economic level of leakage (SELL). The Company's leakage should not rise above this point, however under current government policy, the Company is encouraged to consider if their leakage forecast should be below the SELL, for example, if customers place a value on this and would be willing to pay for a lower level of leakage.

The Company is expected to meet its existing leakage reduction commitments during AMP6 (for the period to 2019/20). In the five year period from 2021 to 2025 we will reduce our leakage by 20% and to continue to reduce leakage in the longer term by 30% by 2040.The initial reduction in leakage is beyond our current estimate of the SELL.

5.5.1 New Leakage Methodology

The Government's *Guiding Principles for Water Resources Planning* (Defra, 2016) states that leakage should not rise at any point in the planning period. At the same time, a new methodology has been developed by the water industry (*Consistency of Reporting Performance Measures: Reporting Guidance*, UKWIR 2017) to ensure that there is consistent reporting between companies. The new methodology uses the 'Lowest Achieved' level of leakage in a control zone. Portsmouth Water is currently using its established methodology for assessing leakage whilst at the same time shadow reporting leakage using the consistent methodology.

For Portsmouth Water the new methodology produces higher outturn leakage figures and also a higher Sustainable Economic Level of Leakage (SELL). This does not represent a deterioration regarding leakage control, or distribution input, only a rebasing of the figure. The new methodology suggests that leakage was higher than previously reported and that per capita consumption was lower.

Portsmouth Water's WRMP19 is based on the new methodology and Ofwat reporting using the consistent methodology will follow in 2020. Historic leakage performance has been re-based to be consistent with the new approach. Distribution Input does not change, therefore historic per capita consumption figures are lower to compensate.

5.5.2 Leakage Assessment

For the last WRMP, Portsmouth Water engaged Tooms Moore Consulting to undertake a full SELL appraisal. The assessment has been updated for WRMP19, using the new methodology.

5.5.2.1 SELL Methodology

The SELL assessment methodology was developed to meet the requirements set out in the main guidance and best practice documents. The key documents are summarised in Table 56 below.

Document	Summary of relevant content for SELL
Economics of Balancing Supply and Demand, EA, 2003	Sets out how options for maintaining the supply-demand balance (including leakage reduction options) should be appraised
Water Resources Planning Guideline, Ofwat/EA/Defra, 2012	Describes the water resource planning requirements and sets out how leakage options should be assessed and reported for the Water Resource Plan
Review of SELL, EA/Ofwat/Defra, 2012	Makes a number of pragmatic recommendations for how SELL should be assessed
Best Practice Derivation of Leakage Cost Curves, UKWIR, 2011	Provides guidance on the assessment of leakage cost curves, but concentrating on active leakage control. It also describes an alternative method, which is a development of a Method B approach
Managing Leakage 2011-Report 3: Setting Economic Leakage targets, UKWIR, 2011	Set out principles of SELL
Tripartite study: Best Practice Principles for Economic Level of Leakage Calculation, EA/Ofwat/Defra, 2002	Now partially superseded. This report provides guidance on principles of SELL, including the idea of Method A and Method B approaches
Best Practice Guidance on the Inclusion of Externalities in the ELL Calculation, Ofwat, 2007	Covers the calculation of externalities. Partially superseded by the Review of SELL (2012)
Consistency of Reporting Performance Measures UKWIR 2017	Revised leakage calculation methodology.

Table 37 SELL Guidance Documents

The activities that were assessed as part of the SELL were:

- Changing Active Leakage Control (find and fix) (ALC) – This could include changes in detection technology, improvements in management systems, changes in the number of detection staff and reconfiguration of SMAs and DMAs to improve efficiency.
- Changing pressures by the use of control valves or pumps – This includes pump control, changed PRV control, new PRVs and zone reconfiguration.
- Infrastructure renewal – This includes mains, communication pipes, supply pipes and possibly service reservoirs. Activities are likely to be targeted on particular assets with known poor performance.
- Management of repairs – This is mainly about shortening repair time for reported and detected leaks by changed systems and increased repair resources.

For the SELL assessment, data for the key parameters were reviewed and a simple model of Active Leakage Control (ALC) was developed.

The costs of different levels of activities (and their interaction) were assessed to identify a leakage level that minimised total costs. This was identified as the Short Run SELL (i.e. the leakage level that would be optimum if no supply-demand issues or willingness to pay were to be included). The uncertainty in the Short-Run SELL was also assessed.

The SELL assessment also considered options for further leakage reduction beyond the Short-Run SELL. The cost of further leakage reductions by different methods was assessed and a cost versus leakage reduction relationship was developed.

5.5.2.2 SELL Results and Conclusions

The initial SELL assessment concluded that the current SELL is in the range of 32.0 to 39.9 Ml/d with the central point being 34.2 Ml/d. The range in the SELL reflects the uncertainty in the underlying data.

The full SELL appraisal identified that leakage could be economically reduced by 4.7 Ml/d over 5 years, leading to a central estimate of SELL of 29.5 Ml/d. The new estimated range of possible values, taking into account uncertainties in the central estimate is 27.6 to 33.7 Ml/d.

The SELL assessment identified that the reduction could be achieved through the introduction of District Meter Areas (DMAs) but also identified other alternatives to achieve leakage reduction such as the introduction of permanent correlating noise loggers.

As a result of the full SELL appraisal, the Company has decided to set an initial leakage reduction target of 7.1 Ml/d, reducing leakage from 35 Ml/d down to 27.90 Ml/d by 2024/25. This will result in a leakage target at SELL by 2025.

Options for varying the Company's leakage management policy in order to target a lower level of leakage are considered as part of the options appraisal (section 7). The programme appraisal undertaken by the Company to derive its preferred final planning programme considers feasible options for leakage reduction, taking account of financial, social and environmental and carbon costs and benefits, as well as other wider factors.

5.5.3 Forecasting Leakage

Over the planning period the level of leakage will change through a combination of influences including:

- Growth in number of properties (likely to result in an increase in the length of mains and the number of connections which may result in a rise in leakage, although new water mains are not expected to leak at the same rate as the remainder of the Company's network)
- Increased customer metering (this is likely to reduce supply pipe leakage, as described further below)
- Improvements in leakage detection technology (likely to result in a reduction in the costs of leakage management and a corresponding fall in the SELL).

In terms of improvements in leakage detection technology, the Company has been conducting satellite leak detection trials using satellite imaging technology. This technology has been in use for over 20 years detecting the presence of water on distant planets. Taken from satellite mounted sensors, the raw imagery is overlaid on geographic information systems and processed by a unique algorithm that detects treated water, which in most cases indicates the presence of a leak.

The Company anticipate significant improvements in leakage detection and repair efficiency through innovation (through satellite leak detection and other means) over the next 40 years and have taken this into account when forecasting the baseline level of leakage.

The Company believes that it is reasonable to expect the increase in leakage from growth in the distribution network will be less than savings made through gains in efficiency.

Additionally, it is reasonable to expect that the savings resulting in supply pipe leakage from the metering of customers to be reflected in the leakage forecast.

The Company has allowed for these benefits in its baseline leakage forecast which results in a falling leakage forecast over the planning period. This is illustrated in the graph below.

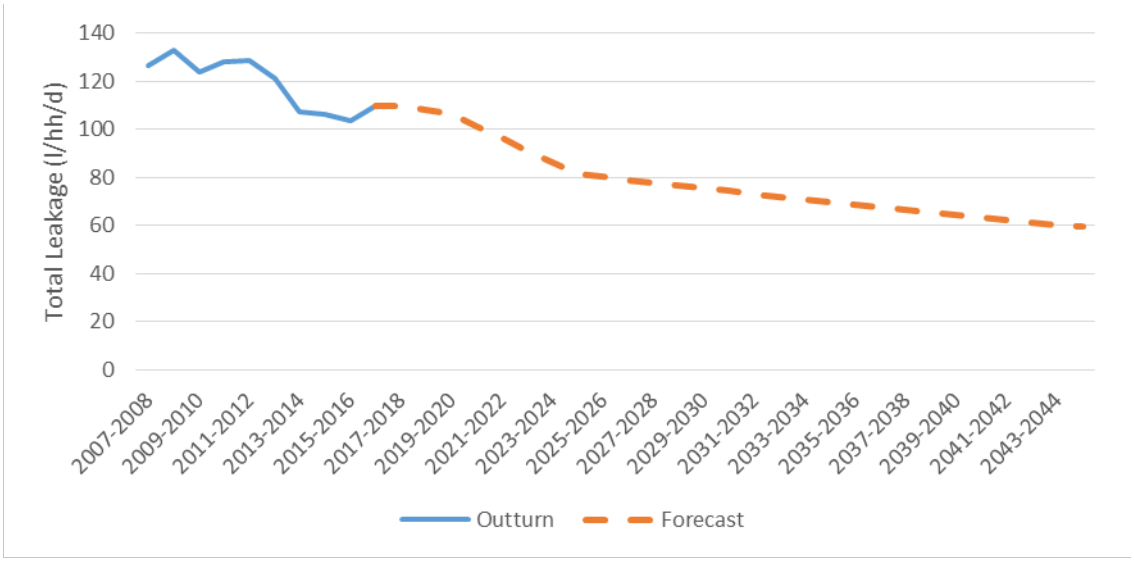


Figure 35 Leakage per property per day

The Company's innovation programme with regards to leakage reduction in AMP7 is set out in section 10.5.

5.5.4 Supply Pipe Leakage

The leakage figure reported by Portsmouth Water includes unmeasured water that is lost through leaks in customer supply pipes and/or internally within customer properties. Portsmouth Water undertakes leakage detection activity to identify these leaks or customers sometimes become aware of the leaks themselves. The Company continues to offer up to two free supply pipe repairs or a subsidised replacement of the supply pipe.

Supply pipe leakage tends to be lower on measured properties than on unmeasured properties. If a leak occurs on a measured property, customers will notice the step change in the volume consumed. Also, when a customer opts for a meter a check is undertaken on the customer's supply pipe. Consequently, the leakage forecast falls over the period to take account of the reduction in supply pipe leakage as a result of the number of customers opting for a meter.

5.6 Other Components of Demand

Other components of demand include:

- **Distribution System Operational Use (DSOU)** – Water run to waste such as that used for the purpose of mains flushing.
- **Water Taken Unbilled** – Includes water legally and illegally unbilled. Legally unbilled water includes water used for firefighting purposes whilst water illegally unbilled includes void properties which are actually occupied.

Water Taken Unbilled and Distribution System Operational Use are assumed to stay at the same rate over the period at 2.45 Ml/d and 0.43 Ml/d respectively.

6 Baseline Supply/Demand Balance

6.1 Introduction

This section takes forward the information from previous sections which have determined how much water is available for supply and the demand for water. Headroom is considered to give an indication of whether a company has sufficient resources to meet demand.

The information is drawn together and presented as a series of baseline supply-demand balance graphs under different WRMP planning scenarios. These plot demand and demand plus target headroom against Water Available For Use (WAFU).

This section also includes an assessment of the potential WFD impact that may result from changes in operation of existing sources to meet the baseline supply-demand balance forecast.

6.2 Headroom Assessment

In accordance with the WRPG and industry standard practice, the supply-demand balance includes a margin between supply and demand to allow for uncertainties inherent within the supply and demand forecasts. This margin is known as 'headroom'. The headroom value determined for each year across the planning horizon is termed the target headroom allowance. The aim of calculating a target headroom allowance is to provide a reasonable margin to cover the combined impact of factors leading to uncertainty on the supply-demand balance at a defined level of risk.

6.2.1 Methodology

Portsmouth Water employed AECOM to carry out the headroom assessment for WRMP19. Following feedback from the Environment Agency, some adjustments to the data and assumptions have now been applied to the assessment for Portsmouth Water's Final WRMP19. The updated analysis is reported in Appendix F and summarised in the following sections.

The industry standard method for the calculation of target headroom allowance has been followed. This is a probabilistic approach based on the 2002 UKWIR report and the guidance published by the Environment Agency. The Monte Carlo simulations were carried out using @ RISK software with 10,000 iterations. A high number of iterations were used to improve repeatability of results.

The standard methodology includes 13 uncertainty factors. These are listed in Table 38.

Factor	Name
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
S7	Single Source Dominance
S8	Impact of Climate Change on Deployable Output
S9	New Sources
D1	Accuracy of Sub-Component Demand Data
D2	Demand Forecast Variation
D3	Impact of Climate Change on Demand

Factor	Name
D4	Demand Management Measures

Table 38 Uncertainty Factors

A probability distribution is assigned to each uncertainty factor to represent a range of possible outcomes. The probability distributions are then combined using the Monte Carlo software to produce an overall curve that relates to a particular level of risk.

The level of risk can be set for each Monte Carlo simulation and a family of headroom graphs produced. The Water Resources Planning Guideline states that companies should accept a higher level of risk in the future. There is an expectation that, through better planning, companies will reduce higher risks in the future.

6.2.2 Headroom Uncertainty Factors

It is helpful to consider each of the uncertainty factors and their influence on the final headroom figure. More detail is contained in the AECOM Headroom Allowance Assessment Report (see Appendix F).

6.2.2.1 S1 Vulnerable Surface Water Licences

No allowance has been included for this factor in the calculations.

Portsmouth Water only has one surface water abstraction, at Source A. There is a requirement for further investigations on the River Itchen (as outlined in section 4.3.2). However, in accordance with the WRPG, potential changes to the licence have been explored through sensitivity scenarios rather than being included as part of headroom.

6.2.2.2 S2 Vulnerable Groundwater Licences

The WRPG, published by Ofwat, the Environment Agency and Defra, states that the headroom component should not include any allowance for sustainability changes to abstraction licences as they will work with water companies to ensure that any such changes would not impact on security of supply. On this basis, no allowance has been included for this factor in the calculations.

6.2.2.3 S3 Time Limited Licences

The guidelines state that "…[the company] may include an allowance for uncertainty related to non-replacement of TLL on current terms. This should be based on your assessment of environmental risks…"

Time limited licences are not considered a potential area of uncertainty for Portsmouth Water at present. The existing bulk supply to Southern Water in Sussex North relies on a licence variation that is time limited to 2028. The licence that relates to the new bulk supply into Hampshire is not time limited. Portsmouth Water has assessed this as sufficiently long not to cause any concern particularly, in the light of abstraction reform which is likely to occur on a shorter timescale. The potential for non-replacement of TLL on current terms is therefore not included in headroom.

6.2.2.4 S4 Bulk Imports

Portsmouth Water does not currently have any bulk imports of water and there are no such arrangements currently planned. This factor has been excluded from the headroom assessment.

6.2.2.5 S5 Gradual Pollution

Five key sources of pollution which could potentially place some or all of Portsmouth Water's sources of water at risk of loss of DO for medium to long periods of time were initially

considered. In previous assessments (including the Draft WRMP19), short term pollution events associated oil spillage were assessed as part of the outage allowance, whilst events longer than 90 days were considered as part of the headroom assessment. However, to address comments received from Regulators during consultation and to avoid any potential double counting, the risk of oil pollution has been removed from the headroom assessment.

The four remaining sources of gradual pollution considered include:

- Nitrates
- Pesticides
- Turbidity
- Cryptosporidium

After consideration of each potential source of gradual pollution, it was decided not to include any of them as future risks within the headroom calculation. Further explanation is provided in Appendix F.

6.2.2.6 S6 Accuracy of Supply Side Data

A small allowance has been included from the uncertainty in the accuracy of abstraction meters and the source yield assessments. There have also been minor adjustments from 2019/20 and 2023/24 to allow for specific groundwater deployable output recovery schemes. This does not significantly influence the overall headroom figure.

6.2.2.7 S7 Single Source Dominance

This factor is not included in the headroom assessment because Portsmouth Water only has one water resources zone.

6.2.2.8 S8 Impact of Climate Change on Deployable Output

For the WRMP19, a new assessment has been carried out by AECOM and HR Wallingford using the latest UKCP09 climate change scenarios. The assessment is based on a sub set of 100 scenarios selected from the full set of 10,000 scenarios in UKCP09. For each of the 100 scenarios, models have been produced for groundwater level, spring flow and river flow. These were used to develop a 'Resource Zone Model' to give 100 possible outcomes for each scenario.

From the 100 sampled scenarios, a profile of 'most likely' climate change impacts was determined, as well as the lower range and upper range profiles. These were used to define probability distributions to represent the uncertainty range in climate impacts on deployable output in each year across the planning horizon.

6.2.2.9 S9 New Sources

An allowance for new sources has been included in headroom from 2029/30 to take account of the proposed new reservoir at Havant Thicket and capture the uncertainty associated with it.

6.2.2.10 D1 Accuracy of Sub-Component Demand Data

A small allowance has been included for the uncertainty in the accuracy of distribution input meters. These meters are located at Service Reservoirs and are not the same as the meters located at source works. As Portsmouth Water has recently replaced many of their distribution input meters with new magflow meters (which have better accuracy and an improved electronic calibration) a smaller range of uncertainty has been used than for WRMP14.

6.2.2.11 D2 Demand Forecast Variation

The demand forecasts for the WRMP19 submission are based upon population and property estimates provided by Experian. In addition to the central estimate presented in the WRMP19 text, Experian also provided forecasts at 10% and 90% confidence. These bands were used

as scenarios in the Portsmouth Water demand model to derive a 'low' and 'high' forecast which in turn are used in the headroom assessment.

6.2.2.12 D3 Impact of Climate Change on Demand

Portsmouth Water has assessed the impacts of climate change on their company demand forecasts following UKWIR guidance (UKWIR, 2013). Three climate change scenarios were produced for measured and unmeasured household demand:

- Minimum (10th quantile)
- Most likely (median)
- High (90th quantile)

These values have been used to determine the parameters for the statistical probability distribution in the headroom calculation to calculate the uncertainty in climate change impacts on demand.

6.2.2.13 D4 Demand Management Measures

Portsmouth Water's demand forecasts include assumptions relating to the average number of meter optants each year, percentage savings from metering and the magnitude of leakage reduction included in the plan. The uncertainty surrounding the demand savings which will be achieved in practice from these demand management measures is accounted for within factor D4 of the headroom calculation.

Portsmouth Water has calculated a central forecast and a lower and upper band representing the possible variations on its demand forecast due to metering assumptions. The range between the forecasts has been taken to define the parameters for the statistical probability distribution in the headroom calculation. The distributions contribute to the target headroom allowance in each year across the planning horizon.

6.2.3 Target Headroom Allowance

The results of the Monte Carlo simulation are presented in Appendix F. This includes the headroom uncertainty allowance for each year across the planning horizon for a range of probabilities and for both the annual average and critical period planning scenario.

The WRPG states that companies should be prepared to take more risks at the end of the planning period. Table 39 presents the risk profile adopted. This is based on an initial level of risk of 10%, followed by 5% increments in each five-year period. Figure 36 shows the resulting headroom profile which has been used for the Final WRMP.

Period	Risk	Probability
2020/21–2024/25 (AMP7)	10%	90%
2025/26–2029/30 (AMP8)	15%	85%
2030/31–2034/35 (AMP9)	20%	80%
2035/36–2039/40 (AMP10)	25%	75%
2040/41–2044/45 (AMP11)	30%	70%

Table 39 Headroom Risk Profile

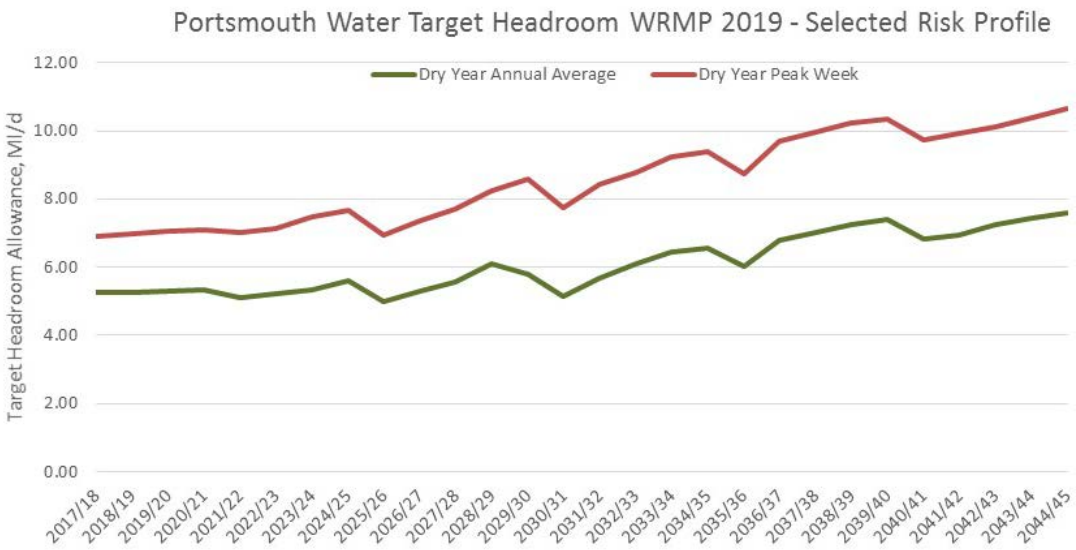


Figure 36 Final Headroom Profile

Table 40 compares the final headroom allowance with those from previous plans.

Submission	Combined Company Target Headroom Allowance (Ml/d)			
	Dry Year Annual Average		Dry Year Critical Period	
	2019/20	2024/25	2019/20	2024/25
WRMP 2009	10.7	9.6	12.4	8.9
WRMP 2014	10.3	9.5	13.8	13.4
WRMP 2019	5.3	5.6	7.1	7.7

Table 40 Target Headroom Allowance – Comparison with Previous Results

Table 40 shows that the Company's target headroom allowance has decreased compared to previous WRMPs. A smaller reduction is seen at the end of the Company's 25 year planning horizon.

The decrease is due to the following changes:

- Exclusion of oil pollution risks from the headroom assessment
- Probability profile starts at 90% and drops by 5% in each 5 year AMP period (compared with 1% per 5 years in WRMP14)
- Minor adjustments to the S6 (accuracy of supply-side data) uncertainty factor from 2019/20 and 2023/24 to allow for specific groundwater deployable output recovery schemes
- Inclusion of S9 (new sources) uncertainty factor from 2029/30 to allow for implementation of the Havant Thicket reservoir
- Inclusion of slightly lower uncertainty range for D3 (impact of climate change on demand)
- Notwithstanding increased demand forecast and climate change supply impact uncertainty.

Table 41 provides a summary of the final results of the headroom assessment.

Year	Dry Year Annual Average Ml/d	Dry Year Critical Period Ml/d (Peak Week)
2017/18	5.26	6.91
2019/20	5.31	7.06
2024/25	5.60	7.65
2029/30	5.79	8.57
2034/35	6.58	9.40
2039/40	7.38	10.35
2044/45	7.58	10.66

Table 41 Headroom Allowance through the Planning Period

6.3 Baseline Supply Demand Balance

For the Baseline Supply Demand Balance, Portsmouth Water has compared the baseline deployable output with the baseline demand forecast on the basis that both have the same probability of occurrence or return period.

A Design Drought Scenario of 1 in 200-year has been chosen by the Company to reflect the most challenging design scenario (see section 2.4.3). In accordance with the WRPG Guidance (July 2018), the baseline position is based on the dry year annual average (for demand) and a design drought (for supply).

As set out in section 2.4.4, following WRSE modelling, Portsmouth Water has agreed in principle to provide bulk supplies to Southern Water. Providing the agreed bulk supplies to Southern Water means that they effectively form an additional demand. They must therefore be added to the Company's baseline demand to enable a planning solution to be developed to maintain the balance between supply and demand.

The baseline position is a forecast of what would happen if the Company did not take any new supply or demand actions and did not implement any changes in company policy or existing operations.

The baseline supply forecast includes the water available for use from current sources under the design drought scenario. For this scenario, the Deployable Outputs have been calculated to represent a 1 in 200-year return period in terms of demand (see section 4.2).

The baseline demand forecast covers what people and businesses need, together with anticipated losses through leakage and operation. This is based on forecast dry year annual average demand, when demand for water is at its highest before water use restrictions are imposed.

WRMP Tables have been prepared for both Annual Average and Peak Week.

6.3.1 Design Drought Dry Year Annual Average: Baseline Supply–Demand Balance

This section presents the baseline supply-demand balance for the design drought (1 in 200-year period) under annual average conditions.

The baseline supply/demand balance is shown in the Water Resource Management Planning Table 4 with deployable output information drawn from Table 2 and demand data from Table 3. These tables form a separate appendix to this report. The balance can be represented as five-year time steps as shown in Table 42. This shows the supply-demand balance as a comparison of Deployable Output and Distribution Input. Further explanation is provided below.

	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Distribution Input	175.3	178.0	179.9	181.5	183.3	185.1
Deployable Output	190.7	190.7	190.7	190.7	190.7	190.7
Process Losses	2.4	2.4	2.4	2.4	2.4	2.4
Climate Change	0.1	0.2	0.4	0.6	0.8	1.0
Outage	13.1	13.5	14.6	14.6	14.6	14.6
WAFU	175.2	174.6	173.3	173.1	172.9	172.7
Bulk Supplies	22.5	39.0	60.0	60.0	60.0	60.0
Total WAFU	152.7	135.6	113.3	113.1	112.9	112.7
Target Headroom	5.3	5.6	5.8	6.6	7.4	7.6
Available Headroom	-22.7	-42.4	-66.6	-68.4	-70.4	-72.4
Supply Demand Balance	-27.9	-48.1	-72.4	-75.0	-77.8	-80.0

Table 42 Baseline Supply Demand Balance – Design Drought Annual Average

As it is a 1 in 200-year scenario (severe drought), the DO is lower than in a normal or average year. This is because groundwater levels and river flows would be low and therefore the amount of water available for abstraction would be less. For the baseline balance, the annual average demand represents a dry year because it is 'unconstrained'; the reduction as a result of demand restrictions is considered in the final planning tables.

In Table 42, there are reductions in DO as a result of climate change, outage and process losses. The resulting volume is termed 'Water Available For Use' (WAFU). After allowing for existing bulk supplies, and new bulk supplies, WAFU is compared with DI. This figure is called 'Available Headroom' and it can be compared to the 'Target Headroom' calculated in Section 6.2. If 'Available Headroom' is greater than 'Target Headroom', at any given time step, then there is a surplus.

Table 42 shows that under the baseline scenario, which includes the bulk supplies to Southern Water, the supply-demand balance is in deficit throughout the planning period and other options will be required to address this imbalance. The options appraisal process is presented in section 7. It should be noted that the other options include demand restrictions, as discussed in section 7.5.2.

The supply-demand balance can also be represented graphically. The graph in Figure 37 comes from the Water Resource Management Tables and includes a representation of the components of total demand (household and non-household consumption, leakage and other factors). The changes through the planning horizon are due to the Company's baseline activities (described in sections 5.3, 5.4 and 5.5). In summary, the number of measured households increases through time (as a result of Company baseline activities and optant metering) whilst non-household consumption and leakage decrease through time (leakage reductions through baseline activities such as active leakage control, pressure management and reductions in supply pipe leakage).

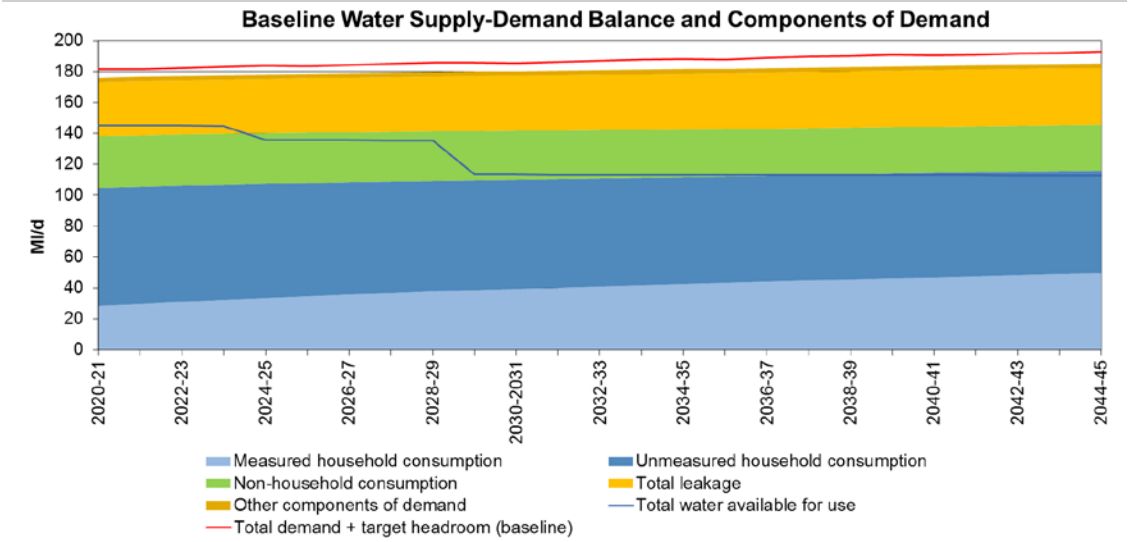


Figure 37 Baseline Supply Demand Graph - Design Drought Annual Average

In Figure 37, the red line represents demand plus target headroom and the blue line represents total water available for use (Total WAFU). The supply-demand balance can be determined through comparison of the red and blue lines.

In Figure 37, it can be seen that the blue line is significantly below the red line throughout, which shows there is a supply demand deficit. The deficit increases with time with the impact of climate change and as the volume of bulk supplies increase.

6.3.2 Design Drought Critical Period: Baseline Supply–Demand Balance

This section presents the baseline supply-demand balance for the design drought (1 in 200-year period) for the critical period.

Portsmouth Water has historically been a peak driven company due to the shape of the demand profile and the lack of raw water storage. The critical period has always been the peak week. The baseline supply-demand balance for the peak week is represented as five-year time steps in Table 43.

	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Distribution Input	218.2	221.1	223.2	225.0	227.0	229.1
Deployable Output	235.6	235.6	235.6	235.6	235.6	235.6
Process Losses	2.4	2.4	2.4	2.4	2.4	2.4
Climate Change	0.2	0.7	1.2	1.7	2.2	2.7
Outage	12.5	12.6	15.4	15.4	15.4	15.4
WAFU	220.5	219.9	216.6	216.1	215.6	215.1
Bulk Supplies	22.5	39.0	60.0	60.0	60.0	60.0
Total WAFU	198.0	180.9	156.6	156.1	155.6	155.1
Target Headroom	7.1	7.7	8.6	9.4	10.3	10.7
Available Headroom	-20.2	-40.2	-66.6	-68.9	-71.4	-74.0
Supply Demand Balance	-27.3	-47.9	-75.1	-78.3	-81.7	-84.6

Table 43 Baseline Supply Demand Balance – Design Drought Critical Period

In this scenario, the DI is higher as it is peak week. The deployable output is also higher as it reflects the DO during the peak summer demand period. This is not the period when groundwater levels and river flows are at their lowest (see section 4.2).

The critical period demand is 'unconstrained'; the reduction as a result of demand restrictions is considered in the final planning tables.

Table 43 indicates that under the baseline critical period scenario, which includes the bulk supplies to Southern Water, the supply-demand balance is in deficit throughout the planning period and other options will be required to address this imbalance. The options are considered in the options appraisal process is presented in section 7.

The supply-demand balance is represented graphically in

Figure 38.

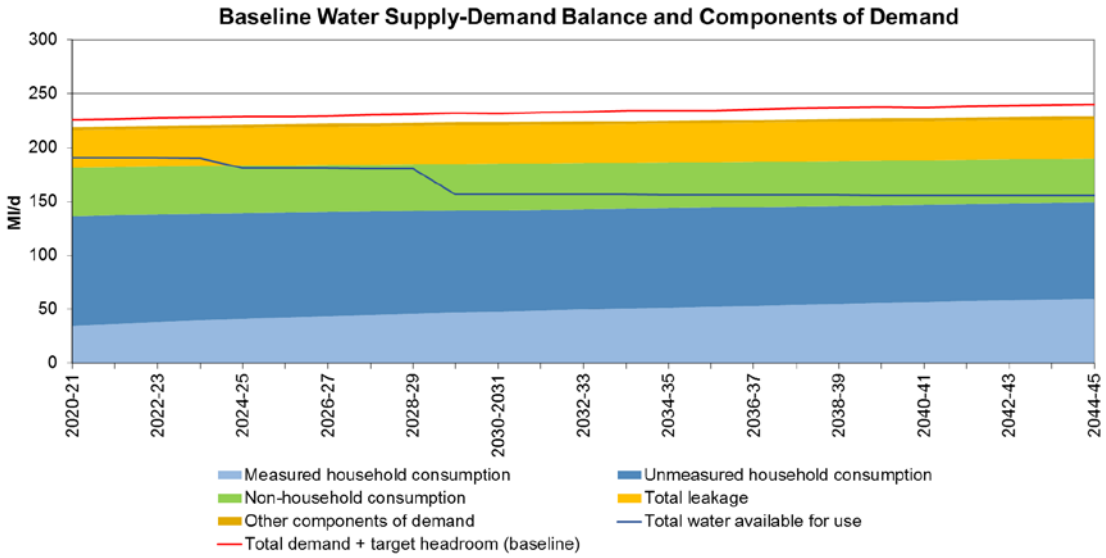


Figure 38 Baseline Supply Demand Graph - Design Drought Critical Period

In

Figure 38, the red line represents demand plus target headroom and the blue line represents total water available for use (Total WAFU). It can be seen that the blue line is significantly below the red line throughout which shows there is a supply demand deficit. As with the annual average scenario, the deficit increases with time with the impact of climate change and as the volume of bulk supplies increase.

6.4 Changes in operation of existing sources and the WFD

From the supply-demand balances presented above, it can be seen that the Company needs to fully utilise its existing sources to meet demand plus target headroom for the planning period under all scenarios. The Environment Agency's approach to assessing the potential need for sustainability reductions, as set out in section 4.3, has been based on the operation of existing sources at recent abstraction rates.

However, the WRPG requires companies to ensure that their plan supports the achievement of WFD obligations and RMBP objectives. This includes the requirement to ensure that planned abstraction will not result in water body status (or potential) compared to the baseline status reported in the 2015 RBMP. It should be noted that some of the Company's abstractions

cannot currently be operated at maximum licensed rates due to other constraints on DO, e.g. infrastructure or water quality. Where this is the case, and where the constraint can be addressed through investment, the Company has included an option for addressing the constraint as part of its WRMP options appraisal process. The assessments of the potential WFD impacts of feasible options comprising the Company's preferred final planning programme are discussed in the SEA Environmental Report that accompanies the WRMP and are also considered in sections 7.5, 7.7 and 9.5.

7 Options Appraisal

7.1 Introduction

This section sets out the process the Company has used to develop potential options that could be used to balance supply and demand, as well as the way in which these options have been appraised economically.

The section introduces the stages of the options appraisal process and then goes into some detail about the development of the options themselves. Details are provided as to how these options were developed by the Company, and how financial, environmental and social and carbon costs were assigned. The economic appraisal is presented and the programme appraisal, which explains the derivation of the preferred plan.

7.2 Options Appraisal Process

The options appraisal process considers potential options to balance supply and demand. Figure 39 shows the approach that the Company has taken to determine its preferred final planning programme.

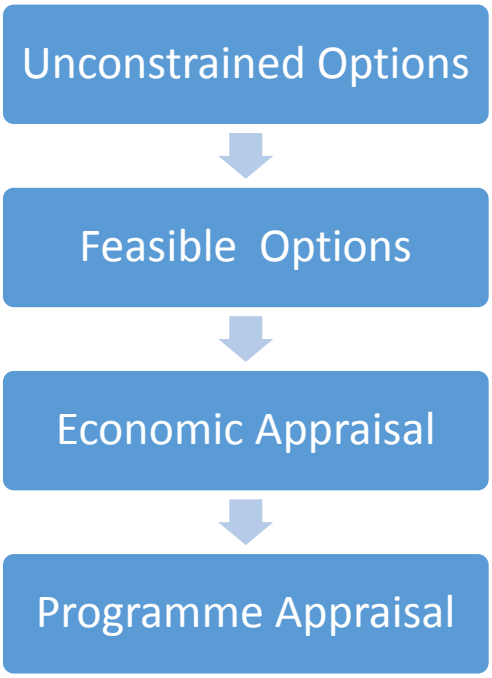


Figure 39 Flow Chart illustrating stages of the Company's Options Appraisal Process

Wood were commissioned by Portsmouth Water to support the Options Appraisal work, and they undertook work on the first three stages shown in Figure 39.

The first stage in the process was to establish an "unconstrained" list of options by identifying all potential options that could be used to balance supply and demand. Unconstrained options are generated based on technical feasibility, but tend not to be constrained by regulatory restrictions. These options are generated from past and present information available to the Company and take into account the core business functions and government aspirations.

The viability of these options was then considered to identify those to take forward for more detailed options appraisal, i.e. as part of the 'feasible' or 'constrained' options list. Section 7.3 describes the unconstrained options considered and the screening process.

The feasible options (those shortlisted from the original list of unconstrained options) were then examined further by taking into account financial costs, social and environmental costs, carbon costs, yield and delivery uncertainties. Section 7.4 presents the feasible options list and describes how the feasible options were assessed. Section 7.5 provides an appraisal of the feasible options.

The next stage in the process was an economic appraisal. The relative economic costs and benefits of all feasible options, to the extent which they have been possible to monetise were analysed to determine the least-cost planning solution. Further detail on the economic appraisal is provided in section 7.6.

Following identification of the least-cost solution, alternative solutions were considered taking into account environmental performance from the Strategic Environmental Assessment (SEA) and other non-monetisable information about each option or set of options. The process of programme appraisal is described in section 7.7.

7.3 Unconstrained Options

7.3.1 Developing the Unconstrained List of Options

The Company developed an unconstrained list of options, taking into account all options that were considered technically feasible. In formulating the list, the Company took account of UKWIR guidance (UKWIR, 2012) and started by considering the generic list of unconstrained options included within the guidance document.

The list encompasses the following types of management options:

- Customer-side – options affecting customers involving demand management implemented at customers' properties, such as water efficiency and metering;
- Production-side – options targeted at activities between abstraction and the point of consumption, e.g. at water treatment works;
- Distribution-side – options that address activities involved with the management of the system, such as leakage control; and
- Resource management – options that affect deployable output (DO), e.g. a new reservoir or a new raw or treated water transfer.

The unconstrained list was further developed by considering the additional factors described below.

7.3.1.1 Portsmouth Water's previous WRMP options

Options from previous plans were identified and updated as relevant. Options were reviewed technically to ensure that the detail within them was correct for WRMP19.

7.3.1.2 WRSE options

As mentioned in section 3.1.1, the Company has actively participated in the WRSE Group and has proactively pursued more detailed discussions with specific water companies to identify potential transfer options which may improve resource sharing and resilience across South East England. The unconstrained list contains many different bulk transfer options in addition to the options associated with the development of Havant Thicket Winter Storage Reservoir which has been modelled and assessed in detail by the WRSE Group.

7.3.1.3 Leakage management options

Options for leakage reduction and leakage detection were considered, informed by the Company's Sustainable Economic Level of Leakage (SELL) report (Appendix K).

7.3.1.4 *Third party options/ upstream providers*

The WRPG requires companies to engage with third party suppliers to see if they have feasible options. As set out in Section 3.1.5, Portsmouth Water contacted a number of water companies and potential suppliers as part of the pre-consultation process. The following organisations were considered to be potential suppliers:

- Southern Water
- South East Water
- Albion Water
- SSE Water

No specific third-party resource or alternative supply options were identified.

7.3.1.5 *Changes since the Draft Plan*

As set out in Section 2.3, the WRMP process requires a period of public consultation. A number of changes have been made to the Draft WRMP in response to stakeholder and customer engagement as well as the formal representations made to Defra (see section 3.2.2). These include changes with respect to metering, water efficiency and leakage options.

The specific changes made regarding the unconstrained list of options are summarised in Table 44 below.

Option Number	Change Since Draft Plan	Details
CO05	This option has been altered slightly	In the Draft WRMP, Option CO05 represented smart metering of all households where a meter or meter box already exists. In the Final WRMP, this option is now a trial of smart meters which are being installed where a meter or meter box already exists. The smart meters will initially provide customers with more information and be Not for Revenue (NFR).
CO06a	This option has been altered slightly and split into two phases	In the Draft WRMP, Option CO06a was previously 'Metering on Change of Occupancy (when sold)'. This has been changed slightly and split into two phases. The first phase is 'Metering on change of occupancy – existing meter pits' and occurs from 2020–2025. During this 5-year period, on change of ownership households with an existing meter pit would be metered.
CO06b	This option has been added to the unconstrained list (it is the second phase of the amended option CO06)	This option is the second phase of the amended option CO06. The second phase 'Metering on change of occupancy' will occur from 2025 onwards. This will implement metering on change of occupancy (regardless of there is an existing meter pit).

CO46a	**This option has been added to the unconstrained list**	**This option represents an enhancement to the household water efficiency programme (CO46). This has been added following consultation on the Draft WRMP. It follows an offer from Waterwise to work with the Company to achieve further efficiency savings.**
CO86	This option has been added to the unconstrained list	The 'Compulsory Household Metering' option has been added following consultation on the Draft WRMP. Compulsory metering of all households has been added to the unconstrained list and has been costed for information purposes, to comply with Directions 3(f) and 3(h). It is not a feasible option as Portsmouth Water's area of supply is in an area of 'moderate water stress', and the Company cannot therefore legally consider compulsorily metering its domestic customers.
DO04a	This option has been altered slightly	In the Draft WRMP, Option DO04a was for deployment of permanent noise loggers (25% of the network). This is now being replaced with a new option DO04a which is for the first phase of a fixed network of permanent noise loggers connected to an instant data transmission network. This option has a start date of 2020/21 and is initially intended to complement the existing DMAs. It is similar to the previous option DO04a but an alternative version using the latest technology (see section 7.5.4)
DO04b	This option has been altered slightly	In the Draft WRMP, Option DO04b was for deployment of permanent noise loggers (75% of the network). This is now being replaced with a new option DO04b which is for the second phase of a fixed network of permanent noise loggers connected to an instant data transmission network. This option has a start date of 2025/26 and continues from DO04a (phase 1).

Table 44 Summary of Changes to the Unconstrained List of Options for the Final WRMP19

7.3.2 Unconstrained Options List

The Company's unconstrained option list comprises 183 potential options, 53 of which have been newly identified for WRMP19.

Table 45 provides a summary of unconstrained options.

Option Category	Number of Options	Range of options
Customer	85	Water efficiency
		Water conservation
		Metering
		Tariff
Production	4	Washwater recovery
Distribution	12	Leakage detection
		Leakage reduction
		Distribution capacity expansion
Resource	82	Direct river abstraction
		Groundwater abstraction
		New storage
		Reclaim and reuse
		Managed Aquifer Recharge
		Bulk Transfer
		Desalination
		Retain resources
		Other (tankering, trading, conjunctive use)

Table 45 Summary of unconstrained options

The full list of unconstrained options is included in Appendix R in the following tables:

- Table A.1 Unconstrained customer options
- Table A.2. Unconstrained production options
- Table A.3 Unconstrained distribution options
- Table A.4 Unconstrained resource options

7.3.3 Screening of Unconstrained Options List

Screening criteria were applied to the list of unconstrained options to refine the list and identify feasible options for further investigation and assessment. The following screening process was used:

- Step 1 – Remove baseline and duplicate activities
- Step 2 – Remove options that compete with Southern Water for resources
- Step 3 – Identify mutually exclusive options and apply a risk-based approach to options selection
- Step 4 – Assess technical credibility
- Step 5 – Assess how well the option can be promoted and if it is acceptable to stakeholders and customers
- Step 6 – Consider other issues which may suggest that an option is not feasible

The screening process was undertaken to remove options with unalterable constraints or which had a high risk of failure. Options were assessed on a Pass/Fail basis. Feasible options were considered to be technically feasible and capable of implementation within the current regulatory and legal framework. The process is described in more detail below.

Step 1: Remove baseline and duplicate activities (i.e. options that are not materially different to baseline activities and options that are fundamentally the same as another within the unconstrained list).

Step 2: Remove options that are likely to compete with Southern Water's need for resources. This is based on communication with Southern Water regarding its own unconstrained list and feasibility assessment. For example, building a desalination plant to provide a bulk supply to Southern Water is not feasible as they have one in their plan and could just increase its size.

Options to utilise treated effluent from Southern Water wastewater treatment works were considered on their merits, but were excluded as they appear in Southern water's options.

Step 3: Identify mutually exclusive options (including variations with option type) and remove those that are the least technically feasible from a range of similar or mutually exclusive options. Portsmouth Water has adopted a Risk-Based Approach to developing and evaluating its range of potential options. Technical feasibility is a basic premise for options being included in the Unconstrained List. The level of technical feasibility was determined based on:

- the level of need for the specific option (i.e. the demand response to drought may negate the need for drought specific options);
- environmental objectives or regulatory constraints (i.e. known sustainability abstractions, clear risk of driving WFD deteriorations, conflicts with existing resources, National Environment Programme objectives, high risks to landscape objectives or known cultural heritage issues);
- the scale of technical intervention or level of technical complexity required to realise the deployable output; and
- the presence or absence of opportunities to mitigate potential adverse impacts.

During this step, information from the Strategic Environmental Assessment (SEA) was used. The early part of the SEA process involved establishing the environmental baseline, identifying environmental problems and considering strategic environmental objectives. The environmental information collated was used within the Options Appraisal screening process. Any options which had constraints from an environmental perspective which made them unfeasible were ruled out.

Step 4: Assess the technical credibility of the option. The focus was on removing the least technically credible options. Basic technical credibility was assessed by considering whether under the conditions that are driving the deficit:

- the option would be able to provide an appropriate solution;
- the likelihood of delivering the required deployable output; this can be constrained by technical issues;
- the sustainability of the source; and
- the ability to mitigate any highly negative impacts.

For demand management options a key consideration was the level of certainty that the option would be able to deliver water savings if implemented.

For supply options, a key consideration was the sustainability of the source on environmental grounds, taking into account abstraction licencing considerations, WFD objectives and views expressed by the Environment Agency and Natural England.

During this step, any dependencies on assets that are not yet in place or otherwise outside of Portsmouth Water's own control were assessed (e.g. options to reduce bulk exports on the basis of large-scale storage that is not yet in any other company's baseline invoke too high a risk for Portsmouth Water's own customers). These options will remain under consideration in the longer-term.

Step 5: Assess how well the option could be promoted / accepted. This involved two elements. Firstly, political acceptability. This considered how appropriate the option is in the context of national (and if relevant) local policy (such as policy on water metering). It also considered the viability of the option in the context of Portsmouth Water's own commercial policies. Secondly, customer acceptability. Where Portsmouth Water has collated its own customer research (e.g. willingness to pay, forums, or via other communication routes) this evidence was used to assess the likely reaction of customers to a proposed option and the significance it may have.

Step 6: There was scope to consider any other bespoke or otherwise option specific issues that may strongly suggest an option is feasible, infeasible, or otherwise invalid for the WRMP. For example, there are some options that were identified via the Water Resources South East group work which rely on Portsmouth Water releasing its resources to benefit the wider South East. These are critical considerations for this WRMP.

The evaluation of the unconstrained options set is provided in Appendix R in Table B.1. This confirms which options successfully passed to the feasible list and includes the rationale supporting the screening outcomes.

Following the screening, a total of 25 feasible options were identified for Portsmouth Water to consider further. Table 46 provides a summary. The full list of feasible options is included in section 7.4.1.

Option Category	Number of Options	Range of options
Customer	15	Water efficiency
		Water conservation
		Metering
Production	0	N/a
Distribution	4	Leakage detection
		Leakage reduction
Resource	6	Direct river abstraction
		Groundwater abstraction
		New storage

Table 46 Summary of feasible options

7.3.4 Commentary on Screening Results

7.3.4.1 Customer Side Options

The screening criteria set out in section 7.3.3 reduced the number of customer options on the unconstrained list. Full details of the rationale supporting the screening outcomes are provided in Appendix R in Table B.1. A summary of some of the items screened out is provided below:

- Compulsory metering options and several options which were forms of compulsory metering were ruled out as Portsmouth Water does not operate in an area of Serious Water Stress.
- Options which considered different changes to tariffs and charging were ruled out for different reasons, often being seen to be unacceptable to stakeholders and customers
- Options such as changing labelling water consumption of household appliances and providing water efficiency advice for designers were considered to be beyond the scope of an individual water company.
- Various water efficiency advice options were ruled out on the basis that targeted advice is a much more powerful method than blanket messaging.
- A number of water saving device options were ruled out due to duplication – for example, Portsmouth Water already distributes low flow shower heads, flow aerators and shower timers for free.
- Options such as treated greywater reuse and rainwater harvesting in new households were ruled out as the Company has no mechanism to enforce this.

7.3.4.2 Production Side Options

The four unconstrained production side options were all screened out, as detailed in Appendix R in Table B.2.

The two unconstrained options relating to washwater at the Company's biggest treatment works, Works B, were screened out as a new washwater recovery plant was commissioned in

2016/17 and this will reduce operational losses and provide sufficient capacity for potential Havant Thicket flows.

The other two options considered the installation of modern membrane plants at Source F and Source P. Given the type of treatment already in place, the additional recovery of yield from the membrane plants was not considered significant i.e. the options were screened out as they provided no additional benefit.

7.3.4.3 Distribution Side Options

The screening criteria set out in section 7.3.3 reduced the number of distribution side options, as detailed in Appendix R in Table B.3.

A number of leakage reduction and leakage detections options were ruled out as they were duplications. For example, the unconstrained option DO02 (increase find and fix leakage control activity on trunk and distribution mains) was considered too similar to DO07 (targeted mains replacement) and DO10 (risk-based selection for mains renewal).

Other options were ruled out as being too similar to existing baseline activities (e.g. DO03 - increase find and fix leakage control activity on communication pipes) or not currently being technically feasible (e.g. DO08 and DO09 Trunk Main Expansion & Distribution Main Expansion). Option DO01 – decrease time taken to fix reported leaks was ruled out as being unfeasible as it is already company policy to repair large reported leaks within 1 day and smaller reported visible leaks within 3 days. With the options of District Metering and Fixed Networks, an increase in the number of leaks identified and repaired is already accounted for.

Two distribution side options were given further detailed consideration for the Final WRMP but were ultimately screened out. These are described in more detail below.

Risk Based Mains Renewal

This option would result in targeted replacement of the parts of the network with greatest leakage and where the cost-benefit ratio of renewal would be most favourable. Existing distribution mains would be excavated and replaced with new mains, reducing leakage.

The option (DO10) involves renewing 200 km of distribution mains in AMP7, which will maintain the Company's current burst rate but also help to reduce leakage further. This option is in addition to the baseline leakage reduction that comes from the Company's maintenance of the water distribution system (including strategies specifically targeted at bursts). It is considered in the SELL assessment as an option for further leakage reduction beyond District Metering or Fixed Networks in AMP7. However, the SELL report (Appendix K) suggests that there is some uncertainty in the predicted yield as it is based on a high-level planning estimate and there is potential for double counting of leakage savings with other options such as District Metering or Fixed Networks. Following careful consideration, this option was screened out on the grounds of technical ability as it was unlikely that substantial additional leakage savings would be achievable beyond that already accounted for by District Metering or Fixed Networks.

Additional Pressure Management

Pressure management reduces the amount of water lost through existing (undetected) leaks and also reduces the rate at which new leaks occur (due to reduced pressure within mains).

Portsmouth Water's approach to leakage reduction to date has been to place large portions of the network under pressure control. As a result, the options for further pressure management are now very limited.

The SELL assessment (Appendix K) identified that there were some (limited) options for further pressure management at a sub-DMA level. The UKWIR long-term leakage targets pressure versus expenditure relationship was used to estimate the cost of further pressure reduction. AISC cost curves were derived and used to determine the AISC cost for a further potential leakage reduction of 2.7 Ml/d. However, no specific sites were identified for further

pressure management and there is considerable uncertainty as to where and how this would be achieved. The SELL report flagged the potential for double counting of leakage savings with other options such as District Metering or Fixed Networks. Following careful consideration, this option was screened out on the grounds of technical ability as it was unlikely that substantial additional leakage savings would be achievable beyond that already accounted for by District Metering or Fixed Networks.

7.3.4.4 Resource Side Options

The screening criteria set out in section 7.3.3 substantially reduced the number of resource options on the unconstrained list. Full details of the rationale supporting the screening outcomes is provided in Appendix R in Table B.4. A summary of some of the main reasons under which options were ruled out is provided below:

- Many options with increases in abstraction licence volumes have been screened out on environmental grounds, based on the presumption against further abstraction in different catchments. There are also risks to landscapes and heritage features associated with surface water abstractions and associated treatment works downstream of the tidal limit.
- The different options for impounding reservoirs have been screened out due likely impacts on various designated sites and WFD objectives
- Different variations for winter storage reservoirs have been considered and ruled out either for being variations of option RO13 or for environmental considerations or based on technical feasibility.
- Several options relating to effluent re-use (RO32 -37, RO85) have been screened out on mutual exclusion grounds as these are included within Southern Water's plan
- Of the remaining effluent re-use schemes available to the Company (Portsmouth Water is a supply only company), Option RO83 was screened out as it would derogate Portsmouth Water's abstraction at Source A and RO59 was ruled out on environmental grounds. RO60 has been excluded on the basis of timing, need and potential mutual exclusivity (it would only become available after RO13 had been developed).
- Options relating to desalination (RO27 – 30) have been screened out on mutual exclusion grounds as these are included within Southern Water's plan. It should also be noted that the potential locations considered (Portsmouth Harbour, Hayling Island, River Arun and River Itchen downstream of the tidal limit) would not be feasible on environmental grounds as these areas are within Special Protection Areas (SPAs). They may also pose risks to landscapes and heritage features.

7.4 Feasible Options

7.4.1 Feasible Options List

The feasible options that were taken forward for further consideration in the options appraisal process are summarised in Table 47. Further detail regarding each option is provided in section 7.5.

Option Reference	Type	Name	Summary Description
CO05	Smart metering	Smart Meter MNFR Trial	Smart meter a small number of households where a meter box already exists. Use dual billing to try an encourage conversion to a measured tariff.

CO06a	Metering	Metering on change of occupancy – existing meter pits	On change of ownership households with an existing meter pit would be metered. This is the first, lower cost, phase of C006.
CO06b	Metering	Metering on Change of Occupancy (when sold)	On change of ownership install meters into households that currently do not have a meter.
CO26	Water efficiency	Subsidy to customers that purchase water efficient appliances (washing machines and dishwashers, showers and WCs)	This option would introduce a Portsmouth Water funded subsidy (i.e. vouchers) on water efficient appliances. The rationale behind this option is to encourage wider uptake of water efficient appliances amongst customers.
CO34	Water efficiency	Water saving devices – Retrofitting existing toilets	Retrofit dual flush mechanisms in toilets in household and non-household properties to replace existing higher flush volume mechanisms.
CO40	Water efficiency	Water saving devices – spray taps	Install spray taps (new taps not inserts) in household and non-household properties. These would replace non-spray taps.
CO43	Water efficiency	Water saving devices – trigger nozzles for hoses	Distribute trigger nozzles for use on hosepipes to household properties. The rationale behind this option is that the trigger nozzle would allow customers to control the amount of water used through hosepipes (when compared to a hosepipe with no control fitted).
CO46	Water efficiency	Household water efficiency programme (partnering approach, home visit)	Home visit by plumbers to install water efficiency devices in households and provide information to encourage and support behavioural changes.
CO46b	Water efficiency	Waterwise household water efficiency	Working with Waterwise to enhance the household water efficiency programme.
CO69	Smart metering	Target occupants of new build housing with smart meters and water efficiency advice	Ensures that all new homes have a smart meter (rather than basic meter) installed and new owners are provided with advice on their fittings and appliances and how to improve water efficiency.
CO75	Metering	Smart metering – replacing existing household water meters and provide water efficiency audit and advice	Replacing existing basic meters with smart meters and installing smart meters in remaining unmetered households.
CO78	Water efficiency	Voluntary restraint and leakage action	Enhanced public awareness campaigns on dry year versus drought situation as triggered by emergent conditions. This includes advice on benefits of mild restraint to households and non-households.
CO79	Water conservation	Mandatory restraint	Hosepipe Ban implemented via the statutory Drought Plan.
CO80	Water conservation	Imposition of Drought Direction Restrictions	Non Essential Use Ban implemented via the statutory Drought Plan.

		(mandatory commercial restraint)	
CO84	Metering	Voids metering	Metering of empty properties to ensure future revenue and to detect supply pipe leaks.
DO04a	Leakage detection	Fixed network of permanent noise loggers connected to an instant data transmission network (phase 1)	A fixed network of noise loggers initially used to complement the DMA's but eventually replacing them. Loggers connected to 'Smart' software via telemetry to allow the detection of smaller leaks more quickly.
DO04b	Leakage detection	Fixed network of permanent noise loggers connected to an instant data transmission network (phase 2)	Second phase of installation of noise loggers (from 2025 onwards)
DO05	Leakage detection	Installation of district meters – partial network	Installation of DMA's in selected areas to reduce leakage
DO11	Leakage detection	Installation of district meters – full network	Installation of DMA's over the whole area of supply to reduce leakage.
RO13	New winter storage reservoir	Havant Thicket Winter Storage Reservoir	Construction of a pumped storage reservoir at Havant Thicket. Water would be pumped from the Havant & Bedhampton Springs during the winter period and stored in the reservoir for use in dry or drought conditions. Water would be abstracted using a draw-off structure and gravity feed back to the Bedhampton for treatment. Water would then be transferred through a dedicated main to Farlington for further treatment.
RO21a	Groundwater abstraction	Source O – Maximising DO	Increase the DO of the source to recent actual levels by blocking an adit and deepening a borehole.
RO22a	Groundwater abstraction	Source J – Maximising DO	Maximise DO of the source within existing licence limits by the provision of a satellite borehole.
RO23a	Groundwater abstraction	Source H – Maximising DO	Increase DO to average licence quantities by water quality improvements.
RO24a	Groundwater abstraction	Source C – Maximising DO	Increase DO to average licence quantities by water quality improvements.
RO68	Groundwater abstraction	Source S – Drought Permit	When Swanbourne Lake is already dry increase abstraction from the Source S from licensed limit of 2.5Ml/d to 11.5 Ml/d.

Table 47 List of Feasible Options with Summary Description

7.4.2 Feasible Options Cost and Benefits Assessment Methodology

The next stage in the process was to derive estimates of costs and benefits for each feasible option. These costs (or benefits) are split up into:

- Cost of building the scheme, including maintenance/replacement costs (The Capital cost or CAPEX)

- Cost of operating the scheme (The Operating cost or OPEX)
- Social and Environmental costs of the scheme
- Carbon costs of the scheme.

Cost assessments have been undertaken for all feasible options. This work is presented in full in an Options Costing report which has been shared with the regulators, but is not included in the public version of this plan for commercial confidentiality reasons.

It should be emphasised that the option and therefore programme costs presented in this WRMP are indicative, based on currently available information, and will be refined as the options are further investigated and developed.

The following sections summarise the methods used to estimate costs for each feasible option.

7.4.2.1 Capital (Capex) Costs

Capex estimates have been prepared for all the feasible options.

The capex components for supply options are fixed and capex is composed of four elements:

- Investigations and feasibility
- Design
- Construction
- Replacement (i.e. replacement of key parts of assets)

The capex for demand options (water efficiency, metering and leakage) generally fall within four main categories:

- Preparatory work
- Equipment
- Access and installation
- Replacement (not applicable to all demand options)

The capex of demand options includes both fixed and variable elements. Relevant components have been assessed for each options.

7.4.2.2 Operating (Opex) Costs

Estimates for fixed and variable operating costs have been derived for the supply side options. Fixed opex estimates have been derived for relevant components for each option (primarily human resources: operational and maintenance). Variable opex has been derived for the following components (where appropriate):

- Abstraction charges
- Power
- Chemicals.

Opex costs for demand schemed are those associated with operating the scheme in the long-term. For example:

- Cost to read a meter (or savings from smart meters);
- Active Leakage Control surveys (after the initial capex effort has achieved the leakage savings), only the level of effort required to sustain the additional savings are included in the opex costs. All other ALC costs are baseline;
- Cost to deal with the incoming calls relating to meters/bills;
- Number of calls per customer arising specifically from the scheme.

Operational costs also sub-divide into fixed and variable, plus potential opex savings that demand management generates.

7.4.2.3 *Social and Environmental Costs*

Portsmouth Water has used the Benefits Assessment Guidance (BAG) approach to assess social and environmental costs.

The BAG guidance was developed for the use of Environment Agency and water company planners to ensure consistency in approach to the assessment of water resource options. The approach allows an assessment of environmental and social costs and benefits of options using a desk-top approach. This cost-benefit approach requires that the impacts are described qualitatively and, where appropriate, a monetary assessment is made of the potential costs and benefits of implementing a water resource option.

The BAG uses a benefit transfer approach, whereby information on environmental and social costs are taken from published data (for example, from willingness to pay studies) and applied to the option under consideration. The BAG enables the assessment of the environmental and social costs of water resource options as a desk-top study.

Although there are limitations to the approach set out in the BAG, the methodology was subject to a peer review and testing process by relevant policy stakeholders (the Environment Agency, Defra, the Welsh Assembly, Ofwat, Natural England), academics and water company economists at the time of publication, and remains part of the recommended approach to option assessment set out within the WRPG.

For each option, the potential environmental and social impacts have been described against the criteria set out in the BAG. In accordance with the guidance, impacts against each criterion have been monetised where it is considered that the transfer values available are suitable for monetisation.

A monetised assessment of the impacts upon the environment and the relevant population affected using the approach recommended by the WRPG. This assessment was also informed by the Environmental and Social Costs Supporting Document.

7.4.2.4 *Carbon Costs*

For WRMP19, the cost of carbon has to be reported in terms of the cost of fixed carbon, and variable carbon. Underpinning those cost calculations is a further sub-division of whether the cost components fall within the definition of traded or non-traded carbon.

In 2017 the Department for Business, Energy, & Industrial Strategy provided updated supplementary guidance to the Treasury's Green Book (HM Treasury, 2016) with rules for valuing energy usage and greenhouse gas emissions (DBEIS, 2017). The guidance is aimed at all industrial sectors but is pertinent to the water sector.

The DBEIS guidance is in turn supported by a series of data tables for industry which include data to convert different fuel types to CO_2 and CO_2e, and carbon prices and sensitivities for traded and non-traded carbon categories between 2010 and 2100. The data include low, central, and high sensitivity bands. Portsmouth Water's assessment has applied the Central sensitivity cost profiles.

Whole life carbon costs have been determined for each feasible option. For supply options, fixed carbon has been quantified by considering embodied carbon in materials and carbon emissions from plant during construction. Variable carbon has been estimated considering emissions from energy use and embodied carbon in chemicals.

For demand options, carbon from vehicle movements, embodied carbon in materials and carbon from plant during Implementation have been considered. In terms of variable carbon, distribution carbon saving, carbon emissions during operational driving and within property carbon saving have all been considered.

7.4.2.5 Average Incremental Costs and Average Incremental Social Costs

The costs and benefits assessment for each feasible option (described in sections 7.4.2.1 to 7.4.2.4) have been forecast across an 80-year period, from 2019/20 to 2099/2100. Costs have been discounted over this period using the HM Treasury Green Book guidance. These costs are used to calculate the Average Incremental Costs (AIC) and Average Incremental Social Costs (AISC) values in pence per cubic metre of water delivered or saved.

7.4.3 Strategic Environmental Assessment and Habitats Regulation Assessment

The Strategic Environmental Assessment Directive (SEA EU, 2001) requires a formal environmental assessment of certain categories of plans and programmes which are likely to have significant effects on the environment. The directive has been transposed into The Environmental Assessment of Plans and Programmes Regulations HM Government, 2004. The Company accept that the WRMP falls within the remit of the SEA Directive and has carried out the appropriate assessments. The Environmental Report produced as a result of the SEA process is available in Appendix P.

The SEA considers the potential impacts of the options that could be included in the WRMP against 10 objectives including; biodiversity, soil/land use, water quality/quantity, flood risk, effects on climate change, economic/social needs, protection/enhancement of human health, wise use of water and other resources, protecting/enhancing historic assets and landscape character. The assessment considered the nature of the effect, its timing and geographic scale, the sensitivity of the people or environmental receptor that could be affected, and how long any effect might last (short, medium or long-term). The objectives and approach to the assessment was set out in a Scoping Report which was issued for consultation on 22 July 2016. The approach taken was refined to address the feedback from the three regulators who responded (English Heritage, Environment Agency and Natural England).

The Company also determined that because of the proximity and potential for an impact on European Protected sites of some of the feasible options the plan needed to be assessed under the Conservation of Habitats and Species Regulations HM Government, 2010. Regulation 102 requires that competent authorities assess the potential impact of land use plans on the Natural 2000 network of European protected sites. The HRA determines whether there will be any ‘likely significant effects’ on any European site as a result of the Plan’s implementation (either on its own or ’in combination’ with other plans or projects), and if so, whether these effects will result in any adverse effects on the site’s integrity.

In accordance with accepted best practice, the HRA and SEA have been run as an iterative process alongside the plan development. All feasible options have been screened in accordance with national SEA and UKWIR guidance where appropriate, to identify whether potentially significant effects are likely to occur which would then require further assessment, or if serious enough the rejection of an option. The completion of the HRA had the added benefit of identifying options that might be high risk in terms of plan delivery if they were selected, as they were unlikely to meet the requirements of the Habitat Regulations, or where further detailed assessment and studies would be needed before the option could be fully assessed.

Portsmouth Water has ensured that the Strategic Environmental Assessment (SEA) and Habitats Regulations Assessment (HRA) have been an intrinsic part of the options appraisal process. Information on the outcome from the HRA and SEA process is summarised below the description of each of the options. The HRA and SEA have been completed by environmental consultants at AMEC who specialise in this work. The full HRA and SEA can be found in Appendix O and P, along with tables summarising the outcome of each assessment for all of the feasible options.

7.5 Description of Feasible Options for the Draft Plan

7.5.1 Overview

This section presents an appraisal of each of the feasible options. For each of the feasible options, a description is given and consideration of the following factors:

- Yield
- Option start date
- Risks and uncertainty
- Dependency or mutual exclusivity
- Factors or constraints specific to the option
- How the option will be utilised and effects on costs
- Environmental impacts
- Assessment of customers support

7.5.2 Customer Side Options

There are 15 customer-side options in the Company's feasible list, comprising:

- Six metering options, including change of occupancy metering, smart metering, compulsory metering and void turnaround (metering of empty properties to detect supply pipe leaks);
- Six water efficiency options; and
- Three water conservation options (restraints on demand consistent with Drought Plan actions).

Customer side options primarily relate to enabling customers to reduce their consumption, by provision of additional information relating to their consumption (metering), providing water efficiency advice and devices to encourage and support behavioural change, and additional promotion of water conservation measures during droughts. Descriptions of each of these option types are provided below, along with the assumptions underpinning these options where they are possible to disclose in the public domain. The full set of cost and demand saving assumptions relating to customer side options is set out in the WRMP19 Options Support: Options Costing report (Wood, February 2018), but this contains commercially confidential information so is not available in the public domain.

All demand management options are available to start at the beginning of the planning period in 2020/21, with the exception of option C006b Metering on change of occupancy - all properties, which is available to start in 2025/26 after the completion of the first change of occupancy metering option (C006a).

Reductions in demand from customer side options have the potential to increase the resilience of the Company's supply system because they may reduce demand in the run up to a design drought event. However, the assumptions around achievable demand reductions are subject to a high degree of uncertainty, due to the strong reliance upon behaviour change. Therefore, their reliability during drought events should not be considered the same as for other options. The uncertainty around volumetric savings from demand management is considered within the sensitivity testing in section 8.

7.5.2.1 Metering Options

For ease of reference, the Company is considering the feasible metering options as shown in Table 48.

Option code	Option name	Option description
C005	Meters Not For Revenue (MNFR) switchers	Under this option the Company would install "smart" meters at properties and provide customers with timely information and comparisons on their recent usage. A

Option code	Option name	Option description
		trial of 500 customers has already begun and this option involves installing an additional 500 meters a year during AMP7.
C006b	Metering Change of Occupancy - all properties	This option involves selectively installing meters when a change of occupier occurs, whether there is a boundary box or not.
C006a	Metering Change of Occupancy - existing meter pits	This option involves selectively installing meters when a change of occupier occurs and a boundary box exists. This will minimise the overall cost of the programme on all customers.
C069	Target occupants of new build housing with smart meters and water efficiency advice	This option involves installing smart meters at new build households, and providing these customers with water efficiency advice.
C075	Replace existing household water meters with smart meters and provide water efficiency audit and advice	Under this option, the Company would replace existing household meters with smart meters instead of AMR meters. The Company would also provide a water efficiency home audit and advice to these customers.
C084	Void turnaround (metering of empty properties to detect supply pipe leaks)	Where feasible, the Company will meter properties that have been void for more than six months. This will improve confidence that they are correctly marked as void, and will allow the Company to identify re-occupation.
C004[7]	Compulsory metering	The Company is not currently allowed to compulsorily meter its customers as it is not in an area of serious water stress. However, it has included this option in its options appraisal in order to show the cost effectiveness of the option and to comply with WRMP Direction (h).

Table 48 Feasible metering options

The costs of each option have been built up from estimates of preparatory work required, equipment, installation and replacement (where applicable), and the operational costs of reading meters and answering customer queries. Replacement costs only apply to the metering options, and the cost of replacing meters and other assets installed under these options have been included, but the cost of replacing meters and other assets that have been installed previously or would be installed under baseline activity is not included. It has been assumed that meters have an asset life of 12 years and so replacement costs commence in year 13 of the option profiles.

For the smart meter replacement option, the meter acquisition costs are the difference between a baseline standard meter replacement -an Automated Meter Read (AMR) meter, and a smart meter.

Metering options do not have a fixed yield or demand saving, year on year; the savings relate to the number of properties metered in any particular year. For some of the options, Portsmouth Water has pre-determined a target to install a stated number of meters (e.g. C005 where 500 smart meters are proposed to be installed). For other metering options, the number of available properties to target is the number of households in 2020/21 (year 1 of the planning period) (e.g. the total number of measured households available for targeting by a meter replacement option at the start of the planning period is 105,725).

For the metering options considered in this WRMP which involve installation of smart meters to already metered households, it is not appropriate to assume the demand saving that tends to be observed from the initial metering of a property. Instead a 1% further demand saving is

[7] Compulsory metering is not a feasible option but has been considered within the options appraisal assessment for comparison.

assumed for these properties. Additionally, a 10l/prop/d saving in underground supply pipe leakage (USPL) is assumed to be achieved at all newly metered properties, except new build properties (which are not assumed to demonstrate supply pipe leakage until later in the planning period). This USPL saving is generated by the meter (an Automated Meter Reading or AMR meter) producing an alarm when it detects continuous flow passing through it over a 24-hour period. This suggests a leak either on the supply pipe or in the customer's property. When the meter is read, the alarm is detected by the Company and steps are taken to notify the customer and for the leak to be fixed.

In the SEA the metering and tariff options were assessed as having neutral or minor adverse effects against seven of the ten objectives. The exceptions to this were;

- Climate change – significant negative effect during construction, positive during operation.
- Economy – significant positive effect during construction, neutral during operation.
- Human health – combination of positive and negative effects for tariff options. The use of tariffs to manage demand may impact on vulnerable customers, such as those on low incomes, or those with medical conditions that are dependent on using more water for treatment and personal hygiene.

The large-scale metering options have been assessed as having significant adverse effects against the climate change objective during construction. This is due to the large number of meters being installed and the embodied carbon within the meters, and the emissions associated with their installation (vehicle movements). Following implementation, the same options are assessed as having a significant positive effect against the same objective due to the reduction in emissions from pumping, treating and distributing water and reduction in energy use from heating water in the home. These options are also assessed as having a significant positive effect against the economy objective during construction due to the large number of meters that would require installation, and employment opportunities that result. Options C005, C069 and C075 and the tariff options were also assessed as having a significant positive effect against objective 8 (wise use of resources) as a result of the reduction in energy use (treatment, pumping, distribution and heating water in the home) during operation.

Demand side measures such as metering options were screened out and not considered further in the HRA. This was because collectively they are likely to have a positive effect on European sites by reducing water demand. The only potential mechanism for a negative effect would be through direct encroachment at the local level. For example, if a meter was installed in or near a Special Area of Conservation (SAC). Further information on why it was appropriate to screen out demand side measures is included in Section 3 of the HRA (Appendix O).

The views of Portsmouth Water customers on metering have been described in section 3 of this WRMP. The customer research undertaken shows that there is a wide range of views on metering, and overall customers prefer choice rather than compulsion. The inclusion of compulsory metering in the feasible options list is to satisfy WRMP Direction (h) (see Table 2).

7.5.2.2 Water Efficiency Options

For ease of reference, the Company is considering the feasible water efficiency options as shown in Table 49.

Option code	Option name	Option description
C026	Subsidies to customers who have purchased water efficient appliances	This option involves the introduction of a Portsmouth Water funded subsidy (i.e. vouchers) on water efficient washing machines and dishwashers. The rationale behind this option is to encourage wider uptake of water efficient appliances amongst customers.

Option code	Option name	Option description
C034	Water saving devices - Retrofitting existing toilets (with flush >9l)	Retrofitting using dual flush mechanisms in toilets in household and non-household properties would replace existing higher flush volume mechanisms. The rationale behind this option would be to reduce demand for water used for toilet flushing.
C040	Water saving devices - Spray taps	Retrofit spray fittings to existing taps in household and non-household properties. This would be applied to bathroom taps as kitchen use is often more volume driven whereas wash basin taps is often 'action' driven. Spray inserts are only suitable for taps with round flow diameters. The rationale behind this option is that spray fitting reduces the volume of water that passes through the tap each time it is used (compared to a tap that does not have a spray fitting).
C043	Water saving devices - trigger nozzles and water butts	Fitting water butts and trigger guns to properties with gardens.
C046	Household water efficiency programme (Partnering approach, home visit)	Running a Water Efficiency Programme in association with partners such as Housing Associations and possibly Southern Water.
CO46b	Waterwise programme	Working with Waterwise to develop a strategy that will deliver meaningful reductions in PCC by: • Effectively conveying the message that using less water is a good thing and the right thing to do. • Working with stakeholders, e.g. Housing Associations/Councils to improve messages and undertake audits to identify wastage and inefficient appliances. • Working with developers and new appointments and variations (NAVs) to ensure new homes are highly efficient. • Publicising our leakage reductions achieved to show that we are doing our bit. • Working with retailers and non-household customers to ensure that commercial use is well managed. • Co-creating strategies with customers from engagement and trials. • Continuing to promote our water saving challenge, which encourages customers to think about water use and provides free water saving devices.

Table 49 Feasible water efficiency options

The costs of these options have been built up from their component parts, taking account of the costs associated with initial set up (customer campaigns, contacting customers etc.), the procurement costs of equipment (water efficiency devices etc.) and the logistical costs of distribution (typically fuel costs associated with driving to properties).

Water efficiency options do not have a fixed yield, year on year. Demand savings are contingent on:

- The number of customers being targeted for specific water efficiency schemes in each year of the planning period;
- The customer uptake of schemes, i.e. only a proportion of households to which water efficiency schemes are offered actually take-up the scheme and achieve demand savings. The Company estimated both the initial response rates, i.e. initial response to water audits, or installation of meters, followed by the behavioural

uptake rate (i.e. the proportion of engaged customers who go on to make water efficiency changes). It is this proportion (in combination with estimated savings per property) that generates the forecast water saving (option yield) profiles; and

- The time decay of water efficiency savings - demand savings gained from water efficiency schemes are assumed to decay over time as, despite ongoing customer engagement to maintain efficient behaviours, an element of 'bounce back' is expected as customers in receipt of water efficiency measures begin to slip back into former behaviours. The demand savings are assumed to halve over 50 years, declining linearly over that period.

The water efficiency options were assessed as having neutral effects against most of the SEA objectives during construction and operation. Minor positive and minor negative effects were recorded against three of the objectives (water, climate change and use of resources) reflecting benefits of water savings, and minor increases or decreases in energy use and carbon emissions during construction and operation.

Demand side measures such as water efficiency options were screened out and not considered further in the HRA. This was because collectively they are likely to have a positive effect on European sites by reducing water demand. Further information on why it was appropriate to screen out demand side measures is included in Section 3 of the HRA (Appendix O).

The views of Portsmouth Water customers on water efficiency have been described in section 3 of this WRMP. The customer research undertaken shows that there is a desire for the Company to co-create and deliver more water efficiency education, which is reflected in the inclusion of the range of water efficiency options in the feasible options list.

7.5.2.3 Water Conservation Options

Water conservation options are those which the Company may utilise in a drought situation of a particular severity - as detailed in its Drought Plan. The Company is planning as part of this WRMP to balance supply and demand during a 1 in 200-year drought. Therefore, it is likely that drought actions set out in the Company's Drought Plan will need to be implemented as part of the preferred plan.

On the demand side, the first drought option that would be implemented comprises voluntary calls for restraint in water use by customers as a drought starts (option C078). It has been assumed that demand will fall by approximately 2.5% as a result of this option, representing a 4.3 Ml/d reduction under all scenarios.

The second drought option (option C079) comprises the introduction of Temporary Use Bans (TUBs) which can only be implemented once option C078 is in place. This option will be required in a drought severity of greater than 1 in 20 years, a 5% chance of occurrence in each year. It has been assumed that demand will fall by an additional 5% under this option, representing an 8.3 Ml/d demand saving under all scenarios. The Drought Plan now contains additional concessions, which have reduced the potential savings from TUBs.

The third drought option (option C080) is a demand side drought order that would be granted by the Secretary of State. In order to be granted a drought order, an exceptional shortage of rainfall must have occurred, which must be demonstrated to be causing or threatening a serious deficiency of supply. This option will be required in a drought severity of greater than 1 in 80-years, a 1.25% chance of occurrence in each year. This option comprises demand restrictions on non-household customers and was previously known as a Non-Essential Use Ban. A further 5% reduction in demand has been assumed to result from this option, representing a 7.9 Ml/d demand saving under all scenarios.

7.5.3 Production Side Options

No feasible production-side options were identified.

7.5.4 Distribution Side Options

Distribution side options relate to activities involved with management of the water distribution system. A water company can manage demand for water by enhancing leakage control, managing pressure effectively and replacing mains when appropriate to reduce the amount lost through leakage and excess consumption.

As noted in section 5.5, the Company seeks to balance the cost of leakage reduction activities against the cost of the water lost through the leaks. The point at which the costs of the water lost through leakage is equal to the cost of reducing leakage further is known as the sustainable economic level of leakage (SELL). The Company's leakage should not rise above this point, however the Company should consider if their leakage forecast should be below the SELL, for example, if customers place a value on this and would be willing to pay for a lower level of leakage.

The Company has undertaken an assessment of SELL (summarised in section 5.5 and included as Appendix K[8]). This identified options for further leakage reduction and these have been considered as part of the Options Appraisal process.

The views of Portsmouth Water customers on leakage have been described in section 3 of this WRMP. The customer research undertaken shows that there are a range of views on leakage. In the customer consultation on the Draft WRMP, the customer survey showed there was very strong support for plans to reduce leakage by 15% by 2025 (95% of customers agreed). In addition, one of the most common observations made by customers was that there should be more ambitious leakage targets. Some customers also expressed the opinion that the Company should focus on reducing leakage before asking customers to install meters and reduce their own consumption. However, in the customer advisory panel, although there was some support for further leakage reduction beyond 2025, some were less convinced about driving further leakage reduction beyond the 15% as they did not want to see their bills increase.

As noted in section 7.3.1.5, some changes have been made between the Draft and Final Plan. This includes consideration of additional leakage options, to address responses received during consultation from the regulators. The SELL assessment (Appendix K) has also been updated. For the Final WRMP, four feasible distribution-side options were identified. These comprise:

- Installation of district meters - partial network
- Installation of district meters – full network
- Fixed network of permanent noise loggers connected to telemetry – phase 1
- Fixed network of permanent noise loggers connected to telemetry – phase 2

7.5.4.1 Installation of District Meters

At present, Portsmouth Water operates Strategic Metering Areas (SMA's). The SELL report (Appendix K) identified that a reduction in leakage could be achieved though subdividing the networks into smaller District Metering Areas (DMA's). The introduction of DMAs was identified as one of several potential options for achieving a lower sustainable level of leakage (SELL).

The installation of additional district meters throughout the distribution network would enable more detailed monitoring of flows within the distribution network and allow leakage to be targeted more readily. This would result in an increase in the number of leaks identified and repaired, reducing the amount of water lost through leakage.

[8] Note that the SELL assessment (Appendix K) has been updated since the Draft WRMP and now includes alternatives to the introduction of further DMAs in its conclusions.

There are two options within the feasible list for installation of District Meters: DO05 (which involves installation over part of the network); and DO11 (installation over the whole area of supply).

Option DO05 involves introduction of DMAs to part of the network (described in the SELL report as installation of tranches zero to six of new DMAs). The option would commence in AMP7 (2020/21) with the programme being carried out through the five-year period. Leakage would be expected to fall by approximately 7 Ml/d over the AMP7 period (i.e. a reduction in leakage to approximately 28 Ml/d by 2024/5) as a result of the installation of district meters and active leakage control (ALC) operations.

Option DO11 involves installation of DMA's over the whole area of supply to reduce leakage described in the SELL report as installation of tranches zero to ten of new DMAs). This option would also commence in AMP7 (2020/21) but would be carried out over a ten-year implementation period. Active leakage control (ALC) operations subsequent to the installation of the additional meters would assist in identifying and reducing network leakages. As a result, leakage would be expected to fall by approximately 12 Ml/d by 2044/45.

The principle risk associated with the district metering options is the condition of the pipe network on which the meter and valve installations will be made. Parts of the network are old and in cast pipework where there can be mating issues with new fittings. The creation of DMAs can be a lengthy process and the SELL assessment (Appendix K) identified that there was a great deal of uncertainty in the costs involved with installation of DMAs throughout the supply area.

The two district meter options are mutually exclusive to one another (i.e. can choose to introduce DMAs to part of the network or all the network, but not both). The district metering options are also mutually exclusive with options DO04a and b (i.e. having a fixed network of noise loggers is an alternative option to the introduction of DMAs).

The district meter options were costed for Portsmouth Water by Wood (previously Amec Foster Wheeler), following the methodology presented in section 7.4.2.

In the SEA, the district meter options were assessed as having adverse impacts during construction in terms of human health, climate change, waste and resources (minor negative for DO05 and significant negative for climate change and waste and resources for DO11). However, both options were assessed as having positive impacts during operation (significant positive for DO11 in the case of waste and resources).

7.5.4.2 Fixed network of permanent noise loggers connected to telemetry

When leaks develop on distribution pipes, the flow of water under pressure through holes in pipes generates vibration and noise. Noise loggers help to identify the noise generated by leaks. By installing permanent noise loggers throughout the distribution network and linking these to telemetry, the loggers can automatically identify new leaks. This would result in an increase in the number of leaks identified and repaired, reducing the amount of water lost through leakage.

The SELL report (Appendix K) identified that the introduction of permanent correlating noise loggers in the network could be effective and viable as an alternative to new DMAs.

Fixed networks are an alternative to 'metering and valving in' DMA's. Instead leaks are detected through permanent noise logging at fittings on the network, typically spaced 100m apart. The fixed network listens for leakage during the night period and then reports back on a daily basis. The approach will allow for more targeted and efficient Active Leakage Control (ALC).

Fixed networks significantly reduce the leak awareness time on small leaks that would not be individually seen at the DMA meter. Fixed networks will also locate the leak to the street level, which greatly reduces the detection time compared to having to survey a whole DMA.

Fixed networks have been used extensively by Affinity Water during AMP6, with successful results. Portsmouth Water and other companies have subsequently been investigating the different manufacturer products available. Trials at Portsmouth Water has seen similar positive results.

In the Draft WRMP, options DO04a and DO04b were for the deployment of permanent noise loggers throughout the distribution network, with fortnightly collection of data from data loggers. Option DO04a would cover 25% of the network, located in leakage 'hotspot' areas whilst DO04b was a continuation of the programme, covering the remaining 75% of the network. For the Final WRMP, these options have been amended slightly (as noted in section 7.3.1.5). Instead of the requirement for data collection every two weeks (with associated investment of personnel time and resources), the option has been amended to take into account the latest technology and innovation and is now based on instant data transmission, from leak noise loggers, back to the Company using a custom-built network, based on 'internet of things' (IoT) technology. The use of IoT technology enhances operational performance and levels of service and reduces the need for regular operational staff visits to download loggers. In addition, the innovative solution will save costs from airtime on mobile networks and will increase the battery life of each unit.

Option DO04a is the first phase and would commence in AMP7 (2020/21) with the programme being carried out through the five-year period. Leakage would be expected to fall by approximately 7 Ml/d over the AMP7 period (i.e. a reduction in leakage to approximately 28 Ml/d by 2024/25).

Option DO04b is the second phase and would continue from DO04a, commencing in AMP8 (2025/26) with the programme being carried out throughout the remainder of the planning period. Leakage would be expected to fall by a further 5% per AMP up to 2044/45.

Fixed networks allow for all leaks in areas logged to be detected within one day of occurring, compared to a current average of 2–3 weeks in SMA's and an estimated 1 week in metered DMA's. Based on an average leak flowrate of 0.4 l/s, fixed networks would result in an average saving per leak of 0.57 Ml compared to SMA's and 0.22 Ml compared to metered DMA's. This saving would be obtained without the need for additional leakage technicians.

During 2017/18 Portsmouth Water conducted successful trials with two fixed network manufacturers, proving that the new technology works on the Company's network. As part of the trials, the Company installed IoT aerials in areas of low SMS signal, allowing for fixed networks to be used in remote areas.

The principle risk is the unproven reliability of the noise loggers over a long time period as fixed networks of noise loggers have only been deployed with the UK water industry for two years. This risk is mitigated, however, by the fact that the technology is based on previous 'lift and shift' loggers, which the Company has used for many years with limited issues.

The two options for the fixed network of permanent noise loggers are dependent on one another to the extent that the second phase follows on from the first. The options are mutually exclusive with options DO05 and DO11 (i.e. having a fixed network of noise loggers is an alternative option to the introduction of DMAs).

The fixed network options were costed for Portsmouth Water by Wood (previously AMEC Foster Wheeler), following the methodology presented in section 7.4.2.

In the SEA, the options were assessed as having minor negative effects (with some uncertainty) in terms of human health, reflecting the identification and repair of network leakages which might result in minor localised adverse effects on human health regarding noise disturbance and adverse air quality impacts (dusts) depending on the scale, duration, and proximity of the works to sensitive receptors. This would be common to any of the leakage options. In all other respects, the options were assessed as having positive effects.

7.5.5 Resource Options

Six feasible resource options were identified. These comprise:

- Havant Thicket Winter Storage Reservoir
- Source O – Maximising DO
- Source J – Maximising DO
- Source H – Maximising DO
- Source C – Maximising DO
- Source S – Drought Permit

7.5.5.1 Havant Thicket Winter Storage Reservoir

Following a commitment to further work in previous plans, the Company considered several winter storage options. These included alternative sizes for Havant Thicket and the following alternative locations:

- Southleigh Farm (Havant)
- Colden Common
- Testwood Lakes
- Woodend (Source F)
- Boarhunt

Havant Thicket Winter Storage Reservoir (HTWSR) was assessed and agreed with stakeholders as the most feasible reservoir option to take forward. This option relates to the construction of a pumped storage reservoir at Havant Thicket. Water would be sourced from the Source B Springs during the winter period (within the existing annual average licence) and stored in the reservoir for use in the summer when necessary. Water would be abstracted from Source B Springs using a draw off structure. Water would be pumped to the reservoir for storage via a new pipeline but would have a gravity feed to return to Source B Springs, where it would link to existing infrastructure for transfer to Works B. Depending on the quality of the reservoir water, some additional treatment may be required at Source B Springs.

The winter storage reservoir would store excess water from the winter when it is plentiful for use in the summer when it is less so. It would significantly increase the water resource available in Portsmouth and consequently free up resources to support with wider South East region. There are sufficient flows during the winter period to provide this resource – this has been modelled and assessed in detail by the WRSE Group.

The option is designed to deliver an annual average deployable output of 23 Ml/d with a peak deployable output of 50 Ml/d, through this would be subject to the hands-off flows of Brockhampton Mill Lake and Langstone Mill Stream. Southern Water have requested a bulk supply of 21 Ml/d be made available from March 2029. This has been used as the start date for supply of water from HTWSR.

As it is a winter storage reservoir, designed to store excess water from winter spring flows, the level of risk and uncertainty associated with the design yield is low. The option will help Portsmouth Water increase resilience, by providing raw water storage.

As noted in section 7.2, the options costing work for Portsmouth Water was largely undertaken by Wood (previously known as AMEC Foster Wheeler). However, their starting point for costing HTWSR was a detailed cost assessment undertaken in 2018 by Atkins. This considered the fixed capex for components including investigations, design, construction, replacements. Table 50below provides a summary of the capex and opex components considered in the options costing work.

Fixed capex	Fixed opex	Variable opex
Investigations, design, construction, all replacements.	Annualised opex energy (based on pre-determined volumes and fixed energy costs). Human resources (i.e. reservoir ranger', landscape manager salaries). No operational utility costs as the production site would be unmanned. Air blowers at the control building. Periodic (but fixed) inspection fees.	Additional pumping (as required) i.e. to Works B Reservoir losses in a dry year (different rates). Power requirements at Works A (treatment – quantities are variable) Additional human resources and chemicals as required at Works A Treatment requirements, and maintenance requirements at the DAF plant at Source B. Control building operational and maintenance.

Table 50 Capex and opex components of HTWSR

The SEA process identified the impacts of HTWSR as having different effects during the different phases of the project. During the construction phase, there would be significant negative effects against the climate change and landscape objectives of the assessment. For the former due to emissions of greenhouse gases from vehicle movements and the embodied carbon in construction materials; whilst for the latter because this would be a large construction project visible to some extent from the South Downs National Park, Staunton Country Park and some residential properties. A significant positive effect is recorded against the economic and social wellbeing objective due to the employment and supply chain benefits that will arise from this large construction project.

During operation, the SEA records significant positive effects against the economy as the large yield from the HTWSR will support economic growth in the region and ensure the continuity of a safe and secure supply of drinking water. The associated green infrastructure will be of benefit to the existing community and help to support new housing growth, as this is a strategic project in the Partnership for Urban South Hampshire (PUSH) Green Infrastructure Strategy. The new paths, cycle ways, spaced play and water sports training facilities will provide a significant positive benefit in relation to the human health and wellbeing objective. Positive effects are also recorded in the longer term in relation to biodiversity and flood risk.

Once constructed, the reservoir provides a conjunctive use scheme which anticipates the future effects of climate change to store excess water from the Source B Springs in wetter winters, to be supplied to customers in drier summers. A new visitor centre will provide opportunities to explain and promote 'water wise' messages and alternative energy solutions.

The HRA concluded for the HTWSR site that construction works associated with this option will have no likely significant effects on the European sites (SPA/SAC/Ramsar) downstream of the reservoir, assuming normal best practice measures are adopted during construction. The analysis of operational impacts has concluded that there will be no significant effect on European sites (SPA/SAC/Ramsar) from the additional abstraction within the existing licensed volume at the springs, potential changes in water quality, or emergency drawdown.

There has been ongoing customer and stakeholder engagement on HTWSR as described in section 3. For example, the Company consulted on different access arrangements for Havant Thicket Reservoir and selected the northerly route to minimise impacts on the local community during construction and through the life of the project. As part of the online consultation, customers were invited to complete questions relating specifically to Havant Thicket Reservoir as part of a regional solution. The results indicated that 87% of customers supported plans to

build Havant Thicket reservoir as a regional water source and community facility. This was also the consensus from the customer comments received.

7.5.5.2 Schemes to Maximise DO

The options appraisal process considered several schemes to recover deployable output. These options were initially identified through the Deployable Output Assessment (Appendix A). Consideration of water quality issues and Deepest Advisable Pumping Water Level indicated that DO could be recovered at:

- Source O
- Source J
- Source H
- Source C

At **Source O** the existing boreholes are connected with horizontal adits which are at a relatively high level. As the water level is drawn down in dry conditions the adit is exposed and sediment causes water quality problems. The proposed solution is to extend the casing at the top of Borehole No2 to block off the adits, and then to deepen the borehole by 24 m so that it matches borehole No1. The borehole pump would then be re-installed at a lower level to give greater drought resilience and to increase the ADO. The increase in ADO is well below the average licence volume and therefore wouldn't require a change to the abstraction licence. No changes are required to above ground pipework or to treatment capacity.

This is a water quality scheme designed to improve deployable output by 1.8 Ml/d. It should be available early in the planning period, at the start of AMP7. This is a relatively low risk scheme as it involves improvements works to improve water quality on an existing borehole where the yield has already been proved.

The capex assessment for works required was provided by Portsmouth Water Investments Team. There was no fixed opex (no additional human resource) and variable opex was based on electricity for pumping in a dry year.

The SEA process identified minor positive impacts regarding economic and social wellbeing and human health for Option RO21a (Source O) and minor negative impacts for climate change and resource use.

Source J is currently being investigated for water quality reasons. The feasible option involves maximising the DO of the source within existing licence limits by construction of a satellite borehole. The satellite borehole would be 140m deep with a new pump and raw water mains (<300 m) connecting the borehole to the existing raw water network. Once operational, the anticipated change in the source ADO is 12.5 Ml/d. The anticipated change in the source PDO is 15 Ml/d.

The improvement in deployable output should be available in AMP7. This scheme does not involve any increase in licensed quantity and there is reasonable confidence in achieving the yield and the satellite borehole will replace one of the existing boreholes where yield has been proven. However, there is some uncertainty due to Environment Agency concerns regarding sustainability, recognising the importance of spring flow and potential impacts on designated sites.

The strategic importance of Source J and Option RO22a for resilience cannot be overstated. Existing mains allow water from this source to be used very flexibly supporting both existing customers and the bulk supplies to Southern Water. Alternative resilience options to improve the network are likely to be much more expensive.

The capex assessment was developed by Wood based on scheme details provided by Portsmouth Water. The capex and opex assessment followed the methodology outlined in section 7.4.2.

The SEA process identified significant positive impacts for Option RO22a (Source J) concerning economic and social wellbeing and human health. Minor negative impacts were identified against climate change and resource use during construction and operation.

The Company has considered the impact of not being able to deliver this option in Section 8. Testing the Plan.

In response to a customer survey in the dWRMP consultation document, 84% of customers supported plans to provide an enhanced groundwater source.

At **Source H**, the ADO is 7.1 Ml/d and this is constrained by water quality problems at higher flows. The feasible option involves airlifting the existing boreholes after a maximum flow pumping test. This should clean the boreholes of sediment and return the source ADO to 9.1 Ml/d (the average licence quantity). No changes are required to the pipework or treatment works.

This is a water quality scheme designed to improve deployable output by 2 Ml/d. It should be available early in the planning period, at the start of AMP7. This is a relatively low risk scheme as it involves cleaning to improve water quality at existing boreholes. This scheme does not involve any increase in licensed quantity however, there is some uncertainty due to Environment Agency concerns regarding sustainable abstraction in the catchment.

The capex assessment for works required was provided by Portsmouth Water Investments Team. There was no fixed opex (no additional human resource) and variable opex was based on electricity for pumping in a dry year.

The SEA process identified a significant negative effect against flood risk during construction for Option RO23a (Source H) as the works proposed could be within a Flood Zone 3 associated with the River Meon. However, the risks of this could be reduced through timing of proposed activities. Negative effects were also assessed against resource use during construction. Positive impacts were identified during operation in terms of economic and social wellbeing and human health. Minor negative effects were assessed against climate change and resource use.

At Source C, the feasible option involves modification of the treatment process at Source C through the installation of disposable cartridge filters to reduce turbidity at the WTW. Implementation of the new disposable cartridge filters is expected to recover between 4Ml/d (ADO) and 5.5 Ml/d (PDO).

This is a relatively low risk scheme as it involves applying additional filtration to improve the water quality and hence increase DO. This scheme does not involve any increase in licensed quantity however, there is some uncertainty due to Environment Agency concerns regarding sustainability in the catchment.

The capex assessment was developed by AMEC Foster Wheeler based on scheme details provided by Portsmouth Water. The capex and opex assessment followed the methodology outlined in section 7.4.2.

The SEA process identified positive impacts for Option RO24a (Source C) during operation regarding economic and social wellbeing and human health. Minor adverse impacts were identified against resource use and climate change (with some uncertainty).

7.5.5.3 Source S Drought Permit

Portsmouth Water's Drought Plan includes a Drought Permit at Source S (Option RO68) which is considered to be a feasible option in the context of this WRMP. The PDO of the QRST Group of sources is currently limited by the abstraction licence to 41 Ml/d. The Group licence is also constrained by a requirement not to abstract more than 2,100 Ml in any period of 60 days. A Drought Permit has been proposed to enable additional abstraction at Source S.

Abstractions from the QRST Group sources are believed by the Environment Agency to impact upon Swanbourne Lake at Arundel. This lake is an artificial feature and relies on groundwater flows to maintain its level. Under serious drought conditions, despite dredging of the lake (which was carried out in 2002), the lake is known to dry out, impacting the wetland features. Under such serious drought conditions, where further detrimental environmental impact on the lake is unlikely (as acknowledged in the Environment Agency's South East Drought Plan, July 2011), it may be acceptable to abstract additional quantities of water at Source S. A Drought Permit has therefore been proposed, which would increase the daily abstraction limit at Source S by 8.5 Ml/d (to 11 Ml/d), and simultaneously increase the daily peak licence of the QRST Group by 8.5 Ml/d, resulting in an additional 8.5 Ml/d available at both ADO and PDO. This additional yield is assumed to be available under all drought scenarios as the environmental constraint does not vary with drought severity. As it is a drought option the benefit it is applied to the distribution input (rather than being considered as an additional DO benefit on the supply side). It therefore provides a 1:1 benefit to the supply/demand balance.

As mentioned previously, the QRST Group licence also has a condition that during June, July and August in any 60-day period, abstraction should not exceed 2,100 Ml. It is unlikely that this condition will cause a constraint during a drought; however, it may be necessary to apply for a Drought Permit to suspend this condition.

The option is available to the Company from the start of the planning period (2020/21), subject to the Company being able to demonstrate that an exceptional shortage of rainfall has occurred that has resulted in or threatens a serious deficiency of supplies in the Company's area, and subject to the Drought Permit application being granted by the Environment Agency. This poses a risk to the availability of the permit, although as it should only be required during serious droughts, this risk is considered to be low, because an exceptional shortage of rainfall should be easily demonstrable.

It should be noted that implementation of the option is also dependent on the sequential implementation of water conservation options as set out in the Company's Drought Plan, i.e. option CO78 (Voluntary restraint and leakage action), option CO79 (Mandatory restraint – hosepipe ban) and option CO80 (Imposition of Drought Direction Restrictions - mandatory commercial restraint) (as set out in section 7.5.2.3) must be in place prior to the Drought Permit application being granted.

As Source S's existing infrastructure maintains an 11 Ml/d design capacity, implementation of the Drought Permit would not require modifications to the site nor construction of new ancillary infrastructure as operation would revert back to using the higher capacity pumps. There are therefore no construction impacts identified. Operational impacts identified through the SEA process are generally positive in relation to climate change, economic and social wellbeing and human health. Potential minor adverse impacts were identified against biodiversity and water quality and quantity (with some uncertainty), and a potential neutral effect against cultural heritage (with some uncertainty).

Swanbourne Lake is a SSSI and further investigations will be required to confirm that no permanent damage would be caused to the site by the Drought Permit. Environmental monitoring requirements have been developed with Southern Water, which operates two other abstractions in the area, and are set out in the Company's Drought Plan. The Environment Agency has a ground water model of the area, namely the East Hants and Chichester Chalk (EHCC) model, which could be used (by agreement with Southern Water, which has the capability to run the model, while Portsmouth Water does not) to help investigate the impacts.

It should be recognised that this Drought Permit may pose a potential risk to the historic environment. Lowering of the water table, due to increased abstraction at the QRST Group of sources, may cause dewatering on archaeological deposits. There are no records of any archaeological deposits in the vicinity of the Drought Permit site, so this is not expected to be an issue, but Historic England and English Heritage are expected to be able to provide further

advice on this matter, and will be contacted as part of the process for applying for a Drought Permit at Source S.

Potential derogations relating to this permit have already been considered during the application for the original licence. People with concerns had the opportunity to raise these issues during the licence application process and mitigation measures were considered at that time. As the source was originally licensed for the higher quantity, any derogation would have already been assessed.

Possible constraints, such as access to land are not an issue as this permit relates to a borehole on Portsmouth Water's own land and therefore the Company has access to the site whenever necessary.

The costs associated with this option primarily relate to the preceding investigations that would be required to support the permit application, as well as the additional electrical and control equipment and associated opex required to pump additional water from the Source S borehole. The capex assessment was developed by Wood based on scheme details provided by Portsmouth Water. The capex and opex assessment followed the methodology outlined in 7.4.2.

During the public consultation on the Draft WRMP, Natural England made reference to Drought Permits and the fact that they did not sit comfortably with protecting the water environment. Portsmouth Water will try to avoid the use of Drought Permits, if possible.

7.6 Economic Appraisal

This section presents the way in which Portsmouth Water has undertaken the economic appraisal of its feasible options.

Portsmouth Water has followed the UKWIR guidance on investment appraisal and optimisation methodologies (UKWIR 2016a). The Company initially undertook a Problem Characterisation Assessment (Appendix H) and determined a score of medium under both strategic needs and complexity factors. The Problem Characterisation exercise suggested only a moderate level of concern as a result of specific issues and therefore the Company decided, in consultation with the Environment Agency, that 'current' Economics of Balancing Supply and Demand (EBSD) decision-making approaches were appropriate.

When bulk supplies were added to the baseline demand, it became clear that nearly all the feasible options would be needed and to meet the supply-demand deficit, the options had to be delivered as soon as practically possible. A cross-check of costs, yields and timings was required to show that the economics were not unreasonable. On this basis, within EBSD, it was considered most appropriate to use AISC ranking plus 'expert judgement' as the decision-making tool (described in Table 8 of UKWIR 2016a).

The Company recognises the importance of assessing options on a consistent basis, ensuring that the relative merits of different sizes and types of options that are available over different time periods can be appraised. With reference to the WRPG, the costs and benefits for all options have been estimated over an 80-year period, with costs and benefits broken down where applicable into option yield/demand saving, capital costs, operating costs, environmental and social costs and benefits, and carbon volumes and costs.

The methodology for the costs and benefits assessment has previously been summarised (see section 7.4.2). However, it is worth noting here that this work is presented in full in an Options Costing report which has been shared with the regulators, but is not included in the public version of this plan for commercial confidentiality reasons.

The results from the costs and benefits assessment for all feasible options are included in the WRMP Tables (these accompany the WRMP text and form part of the WRMP submission). Within Table 5, the Average Incremental Cost (AIC) is calculated for each feasible option. This

is the cost to the Company (and customer) per unit volume of water produced/saved by the option, expressed in pence per cubic metre (p/m^3). The Average Incremental Social Cost (AISC) is also calculated, which is based on the AIC but takes into account the environmental and social costs and/or benefits of the option.

Using the AISC, the Company has ranked its feasible options to help prioritise them. The results are shown in Table 51.

It should be noted that the ranking of AISCs takes no account of mutual exclusivities between options. In addition, AISCs only take account of those environmental and social impacts that have been monetised. Therefore, to identify a least-cost programme of options, the Company has considered the wider costs and benefits of options its programme appraisal. This is described in Section 7.7.

Option code	Option name	Max. DO/demand saving (Ml/d)	AISC (p/m3)	AISC ranking
CO69	Target occupants of new build housing with smart meters and water efficiency advice	0.2	−46.58	1
CO46	Household water efficiency programme (partnering approach, home visit)	1.3	−21.74	2
CO46b	Waterwise programme	1.3	−21.74	2
CO26	Subsidy to customers that purchase water efficient appliances (washing machines and dishwashers, showers and WCs)	0.3	−14.68	4
CO80	Imposition of Drought Direction Restrictions (mandatory commercial restraint)	8.1	0.21	5
CO79	Mandatory restraint (TUBs)	8.3	0.60	6
CO78	Voluntary restraint and leakage action	4.3	1.55	7
RO68	Source S – Drought Permit	8.5	5.32	8
RO22a	Source J – Maximising DO	12.5	6.20	9
RO21a	Source O – Maximising DO	1.8	6.31	10
RO23a	Source H – Maximising DO	2	6.55	11
CO34	Water saving devices – Retrofitting existing toilets	0.1	11.21	12
CO06a	Metering on change of occupancy – existing meter pits	0.3	11.29	13
DO04a	Fixed network of permanent noise loggers connected to telemetry - Tranche 1	7.1	12.99	14
DO05	Installation of district meters – partial network	5.1	13.25	15
RO24a	Source C – Maximising DO	4.0	14.35	16
DO04b	Fixed network of permanent noise loggers connected to telemetry - Tranche 2	8.4	24.25	17
CO06	Metering on Change of Occupancy - all properties	4.7	29.18	18
DO11	Installation of district meters – full network	10	31.06	19
CO84	Voids metering	0.3	34.62	20
RO13	Havant Thicket Winter Storage Reservoir	23.0	41.92	21
CO75	Smart metering – replacing existing household water meters and provide water efficiency audit and advice	1.4	191.14	22
CO43	Water saving devices – trigger nozzles for hoses	0.1	273.75	23
CO40	Water saving devices – spray taps	0.1	426.08	24
CO05	Smart Meter MNFR Trial	0.1	553.62	25

Table 51 AISCs of feasible options, ranked lowest to highest

7.7 Programme Appraisal

To develop a combination of feasible options which balances supply and demand throughout the Company's supply area from 2020/21 to 2044/45, the Company has undertaken a

programme appraisal. This ensures that the non-monetisable impacts of options (both negative and positive) are taken into account, together with any risks and uncertainties that have not been captured earlier in the options appraisal process.

The base case scenario includes exports that have been agreed in principle with Southern Water and included within the WRSE modelling. These have also been included within Southern Water's preferred programme in their WRMP. It should be noted that whilst these schemes are agreed in principle, commercial terms have yet to be defined and agreed.

Section 7.7.1 outlines the programme appraisal assessment methodology. The different programmes that have been considered are presented in subsequent sections. Scenario testing of the final plan is presented in section 8.

7.7.1 Programme Appraisal Methodology

The Water Resources Planning Guidance (July 2018) clearly states that the preferred solution for a company may not necessarily be the least-cost solution as there may be other criteria (other than least-cost) that are important to the plan. The preferred or best value solution (best value refers to the best value solution or plan for water company customers and the environment over the long-term) will be the optimum balance of financial, environmental and social costs, and other non-monetisable impacts.

To determine the preferred solution, the Company has considered various factors which are summarised below. These have been developed based on the WRPG and a review of Company priorities and the perceived priorities of its customers. Except for cost (financial, environmental and social and carbon), the programme appraisal is qualitative.

7.7.1.1 Total cost

Measured in terms of net present value (NPV), total cost represents the financial (capex and opex), environmental and social and carbon costs of the programme of options. The way in which these costs have been built up for the options has been described in section 7.4.2 of this WRMP, with additional information specific to different option types being provided where relevant in section 7.5.

The NPV of an option is the value of all future costs and benefits over a defined period of time (in the case of the WRMP, 80 years) discounted to the present. The NPV is calculated in the WRMP Tables for each option, and these NPVs are summed for all options in a programme for the purposes of the programme appraisal. These NPVs are based on costs and outputs of options at their maximum capacities.

7.7.1.2 Performance against SEA objectives

In addition to the environmental and social costs that contribute to the NPV of each programme as set out in section 7.7.1.1, environmental and social considerations have also been taken into account in the Strategic Environmental Assessment (SEA) of the WRMP.

As part of the SEA assessment, each feasible option was assessed against the following objectives to identify any potential significant environmental and/or social impacts. These objectives were assessed for the construction phase and then the operational phase in turn.

- Biodiversity;
- Geology and Soils;
- Water Quantity and Quality;
- Flood Risk;
- Climate Change;
- Economic and Social Wellbeing;
- Human Health;
- Waste and Resources;
- Cultural Heritage; and

- Landscape.

The extent of the potential impact against each of the above objectives was assessed using the qualitative scoring system detailed in Table 52. This is detailed further in section 4.4 of the SEA report (Appendix P).

Score	Description	Symbol
Significant Positive Effect	Significant positive effect of the option on this objective	++
Minor Positive Effect	Positive effect of the option on this objective	+
Neutral	Overall neutral effect of the option on this objective	0
Minor Negative Effect	Negative effect of the option on this objective	-
Significant Negative Effect	Significant negative effect of the option on this objective	--
No Relationship	There is no clear relationship between the option and the achievement of the objective or the relationship is negligible	~
Uncertain	The option has an uncertain relationship to the objective or the relationship is dependent on the way in which the aspect is managed. In addition, insufficient information may be available to enable an assessment to be made	?
Mixed Effect	Mixed positive and negative effect of the option on this objective	+/-

Table 52 Qualitative SEA scoring system

For the purposes of the programme appraisal, a view not only of the individual option results is required, but also an assessment of the cumulative effects of all options in each programme.

The assessment of individual options against SEA objectives is provided in full in the SEA (Appendix P) and referred to in section 7.5 above. To enable programmes to be assessed and compared in terms of their performance against SEA objectives, the summary table of scores and a qualitative description of the impacts has been provided for the first (the least-cost) programme. Then for subsequent programmes the summary scores and descriptive text has been provided for any options added or removed from the programme, facilitating a view of whether overall programme performance against SEA objectives improves or deteriorates.

If an option has been assessed to perform poorly against any of the SEA objectives, it is considered for removal from the programme only if those impacts cannot be mitigated against. Mitigation measures are discussed in the qualitative description of each programme.

7.7.1.3 Programme risk

Each programme has been qualitatively assessed in terms of the level of risk posed by the combination of options under the following criteria:

- *Yield uncertainty:* The Company would expect to assign different levels of confidence in the yield assessments of different option types, as follows (in order of highest to lowest confidence):

- Leakage reduction;
- Enhancement of groundwater sources;
- New reservoirs;
- New groundwater sources;
- Drought options;
- Water efficiency; and
- Metering.
- *Cost and programme uncertainty:* Under this criterion, the programme is assessed for risks that may be posed by potential planning constraints, unforeseen stakeholder opposition, and/or unforeseen issues arising during construction.
- *Water Framework Directive:* With any programme of options that results in development of water resources, the risk that such development may result in deterioration of any Water Framework Directive water bodies must be considered and avoided or mitigated against.
- *Flexibility:* The Company has assessed the degree to which options within a programme could be scaled up or down in future if additional resource was required or if less resource was found to be needed. This includes the ability to reduce the operational output of schemes once they have been commissioned.

The qualitative and relative performance of each programme in relation to the above criteria is set out in sections 7.7.2.5 and 7.7.3.5.

7.7.1.4 Alignment with Government policy priorities

An important aspect of the selection of the Company's preferred final planning programme is whether or not the options selected align with Government policy priorities. The Company has made reference to these priorities in section 2.3.3 but has summarised them again here for reference.

Key Government policy priorities for water company WRMPs have been set out in the *Guiding principles for water resources planning* (Defra, 2016), and are summarised as follows:

- We expect to see evidence that you have taken a strategic approach to water resources planning that represents best value to customers over the long-term.
- We want to see a real change in approach to your WRMP so that it properly examines the value of resilience for your customers, is informed by your customers' views and identifies what actions you will take to reduce risk now and in the future.
- We expect more thorough testing of vulnerability of water supply systems - not solely tests based on historic events, but future events that could reasonably be foreseen – to enable you to better plan for and respond flexibly to future uncertainties.
- We expect to see evidence of a strategic approach to water resources planning that represents best value to customers over the long-term and draws on the latest information from collaborative projects.
- You should demonstrate how you value nature in your decisions. We expect you to thoroughly investigate and report on environmental and social costs and benefits.
- You will need to consider whether your abstractions are truly sustainable, looking across a catchment as a whole.
- You will need to ensure your current abstractions and operations as well as future plans support the achievement of environmental objectives and measures set out in RBMPs.
- You should consider drought management options as part of your plan.

- Companies' plans must demonstrate how they will promote water efficiency and leakage control and, where appropriate, increase customer metering.
- Defra expects companies to choose demand-side options as part of the preferred programme wherever it is reasonably likely that the benefits will outweigh the costs.
- Defra wants to see the downward trend for leakage continue and companies must consider leakage management fully as an option to balance supply and demand.

These priorities are supported by the following more recent publications, the points of most relevance to the programme appraisal from which are summarised below.

A Green Future: Our 25 Year Plan to Improve the Environment (Defra, 2018):

- Setting of high environmental standards for all new builds. New homes will be built in a way that reduces demands for water.
- Reforming the approach to abstraction such that abstractors will be supported to access the water they need to operate efficiently, but licences will continue to be amended in cases of unsustainable abstraction. Innovation will be supported and encouraged, for example, in the area of water trading and the provision of storage where it is needed most. Defra will also make sure that water companies take a leading role in addressing unsustainable abstraction as part of the Water Industry National Environment Programme.
- Increasing water supply and incentivising greater water efficiency and less personal use through the setting of ambitious leakage reduction targets and per capita consumption targets and supporting companies in developing ways to achieve the latter.

The government's strategic priorities and objectives for Ofwat – Presented to Parliament pursuant to section 2A of the Water Industry Act 1991 (Defra, 2017a) - this has been published by the Secretary of State under new powers created by the Water Act 2014:

- The water sector should be challenged to plan, invest and operate to meet the needs of current and future customers, in a way which offers best value for money over the long-term.
- There should be further reduction in the long-term risk to water supply resilience from drought and other factors, including through new supply solutions, demand management and increased water trading.
- Companies should be challenged to further the resilience of ecosystems that underpin water and wastewater systems, by encouraging the sustainable use of natural capital and by encouraging water companies to have appropriate regard to the wider costs and benefits to the economy, society and the environment.

The National Infrastructure Commission (NIC) published a report entitled *Preparing for a drier future: England's water infrastructure needs* (NIC, 2018), which stated that to assure a long-term supply of water, the following actions are needed:

- Improving infrastructure through a national transfer network in England and new infrastructure, such as reservoirs and water re-use systems.
- Halving leakage by 2050.
- Reducing demand from the current national average of 141l/h/d to 118l/h/ d.
- Defra should enable companies to implement compulsory metering beyond water stressed areas by the 2030s, by amending regulations before the end of 2019 and requiring all companies to consider systematic roll out of smart meters as a first step in a concerted campaign to improve water efficiency. In its PR19 Business Plan Portsmouth Water also proposes to continue to seek support for its ability to compulsory meter all customers, to benefit the region.

In December 2017, Ofwat published *Delivering W2020: Our final methodology for the 2019 price review* (Ofwat, 2017), which set out its expectations of companies' plans for the period 2020/21 to 2024/25. Those relevant to Portsmouth Water's WRMP are as follows:

- Reduce water leakage by at least 15%;
- Make performance commitments specifically on improving resilience to drought and flooding;
- Assess a wide range of options for securing water supply resilience including investment in new infrastructure, water transfers and measures to significantly improve water efficiency and reduce consumption; and
- Take account of our seven principles for resilience planning, including a naturally resilient sector reflecting the importance of ecosystems and biodiversity.

Portsmouth Water has considered the extent to which its programmes of options adhere to these policy priorities in sections 7.7.2.5 and 7.7.3.5 below.

7.7.1.5 Customer Preference

As set out in section 3.4.1, research undertaken to inform the WRMP has shown that the key priorities for Portsmouth Water customers include:

- Doing more to reduce leakage than was originally proposed;
- Support for regional resource sharing provided Portsmouth Water's customers are not adversely affected by bill increases for the cost of development of Havant Thicket Reservoir;
- Environmental enhancement that goes beyond legal responsibilities;
- Co-creation and delivery of more water efficiency education; and
- Choice rather than compulsion is preferred by customer when it comes to metering.

The way in which each programme meets the above customer preferences is set out in sections 7.7.2.6 and 7.7.3.6.

7.7.1.6 Resilience

The Cabinet Office (Cabinet Office 2011) states that "*resilience is the ability of assets, networks and systems to anticipate, absorb, adapt to and/or rapidly recover from a disruptive event. Resilience is secured through a combination of activities or components; the four principal strategic components are*" presented in Figure 40:

Figure 40 Infrastructure resilience components (Cabinet Office, 2011)

- *Resistance* relates to the provision of adequate strength or protection to resist a hazard or its primary impact (in this case a supply-demand deficit).

- *Reliability* is about ensuring the infrastructure components (in this case the options included in a programme) can operate under a range of conditions.
- *Redundancy* is concerned with the capacity of the system to ensure continuity of service in the event of disruption, and essentially refers to the availability of spare capacity in the system, or in the case of a water resources system, the extent of any supply-demand surplus.
- *Response and Recovery* in this context describes how quickly and effectively Portsmouth Water is able to respond to and recover from disruptive events. Good understanding of the system is vital to being able to do this.

The contribution of the combination of options forming each programme to overall resilience has been assessed with reference to the above categories. In particular, different types of sources will react differently to differing hydrological conditions. Hence it is important to give consideration to the mix of source types operated by Portsmouth Water, to optimise resilience to a range of drought events and other hazards. For example, if a programme increases the diversity of the Company's sources across different option types, then it may result in improved resilience to different drought events. Additionally, if a programme incorporates options that would improve the Company's understanding of its water supply system, for example, through improvements to monitoring systems that facilitate leakage reduction, this could improve resilience by enabling the Company to identify more quickly, and then to respond and recover from disruptive events. Conversely, where an option depends heavily on assumptions about changes in customer behaviour, it is less reliable than an option that is unaffected by such factors.

More recently, in a letter to Portsmouth Water entitled *Building resilient water supplies – a joint letter*, dated 9th August 2018, Defra has also set out the need for, amongst other things, the following actions to assist in building resilience in water resources management in England:

- Increased ambition in the forthcoming company business plans for the 2020 to 2025 period, including:
- On the supply side demonstrating tangible progress in increasing collaboration between companies through regional groups and developing creative strategic water supply solutions; and
- On the demand side reinforcing the importance of meeting Ofwat's ambitious targets on leakage reduction and the ambitious personal consumption targets also supported by Government; and
- Regional water resource planning that transcends company boundaries and identifies optimum solutions for the region, and the nation as a whole.

Portsmouth Water's customers generally understand resilience to be long-term planning and future proofing the system against unlikely eventualities. The Company is well placed, relative to many other companies, to demonstrate it is resilient and can supply its customers with wholesome water under varying weather conditions and the ability to react to changes in water quality. The recent freeze-thaw event (March 2018) and long dry period (summer 2018) supports this statement. Within 3 months, the Company demonstrated that its business and network, in its widest sense, are resilient to extreme weather events.

Resilience in the wider context also relates to the ability of the Company to withstand the impacts of non-drought hazards:

- In 2005, Portsmouth Water commenced a programme of increasing resilience against flooding which successfully protected assets in the floods of 2012 and 2013. Further work has been undertaken following the Somerset Levels flooding, when the Company revised its capacity to withstand 'extreme' flooding conditions and enhanced its Emergency Plan accordingly. The Company is now confident that supplies can be maintained during floods of a 1 in 1000 year return period.

- As demonstrated in its Business Plan, the Company has undertaken studies in AMP6 to determine its resilience to the loss of a major treatment works, the results are shown in section 4.5.7
- As demonstrated in the Risk and Resilience Register set out in the Company's PR19 Business Plan, Portsmouth Water is resilient to electricity supply failures with standby generation or alternative power supplies at all key works.
- With respect to cyber security in the operational context, operational equipment at Portsmouth Water works are not connected to the Company's network; as such the risks from cyber-attack are considered to be low. The Company does recognise that in future, efficiency could be increased by employing increased levels of remote operation/control/monitoring that may require operational equipment to be connected to its central networks, but it clear that it will do so by deliberate design. Given the increasing threats and need for cyber security the Company has closely monitored the situation and has developed a clear IT and Operational Technology (OT) position. Throughout AMP6 the Company has invested in modern, resilient IT Infrastructure and targeted OT improvements now employs a wide portfolio of security products to help prepare for and eradicate the rapidly evolving threats. Portsmouth Water has also invested in the maturity of its practices, processes and human behaviours. This approach has enabled it to move away from traditional wide, but shallow protection, toward a more intimate, focused and ultimately more effective class of prevention, detection and response. The Company continues to partner with world class cyber security providers, but is by no means complacent. Moving into AMP7 the Company will continue to review the ever-evolving cyber threat and identify opportunities that will enable it to remain effective and secure and to improve its resilience to cyber-attack.

The way in which each programme contributes to resilience is summarised in sections 7.7.2.8 and 7.7.3.8. Further consideration of the resilience of the Final Plan is provided in section 9.6.2.

7.7.2 The Least-Cost Plan

To develop a combination of feasible options which balances supply and demand throughout the Company's supply area from 2020/21 to 2044/45, a least-cost programme has been developed.

7.7.2.1 Description

The least-cost programme has been arrived at by identifying the projected supply-demand deficit after allowance for headroom, each year for 25 years ahead. The options that could be used to meet any deficits are then identified. The options are chosen considering those with the lowest AISCs (least-cost) first. The schemes are scheduled into an optimal programme that eliminates the deficit by having them implemented one at a time, least-cost first, at dates that keep supply above demand plus headroom every year, to the end of the horizon. The earliest-available dates for each scheme are considered in the scheduling step.

It should be noted that the least-cost programme is the least-cost determined through the use of AISC ranking plus 'expert judgement' as the decision-making tool. The earliest available dates are used to meet the supply-demand deficit.

Whilst the AISC approach is considered appropriate for the problem under consideration, a lower NPV solution could potentially be arrived at through use of a least-cost optimisation model. This might however, rule out the smaller cost-effective demand management measures required for a twin-track approach.

The Company's least-cost programme including drought options is set out in Table 53.

Option code	Option name	Date Selected
CO69	Target occupants of new build housing with smart meters and water efficiency advice	2020–21
CO46	Household water efficiency programme (partnering approach, home visit)	2020–21
CO46b	Waterwise programme	2020–21
CO26	Subsidy to customers that purchase water efficient appliances (washing machines and dishwashers, showers and WCs)	2020–21
CO78	Voluntary restraint and leakage action	2020–21
CO79	Mandatory restraint	2020–21
CO80	Imposition of Drought Direction Restrictions (mandatory commercial restraint)	2020–21
RO68	Source S – Drought Permit	2020-21
RO21a	Source O – Maximising DO	2020–21
RO23a	Source H – Maximising DO	2020–21
CO34	Water saving devices – Retrofitting existing toilets	2020–21
CO06a	Metering on change of occupancy – existing meter pits	2020–21
DO04a	Fixed network of permanent noise loggers connected to telemetry - Tranche 1	2020–21
RO24a	Source C – Maximising DO	2020–21
CO84	Voids metering	2020–21
RO22a	Source J – Maximising DO	2024–25
DO04b	Fixed network of permanent noise loggers connected to telemetry - Tranche 2	2025–26
CO06	Metering on Change of Occupancy - all properties	2025–26
RO13	Havant Thicket Winter Storage Reservoir	2029–30

Table 53 The Least-Cost Plan

The Least Cost Plan has been determined using the methodology set out above. An element of expert judgement has been applied to choose the options making up the least-cost-solution and the scheduling of the investment plan. This is in accordance with the decision-making tool (AISC ranking plus 'expert judgement'). The decisions made are described below.

Selection of fixed network of permanent noise loggers over district metering

Option DO04a (phase 1 of fixed network of permanent noise loggers) has a lower AISC than Option DO05 (installation of district meters – partial network) and has therefore been selected in preference. The two options are alternatives (as discussed in section 7.5.4). The option DO11 (installation of district meters – full network) has a higher AISC but has also been excluded as the options are mutually exclusive.

Selection of drought options

Option CO78 (Voluntary restraint and leakage action) has a higher AISC than CO79 (Mandatory restraint – hosepipe ban) which in turn has a higher AISC than Option CO80 (Imposition of Drought Direction Restrictions - mandatory commercial restraint). The design scenario being used is a 1 in 200-year drought and under this situation, the drought options would all be implemented (in accordance with the Drought Plan). The Drought Options have to be selected in sequence and this is not influenced by least-cost. Therefore, the drought

options have been included in order of implementation within the least-cost programme. Option CO78 (Voluntary restraint and leakage action) comes before Option CO79 (Mandatory restraint – hosepipe ban). In practice, Option CO80 (Drought Directions) and Option RO68 (Drought Permits) would be initiated afterwards, at the same time, but drought permits would be avoided if possible.

7.7.2.2 Options included in the Programme

The Least Cost Plan includes a mixture of customer, distribution and resource options.

The customer-side options include metering options (metering on change of occupancy and voids metering), water efficiency options (household water efficiency initiatives) and water conservation options (drought options).

The distribution-side options are the two phases of installation for a fixed network of permanent noise loggers. The recent emergence of fixed networks offers a viable alternative to district metering as discussed in section 7.3.4.3.

The resource-side options include schemes to maximise DO (at sources O, J, H and C) in addition to Havant Thicket Winter Storage Reservoir.

The following options have been excluded by following the AISC ranking methodology:

Distribution-side options (excluded due to Option DO04a having a lower AISC as explained in section 7.7.2.1)

- Option DO05 (installation of district meters – partial network)
- Option DO11 (installation of district meters – full network)

Customer-side options (excluded due to their relatively high AISC in comparison to other options)

- CO75 (smart metering – replacing existing household water meters and provide water efficiency audit and advice)
- CO43 (Water saving devices – trigger nozzles for hoses)
- CO40 (Water saving devices – spray taps)
- CO05 (Smart Meter MNFR Trial).

7.7.2.3 Total cost

The cost for the least-cost programme has been calculated as £112.59m (NPV). Of this total cost:

- Carbon costs are calculated to be - £12.35m (NPV)
- Environmental and Social costs are calculated to be - £58.20m (NPV)

7.7.2.4 Performance against SEA objectives

The following section summarises the findings of more detailed assessments of the 19 options that comprise the least-cost plan regarding how they perform against the SEA objectives.

The findings of the detailed assessments of these options during construction and operation are presented in Table 54. The findings are discussed in more detail below.

Construction

The implementation of Option R013 would exceed £10m in capital investments regarding the construction of Havant Thicket impound reservoir (IR) which is expected to generate supply chain benefits and many employment opportunities as well as increased spend in the local economy by contractors and construction workers. Similarly, the implementation of Option C006 would represent a significant capital investment (£21.5m, albeit over 20 years) which is expected to generate a number of long-term jobs and which could have effects on the local economy. Notwithstanding, HGV movements associated with the development of Havant

Thicket IR and the implementation of Option C006 have the potential to cause traffic disruption within the public road network. Consistent with the definitions of significance (see Appendix D), Options R013 and C006 have been assessed as having a mixed significant positive effect on SEA Objective 6. No further significant positive effects were identified during the assessment of the construction of the options.

Given the scale of construction activity associated with the construction of Havant Thicket IR (Option R013) and the number of meters implemented in Option C006, both options were assessed as having a significant negative effect on climate change (SEA Objective 5). This reflects the anticipated emissions of greenhouse gases from vehicle movements, construction plant, and the embodied carbon in raw materials which would collectively produce up to 20.4k tCO2e for Option R013 and 2.3ktCO2e for Option C006. Option C006 was also assessed as having a significant negative effect against waste and resources (SEA Objective 8).

The magnitude of change resulting from the ongoing construction of Havant Thicket IR is expected to have a significant negative effect on the surrounding landscape (SEA Objective 10) as recreational and residential receptors may perceive the works as adversely impacting the visual amenity associated with the proximate South Down National Park's setting in addition to altering the local greenfield setting and character.

A significant negative effect of flood risk (SEA Objective 4) was identified for Option R023a. The source boreholes and pumping station where works would be undertaken are located in Flood Zone 3 associated with the River Meon. In consequence activities would be at risk of flooding (1 in 100 or greater annual probability of river flooding); however, the risks of this could be reduced through the timing of the proposed activities.

No further significant adverse effects were identified during the assessment of the construction of the options.

Operation

The design capacity of Options R013 and R022a, 23 Ml/d and 12.5 Ml/d respectively, would help to ensure the continuity of a safe and secure drinking water supply which may in-turn support economic and population growth. In the case of Option R013, the new reservoir could potentially provide new social and recreational facilities and activities in addition to increasing foot traffic within Portsmouth which could provide a minor economic boost to local businesses. Consequently, these options have been assessed as having a significant positive effect on these objectives.

The operation of CO78, C079 and CO80 would generate reductions of water demand by domestic and commercial customers through the restriction of non-critical water uses should facilitate a water saving of up to 8.1 Ml/d to 8.3 Ml/d which could subsequently be utilised elsewhere during times of drought. Similarly, D004a, D004b and D005 would generate notable water savings through leakage reduction. As all five options would generate savings in excess of 5 Ml/d; therefore, consistent with the definitions of significance, they were assessed as having a significant positive effect on resource use (SEA Objective 8).

No further significant positive operational effects were identified during the assessment nor were there any significant adverse effects established.

Cumulative Effects

The cumulative effects of the preferred options at this stage reflect the significance and scale of the construction and operation of R013.

Option code	Option name	Construction (C) or Operation (O)	1. Biodiversity	2. Geology and Soils	3. Water Quantity and Quality	4. Flood Risk	5. Climate Change	6. Economic and Social Wellbeing	7. Human Health	8. Waste and Resources	9. Cultural Heritage	10. Landscape
R013	Havant Thicket Winter Storage Reservoir	C	-	-	0	0	--	++/-	-	-	-	--
		O	+/?	0	0	+	+	++	++	-	0	+/?
R021a	Source O – Maximising DO	C	0	0	0	0	?/-	0	0	-	0	0
		O	0	0	0	0	0/?	+	+	0/?	0	0
R022a	Source J – Maximising DO	C	0	0	0	0	-	0	0/?	-	0	-
		O	0/?	0	0	0	-	++	++	-	0	0
R023a	Source H – Maximising DO	C	0	0	0	--	-/0/?	0	0	-	0	0
		O	?	0	?	0	0/?	+	+	0/?	0	0
R024a	Source C – Maximising DO	C	0	0	0	0	0	0	0	0	0	0
		O	0	0	0	0	+/-	+	+	+/-	0	0
R068	Source S - Drought Permit	C	0	0	0	0	0	0	0	0	0	0
		O	-/?	0	-/?	0	+	+	+	0	0/?	0
C006b	Metering on change of occupancy - all properties	C	0	0	0	0	--	++/-	0	--	0	0
		O	0	0	+	0	++	+	+	++	0	0
C006a	Metering on change of occupancy - existing meter pits	C	0	0	0	0	-	0	0	-	0	0
		O	0	0	+	0	+	0	0	+	0	0
C026	Subsidy to customers that purchase water efficient appliances (washing machines and dishwashers, showers and WCs)	C	0	0	0	0	-	0	0	-	0	0
		O	0	0	+	0	+	0	0	+	0	0
C034	Water saving devices - Retrofitting existing toilets (with flush >9l) Target metered customers	C	0	0	0	0	0	0	0	0	0	0
		O	0	0	+	0	0	0	0	+	0	0
		O	0	0	+	0	0	0	0	+	0	0
C046	Household water efficiency programme (partnering approach, home visit)	C	0	0	0	0	-	0	0	-	0	0
		O	0	0	+	0	+	+	+	+	0	0
C046b	Waterwise programme	C	0	0	0	0	-	0	0	-	0	0
		O	0	0	+	0	+	+	+	+	0	0

Option code	Option name	Construction (C) or Operation (O)	1. Biodiversity	2. Geology and Soils	3. Water Quantity and Quality	4. Flood Risk	5. Climate Change	6. Economic and Social Wellbeing	7. Human Health	8. Waste and Resources	9. Cultural Heritage	10. Landscape
C069	Target occupants of new build housing with smart meters and water efficiency advice	C	0	0	0	0	-	+	0	-	0	0
		O	0	0	+	0	0	0	0	0	0	0
C078	Voluntary restraint & leakage action	C	0/?	0	0	0	0	0	-/?	0	0	0/?
		O	0	0	+	0	+	+	+	+	0	0
C079	Mandatory restraint	C	0	0	0	0	0	0	0	0	0	0
		O	0	0	+	0	+	+	+	++	0	0
C80	Imposition of Drought Direction Restrictions (mandatory commercial restraint)	C	0	0	0	0	0	0	0	0	0	0
		O	0	0	+	0	+	+	+	++	0	0
C084	Voids metering	C	0	0	0	0	-	0	0	-	0	0
		O	0	0	+	0	+	0	0	+	0	0
D004a	Fixed network of permanent noise loggers connected to telemetry - Tranche 1	C	0/?	0	0	0	0/?	+	0	0	0	0
		O	0	0	+	0	+	+	+	++	0	0
D004b	Fixed network of permanent noise loggers connected to telemetry - Tranche 2	C	0/?	0	0	0	0/?	+	0	0	0	0
		O	0	0	+	0	+	+	+	++	0	0
Cumulative Effects		**C**	**-**	**-**	**0**	**0**	**--**	**+/-**	**-**	**-**	**-**	**--**
		O	**+/?**	**0**	**0**	**+**	**+**	**+**	**+**	**-**	**0**	**+/?**

Table 54 Performance against SEA objectives of the Least Cost Plan options

7.7.2.5 Programme risk

The programme risk for the least-cost programme is summarised in Table 55 and discussed in more detail below.

Category of Programme Risk	Assessment
Yield uncertainty	The least-cost programme is comprised of a mix of different option types which together provide a high level of yield certainty, with over 60% of yield coming from leakage reduction measures, enhancement of groundwater sources and new reservoirs.
Cost and programme uncertainty	Within the mix of options included in the least-cost programme, it is considered that the greatest risk in terms of cost and programme uncertainty is likely to be associated with the resource-side options. The Company's largest resource side option is the development of Havant Thicket Reservoir. The Company also has a number of groundwater DO recovery schemes. Potential risks are being mitigated by detailed project planning and ongoing customer and stakeholder engagement. A delivery team is already in place for Havant Thicket Reservoir.
Water Framework Directive	Although none of the resource-side options included in the least-cost programme involve changes to existing abstraction licences, the Environment Agency have expressed some concerns regarding sustainable abstraction in relation to Sources H, C, J and the Source S Drought Permit. The Company will continue to work with the Environment Agency to investigate concerns.
Flexibility	Development of the Havant Thicket reservoir option will provide increased flexibility to Portsmouth Water. Taking surplus spring flows in the winter and storing the water in the reservoir, provides a flexible resource which can be used in the summer when necessary. The groundwater DO recovery schemes offer flexibility to the extent that once commissioned, a lesser volume could be abstracted if less resource was found to be needed. Similarly, there is some flexibility with regards the introduction of the Source S Drought Permit. The leakage reduction, metering and water efficiency options are likely to offer less flexibility.

Table 55 Summary of Programme Risk for the Least Cost Plan

Yield

The yield provided in the least-cost plan is provided from different option types. There are different levels of confidence in the yield assessments of different option types, as described in section 7.7.1.3.

The contribution of yield from the different option types (in order of highest confidence to least confidence) is as follows:

- 12% leakage reduction
- 30% enhancement of groundwater sources
- 26% new reservoirs
- 23% drought options
- 3% water efficiency
- 6% metering

It should be noted that the above proportions are based on the maximum DO/demand saving and that the proportions will change through the planning period as different options are implemented.

In general, the different option types show that the programme provides a high level of yield certainty, with over 60% of yield coming from leakage reduction measures, enhancement of

groundwater sources and new reservoirs. There is slightly lower confidence in terms of the yield from drought measures as to date, such measures have never had to be enforced by the Company. Water efficiency and metering options provide an important contribution to the Company's strategy, but there is less confidence associated with the yield as this is strongly reliant on changes in customer behaviour.

Cost and programme uncertainty

There will inevitability be some cost and programme uncertainty throughout the Company's 25-year plan. The programme costs presented in this WRMP are indicative, based on the best currently available information, and will be refined as the options are further investigated and developed.

Within the mix of options included in the least-cost programme, it is considered that the greatest risk in terms of cost and programme uncertainty is likely to be associated with the resource-side options and due issues such as unforeseen issues arising during construction.

The Company's largest resource side option is the development of Havant Thicket Reservoir. The risks are being mitigated by detailed project planning and ongoing customer and stakeholder engagement.

The size of the project is significant in the context of the wider business. The chosen delivery model allows for clear risk transfer, and single-point of responsibility for the discrete works packages, with appropriate oversight and minimal interface risk between packages of work. The Company will need to strengthen its programme management capabilities, and in this regard we have, or will, put in place for example the following measures:

- We have engaged a highly experienced core project team of nationally recognised experts that is integrated within the organisation, comprising Project Delivery, Stakeholder and Environment, and Commercial Leads;
- We have engaged a Project Management Contractor (PMC) to manage the Project to operational readiness. The PMC will provide further technical expertise in the areas of Delivery, Commercial and Procurement management, Project Controls, integrating the engineering management (including environmental management), planning and the Project executive. As part of the PMC, well established processes and procedures will be applied to the Project, alongside industry recognised systems and tools to run the Project to budget and time. The benefits of the PMC will be transferred to the internal project delivery of PW on other projects.

As discussed in section 7.5.5.2, the Company also has a number of groundwater DO recovery schemes. The cost and programme uncertainty risks for DO recovery at Sources O, H and C are fairly low as the schemes involve improvement works to water quality on existing boreholes by methods such as relining, cleaning and additional filtration. There is slightly greater cost and programme uncertainty associated with Source J DO recovery as this option involves maximising the DO of the source within existing licence limits by construction of a satellite borehole. This might be subject to greater risk regarding unforeseen issues during construction. However, the satellite borehole will replace one of the existing boreholes where yield has been proven. Following feedback on the Draft WRMP, the option start date has been pushed back slightly and more detailed planning is being developed to help mitigate against programme risk.

WFD

There is an element of uncertainty associated with the resource-side options included in the least-cost programme due to ongoing Environment Agency work associated with the Water Framework Directive. Although none of the groundwater DO recovery schemes involve

changes to existing abstraction licences, the Environment Agency have expressed concerns regarding sustainable abstraction in relation to Sources H, C and J. The Company is committed to working with the Environment Agency during development of these options to investigate and address any sustainability concerns.

The Environment Agency has also expressed some concerns regarding 'Deterioration' under the WFD associated with the Source S Drought Permit. This option would be introduced as and when required under the Drought Directions and is included within the Draft Drought Plan 2018. The Company will continue to work with the Environment Agency to investigate concerns. It should be noted that during a drought, use of drought permits would be avoided if possible. Additionally, through the planning period, as the demand savings from leakage and metering options increase, the need for a drought permit will reduce.

Flexibility

The least-cost programme offers flexibility in terms of options that could be scaled up or down if additional resource was required or if less resource was found to be needed. Most notably, development of the Havant Thicket reservoir option will provide increased flexibility to Portsmouth Water. Taking surplus spring flows in the winter and storing the water in the reservoir, provides a flexible resource which can be used in the summer when necessary.

The groundwater DO recovery schemes offer flexibility to the extent that once commissioned, the operational output of the schemes can always be varied to meet demand. Whilst this can't generate a higher DO than planned, a lesser volume could be abstracted if less resource was found to be needed. Similarly, there is some flexibility with regards the introduction of the Source S Drought Permit. As previously discussed, use of drought permits would be avoided if possible.

The leakage reduction options (fixed network of permanent noise loggers) would not be able to provide additional resource but could be scaled back if needed. This is unlikely to be desirable however, as it goes against government policies and customer preferences.

The metering options are largely based on change of occupancy. The demand savings achieved will be dependent on customer behaviour and whilst this could potentially be increased by more intensive customer engagement, this could not be guaranteed. The same is true for the water efficiency options. Both metering and water efficiency options could be scaled down in future if less resource was found to be needed, but this would not be desirable as it would be at odds with stakeholder preferences and government priorities.

7.7.2.6 Alignment with Government policy priorities

The extent to which the least-cost plan aligns with Government policy priorities is summarised in Table 56 below.

Government policy priority	How the priority is addressed by the least-cost plan
Guiding principles for water resources planning (Defra, 2016)	
We expect to see evidence that you have taken a strategic approach to water resources planning that represents best value to customers over the long-term.	The Company's programme appraisal methodology demonstrates that it is proposing a least-cost plan that represents best value to customers taking into account costs and benefits over an 80 year period as well as other non-monetisable impacts.

Government policy priority	How the priority is addressed by the least-cost plan
We want to see a real change in approach to your WRMP so that it properly examines the value of resilience for your customers, is informed by your customers' views and identifies what actions you will take to reduce risk now and in the future.	The views of Portsmouth Water customers have been taken into account when shaping the Company's least-cost plan, as have the extent to which the programme of options contributes to the resilience of the Company's water supply system. As a result, the least-cost plan incorporates options that will reduce our risk of supply-demand deficits occurring in droughts of severity up to and including 1 in 200 year events.
We expect more thorough testing of vulnerability of water supply systems - not solely tests based on historic events but future events that could reasonably be foreseen – to enable you to better plan for and respond flexibly to future uncertainties.	The Company's least-cost plan enables it to be resilient to a 1 in 200 year drought event, which it considers demonstrates thorough testing of the vulnerability of its water supply system.
We expect to see evidence of a strategic approach to water resources planning that represents best value to customers over the long-term and draws on the latest information from collaborative projects.	Inclusion of Havant Thicket Reservoir, the need for which has been identified through the WRSE Group, demonstrates that the Company has worked collaboratively with its neighbour, Southern Water, and has drawn on the latest information from the regional collaborative project.
You should demonstrate how you value nature in your decisions. We expect you to thoroughly investigate and report on environmental and social costs and benefits.	The economic appraisal of feasible options incorporates the monetary valuation of environmental and social costs wherever possible. Additionally, the programme appraisal takes into account the cumulative performance of the least-cost plan options against SEA objectives.
You will need to ensure your current abstractions and operations as well as future plans support the achievement of environmental objectives and measures set out in RBMPs.	The SEA (Appendix P) and HRA (Appendix O) undertaken on this WRMP set out the way in which the least-cost plan supports the achievement of RBMP measures.
You should consider drought management options as part of your plan.	Consideration of and inclusion in the least-cost plan of three demand side and one supply side drought management options, aligned with the Company's Drought Plan.
Companies' plans must demonstrate how they will promote water efficiency and leakage control and, where appropriate, increase customer metering.	Despite not being allowed to compulsorily meter its customers due to not being in an area of serious water stress, Portsmouth Water's least-cost plan still incorporates 4 metering options, comprising change of occupancy metering, void household metering and a trial of smart 'not for revenue metering'. The least-cost plan also includes 6 water efficiency options, to facilitate reductions in customers' consumption. Additionally, the least-cost plan includes 2 tranches of leakage reduction through the installation of a fixed network of permanent noise loggers connected to telemetry.
Defra expects companies to choose demand-side options as part of the preferred programme wherever it is reasonably likely that the benefits will outweigh the costs.	The Company has included in its least-cost plan a number of demand side options where they are required to reduce the supply-demand deficit. These options have been selected both on economic grounds but also taking into account non-monetisable costs and benefits as set out in the programme appraisal.

Government policy priority	How the priority is addressed by the least-cost plan
Defra wants to see the downward trend for leakage continue and companies must consider leakage management fully as an option to balance supply and demand.	Portsmouth Water's final planning demand forecast sees leakage reduce year on year throughout the 25 year planning period, and the Company has considered a range of leakage management options as part of its feasible options list, with some going on to be selected as part of the least-cost plan.
A Green Future: Our 25 Year Plan to Improve the Environment (Defra, 2018)	
Setting of high environmental standards for all new builds. New homes will be built in a way that reduces demands for water.	Assumptions made by the Company in its baseline demand forecast regarding the potential water demands of new build households take account of their likely reduced demand. In this way, Portsmouth Water supports Defra's aim to reduce new build homes' demand for water.
Reforming the approach to abstraction such that abstractors will be supported to access the water they need to operate efficiently, but licences will continue to be amended in cases of unsustainable abstraction. Innovation will be supported and encouraged, for example in the area of water trading and the provision of storage where it is needed most. Defra will also make sure that water companies take a leading role in addressing unsustainable abstraction as part of the Water Industry National Environment Programme	The Company is contributing to this policy priority by including in its least-cost plan an option (Havant Thicket Winter Storage Reservoir) that provides increased storage and enables water trading with neighbouring Southern Water. There are some further investigations which have been identified by the Environment Agency as under WINEP3. These are outlined in section 4.3.2. The Company will undertake the required investigations and therefore will be contributing to addressing unsustainable abstraction.
Increasing water supply and incentivising greater water efficiency and less personal use through the setting of ambitious leakage reduction targets and per capita consumption targets and supporting companies in developing ways to achieve the latter.	Portsmouth Water supports Defra's drive for increased water supply and reduced demand for water through the inclusion of a range of supply side and demand management options respectively in its least-cost plan. The Company proposes to reduce total leakage by 15% from base year levels by 2024/25 and by a further 5% per AMP for the remainder of the 25 year planning period. Taking into account the demand savings estimated from Portsmouth Water's least-cost plan demand management options, an ambitious reduction in PCC is expected over the planning period.
The government's strategic priorities and objectives for Ofwat – Presented to Parliament pursuant to section 2A of the Water Industry Act 1991 (Defra, 2017a)	
The water sector should be challenged to plan, invest and operate to meet the needs of current and future customers, in a way which offers best value for money over the long-term.	The Company's programme appraisal methodology demonstrates that it is proposing a least-cost plan that represents best value to customers taking into account costs and benefits over an 80 year period as well as other non-monetisable impacts.
There should be further reduction in the long-term risk to water supply resilience from drought and other factors, including through new supply solutions, demand management and increased water trading.	The Company's least-cost plan includes a range of supply solutions, demand management options which all assist the Company in not only meeting its own supply-demand balance deficit but also enable it to trade water with neighbouring Southern Water to enable it to reduce its own supply-demand deficit.

Government policy priority	How the priority is addressed by the least-cost plan
Companies should be challenged to further the resilience of ecosystems that underpin water and wastewater systems, by encouraging the sustainable use of natural capital and by encouraging water companies to have appropriate regard to the wider costs and benefits to the economy, society and the environment.	The economic appraisal takes into account the quantifiable environmental and social costs and benefits of each feasible option. Subsequently, the programme appraisal process used by the Company to assess the least-cost plan takes into account the performance of the options against SEA objectives. In this way, the Company has endeavoured to take account of and minimise impacts on the economy, society and the environment.
Preparing for a drier future: England's water infrastructure needs (NIC, 2018)	
Improving infrastructure through a national transfer network in England and new infrastructure, such as reservoirs and water re-use systems.	Portsmouth Water's least-cost plan is aligned with this identified infrastructure need in that it incorporates a new winter storage reservoir (Havant Thicket).
Halving leakage by 2050.	The Company's least-cost plan goes some way toward this target by resulting in a reduction in total leakage of 15% from base year levels by 2024/25 and by a further 5% per AMP for the remainder of the 25 year planning period.
Reducing demand from the current national average of 141l/h/d to 118l/h/d.	The Company supports the need to reduce PCC and has included options in its least-cost plan that enable this.
Defra should enable companies to implement compulsory metering beyond water stressed areas by the 2030s, by amending regulations before the end of 2019 and requiring all companies to consider systematic roll out of smart meters as a first step in a concerted campaign to improve water efficiency.	Portsmouth Water supports the NIC's call to Defra that companies should be able to implement compulsory metering even if they are not in water stressed areas. Doing so would enable Portsmouth Water to further support other companies in the region which are in water stressed areas, where of course it has the support of its customers.
Delivering W2020: Our final methodology for the 2019 price review (Ofwat, 2017)	
Reduce water leakage by at least 15% [by 2024/25].	The Company's least-cost plan is expected to reduce total leakage by 15% from base year levels by 2024/25 and by a further 5% per AMP for the remainder of the 25 year planning period.
Make performance commitments specifically on improving resilience to drought and flooding.	The Company sets out its resilience performance commitment in its PR19 Business Plan.
Assess a wide range of options for securing water supply resilience including investment in new infrastructure, water transfers and measures to significantly improve water efficiency and reduce consumption.	The Company's options appraisal process demonstrates that it has assessed a wide range of options. Furthermore, the Company has included options across all the option types listed in its least-cost plan.
Take account of our seven principles for resilience planning, including a naturally resilient sector reflecting the importance of ecosystems and biodiversity.	The Company recognises the importance of resilience planning and has taken into account the importance of ecosystems and biodiversity in its least-cost plan through inclusion of environmental and social costs in the economic appraisal, and the assessment of other non-monetisable costs and benefits to the environment through the SEA. Its approach to the seven principles is demonstrated in the accompanying Company PR19 Business Plan.

Table 56 Government policy priorities and description of how the least-cost plan addresses them

Overall, taking into account the information in Table 56, the Company considers that its least-cost plan is well-aligned with Government policy priorities.

7.7.2.7 *Customer Preference*

The assessment of how the least-cost programme performs against customer preferences is summarised in Table 57.

Customer Priorities	Assessment
Doing more to reduce leakage that was originally proposed	The least-cost programme for the Final WRMP, does more to reduce leakage than originally proposed in the Draft WRMP. The least-cost programme contains options for a fixed network of permanent noise loggers which will not only deliver a leakage saving of 15% in the first 5 years but then continue to drive down leakage at a target rate of 5% every 5 years up to 2040.
Support for regional resource sharing provided Portsmouth Water's customers are not adversely affected by an increased risk of failure or by bill increases for the cost of development of Havant Thicket Reservoir	The least-cost programme includes the option for Havant Thicket Winter Storage Reservoir. This is being developed to supply Portsmouth Water customers and consequently free up resources to support the wider South East region. This is a cost-effective option and there should be no direct bill increase because of the Southern Water trading agreement.
Environmental enhancement that goes beyond legal responsibilities	The Company has a good track record of delivering on biodiversity management and enhancement. The least-cost programme includes the option for Havant Thicket Winter Storage Reservoir where the Company are not only developing a comprehensive mitigation and compensation strategy, but also working with Natural England and other stakeholders to deliver a net biodiversity gain.
Customers would like more information on how much water they use and how they can reduce any wastage, therefore supporting the co-creation and delivery of more water efficiency education	The least-cost programme includes five water efficiency options. In addition to promoting the use of water saving devices and appliances, these include provision of water efficiency advice and home visits.
Choice rather than compulsion is preferred by customer when it comes to metering	The least-cost programme includes metering on change of occupancy and voids metering. Optant metering is included as part of the Company's baseline forecast. Although these options are not driven by customer choice, the majority of customers will still have a choice. The requirement for metering is strongly influenced by government policies and stakeholder preference.

Table 57 Customer Preference Assessment for the Least Cost Plan

7.7.2.8 *Resilience*

In terms of the Cabinet Office's four components of resilience, the least-cost plan has been assessed as follows:

Resistance: The least-cost plan enables Portsmouth Water to demonstrate resistance to the impacts of a 1 in 200 year drought from a supply-demand balance perspective.

Reliability: The DO of the supply side options has been assessed at the 1 in 200 year level; it is expected that they should achieve these yields under droughts up to and including this severity. The demand savings assumed to result from the water efficiency and metering

measures proposed in the least-cost plan are considered to be less reliable because they depend on customer behaviour. Although this can be in part be influenced by the Company, assurance that these savings will be made during severe drought events is limited. However, uncertainty around savings should not be a reason for inaction when it comes to demand management. The mix of resource options and demand management options together provide a reasonable degree of reliability in the Company's plan.

Redundancy: The capacity of the Company's water resource system to ensure continuity of service in the event of disruption is related to network connectivity as well as water resource capacity. Network resilience is addressed in the Company's Business Plan, while water resource capacity is a focus of this WRMP. The method of AISC ranking that has been used to determine the least-cost plan assumes maximum yield from all options, whereas in reality the option yields (for demand management options in particular) will vary over time. The least-cost plan results in a supply-demand surplus that ranges from a minimum of 4.9 Ml/d (in 2020/21) to a maximum of 13.0 Ml/d (in 2041/42), with an average surplus of 10.5 Ml/d. In reality, sources would be operated to supply only as much water as is required to meet demand, usually with more expensive sources being used last (depending on where the water is required and other constraints such as licences). That notwithstanding, the least-cost plan results in a degree of redundancy in the water resources system, which will contribute to its resilience.

Response and Recovery: Some options within the least-cost plan would provide Portsmouth Water with an improved understanding of its network and of demands placed on the system. These options comprise the two tranches of the Fixed network of permanent noise loggers connected to telemetry (D004a and D004b), as well as the change of occupancy (C006a and C006b), void household (C084) and smart meter trial (C005) metering options. The effect of these options would therefore be expected to improve the Company's identification of, and subsequently its response to and recovery from any disruptive events. The Company has shown a system resilient to 1 in 200 year drought events, with this resilience dependent in part on the drought options that would allow it to respond and recover from extreme weather conditions.

In addition to being supported by the economic appraisal, the Company has taken account of the outcomes of the WRSE Group collaborative project by including Havant Thicket Winter Storage Reservoir (R013) in its least-cost plan. In this way, the need identified by Defra in its letter to Portsmouth Water (*Building resilient water supplies – a joint letter*, dated 9th August 2018) to demonstrate "*tangible progress in increasing collaboration between companies and developing creative strategic water supply solutions*" and "*regional water resource planning that transcends company boundaries and identifies optimum solutions for the region*" have been met by the Company, which Defra considers will contribute to a resilient water supply.

Havant Thicket Winter Storage Reservoir helps support Southern Water deliver greater drought resilience in the most cost-effective way by supplying Portsmouth Water customers directly, and freeing water from other abstractions to be transferred. It also increases the diversity of the Company's sources which may potentially achieve a net improvement in resilience, although this has yet to be determined. The winter storage reservoir would store excess water from the winter, when it is usually plentiful, for use in the summer when it is less so. The improvement offered by the reservoir should be viewed in the context that its yield at 23 Ml/d equates to just 10% of total WAFU of the least-cost plan in the option's start year (2029/30).

7.7.3 The Preferred Plan

The Preferred Plan includes the Company's preferred combination of feasible options which balance supply and demand throughout the Company's supply area from 2020/21 to 2044/45.

The following sections provide a description of how the plan was developed and a comparative assessment against the least-cost plan.

7.7.3.1 Description

The Company's preferred programme has been arrived at through consideration of Company priorities, government policy priorities, and the perceived priorities of its customers.

The Company's preferred plan including drought options is set out Table 58.

Option code	Option name	Date Selected
CO46	Household water efficiency programme (partnering approach, home visit)	2020–21
CO46b	Waterwise programme	2020–21
CO26	Subsidy to customers that purchase water efficient appliances (washing machines and dishwashers, showers and WCs)	2020–21
RO21a	Source O – Maximising DO	2020–21
RO23a	Source H – Maximising DO	2020–21
CO34	Water saving devices – Retrofitting existing toilets	2020–21
CO06a	Metering on change of occupancy – existing meter pits	2020–21
DO04a	Fixed network of permanent noise loggers connected to telemetry - Tranche 1	2020–21
RO24a	Source C – Maximising DO	2020–21
CO84	Voids metering	2020–21
CO40	Water saving devices – spray taps	2020–21
CO43	Water saving devices – trigger nozzles for hoses	2020–21
CO05	Smart Meter MNFR Trial	2020–21
CO78	Voluntary restraint and leakage action	2020–21
CO79	Mandatory restraint	2020–21
CO80	Imposition of Drought Direction Restrictions (mandatory commercial restraint)	2020–21
RO68	Source S – Drought Permit	2020–21
RO22a	Source J – Maximising DO	2024–25
DO04b	Fixed network of permanent noise loggers connected to telemetry - Tranche 2	2025–26
CO06	Metering on Change of Occupancy - all properties	2025–26
RO13	Havant Thicket Winter Storage Reservoir	2029–30

Table 58 The Preferred Plan

The Preferred Plan has been derived from the list of feasible options. In selecting options, the Company took account not only of cost (AISC) but also options which would help meet the priorities set out above.

Not all the feasible options could be selected (or were needed to meet the deficit). The feasible options that were excluded and the justification for this are summarised in Table 59 below.

Option	Description	Reason for exclusion
D005	Installation of district meters – partial network	Excluded as Option DO04a (phase 1 of fixed network of permanent noise loggers) has a lower AISC and was selected in preference (the two are alternative options). This option was not included in the least-cost plan.
D011	Installation of district meters – full network	Excluded as both Option DO04a and DO04b (phase 1 of fixed network of permanent noise loggers) have lower AISCs and hence these options were selected in preference. Developing a full network of district meters is mutually exclusive with the fixed network programme. This option was not included in the least-cost plan.
C069	Target occupants of new build housing with smart meters and water efficiency advice	Excluded as the Company considers that it may be more cost beneficial over the long-term to roll out smart meters across its whole supply area. A smart metering trial (Option CO05) has been selected in preference. This is explained further in section 7.7.3.2
C075	Smart metering – replacing existing household water meters and provide water efficiency audit and advice	Excluded due to high cost. This option was not included in the least-cost plan.

Table 59 Feasible Options Excluded from the Preferred Plan

7.7.3.2 Options included in the Programme

The preferred plan is very similar to the least-cost plan and includes a mixture of customer, distribution and resource options.

In addition to the options in the least-cost plan, further water efficiency options have been included, and a smart metering trial. This reflects the Company's commitment to delivering improved water efficiency and reducing household PCC. The following customer-side options have been included:

- CO40 (Install spray taps)
- CO43 (Trigger nozzles and water butts)
- CO05 (Smart metering trial (NFR))

The Company's preferred plan excludes one option which was included on the least-cost programme:

- CO69 (Target occupants of new build housing with smart meters and water efficiency advice)

The excluded option (CO69) was for new homes to have a smart meter (rather than basic meter) installed and to ensure new owners were provided with advice on their fittings and appliances and how to improve water efficiency.

This option has been excluded for a number of reasons which are set out below.

- As smart meter technology is a rapidly developing field of technology, the Company proposes to undertake a smart meter trial (option CO05). Although it has a higher AISC, this option aims to reduce the uncertainty around costs and benefits of smart metering, thus improving the information available to The Company for its options appraisal at WRMP24.

- The Company considers that it may be more cost beneficial over the long-term to roll out smart meters across its supply area as part of a co-ordinated programme whereby efficiencies can be gained from economies of scale and geographical proximity of households (metering area by area). The Company is unable to compulsorily meter its customers under current government policy (due to not being in an area of serious water stress). However, a change in policy in the future would make such a metering roll out feasible.
- The aspect of ensuring new owners are provided with advice on their fittings and appliances and how to improve water efficiency is covered by the household water efficiency programme (Option CO46b, working with Waterwise to deliver an enhanced programme).

7.7.3.3 Total cost

The cost for the preferred plan programme has been calculated as £118.81m (NPV). Of this total cost:

- Carbon costs are calculated to be - £11.90m (NPV)
- Environmental and Social costs are calculated to be - £58.17m (NPV)

7.7.3.4 Performance against SEA objectives

The following section summarises the findings of more detailed assessments of the 21 options that comprise the Company's preferred plan concerning how they perform against the SEA objectives.

The findings of the detailed assessments of these options during construction and operation are presented in Table 60. The findings are discussed in more detail below.

As set out above, the differences between the least-cost plan and the preferred plan comprise the addition of two further water efficiency schemes and a smart meter 'not for revenue metering' trial, while the smart metering of new build properties has been excluded. Overall the impact is an increased amount of water efficiency in the preferred plan, which have either neutral or minor positive impacts on SEA objectives. As such, the overall conclusions of the cumulative effects assessment for the preferred plan is that it performs slightly better than the least-cost plan against economic and social wellbeing and human health objectives. It can be seen from Table 60 that there are cumulative impacts during construction regarding climate change. However, there are no adverse cumulative impacts resulting from the preferred plan options during operation.

Option code	Option name	Construction (C) or Operation (O)	1. Biodiversity	2. Geology and Soils	3. Water Quantity and Quality	4. Flood Risk	5. Climate Change	6. Economic and Social Wellbeing	7. Human Health	8. Waste and Resources	9. Cultural Heritage	10. Landscape
R013	Havant Thicket Winter Storage Reservoir	C	-	-	0	0	--	++/-	-	-	-	--
		O	+/?	0	0	+	+	++	++	-	0	+/?
R021a	Source O – Maximising DO	C	0	0	0	0	?/-	0	0	-	0	0
		O	0	0	0	0	0/?	+	+	0/?	0	0
R022a	Source J – Maximising DO	C	0	0	0	0	-	0	0/?	-	0	-
		O	0/?	0	0	0	-	++	++	-	0	0
R023a	Source H – Maximising DO	C	0	0	0	--	-/0/?	0	0	-	0	0
		O	?	0	?	0	0/?	+	+	0/?	0	0
R024a	Source C – Maximising DO	C	0	0	0	0	0	0	0	0	0	0
		O	0	0	0	0	+/-	+	+	+/-	0	0
R068	Source S - Drought Permit	C	0	0	0	0	0	0	0	0	0	0
		O	-/?	0	-/?	0	+	+	+	0	0/?	0
C005	Smart Meter MNFR Trial	C	0	0	0	0	-	+	0	-	0	0
		O	0	0	+	0	0	0	0	0	0	0
C006b	Metering on change of occupancy - all properties	C	0	0	0	0	--	++/-	0	--	0	0
		O	0	0	+	0	++	+	+	++	0	0
C006a	Metering on change of occupancy - existing meter pits	C	0	0	0	0	-	0	0	-	0	0
		O	0	0	+	0	+	0	0	+	0	0
C026	Subsidy to customers that purchase water efficient appliances (washing machines and dishwashers, showers and WCs)	C	0	0	0	0	-	0	0	-	0	0
		O	0	0	+	0	+	0	0	+	0	0
C034	Water saving devices - Retrofitting existing toilets (with flush >9l) Target metered customers	C	0	0	0	0	0	0	0	0	0	0
		O	0	0	+	0	0	0	0	+	0	0
C040	Water saving devices – Spray Taps	C	0	0	0	0	0	0	0	0	0	0
		O	0	0	+	0	0	0	0	+	0	0
C043	Water saving devices - Trigger nozzles & water butts	C	0	0	0	0	0	0	0	0	0	0
		O	0	0	+	0	0	0	0	+	0	0

Option code	Option name	Construction (C) or Operation (O)	1. Biodiversity	2. Geology and Soils	3. Water Quantity and Quality	4. Flood Risk	5. Climate Change	6. Economic and Social Wellbeing	7. Human Health	8. Waste and Resources	9. Cultural Heritage	10. Landscape
C046	Household water efficiency programme (partnering approach, home visit)	C	0	0	0	0	-	0	0	-	0	0
		O	0	0	+	0	+	+	+	+	0	0
C046b	Waterwise programme	C	0	0	0	0	-	0	0	-	0	0
		O	0	0	+	0	+	+	+	+	0	0
C078	Voluntary restraint & leakage action	C	0/?	0	0	0	0	0	-/?	0	0	0/?
		O	0	0	+	0	+	+	+	+	0	0
C079	Mandatory restraint	C	0	0	0	0	0	0	0	0	0	0
		O	0	0	+	0	+	+	+	++	0	0
C80	Imposition of Drought Direction Restrictions (mandatory commercial restraint)	C	0	0	0	0	0	0	0	0	0	0
		O	0	0	+	0	+	+	+	++	0	0
C084	Voids metering	C	0	0	0	0	-	0	0	-	0	0
		O	0	0	+	0	+	0	0	+	0	0
D004a	Fixed network of permanent noise loggers connected to telemetry - Tranche 1	C	0/?	0	0	0	0/?	+	0	0	0	0
		O	0	0	+	0	+	+	+	++	0	0
D004b	Fixed network of permanent noise loggers connected to telemetry - Tranche 2	C	0/?	0	0	0	0/?	+	0	0	0	0
		O	0	0	+	0	+	+	+	++	0	0
Cumulative Effects		**C**	**-**	**-**	**0**	**0**	**--**	**++/-**	**-**	**-**	**-**	**--**
		O	**+/?**	**0**	**0**	**+**	**+**	**++**	**++**	**-**	**0**	**+/?**

Table 60 Performance against SEA objectives of the Preferred Plan options

7.7.3.5 *Programme risk*

The programme risk for the Preferred Plan is very similar to that assessed for the Least Cost Plan. The Preferred Plan provides a slight improvement.

The additional water efficiency options make very minimal difference in terms of the yield uncertainty. There is still a high level of yield certainty (over 60% of yield still comes from leakage reduction measures, enhancement of groundwater sources and new reservoirs).

The different options provide a very slight benefit in terms of cost and programme uncertainty and WFD components by providing other options and some additional resource to offset risk. It should be noted, however, that the difference in yield terms is very small. Due to the number of feasible options requiring selection, there is little scope for the Preferred Plan to select alternative options with less uncertainty regarding sustainability and WFD.

The preferred plan provides additional programme flexibility as there are additional options to draw on if more resource was found to be needed or if some options weren't able to deliver as much benefit/yield as planned. The preferred plan also includes a smart metering trial which also enhances programme flexibility. Through the smart metering trial, the Company aims to reduce the uncertainty around costs and benefits of smart metering. By collection information, the trial puts the Company in a better position to be able to roll out a co-ordinated programme of smart metering in future.

7.7.3.6 *Alignment with Government policy priorities*

The least-cost plan has been assessed in terms of the extent to which it is aligned with Government policy priorities in Table 56. The preferred plan is largely the same as the least-cost plan, therefore remains aligned with Government policy priorities, and in fact is strengthened in regard to those Government policy priorities that call for demand management and reductions in PCC because the preferred plan includes additional water efficiency options.

The Company is contributing to the policy priority from Defra that water companies take a leading role in addressing unsustainable abstraction as part of the Water Industry National Environment Programme by committing to undertaking the WINEP3 investigations (as outlined in section 4.3.2). By undertaking the investigations, the Company will be contributing to addressing unsustainable abstraction. In addition, the potential impacts from sustainability reductions have been included within the sensitivity analysis on the preferred plan (section 8).

7.7.3.7 *Customer Preference*

The Preferred Plan provides an improvement in terms of customer preference to the Least Cost Plan.

With reference to Table 57, it can be seen that customer priorities in terms of leakage, regional resource sharing and environmental enhancement continue to be met. In addition, the preferred programme provides additional household water efficiency measures (water saving devices) and a smart metering trial. The smart metering trial will help provide customers who participate in the trial with more information on how much water they use and how they can reduce any wastage. The information collected by the Company from the trial can also be shared with other customers.

7.7.3.8 *Resilience*

The resilience offered by the preferred plan is not markedly different to that offered by the least-cost plan, as there are no differences in the key options which contribute to system resilience. As described in section 7.7.2.8, the least-cost plan already improves the resilience of Portsmouth Water's water resources, so the preferred plan can also be considered to do so. It should be noted that the surplus afforded by the preferred plan is, on average, slightly greater than that of the least-cost plan, at 11.2 Ml/d across the planning period, ranging from a minimum of 4.9 Ml/d (in 2020/21) to a maximum of 14.2 Ml/d (in 2041/42).

8 Testing the Plan

8.1 Introduction

In this section, the Company explains the way in which it has tested its preferred plan. A series of different sensitivity scenarios have been developed that represent the main areas of uncertainty concerning risk to supply and demand.

8.2 Methodology

The Company has looked at many different sensitivity scenarios on the preferred plan, which is based on a 1 in 200-year event, to consider how robust the Water Resources Management Plan is. The Company will use the WRMP to make decisions and plan for the future so it is important to ensure the plan is sufficiently robust to allow for minor changes to supply and demand forecasts in the near future and moderate changes as the plan progresses. The Company intends to use the WRMP annual review process to take account of further evidence likely to become available from important studies in the coming few years.

To undertake the sensitivity testing, the Company has varied supply and demand inputs within the WRMP Tables to investigate the effect on the supply-demand balance. The different sensitivity scenarios are shown in Table 61 and are described in the sections below.

Supply Demand Component	Scenario Number	Scenario Description
Demand	D1	Low population and property forecast
	D2	High population and property forecast
	D3	Less benefit from water efficiency
	D4	Less benefit from drought measures
	D5	Compulsory metering
Supply	S1	Further bulk supplies not required
	S2	Option RO13 not developed
	S3	Option RO22a not developed
	S4	Tighter flow standards on the River Itchen
	S5	Sustainability reductions in DO
	S6	Source S Drought Permit not utilised

Table 61 Feasible metering options

8.2.1 D1 - Low Population and Property Forecast

There is uncertainty associated with future population and property growth. As part of the Demand Forecasting in the South East (DFSE) club project (see section 5.2.3), Experian gave a range of scenarios (trend based, plan based, econometric and most-likely/hybrid forecast). The Company used a trend-based scenario in the Draft WRMP19, however plan-based figures have been used for the Final WRMP19, following consultation comments from the Environment Agency.

The plan-based figures used for the Final WRMP19 show the expected growth if local authorities are able to deliver the dwelling targets set out in their plans. As Experian explain (see Appendix G), the plans will have been informed by growth projections but the timing of when the plans were produced, will, together with many other factors, affect the scale of planned growth. Furthermore, the targets set out in local plans are statements of intent and whilst the local authority has a responsibility to find enough sites to accommodate planned growth in the short-term, ultimately developers will decide whether it is profitable to develop on those sites at a given time. For these reasons, plan- based figures may be more ambitious, particularly in the short-term. Experian note that there are a number of districts in the South

East with planned housing provision in excess of the most recent trend-based forecasts and recent delivery targets.

The plan-based population and property figures used for the Final WRMP19 provide the highest population and property forecasts out of the alternative forecasts considered by Experian. Additionally, there is uncertainty present in all forecasts of population, property and occupancy.

This sensitivity scenario considers the effect of a lower than predicted population and property growth scenario. It uses the results from uncertainty analysis undertaken by Experian, reported in Appendix G. The lower bounds from the 90% confidence interval have been used. Although there is uncertainty, Experian are 90% confident that the actual growth scenario will be between the upper and lower bound forecast values. Using the lower bounds from the 90% confidence interval for the sensitivity test therefore gives a realistic lower forecast value on which to test the plan.

8.2.2 D2 - High Population and Property Forecast

This scenario also considers uncertainty in future population and property growth, but this time considers the effect of a higher than predicted estimate. The sensitivity scenario uses the upper bounds from the 90% confidence interval calculated by Experian.

As noted in the previous scenario, there is uncertainty is present in all forecasts of population, property and occupancy. Although the plan-based figures used for the Final WRMP19 provide the highest population and property forecasts out of the alternative forecasts considered by Experian, the uncertainty analysis gives an upper bound forecast. Experian are 90% confident that the actual growth scenario will be between the upper and lower bound forecast values. Using the upper bounds from the 90% confidence interval for the sensitivity test therefore gives a realistic upper forecast value on which to test the plan.

8.2.3 D3- Less Benefit from Water Efficiency

The preferred plan contains a number of customer side options to deliver demand savings. Water efficiency savings do not have a fixed yield, year on year. The demand savings rely on customer uptake and changes in customer behaviour and therefore the volumetric savings are associated with a degree of uncertainty. This scenario considers what would happen if the planned demand savings from water efficiency did not fully materialise. A 30% reduction has been considered.

Although the demand savings have been carefully estimated based on best available information, there is inherent uncertainty associated with uptake and change in customer behaviour. Whilst the water efficiency savings included are believed to be achievable and supported by further Defra initiatives such as product labelling, the water efficiency programmes are by their nature ambitious and the assumption is that there is a greater likelihood of not achieving the water efficiency targets than of achieving more than planned. The yield savings from the water efficiency options are relatively small in comparison to those achieved by other options in the preferred final plan (shown later in this document in Figure 44). A 30% reduction in planned water efficiency benefits has been selected as a sensitivity test to give an indication of the likely impact if the water efficiency targets were not fully met.

8.2.4 D4 - Less Benefit from Drought Measures

The Company's WRMP19 is based on a 1 in 200-year drought. In a 1 in 200-year severe drought, drought measures would be expected to be in place. The Company has never had to enforce any drought measures and therefore has no data on which to base demand savings. Savings have been assumed based on experiences of other companies in the region and the benefit achieved is therefore subject to considerable uncertainty. This scenario assumes a 50% reduction in the assumed demand savings.

A 50% reduction in the assumed demand savings from drought measures has been selected as a sensitivity test to give an indication of the likely impact if the demand savings were substantially less than expected. This high value reflects the uncertainty in benefit likely to be achieved and is considered to provide a useful sensitivity test in the event that the benefit from drought measures has been overestimated.

8.2.5 D5 - Compulsory Metering

Portsmouth Water operates in an area classified by the Environment Agency as under moderate (rather than severe) water stress. As such it is unable by law to compulsory meter its customers. For this scenario, it is assumed that a change in legislation would occur in the next few years, enabling compulsory metering to be introduced in 2025, at the start of the next AMP period.

This sensitivity test has been selected to provide an indication of the likely demand saving benefit from compulsory metering if legislation were to change. It is assumed that legislation will change in the near future and therefore this is considered a likely scenario.

8.2.6 S1 - Further Bulk Supplies Not Required

Portsmouth Water has currently committed to a bulk supply of 30 Ml/d to Southern Water from 2018/2019. Further increases in bulk supplies (in 2024/25 and in 2029/30) have been requested by Southern Water and these are included within the Company's baseline supply forecast for WRMP19 (see section 4.7). This scenario investigates the effect of applying a cap of 30 Ml/d on the bulk supplies, in the event that further bulk supplies were not required by Southern Water.

This sensitivity test has been selected to provide an indication of the likely effect on the Company's supply-demand balance in the event that Southern Water developed an alternative option and no longer required a bulk supply from Portsmouth Water. This scenario is considered unlikely as both transfers have been agreed with Southern Water. The sensitivity test has nevertheless been included for illustrative purposes.

8.2.7 S2 - Option RO13 Not Developed

Portsmouth Water's plan includes development of Option RO13 which is planned to come online in 2029/30. The reservoir is required to provide a continued supply of water to Portsmouth Water customers, as a replacement for the existing Source A which will be used to provide the Bulk Transfer to Southern Water.

This scenario investigates the effect of not developing Option RO13.

This sensitivity test has been selected to provide an indication of the likely effect on the Company's supply-demand balance if the largest of the Company's planned resource options was not developed. This scenario is considered highly unlikely as the development of Option RO13 is central to the Company's WRMP in order to meet the bulk supply requirements of Southern Water.

8.2.8 S3 - Option RO22a Not Developed

Portsmouth Water's plan includes maximising the DO of Source J within existing licence limits by construction of a satellite borehole. The estimated yield benefit is 12.5 Ml/d.

Although Source J is not included in WINEP3, the Environment Agency have expressed some concerns regarding sustainability (see section 4.3.4). As part of the application process for a licence variation, the Company will need to undertake an assessment of any potential environmental impacts. Option RO22a is a key part of the Company's plan. Source J is of strategic importance for resilience within the Company's network. This scenario investigates the effect of not developing Source J, to account for concern over potential sustainability impacts.

8.2.9 S4 - Tighter Flow Standards on the River Itchen

As described in section 4.3.3, the Environment Agency has asked Portsmouth Water to investigate the impact of tighter flow standards on the River Itchen. The Environment Agency have indicated that the MRF may increase from 194 Ml/d to 224 Ml/d at the tidal limit and this is to be the subject of considerable further study in the next 2-years under the agreed WINEP3. The Company believe that the impact will have the most effect on Southern Water's SRN Source A abstraction which lies upstream from both the Chickenhall WWTW discharge and Portsmouth Water's abstraction at Source A.

The Company's Final WRMP19 is based on the 1 in 200 Design Drought Scenario. Under these severe drought conditions, the Company has assumed that its Source A can yield 20 Ml/d.

The Company has met with Southern Water and discussed the approach on uncertain sustainability reductions on the River Itchen. It is understood that Southern Water now have a sensitivity scenario in their rdWRMP19 to assess the impact of a potential MRF increase to 224 Ml/d at the tidal limit. Both companies therefore consider the impact of tighter flow standards on the River Itchen in the same way within their scenario testing. This scenario investigates the effect from a 20 Ml/d reduction in flow at Source A. This assumes the worst-case scenario i.e. that no water is available for abstraction from Source A. This scenario is considered extremely unlikely as the Company considers that even under the lowest flow conditions, Portsmouth Water should be able to abstract 20 Ml/d at Source A as it lies downstream of the Chickenhall WWTW discharge. Although considered extremely unlikely, the sensitivity test has nevertheless been included for illustrative purposes.

8.2.10 S5 - Sustainability Reductions in DO

The Company has identified with the Environment Agency the potential for sustainability reductions which have not yet been quantified (see section 4.3). To reflect the uncertainty and take account of the potential impact of possible future sustainability changes on deployable output, the deployable output has been reduced by an overall 10%. This equates to a total volumetric reduction of 19 Ml/d.

The 10% reduction in DO selected for the sensitivity scenarios is an estimate as the potential sustainability reductions have not yet been quantified. The Company considers that this is a realistic volume for a sensitivity scenario of potential combined sustainability reductions given the Environment Agency concerns associated with Source F, Source J and Source A. It should be noted that sensitivity runs S3 and S4 already consider worst case scenarios for Source J and Source A, respectively.

It is understood that Southern Water now have a sensitivity scenario in their rdWRMP19 to assess the impact of WINEP3 sustainability reductions on the River Itchen on their own abstraction sources.

8.2.11 S6 - Source S Drought Permit Not Utilised

The Company's WRMP19 is based on a 1 in 200-year drought. In a 1 in 200-year severe drought, the Company would be able to apply for a drought permit at Source S. This would allow more water to be abstracted from the QRST Group of licences. The Environment Agency and Natural England have expressed some concern around sustainability of this option and it would only be introduced as and when required under the Drought Directions. This scenario investigates the effect if the drought permit were not available.

8.3 Results from Sensitivity Scenarios

The results from the sensitivity scenario testing are shown in Table 62 and Table 63 below. Table 62 presents the absolute change to the supply-demand balance from each scenario, whilst Table 63 presents the resulting effect on the supply-demand balance.

	Scenario Number	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026	2026-2027	2027-2028	2028-2029	2029-2030	2030-2031	2031-2032	2032-2033	2033-2034	2034-2035	2035-2036	2036-2037	2037-2038	2038-2039	2039-2040	2040-2041	2041-2042	2042-2043	2043-2044	2044-2045
FP SDB (Ml/d)		3.1	4.8	6.3	7.3	12.7	13.7	13.8	14.1	14.1	15.8	16.9	16.8	16.8	16.8	17.0	17.9	17.4	17.4	17.4	17.4	18.1	18.1	18.0	17.9	17.8
Change (+/- Ml/d)	D1	2.4	3.3	3.9	4.4	5.1	5.3	5.6	5.8	5.9	6.1	6.2	6.3	6.5	6.7	6.8	7.4	7.2	7.4	7.3	7.3	7.2	7.2	7.1	7.1	6.9
	D2	-1.2	-1.0	-1.2	-1.8	-2.2	-2.4	-3.0	-3.5	-4.2	-4.7	-4.5	-5.7	-6.2	-6.9	-7.1	-7.6	-9.2	-9.6	-9.9	-10.1	-10.3	-10.5	-10.8	-11.0	-11.3
	D3	-0.2	-0.4	-0.5	-0.7	-1	-1	-1	-1	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-0.8
	D4	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2
	D5	0	0	0	0	0	6.26	5.68	5.14	4.62	4.16	3.72	3.31	2.92	2.58	2.26	1.93	1.65	1.38	1.15	0.91	0.71	0.5	0.32	0.17	0
	S1	0.0	0.0	0.0	0.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	S2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0
	S3	0.0	0.0	0.0	0.0	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5
	S4	0.0	0.0	0.0	0.0	0.0	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20
	S5	0.0	0.0	0.0	0.0	0.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0
	S6	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5

Table 62 Sensitivity Scenario Results – absolute change

	Scenario Number	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026	2026-2027	2027-2028	2028-2029	2029-2030	2030-2031	2031-2032	2032-2033	2033-2034	2034-2035	2035-2036	2036-2037	2037-2038	2038-2039	2039-2040	2040-2041	2041-2042	2042-2043	2043-2044	2044-2045
FP SDB (Ml/d)		3.1	4.8	6.3	7.3	12.7	13.7	13.8	14.1	14.1	15.8	16.9	16.8	16.8	16.8	17	17.9	17.4	17.4	17.4	17.4	18.1	18.1	18	17.9	17.8
Scenario SDB (Ml/d)	D1	5	8	10	12	18	19	19	20	20	22	23	23	23	23	24	25	25	25	25	25	25	25	25	25	25
	D2	2	4	5	6	11	11	11	11	10	11	12	11	11	10	10	10	8	8	7	7	8	8	7	7	7
	D3	3	4	6	7	12	13	13	13	13	15	16	16	16	16	16	17	17	16	16	17	17	17	17	17	17
	D4	-5	-3	-2	-1	4	6	6	6	6	8	9	9	9	9	9	10	9	9	9	9	10	10	10	10	10
	D5	3	5	6	7	13	20	20	19	19	20	21	20	20	19	19	20	19	19	19	18	19	19	18	18	18
	S1	3	5	6	7	22	23	23	23	23	25	26	26	26	26	26	27	26	26	26	26	27	27	27	27	27
	S2	3	5	6	7	13	14	14	14	14	-7	-6	-6	-6	-6	-6	-5	-6	-6	-6	-6	-5	-5	-5	-5	-5
	S3	3	5	6	7	0	1	1	2	2	3	4	4	4	4	5	5	5	5	5	5	6	6	5	5	5
	S4	3	5	6	7	13	-6	-6	-6	-6	-4	-3	-3	-3	-3	-3	-2	-3	-3	-3	-3	-2	-2	-2	-2	-2
	S5	3	5	6	7	13	-5	-5	-5	-5	-3	-2	-2	-2	-2	-2	-1	-2	-2	-2	-2	-1	-1	-1	-1	-1
	S6	-5	-4	-2	-1	4	5	5	6	6	7	8	8	8	8	9	9	9	9	9	9	10	10	9	9	9

Table 63 Sensitivity Scenario Results – effect on SDB balance

8.4 Interpretation of Sensitivity Scenario Results

8.4.1 Population and Property Forecasts

The results from sensitivity scenarios D1 and D2 suggest that although there is uncertainty associated with future population and property growth, the preferred plan appears to be fairly robust to changes in forecast as the supply-demand balance remains in surplus for both the lower and higher sensitivity runs. As the plan-based population and property figures used for the Final WRMP19 provide the highest population and property forecasts out of the alternative forecasts considered by Experian, it is considered likely that the future population and property growth might be lower than forecast, however, there is uncertainty present in all forecasts. Using the Experian upper and lower bound forecast values within the sensitivity analysis provides confidence in the preferred plan as it appears to be fairly robust within the range of variation which could potentially be encountered. The Company will manage the risks from variations in forecast population and property growth on its supply-demand balance through monitoring change and reporting in its Annual Review. Through this mechanism, any departure from forecast trends will be identified early, enabling the Company to review its supply-demand balance, identify any actions which might be required and to discuss these with the Environment Agency.

8.4.2 Water Efficiency Savings

Scenario D3 shows that whilst the 30% reduction in benefits from water efficiency options reduces the volume of water available through the planning period, this does not have a large impact on the supply-demand balance, which remains in surplus throughout. This indicates that whilst water efficiency options are an important part of the preferred plan, they are not sufficient to solve the supply-demand balance in isolation and are required to form a balanced solution, in conjunction with other options. As benefits delivered are strongly reliant on customer uptake and changes in customer behaviour, the fact that the preferred plan is not overly dependent on water efficiency options, helps provide confidence that the supply demand deficit can be met. The Company will monitor the benefits delivered from water efficiency options and report on this within its Annual Review. This will enable any shortfalls to be identified and allow the Company to consider if any actions can be taken to encourage further customer uptake.

8.4.3 Demand Savings from Drought Measures

The results for scenario D4 show that if demand savings from drought measures are 50% less than assumed in the plan, there would be a shortfall in the supply-demand balance during AMP7. This shows a heavy reliance on drought restrictions. As the plan is based on a design drought scenario of 1 in 200 years and represents a severe drought, this is to be expected. The shortfall in the supply-demand balance in the early years under this scenario emphasises the need for the Company's resource side options to be in place to reduce uncertainties in the yield available from drought restrictions. It should be noted that the Company has never had to enforce any drought measures and therefore has no data on which to base demand savings which is why there is so much uncertainty in the benefit likely to be achieved.

8.4.4 Compulsory Metering

Scenario D5 indicates that introducing compulsory metering in 2025 could have a large benefit in reducing demand. This sensitivity test has been selected to provide an indication of the likely demand saving benefit from compulsory metering if legislation were to change. The scenario assumes the largest saving occurs at the start of the programme when compulsory metering is (theoretically) introduced throughout the Portsmouth Water supply area and reduces over time. Under such a scenario, the supply-demand balance would be surplus throughout the planning horizon. Under this scenario, some of the Company's preferred options would potentially not be required, however a change in legislation would be required

before such a benefit could be realised, and therefore it does not change the preferred plan. It is considered likely that legislation could change in the near future. Such a change would be taken into account in the 5 -year WRMP cycle (depending on when legislation were to change, it would most likely be addressed in the preparation of the next WRMP due).

8.4.5 Capped Bulk Supply Volume

The results from scenario S1 indicates that if the bulk supply volume was capped at 30 Ml/d, the supply-demand balance would have additional surplus from 2024-25. This is to be expected as the Company would need to supply less water in total. As noted in section 8.2.6, further increases in bulk supplies (in 2024/25 and in 2029/30) have been requested by Southern Water and these are included within the Company's baseline supply forecast for WRMP19. As both transfers have been agreed with Southern Water, it is considered unlikely that Southern Water would no longer require these. In the unlikely situation that this did occur, the Company would need to review and update its WRMP.

8.4.6 Non-Development of Water Resource Schemes

Scenario S2 shows that if Option RO13 were not developed, there would be a significant supply demand deficit from 2029. The reservoir is required to provide a continued supply of water to Portsmouth Water customers, as a replacement for the existing Source A which will be used to provide the Bulk Transfer to Southern Water. The scenario in which Option RO13 is not developed, is considered unlikely as Southern Water require the bulk supply. The reservoir development is being progressed; a Principal Design Engineer has been appointed and the Company are in process of discussing terms with Southern Water.

The results for Scenario S3 indicate that if option RO22a were not developed, could only just meet its supply-demand balance. The sensitivity results illustrate that the Company is reliant on Option RO22a, to provide resilience to the plan. It would be needed, if for example, any of the currently unquantified sustainability reductions came into effect. The Company considers that further reliance on customer side options would not provide sufficient resilience to the plan as a whole.

The Company has committed to provide a bulk supply to Southern Water, subject to the yield at options RO22a and RO13. The Company would make best use of all available options in the event that option RO22a were not developed (e.g. due to Environment Agency sustainability actions), however in this scenario, it may not be able to meet its bulk supply commitments to Southern Water in full. Portsmouth Water and Southern Water have met to discuss this scenario, and Southern Water are aware that the risk sits with them. Southern Water have a scenario within their WRMP which considers alternative options, in the event that Portsmouth Water's Option RO22a were not developed. Further detail regarding the monitoring of risks in the delivery of the preferred plan is provided in section 10.2.

8.4.7 Sustainability Reductions

Scenario S4 shows that if the tighter flow standards resulted in no water being available at Source A, this would result in a substantial supply-demand deficit from 2025-26. As discussed in section 8.2.9, this scenario assumes the worst-case scenario i.e. a 20 Ml/d reduction in flow at Source A, such that no water is available for abstraction from this source. This scenario is considered extremely unlikely as the Company considers that even under the lowest flow conditions, Portsmouth Water should be able to abstract 20 Ml/d at Source A as it lies downstream of the Chickenhall WWTW discharge.

The Company does not have additional options available that would help meet this deficit and therefore in the event that this unlikely scenario occurred, it would be unable to meet its bulk supply commitments to Southern Water in full. The Company has met with Southern Water and discussed the approach on uncertain sustainability reductions on the River Itchen and

Southern Water are aware of the results of this sensitivity test. Further detail regarding the monitoring of risks in the delivery of the preferred plan is provided in section 10.2. The results from Scenario S5 are similar to S4 as the two scenarios consider similar volume reductions. Scenario S5 considers the potential impact of sustainability changes on deployable output by assuming a 10% reduction in DO (equivalent to 19 Ml/d). The 10% reduction in DO selected for the sensitivity scenarios is an estimate as the potential sustainability reductions have not yet been quantified. The Company considers that this is a realistic volume for a sensitivity scenario of potential combined sustainability reductions given the Environment Agency concerns associated with Source F, Source J and Source A (see section 4.3).

At Source F, the Environment Agency have asked for an investigation and options appraisal with a completion date of March 2022. The current ADO is 6.5 Ml/d; the sustainability reductions have not yet been quantified.

Source J is not on the latest WINEP3 spreadsheet of water resource investigation; however, the Company will need to undertake an assessment of any potential environmental impacts as part of the licence variation application process for Option RO22a. The planned increase in ADO is 12.5 Ml/d.

At Source A, the Environment Agency have asked the Company to undertake a joint investigation with Southern Water and South East Water with a completion date of March 2022. This investigation is to determine the costs, impacts and technical feasibility of reaching or maintaining revised CSMG flow targets for the River Itchen SAC. There is also a linked biodiversity investigation. The Company is committed to ongoing work and collaboration with Southern Water on the River Itchen and to identifying appropriate solutions.

It should be noted that sensitivity runs S3 and S4 already consider worst case scenarios for Source J and Source A, respectively. Sensitivity scenario S5 considers a 10% reduction in DO (19 Ml/d) to account for potential combined sustainability reductions across several sources. Scenario S5 indicates that a 10% reduction in DO would result in a substantial supply-demand deficit from 2025-26. If such a situation were to arise, the Company would be unable to meet its bulk supply commitments to Southern Water in full. The Company has met with Southern Water and discussed the approach on uncertain sustainability reductions, particularly on the River Itchen. Southern Water are aware of the results of Portsmouth Water's sensitivity tests. Further detail regarding the monitoring of risks in the delivery of the preferred plan is provided in section 10.2 xxx.

8.4.8 Source S Drought Permit

Scenario S6 considers what would happen if the Source S Drought Permit were not available. The Environment Agency and Natural England have expressed some concern around sustainability of this option and it would only be introduced as and when required under the Drought Directions. The results of the sensitivity scenario indicate that this could result in a supply-demand deficit in the first four years of AMP7. After 2024-25 however, there would be a surplus in the supply-demand balance, even without this option. This indicates that whilst the drought permit is needed in the short term, once other options within the preferred plan have been developed, there is potential not to rely on the drought permit. This is beneficial as the Environment Agency and Natural England have expressed some concerns regarding the Source S Drought Permit and the Company would like to avoid the requirement for using the drought permit wherever possible.

8.5 Conclusions

The sensitivity scenario testing has indicated that whilst there is a range of uncertainty in the supply-demand forecast, the preferred plan appears to be robust with respect to changes in population and property forecasts and uncertainty in demand benefits from water efficiency savings.

The Company believes that its approach to metering is appropriate in the context of legislative restrictions and the results of customer research (section 3). If permitted, it would prefer to introduce compulsory metering, but that is not currently available as an option.

The scenario testing has emphasised the need for the Company's resource side options to be in place, to reduce uncertainties in the yield available from drought restrictions. The sensitivity testing results have reinforced the fact that many of the options are being driven by the desire for regional resource sharing. The testing illustrates that Option RO13 is a key component of the Company's preferred plan and has been brought in to enable the Company to be able to supply water to its own customers in addition to the bulk supply being offered to Southern Water. Without this option, Southern Water would be required to find alternative supply options that will be significantly more expensive, and thereby offer much poorer value to their customers. As discussed in section 8.4, Portsmouth Water and Southern Water have met to discuss this scenario, and Southern Water are aware that the risk sits with them. Southern Water have a scenario within their WRMP which considers alternative options. Further detail regarding how the Company intends to monitor risks to the delivery of the preferred plan are provided in section 10.2.

The sensitivity results demonstrate the requirement to develop Option RO22a in order to provide flexibility within the Company's distribution system and to provide resilience within the supply-demand balance. It helps address uncertainties regarding future sustainability reductions and reduces reliance on demand savings from metering, water efficiency and leakage which have uncertainty in their yield.

The sensitivity testing shows that the preferred plan is less robust to significant reductions in deployable output. In the event of the worst-case scenario of a loss of output from Source A, or a similar scale reduction in DO arising from a combination of sustainability reductions (from Source A, Source F and potentially Source J), the Company would be unable to meet its bulk supply commitments to Southern Water in full. As discussed in section 8.4, the options for addressing such a scenario are considered in Southern Water's WRMP19. Further detail regarding how the Company intends to monitor risks to the delivery of the preferred plan are provided in section 10.2.

The sensitivity testing has indicated that whilst the Source S drought permit is needed in the short term, once other options within the preferred plan have been developed, there is potential not to rely on the drought permit.

As a result of the sensitivity testing, Company is confident that it has the correct balance of options available to balance supply and demand and manage uncertainties.

9 Final Plan

9.1 Introduction

The Final WRMP sets out Portsmouth Water's approach to maintaining the supply-demand balance in its Company area over the period from 2020/21 to 2044/45. The key components which have been assessed include:

- Licensed source yields and supply capacity;
- Future water demands over the planning period;
- The impact of environmental obligations on sources;
- The potential future impact of climate change; and
- Options available to manage the supply-demand balance.

This section draws together the findings from each of the previous sections and presents the details of the Company's preferred final plan.

9.2 Preferred Final Plan

The Company's preferred final plan is summarised in Table 64 in terms of the options it comprises and their planned start dates. The decision-making process that has been followed has been clearly set out in sections 7.6 and 7.7. The options selected are those which the Company considers most appropriate to adopt over the next twenty-five year planning period to maintain the balance between water supply and demand.

The Company has based its planning on a 1 in 200-year drought event. This is more appropriate for Portsmouth Water than the worst historic drought on record which is not considered severe enough for Water Resources Planning. The company has considered different return periods and calculated the supply-demand balance on each. This analysis has indicated that although the 1 in 200-year scenario represents the most challenging scenario, the 1 in 80-year event actually contains a similar level of supply-demand risk to the 1 in 200-year event. This is due to the Level of Service constraints under the 1 in 80-year scenario (see section 2.4.3). This indicates that the options selected under the preferred plan are required under a range of drought conditions and not just in a 1 in 200 -year drought event.

Planning for the most challenging drought scenario provides future resilience. As the Company has committed to providing a bulk supply to Southern Water with water available up to a 1 in 200-year event, it is appropriate to undertake planning based on this event.

The Company has tested the plan (section 8) to consider main areas of uncertainty concerning risk to supply and demand. The testing has shown the final plan to have resilience to a range of risks, including possible future sustainability changes. The Company believe the plan to be robust to minor changes in supply and demand forecasts in the near future and moderate changes as the plan progresses. The Company's preferred plan has been arrived at through consideration of Company priorities, government policy priorities and the perceived priorities of its customers. The way it helps to meet those objectives can be summarised as follows:

- **Twin-track approach** - the preferred plan has a strong focus on demand management measures (leakage, metering and water efficiency) and demonstrates the Company's commitment to a twin-track approach of resource management and customer- and distribution-side options to balancing supply and demand.
- **Resource sharing** – the baseline supply-demand balance of the preferred plan explicitly assumes the Company will provide bulk supplies to Southern Water. This supports the Government's policy priorities for improved resource sharing, and also takes account of the outcomes of the WRSE modelling work.

- **Resilience to drought** – the options selected in the preferred plan provide supply-demand and DO resilience to a 1 in 200-year drought. The development of Havant Thicket Winter Storage reservoir will also help Portsmouth Water increase resilience, by providing raw water storage.
- **Providing opportunities for environmental improvements** – the preferred plan is integrated with the SEA Environmental Report and as a result performs well against SEA objectives. In addition, it has been identified that environmental improvements can be delivered in many areas through scheme design and catchment management.

Option code	Option name	AMP7 (2020/21-2024/25)	AMP8 (2025/26-2029/30)
CO46	Household water efficiency programme (partnering approach, home visit)	2020–21	
CO46b	Waterwise programme	2020–21	
CO26	Subsidy to customers that purchase water efficient appliances (washing machines and dishwashers, showers and WCs)	2020–21	
RO21a	Source O – Maximising DO	2020–21	
RO23a	Source H – Maximising DO	2020–21	
CO34	Water saving devices – Retrofitting existing toilets	2020–21	
CO06a	Metering on change of occupancy – existing meter pits	2020–21	
DO04a	Fixed network of permanent noise loggers connected to telemetry - Tranche 1	2020–21	
RO24a	Source C – Maximising DO	2020–21	
CO84	Voids metering	2020–21	
CO40	Water saving devices – spray taps	2020–21	
CO43	Water saving devices – trigger nozzles for hoses	2020–21	
CO05	Smart Meter MNFR Trial	2020–21	
CO78	Voluntary restraint and leakage action	2020–21	
CO79	Mandatory restraint	2020–21	
CO80	Imposition of Drought Direction Restrictions (mandatory commercial restraint)	2020–21	
RO68	Source S – Drought Permit	2020–21	
RO22a	Source J – Maximising DO	2024–25	
DO04b	Fixed network of permanent noise loggers connected to telemetry - Tranche 2		2025–26
CO06	Metering on Change of Occupancy - all properties		2025–26
RO13	Havant Thicket Winter Storage Reservoir		2029–30

Table 64 The Preferred Planning Programme

9.2.1 Meeting Planned Levels of Service

The Company's planned levels of service, as set out below, are met by the final plan:

- >1 in 20 years for Hosepipe Bans, representing an annual risk of 5%.
- >1 in 80 years for Non-Essential Use Bans, representing an annual risk of 1.25%.

- >1 in 200 years for Emergency Drought Orders, representing an annual risk of 0.5%.

The plan is based on a 1 in 200-year event, in which all the drought options are implemented. The Company has also considered the supply-demand balance for each of the following drought return periods: worst historic drought on record, 1 in 80, 1 in 125, 1 in 200, 1 in 500. The return periods were based on supply-demand failures (see section 4.2 for further detail) and the levels of service were met in each instance.

The Company is confident that through its testing of different drought scenarios, the planned levels of service can be met. Furthermore, the sensitivity testing carried out has indicated that through time, as other options within the preferred plan are developed, there is potential to be less reliant on securing a drought permit (typically associated with the Drought Orders).

9.2.2 Timing of Supply-Demand Interventions

Many of the options in the preferred plan are implemented early in the planning period. This is largely due to the Company's desire to bring forward demand management measures that help to meet Government policy objectives and customer preferences. The economic and programme appraisal methods used to determine the preferred plan use the earliest available dates to meet the supply-demand deficit.

Whilst the demand management measures are available at the start of the planning period, additional resource schemes are needed to meet the supply demand deficit. Some options (e.g. Havant Thicket Winter Storage Reservoir, RO13, and Source J – Maximising DO, RO22a) are not available at the very start of the planning period due to the commissioning lead-in time that allows for detailed design, planning and construction of the schemes.

The graph in Figure 41 below shows the final planning supply-demand balance with all options in the preferred plan being implemented according to when they are a) available, and b) required to balance supply and demand and/or align with Government policy and customer preferences (as set out in Table 65). The stacked area portion of the graph shows the total final planning WAFU broken down into its constituent parts (baseline WAFU plus supply-side options), while the baseline demand plus target headroom is represented by the red solid line, with demand-side options being shown to reduce demand (in a cumulative way) over the planning period down to its lowest level demonstrated by the dashed line labelled 'Drought demand restriction options', which includes the effects of all the preferred plan demand management measures.

Overall, the graph demonstrates that the timing of implementation of the options in the preferred plan allows the supply-demand deficit to be met (i.e. total WAFU to be greater than or equal to demand plus target headroom) throughout the planning period.

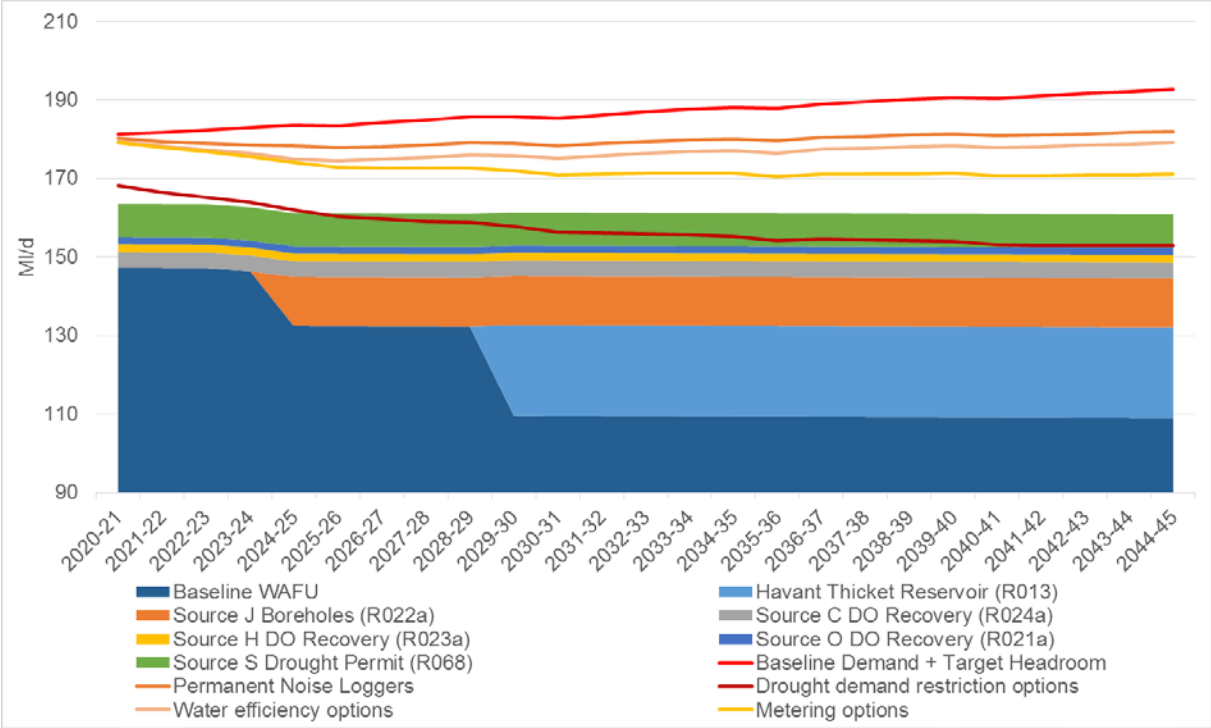


Figure 41 Supply-Demand Balance Showing Timings of Preferred Plan Interventions

9.3 Final Planning Supply-Demand Balance

The supply-demand balance including the influence of the preferred final plan options is presented in the following sub-sections for the DYAA and DYCP scenarios respectively.

The Company has selected options that will balance supply and demand over the planning period during a 1 in 200-year design drought. The options selected and their timely introduction to meet sequential changes in the supply-demand balance should, as discussed in section 8.2, enable the Company to continue meeting its planned levels of service to customers throughout the planning period.

9.3.1 Dry Year Annual Average: Final Planning Supply-Demand Balance

Table 65 presents the final planning supply-demand balance for the 1 in 200-year design drought under dry year annual average conditions. It is represented as five-yearly time steps.

	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Distribution Input	175.3	178.0	179.9	181.5	183.3	185.1
Demand Management	20.7	32.0	36.4	40.2	43.4	46.0
Deployable Output	190.7	190.7	190.7	190.7	190.7	190.7
Resource Schemes	16.3	28.8	51.8	51.8	51.8	51.8
Process Losses	2.4	2.4	2.4	2.4	2.4	2.4
Climate Change	0.0	0.2	0.4	0.6	0.8	1.0
Outage	13.1	13.5	14.6	14.6	14.6	14.6
WAFU	191.6	203.4	225.1	224.9	224.7	224.5

	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Bulk Supplies	22.5	39.0	60.0	60.0	60.0	60.0
Total WAFU	169.1	164.4	165.1	164.9	164.7	164.5
Target Headroom	5.3	5.6	5.8	6.6	7.4	7.6
Available Headroom	14.4	18.4	21.6	23.6	24.7	25.4
Supply Demand Balance	9.1	12.8	15.8	17.0	17.4	17.8

Table 65 Final Planning Supply-Demand Balance – Dry Year Annual Average

Table 65 shows that implementation of the preferred plan results in a small, but increasing surplus in resource over the planning period.

The surplus is based on the maximum capacity of the options, whereas in reality, Portsmouth Water would only utilise its sources to the extent they are required in any given year and/or drought scenario, with reductions in opex being achieved when schemes are not utilised to their maximum capacities. In particular, drought options would only be implemented when required.

The surplus is largely generated as a result of the economic and programme appraisal methods which have been utilised to ensure that the smaller demand management measures are included. In addition, the preferred plan includes a number of options which enable the Company to meet Government policy objectives (for example, the 20% reduction in leakage during AMP7, continued ambition to reduce leakage throughout the remainder of the planning period, measures to drive down PCC and ensuring a twin-track approach to balancing supply and demand), and to meet the preferences of its customers. These options have been included in the preferred plan because the Company considers them to be a key part of its future strategy and helps to demonstrate that the Company is 'doing the right thing' by regulators and its customers. In practice, the demand management measures cannot fully balance supply and demand and resource schemes are required in addition.

The surplus generated helps to provide resilience to a range of risks. This was demonstrated in the sensitivity scenarios (section 8). It is recognised that there are uncertainties associated with maximising DO at Source J (option RO22a), the yield savings associated with water efficiency and metering options and the Source S Drought Permit (option RO68). Having a small surplus enables the plan to be robust to minor changes in supply and demand forecasts. Furthermore, the availability of a supply-demand surplus under the 1 in 200-year drought scenario means that the Source S Drought Permit, may only be required at the start of the planning period, with dependence on it then decreasing over time. This is beneficial as the Environment Agency and Natural England have expressed concerns regarding the drought permit and potential environmental impacts.

The supply-demand balance is represented graphically in Figure 42. As with the baseline supply-demand balance graph (Figure 37), the graph includes a representation of the components of total demand.

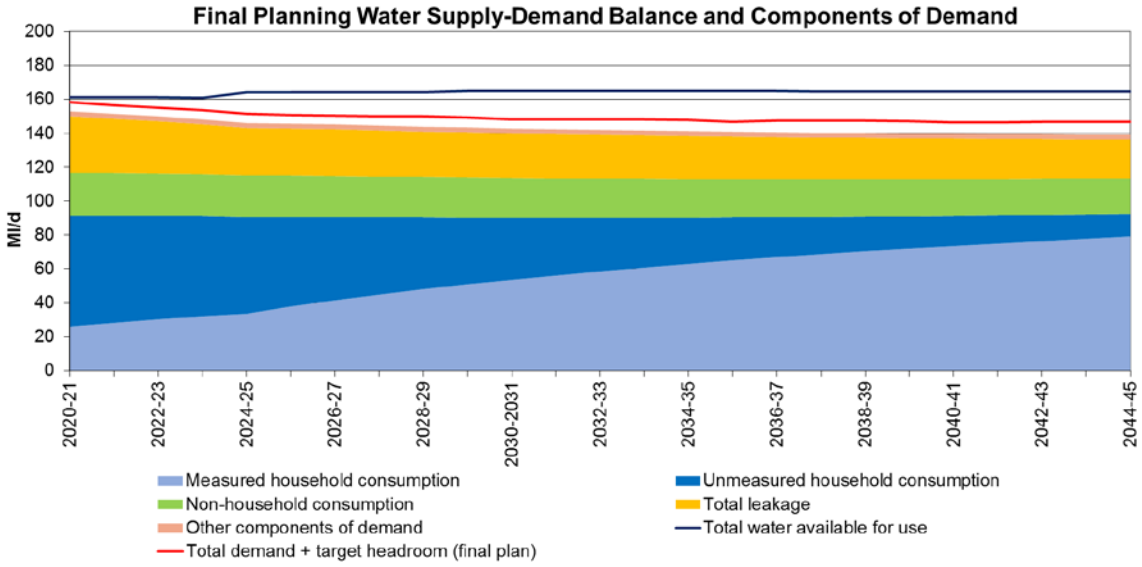


Figure 42 Final Planning Supply-Demand Balance Graph - Annual Average

It can be seen from Figure 42 that the reduction over time in total demand plus target headroom is due to a combination of reducing total leakage and reducing household consumption, the latter of which is due to optant and change of occupier metering resulting in a large proportion of the Company's customer base switching from higher unmeasured to lower measured consumption patterns and the implementation of water efficiency schemes.

9.3.2 Dry Year Critical Period: Final Planning Supply-Demand Balance

Table 66 presents the final planning supply-demand balance for the 1 in 200 year design drought under dry year critical period (peak week) conditions. It is represented as five-yearly time steps. The supply-demand balance is represented graphically in Figure 43.

	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Distribution Input	175.1	166.3	163.0	160.4	158.8	157.9
Demand Management	43.2	52.6	59.1	63.8	67.5	70.6
Deployable Output	251.7	266.2	315.7	315.2	314.7	314.2
Resource Schemes	8.5	16.3	31.3	81.3	81.3	81.3
Process Losses	2.4	2.4	2.4	2.4	2.4	2.4
Climate Change	4.9	5.0	5.1	5.2	5.2	4.8
Outage	12.5	12.6	15.4	15.4	15.4	15.4
WAFU	236.8	251.2	297.9	297.4	296.9	296.4
Bulk Supplies	22.5	39.0	60.0	60.0	60.0	60.0
Total WAFU	214.3	212.2	237.9	237.4	236.9	236.4
Target Headroom	7.1	7.7	8.6	9.4	10.3	10.7
Available Headroom	39.2	45.9	74.9	77.1	78.1	78.5
Supply Demand Balance	**32.2**	**38.3**	**66.3**	**67.7**	**67.8**	**67.8**

Table 66 Final Planning Supply Demand Balance – Dry Year Critical Period

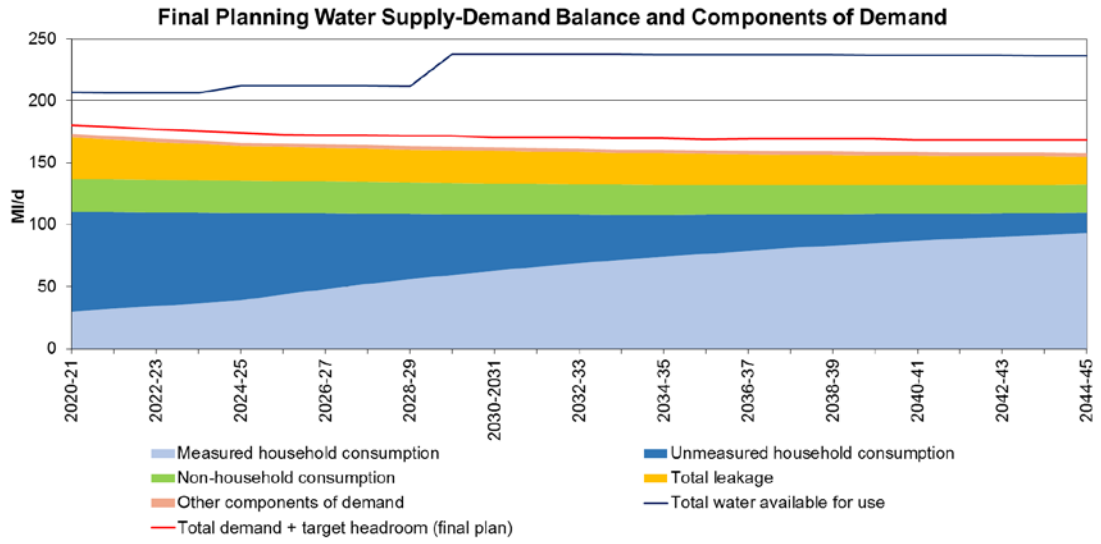


Figure 43 Final Planning Supply-Demand Balance Graph - Critical Period

As with the annual average scenario, the supply-demand balance is in surplus throughout the planning period. The Company has provided an explanation as to why this occurs, and why it considers this to be acceptable in section 8.3.1.

The surplus shown under the critical period scenario is greater than that shown under the annual average scenario. This simply reflects that the difference between PDO and ADO for the supply-side interventions is greater than the difference between the forecast demand in the annual average and critical period scenarios.

Figure 43 shows similar trends to those observed under the annual average scenario. Demand reduces over the planning period primarily due to falling total leakage and falling household consumption, attributable to metering and water efficiency options. Further details of the components of the preferred final plan are provided in section 9.4 below.

9.4 Components of the Final Plan

The final plan is comprised of customer side options, distribution side options and resource options. Details of these options and their role in balancing supply and demand as part of the final plan are set out in the following sub-sections. The demand savings achieved by the demand management (customer side and distribution side) options are presented in Figure 44, while the additional DO provided by the resource options proposed as part of the final plan is demonstrated in Figure 45.

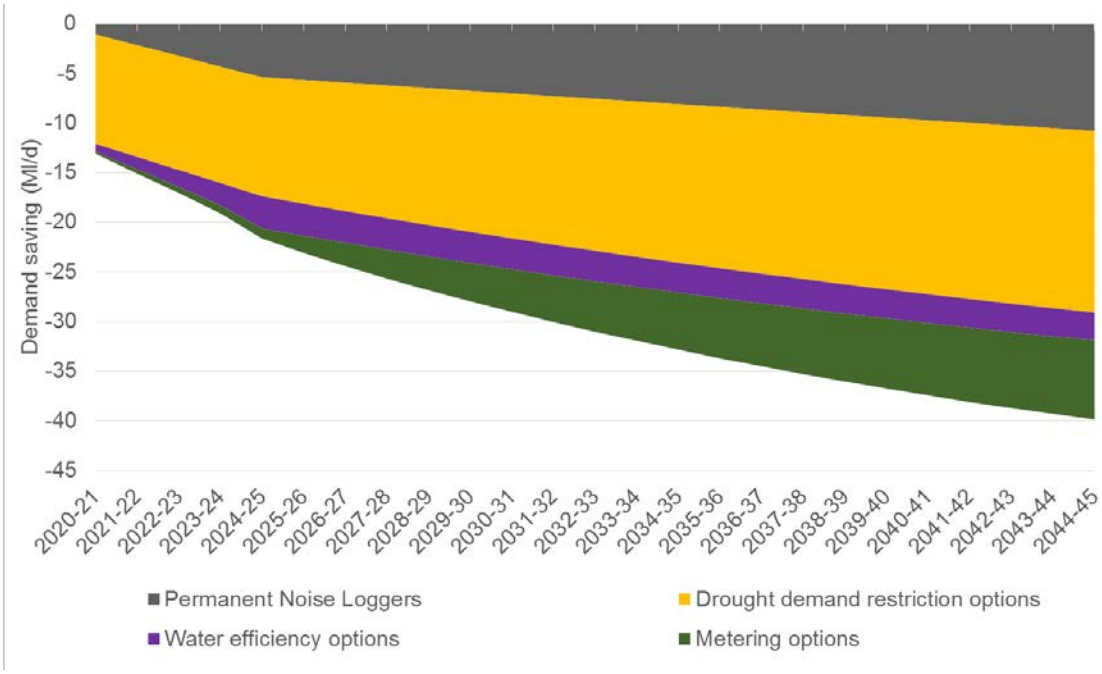


Figure 44 Demand Management (Customer Side and Distribution Side) Option Savings over the Planning Period

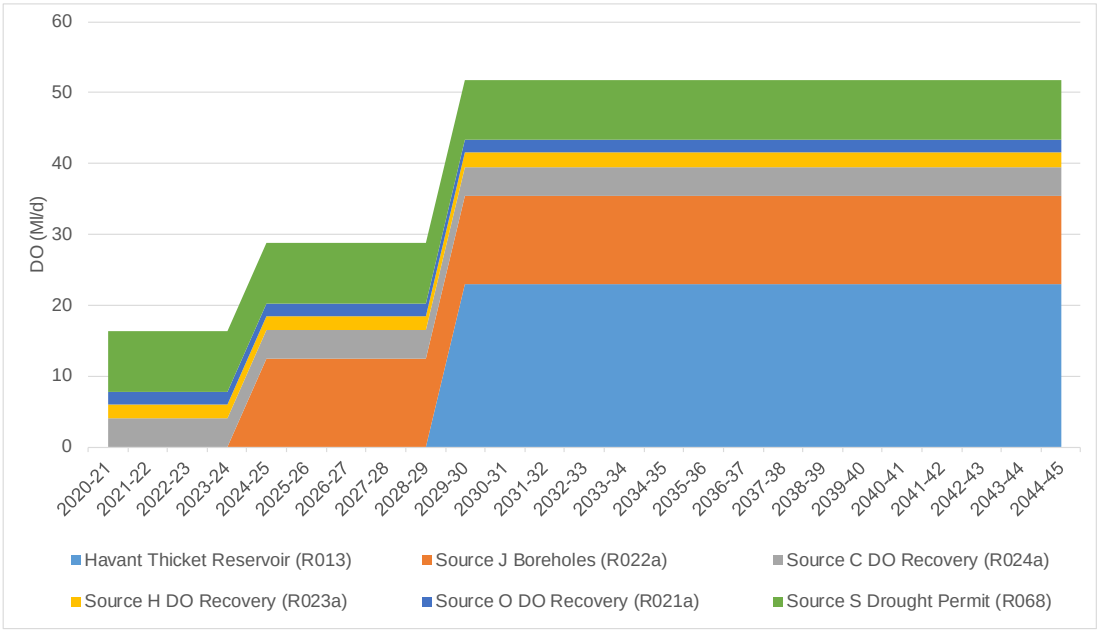


Figure 45 Resource Option Yields over the Planning Period

9.4.1 Customer Side Options

9.4.1.1 Water efficiency options

The Company's preferred final plan includes six water efficiency options. Responses to the online survey demonstrated that 94% of customers agreed that it is important that Portsmouth Water help them to use water efficiently (see section 3). The water efficiency options selected as part of the preferred final plan all commence in 2020/21, and comprise the following:

- CO46 Household water efficiency programme (partnering approach, home visit);
- CO46b Waterwise programme;
- CO26 Subsidy to customers that purchase water efficient appliances (washing machines and dishwashers, showers and WCs);
- CO34 Water saving devices – Retrofitting existing toilets;
- CO40 Water saving devices – spray taps; and
- CO43 Water saving devices – trigger nozzles for hoses.

Table 67 below presents the total yield savings for each option achieved by 2044/45, and the average annual yield savings over the planning period, after taking into account uptake and time decay calculations. These have been calculated through summation of the annual yield savings. A yearly profile of savings is shown within the WRMP Tables which are published alongside this Final WRMP.

Option code	Option name	Total yield savings by 2044/45 (Ml)	Average annual yield savings (Ml/d)
CO46a	Household water efficiency programme (partnering approach, home visit)	25.8	1.0
CO46b	Waterwise programme	32.1	1.3
CO26	Subsidy to customers that purchase water efficient appliances (washing machines and dishwashers, showers and WCs)	6.4	0.3
CO34	Water saving devices – Retrofitting existing toilets	2.3	0.1
CO40	Water saving devices – spray taps	0.9	0.04
CO43	Water saving devices – trigger nozzles for hoses and water butts	1.3	0.1
Total		**68.8**	**2.8**

Table 67 Volumetric savings from water efficiency by 2044/45

It can be seen from Table 67 that the yield savings from the water efficiency options are relatively small in comparison to those achieved by other options in the preferred final plan (shown later in this section). This is partly due to the proposed scale of the options, but also because water efficiency yield savings are subject to decay over time. Despite the relatively small yield savings, the options are nonetheless considered by the Company to be an important part of its preferred final plan. This is because they will enable the Company to develop avenues through which customer engagement can be progressed, with the aim of promoting behaviour change around water consumption. This supports the twin-track approach to balancing supply and demand advocated in the WRPG and suggested by the WRSE Group project outcomes.

9.4.1.2 Metering options

Table 70 lists the metering options that are included in the preferred final plan and provides details of the total number of households metered under each option, the duration of the metering programme, the total yield savings for each option achieved by 2044/45, and the average annual yield savings over the planning period.

It should be noted that the Company has two phases of Change of Occupier metering CO06a and CO06b. The distinction reflects the fact that the Company will be rolling out its Change of Occupier metering programme in two phases, each of which have different costs. The first phase targets new occupants in specific areas where mains renewal has already taken place and meter pits have been installed. In these locations, new occupants will be required to have a meter. In the WRMP Tables, this option is referred to by the Company as Selective Change of Occupier metering as the instances where meters are installed are 'selected' by Portsmouth

Water. The second phase of Change of Occupier metering, which commences in 2025, will target all instances where there is a change of occupancy i.e. all properties with new occupants will be metered from 2025.

Option code	Option name	Total no. of households metered by 2044/45 (000s)	Programme duration	Total yield savings by 2044/45 (Ml)	Average annual yield savings (Ml/d)
CO06a	Metering on change of occupancy – existing meter pits	14.35	2020/21 to 2024-25	19.3	0.8
CO06b	Metering on Change of Occupancy - all properties	112.61	2025/26 to 2044/45	73.3	2.9
CO84	Voids metering	2.97	2020/21 to 2044/45	5.3	0.2
CO05	Smart Meter MNFR Trial	2.5	2020/21 to 2024-25	15.8	0.6
Total		**261.19**		**113.7**	**4.5**

Table 68 Number of Households Metered Under the Preferred Final Plan and Associated Volumetric Savings

In summary, the Company plans to install 126,960 domestic meters on change of occupancy throughout the planning period, firstly (during AMP7) in existing meter pits and secondly (from 2025/26 onwards) extending it out to cover all household properties. The Company also plans to install meters at almost 3,000 void households. Additionally, it will undertake a trial whereby smart meters are installed at customers properties, but with customers remaining on an unmeasured tariff, unless they wish to switch to a measured tariff (e.g. if the meter data shows that they could make a financial saving by doing so). It is hoped that this innovative trial will demonstrate that installing smart meters can, by raising awareness of consumption, inspire behaviour change to save water. Furthermore, it is hoped that the identification of customers who could save money by being on a measured tariff will gradually encourage more customers to opt to have a meter installed. In addition to these options, the new property metering included in the baseline demand forecast results in 59,820 meters being installed over the planning period, and baseline optant metering assumes 27,920 meters will be installed over the planning period.

The yield savings assumed by the metering options (shown in Table 68) include both those generated from customer behaviour change and also those achieved through reducing underground supply pipe leakage. Upon installing a meter, as mentioned in section 7.3.4.1, a 10l/prop/d saving in underground supply pipe leakage (USPL) is assumed to be achieved at all newly metered properties, except new build properties (which are assumed not to demonstrate supply pipe leakage until later in the planning period). This USPL saving is generated by the meter (an Automated Meter Reading or AMR meter) producing an alarm when it detects continuous flow passing through it over a 24-hour period. This suggests a leak either on the supply pipe or in the customer's property. When the meter is read, the alarm is detected by the Company and steps are taken to notify the customer and for the leak to be fixed.

In combination, the above metering programmes will take the Company's overall level of meter penetration to 45% by the end of AMP7 and to 90% by the end of the planning period. The benefits of providing meters to household customers include enabling customers and the Company to improve their understanding of consumption patterns, with the aim of encouraging

behaviour change through awareness and also through the financial incentives that arise from saving water whilst on a metered tariff.

Table 71 provides a comparative summary showing the cost-effectiveness of domestic metering (this includes baseline metering and options in the preferred final plan).

	Demand saving (m^3/day per meter)	AISC (p/m3)
Meter Optants	58.0	29.18
Selective Metering	19.4	11.29
Full Change of Occupier Metering	41.6	29.18

Table 69 Cost effectiveness of domestic metering

9.4.1.3 *Water Conservation Options*

As set out in section 7.5.2.3, the water conservation options included in the options appraisal and selected as part of the final plan are those which, consistent with the Company's Drought Plan, are likely to need to be utilised during a 1 in 200 year drought.

The three water conservation options selected as part of the final plan are set out below, in the order in which they are utilised:

- CO78 Voluntary restraint and leakage action;
- CO79 Mandatory restraint; and
- CO80 Imposition of Drought Direction Restrictions (mandatory commercial restraint).

Option code	Option name	Average annual yield savings (Ml/d)
CO78	Voluntary restraint and leakage action	4.3
CO79	Mandatory restraint (Temporary Use Bans)	8.3
CO80	Imposition of Drought Direction Restrictions (mandatory commercial restraint, Non-Essential Use Bans)	7.9
Total		**20.5**

Table 70 Volumetric Savings from Water Conservation Options

These options are available to the Company for use throughout the planning period.

9.4.2 Distribution Side Options

As part of its preferred final plan, Portsmouth Water plans to implement the distribution side (leakage management) options as detailed in Table 71.

Option code	Option name	Programme duration	Total yield savings by 2044/45 (Ml)	Average annual yield savings (Ml/d)
DO04a	Fixed network of permanent noise loggers connected to telemetry - Tranche 1	2020/21 to 2024/25	-125.4	-5.0
DO04b	Fixed network of permanent noise loggers connected to telemetry - Tranche 2	2025/26 to 2044/45	-89.3	-3.6
Total			**-214.7**	**-8.6**

Table 71 Distribution Side Options and Associated Volumetric Savings over the Planning Period

As discussed in section 7.7.2.1, the distribution side options comprise two phases of installation of a fixed network of permanent noise loggers. Option DO04a is the first phase and would commence in AMP7 (2020/21) with the programme being carried out through the five-year period. Leakage is expected to fall by 20% (approximately 7 Ml/d over the AMP7 period)i.e. a reduction in leakage from approximately 35 Ml/d to approximately 28 Ml/d by 2024/25). Option DO04b is the second phase and would continue from DO04a, commencing in AMP8 (2025/26) with the programme being carried out throughout the remainder of the WRMP planning period. Leakage is expected to fall by a further 10% (approximately 4 Ml/d by 2039/40 to 23 Ml/d.

There are also leakage (USPL) savings associated with metering. These are discussed in section above.

The leakage management options in the preferred final plan enable the Company to ensure that leakage does not rise at any point over the planning period, demonstrating compliance with Water Resources Management Plan (England) Direction 2017 3. (j). In fact, leakage reduces by 20% by 2024/25, consistent with Ofwat's requirements (Ofwat, 2017), and reduces by a further 1 Ml/d every AMP up to the end of the planning period.

This trend is evidenced in both the total leakage metric (despite increases in property numbers over the planning period) and the leakage per property metric. These trends are shown in Figure 46 and Figure 47, along with a comparison of final planning leakage against baseline leakage.

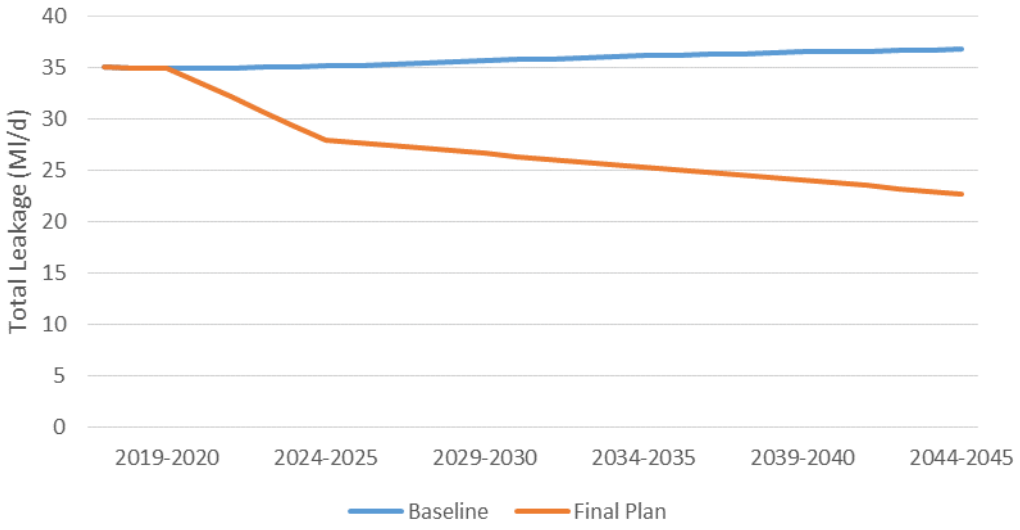


Figure 46 Baseline and Final Planning Total Leakage over the Planning Period

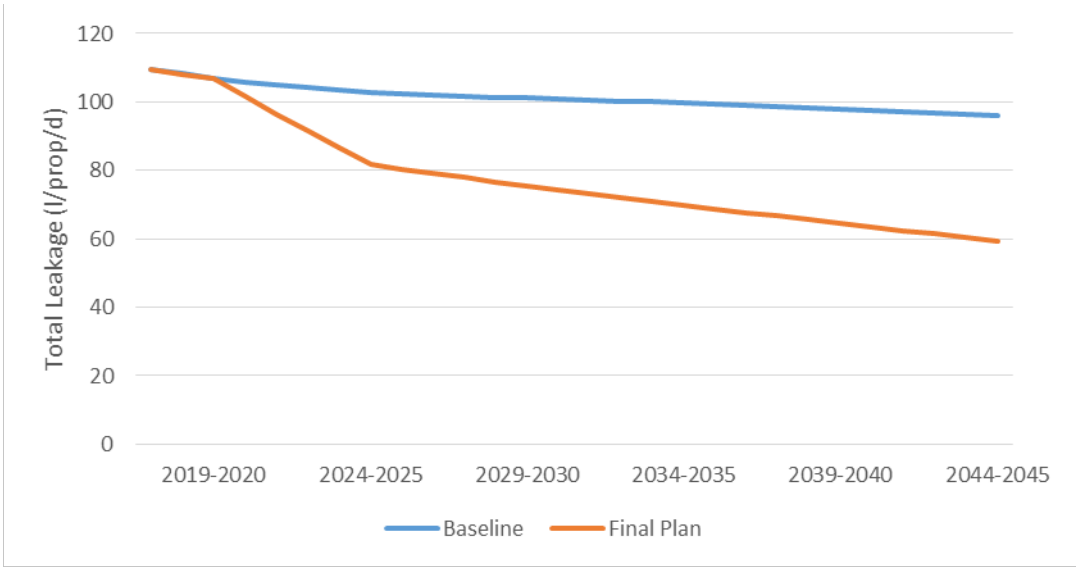


Figure 47 Baseline and Final Planning Total Leakage per Property over the Planning Period

9.4.3 Resource Options

The Company's preferred final plan includes the resource options as set out in, Table 72. The start dates for these options are also presented, and the expected annual average DO.

	Option name	Start date	Average annual DO (Ml/d)
RO21a	Source O – Maximising DO	2020/21	1.8
RO23a	Source H – Maximising DO	2020/21	2.0
RO24a	Source C – Maximising DO	2020/21	4.0
RO68	Source S – Drought Permit	2020/21	8.5
RO22a	Source J – Maximising DO	2024/25	12.5
RO13	Havant Thicket Winter Storage Reservoir	2029/30	23.0

Table 72 Resource Options and Associated DO over the Planning Period

Development of the Havant Thicket Winter Storage Reservoir (option RO13) is a key component of Portsmouth Water's WRMP19. . Taking surplus spring flows in the winter and storing the water in the reservoir provides a flexible resource which can be used in the summer when necessary.

The reservoir will be sourced by transferring any winter excess from the Company's main Source B, to the reservoir by the construction of a dedicated pipeline. The yield of the springs, and indeed all of the Company's sources, has been assessed against more extreme weather conditions than experienced, in response to stakeholder expectations. The springs remain resilient to the most extreme droughts tested, a 1 in 500-year event.

Water from the reservoir will be treated at Treatment Works B where capacity already exists, before it is transferred westward within the network (to supply customers in Gosport and

Fareham in particular). These areas are currently supplied with blended water including from Source A. As water from Source A will be used to provide the bulk supply to Southern Water this will be replaced by the water transferred from Treatment Works B.

Development of the Havant Thicket Winter Storage Reservoir promotes the Government policy priorities of resource sharing and resilience, enabling the deficit created by additional bulk transfer agreements with Southern Water to be met. Customers are supportive of this option, particularly because there should be no direct bill increase because of the Southern Water trading agreement, which was identified as a concern to customers during the consultation. The earliest start date for this option is 2029/30, which is the date from which it is required to support the additional bulk supply to Southern Water. Further detail on the benefits arising from the reservoir option are provided in section 9.6.4.

The drought permit at Source S (option RO68) is available to the Company for use throughout the planning period under the 1 in 200-year design drought scenario. As discussed in section 7.7.2.1, this drought option would be implemented in accordance with the Drought Plan, i.e. it would be selected at the same time as or after the third (final) of the customer side drought restrictions have been implemented.

The remainder of the final plan resource options are associated with maximising DO at Sources O, H, C and J. These schemes remain within existing licences and range from water quality improvements that enable reinstatement of DO to yield maximisation through to additional borehole construction.

9.5 Final Plan Environmental Considerations

9.5.1 Water Framework Directive (WFD)

The WFD impact of the preferred options are considered in the SEA Environmental Report that accompanies the WRMP. The customer side and distribution side options (including metering, water efficiency, water conservation, leakage) are not considered to have any effect on WFD waterbodies.

The effects on WFD for the water supply options have been considered, where appropriate, against the SEA Objective 3 (To protect and enhance water quality and surface and groundwater resources and the ecological status of water bodies). Information used within the assessment of each has been drawn from the collated baseline information presented in Section 3 of the SEA Environmental Report. The following subsections summarise the WFD considerations for the preferred resource options.

9.5.1.1 Havant Thicket Winter Storage Reservoir

For Option RO13, a neutral effect was assessed for the scheme operation on SEA Objective 3. The scheme will not exceed the current abstraction licence and some benefits to stream flows might occur through regular discharges from the reservoir. Prior water quality modelling work concluded that the option is not expected to cause deterioration in the Water Framework Directive status of the Chichester and Langstone Harbours and some water quality benefits (including reducing nitrate concentrations and moderating peaks in iron and manganese concentrations) were identified.

9.5.1.2 Source S Drought Permit

Option RO68 involves additional groundwater abstraction and the increased abstraction may potentially exacerbate the effects of drought on the local water system. It was therefore assessed as having a negative effect on SEA Objective 3, although it was noted that some uncertainty remains until further investigation is undertaken.

9.5.1.3 Schemes to Maximise DO

For Options RO21a and Option RO24a, as no additional abstraction outside the current licence would occur, the options were assessed as neutral against SEA objective 3.

For Option RO23a, the EA has expressed some reservations that this option could have an adverse effect on the lower reaches of the River Meon during periods of low flow in combination with existing abstractions for spray irrigation. In the 2016 WFD classification (Cycle 2) the River Meon was classified as at moderate ecological status and good chemical status. The magnitude of the potential impact on the River Meon remains uncertain until further investigation is conducted. On this basis, whilst within licensed amount, the operation of this option was assessed as having an uncertain effect on water quality and quantity (SEA Objective 3)'.

At Option RO22a, the feasible option involves maximising the DO of the source within existing licence limits by construction of a satellite borehole. This scheme does not involve any increase in licensed quantity and as abstraction would be from a confined chalk aquifer and prior WFD assessment indicated little impact, the option was assessed as having neutral against SEA objective 3. Notwithstanding this assessment, the Environment Agency have expressed concerns regarding sustainability, as outlined in section 4.3. As part of the application process for a licence variation, the Company undertake an assessment of any potential environmental impacts. Results from the analysis will be discussed and agreed with the Environment Agency.

9.5.2 Climate Change

The impact of the preferred options on climate change are considered in the SEA Environmental Report that accompanies the WRMP and have been reported as part of the programme appraisal (section 7.7).

The predicted impacts of climate change on each of the preferred options are presented in Table 73. This shows the climate change impact (in Ml/d) predicted at the end of the planning period, in 2044-45.

Code	Option Name	Year Selected	Impact (Ml/d)	Explanation and assumptions
CO05	Smart Meter MNFR Trial	2020–21	0.00	Climate change is considered unlikely to affect the companies yield savings from metering programmes. The metering on change of occupancy option will be determined by change of occupancy rates which is currently considered unlikely to be affected by climate change. The programme of metering properties that have been void for more than six months is also considered unlikely to be affected by climate change. The impact of the smart meter trial (wherein customers are provided with timely information and comparisons on their recent usage to encourage them to switch to metering) could be potentially be influenced by climate change if this were to result in behaviour change around water consumption. However, the smart metering trial is of relatively short duration (until 2024-25) and therefore any potential effects from climate change impacts are assumed to be negligible.
CO06	Metering on Change of Occupancy - all properties	2025–26	0.00	
CO06a	Metering on change of occupancy – existing meter pits	2020–21	0.00	
CO84	Voids metering	2020–21	0.00	
CO26	Subsidy to customers that purchase water efficient appliances (washing machines etc.)	2020–21	0.00	Climate change is considered unlikely to affect the companies yield savings from delivery of water efficiency programmes. These are schemes that help customers use water efficiently and aim to promote behaviour change around water consumption. The yield savings are relatively small in comparison to other options in the preferred plan. Whilst it could be argued that with time, climate change impact might encourage greater uptake of these schemes, water savings from these programmes are expected to decay over time (as appliances are increasingly replaced with more water efficient versions and more water saving devices are installed). The estimated climate change impacts on predicted water savings are therefore assumed to be negligible.
CO34	Water saving devices – Retrofitting existing toilets	2020–21	0.00	
CO40	Water saving devices – spray taps	2020–21	0.00	
CO43	Water saving devices – trigger nozzles for hoses	2020–21	0.00	
CO46	Household water efficiency programme (partnering approach, home visit)	2020–21	0.00	
CO46b	Waterwise programme	2020–21	0.00	
CO78	Voluntary restraint and leakage action	2020–21	0.00	The water conservation options in the preferred plan are associated with voluntary and mandatory restraint in the event of drought and imposition of drought restrictions. As the Company's plan is based on a 1 in 200-year drought scenario, these water conservation options are assumed to be required and in place every year. Additional climate change impacts on estimated water savings are assumed to be negligible.
CO79	Mandatory restraint	2020–21	0.00	
CO80	Imposition of Drought Direction Restrictions (mandatory commercial restraint)	2020–21	0.00	
DO04a	Fixed network of permanent noise loggers connected to telemetry - Tranche 1	2020–21	0.00	This option involves installing permanent noise loggers throughout the distribution network and linking these to telemetry, so the loggers can automatically identify new leaks. This will result in an increase in the number of leaks identified and repaired, reducing the amount of water lost through leakage. Climate change is unlikely to affect the delivery of this option.
DO04b	Fixed network of permanent noise loggers connected to telemetry - Tranche 2	2025–26	0.00	
RO13	Havant Thicket Winter Storage Reservoir	2029–30	-0.12	This option relates to the construction of a pumped storage reservoir at Havant Thicket. Water would be sourced from the Source B Springs during the winter period (within the existing annual average licence) and stored in the reservoir for use in the summer when necessary. The reservoir water comes from groundwater fed springs and the predicted climate change impacts on Portsmouth Water's groundwater sources are small. In the first instance, to approximate the likely climate change for this option, the predicted climate change impact on Portsmouth Water's total DO by 2040 (-0.5%) has been used to factor the likely climate change impact for the increase in DO for this option (23 Ml/d). Once the water is in the reservoir, it may be affected further by climate change impacts e.g. though evaporation. Additionally, the DO would be subject to the hands-off flows of Brockhampton Mill Lake and Langstone Mill Stream. To fully assess the climate change impacts requires a more detailed study which will be undertaken as part of the reservoir development.
RO21a	Source O – Maximising DO	2020–21	-0.01	This option involves works to improve water quality on an existing borehole where the yield has already been proved. The increase in DO is below the licence volume and wouldn't require a change to the abstraction licence. The predicted climate change impacts on Portsmouth Water's groundwater sources are small. To approximate the likely climate change impact for this option, the predicted climate change impact on Portsmouth Water's total DO by 2040 (-0.5%) has been used to factor the likely climate change impact for the increase in DO for this option (1.8 Ml/d).
RO22a	Source J – Maximising DO	2024–25	-0.08	This option involves maximising the DO of the source within existing licence limits by construction of a satellite borehole. This scheme does not involve any increase in licensed quantity and the satellite borehole will replace one of the existing boreholes where yield has been proven. The predicted climate change impacts on Portsmouth Water's groundwater sources are small.To approximate the likely climate change impact for this option, the predicted climate change impact on Portsmouth Water's total DO by 2040 (-0.5%) has been used to factor the likely climate change impact for the increase in DO for this option (15 Ml/d).
RO23a	Source H – Maximising DO	2020–21	-0.01	This option involves cleaning to improve water quality at existing boreholes. This scheme does not involve any increase in licensed quantity. The predicted climate change impacts on Portsmouth Water's groundwater sources are small.To approximate the likely climate change impact for this option, the predicted climate change impact on Portsmouth Water's total DO by 2040 (-0.5%) has been used to factor the likely climate change impact for the increase in DO for this option (2 Ml/d).
RO24a	Source C – Maximising DO	2020–21	-0.02	This option involves applying additional filtration to improve the water quality and hence increase DO. This scheme does not involve any increase in licensed quantity. The predicted climate change impacts on Portsmouth Water's groundwater sources are small. To approximate the likely climate change impact for this option, the predicted climate change impact on Portsmouth Water's total DO by 2040 (-0.5%) has been used to factor the likely climate change impact for the increase in DO for this option (4 Ml/d).
RO68	Source S – Drought Permit	2020–21	-0.04	This option involves applying for a Drought Permit to increase the daily abstraction limit at Source S. To approximate the likely climate change impact for this option, the predicted climate change impact on Portsmouth Water's total DO by 2040 (-0.5%) has been used to factor the likely climate change impact for the increase in DO for this option (8.5 Ml/d).

Table 73 Impacts of Climate Change on Preferred Options

As shown in Table 73, climate change is considered unlikely to affect the delivery of the customer side and distribution side options (programmes of metering, water efficiency, and leakage).

The water resource options mostly relate to maximising DO from existing boreholes, except Option RO13 which is very similar to a groundwater source as the water is being sourced from groundwater fed springs before being transferred to a winter storage reservoir. Climate change is anticipated to have limited effect on groundwater sources over the planning period.

9.5.3 Greenhouse Gas Emissions

By delivering its preferred final planning programme over the 25-year planning period, the Company will see significant reductions of carbon emissions due to the options associated with water and energy saving. While the options associated with the preferred programme will emit 50.97 tCO2e from fixed or embodied carbon emissions, there will be an associated saving of 96.2 tCO2e from variable or operational activities.

The water resource planning data tables that accompany this revised Final WRMP show the profile of carbon costs associated with the preferred final planning programme.

The carbon emission profile results from the type, timing and utilisation of the options in the preferred plan. Fixed carbon emissions are emitted periodically, relating to the construction or implementation of particular options. The largest fixed carbon emissions are associated with the construction of Option RO13 (Havant Thicket Winter Storage Reservoir).

The release of variable carbon emissions follows a consistent trend as different options are brought into use over the planning period. The emission savings arise from the demand management options associated with reducing water demand and network leakage, and through increased water efficiency.

Energy use and carbon emissions are reported each year in the Company's Annual Report. In the 2017/2018 report year, the Company's gross operational emissions were 9,716 tCO2e. This was a reduction from the previous year's total of 11,079 tCO2e. The Company works proactively to develop sustainable solutions to reduce its carbon footprint. For example, the Company operates solar arrays at 5 of our water treatment works; purchasing almost all its energy for our treatment and pumping sites from low carbon energy sources (biomass) and have report annually against our Energy Savings Opportunities Scheme (ESOS) targets.

9.6 Final Plan Benefits

Portsmouth Water considers that its preferred plan meets the array of objectives it set out to achieve:

- Balancing supply and demand during a 1 in 200-year drought;
- Reflecting the preferences of its customers;
- Incorporating the views of its stakeholders;
- Reflecting Government policy priorities; and
- Demonstrating (in section 8) a robust strategy for long-term resilience against future uncertainties.

Whilst the Company's preferred plan is not the least-cost plan, it does not deviate very much from the least-cost plan, and in fact goes further to meeting some of the objectives listed above that cheaper options do not.

Some of the wider benefits of the preferred plan not discussed explicitly in the programme appraisal (section 7.7) are summarised below.

9.6.1 Reductions in Per Capita Consumption

As a result of a combination of its ongoing baseline demand management activities and the metering and water efficiency measures it proposes to undertake during the planning period as part of the preferred final plan, the Company expects to achieve the PCC trends shown in Figure 48. It should be noted that these PCC trends exclude the impacts of the drought demand restrictions that form part of the preferred plan. These have been excluded because they are only expected to be required during a 1 in 200-year drought, whereas the trends presented in Figure 48 provide a truer estimate of consumption without the short-term influences of drought demand restrictions.

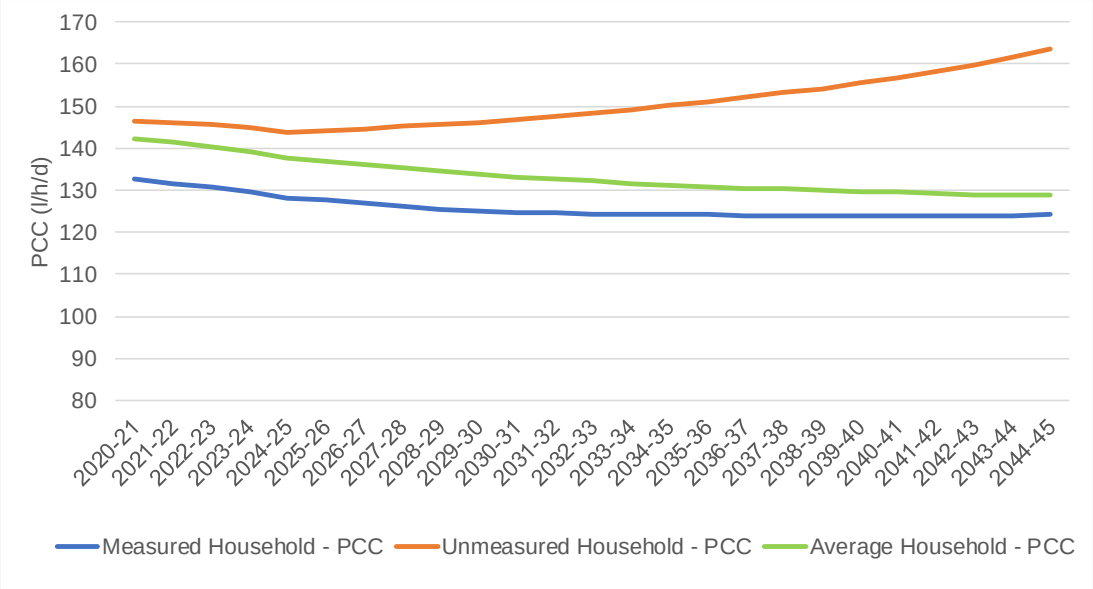


Figure 48 DYAA Per Capita Consumption Resulting from the Preferred Plan but Excluding the Influences of Drought Demand Restrictions

Figure 48 shows that average PCC falls over the planning period from 142.2 l/h/d to 128.7 l/h/d. This reflects the movement of customers from unmeasured to measured tariffs following the final planning metering programmes (which aim to achieve 90% meter penetration by 2044/45), and the anticipated reductions in measured household consumption due to behaviour change and forecast trends in micro-component consumption due to technological improvements and natural appliance replacement rates, supported by the Company's baseline and final planning water efficiency programmes. The residual unmeasured customer base, which reduces in number throughout the planning period, is expected to demonstrate an increase in PCC over the planning period from AMP8 onwards. This is because those customers who remain unmeasured are likely to include those customers who have resisted opting for a meter as their relatively high baseline consumption levels mean they are less likely to benefit financially from having a meter installed.

Whilst the forecast trends shown in Figure 48 are based on best available evidence for what might reasonably be expected from customers regarding reduced consumption, the Company acknowledges that the proposals which rely upon customer behaviour change may be subject to greater uncertainty than some other measures to balance supply and demand. However, Portsmouth Water is committed to encouraging and supporting its customers to enable them to reduce their consumption through the measures set out in its preferred final plan.

The above PCC figures are what can be delivered through options which can be implemented by the Company. However, the Company has an aspiration to see PCC at 100 l/h/d, but to do this it will need a work with developers, local authorities and inset appointees. This is covered in next steps (section 10).

9.6.2 Improved Resilience

The Company has developed a final plan that encompasses all elements of resilience. The options selected provide supply-demand and DO resilience to a 1 in 200-year drought event with an average surplus of 14.7 Ml/d across the planning period (ranging from a minimum of 3.1 Ml/d in 2020/21 to a maximum of 18.1 Ml/d in 2041/42). The Company has not considered any specific response and recovery resilience options in its plan, but has a well-established Emergency Plan to maintain supplies. As part of the WRSE Group, should extreme events beyond that planned for (1 in 200 year, noting that such an event is well beyond anything experienced in the historic record) materialise, then it has the connections and the agreements in place to access resources beyond its operating area. Being part of a regional planning group is in itself considered to be a response and recovery position.

The strategic importance of Source J and Option RO22a for resilience cannot be overstated. Existing mains allow water from this source to be used very flexibly supporting both existing customers and the bulk supplies to Southern Water. Alternative resilience options to improve the network are likely to be much more expensive.

In the wider context, the Company has taken steps to address hazards that might result in power outages, flooding of its operational sites, network connectivity and cyber security. The Company has plans to demonstrate how it will manage supplies to customers in non-drought events which are audited annually by Defra.

The Company's resilience to non-drought hazards has recently been tested with the "Beast from the East" period of cold weather in March 2018. The rapid thaw that followed the cold spell had operational impacts upon the Company (and other water companies across the UK). The effect of this significant temperature change was, to a large degree, mitigated by long term investment in the Company's network. The analysis of the Company's performance to this event from Ofwat and the Drinking Water Inspectorate was that the Company performed well and largely met customers' expectations. As with all such operational events the Company has sought to understand lessons learned and to use this as the basis of improving its response to future events. In September 2018, the Company produced a report responding to Ofwat and the Drinking Water's analysis of the Company's performance and describing lessons learnt. The Company follows a risk management process and has an agreed action plan against which progress is reviewed by the Company's Board on a quarterly basis.

In combination, the Company considers that its overall system resilience will be enhanced by the options included within this WRMP and those outlined in the Business Plan.

9.6.3 Resource Sharing Driven by WRSE Group Outcomes

The Company has worked closely with the WRSE Group and considers that its Final WRMP is consistent with the WRSE work. The modelling undertaken by the WRSE Group indicated that there is both the scope (through options available to Portsmouth Water - in particular Havant Thicket Winter Storage Reservoir) and the need for the Company to provide additional bulk supplies to Southern Water, to assist its neighbour in meeting deficits it faces during the planning period. Portsmouth Water has given careful consideration to these modelling results in preparing its WRMP19. Discussions have been held with Southern Water throughout preparation of both companies' WRMPs. Agreement was reached that as Southern Water's modelling shows a need for the additional bulk supplies, Portsmouth Water would make these available. Portsmouth Water has agreed in principle to provide the requested bulk supplies to Southern Water. The volumes of the two additional bulk supplies have been included in Portsmouth Water's baseline supply-demand balance, to provide certainty that this water will be available to Southern Water. These bulk supplies have been agreed in principle with Southern Water and have also been included within Southern Water's preferred programme in their WRMP. It should be noted that whilst these schemes are agreed in principle, commercial terms have yet to be defined and agreed.

Portsmouth Water in this way supports the WRSE Group strategy and Government policy priority of enhanced sharing of available water between companies in the region.

A joint statement on the benefits of Havant Thicket Reservoir is provided in 9.6.4 below.

9.6.4 Havant Thicket Winter Storage Reservoir

The £103 million Havant Thicket Reservoir Resilience Project involves the construction of a new winter storage reservoir – the first large scale new reservoir to be built in the South East since the 1970s. It is a collaboration between Portsmouth Water and Southern Water, through the Water Resources in the South East group, to provide resilient water supplies to the region. It supports reduced abstraction on chalk rivers, has an overall biodiversity net gain and will provide a new community leisure facility for the area.

The project's innovative approach to collaboration and water trading sets a precedent for the water industry and fulfils the recommendations of the National Infrastructure Commission's 'Preparation for a drier future' report as well as being in line with the Government's 25-year environment plan.

The reservoir, which will take-up to 10 years to fully commission, will be filled with surplus spring water in winter and allow Portsmouth Water to provide a flexible bulk transfer of around 21 Ml/d to Southern Water, as part of an overall commitment to supply 60 Ml/d from a range of sources by 2029. This will help meet a deficit created by the imminent reduction of the Southern Water abstraction licences on the Rivers Test and Itchen.

It is part of a twin-track approach and both companies have ambitious plans to reduce leakage, help customers use less water and increase metering. A third track is to engage with partners on catchment solutions.

The project, which is supported by and developed with customers and stakeholders, forms one part of a package of solutions which can provide the best value resilient water supplies with the lowest bill impact, compared to other strategies.

Portsmouth Water and Southern Water are also committed to further exploring ways to increase resilience though additional enhancements, such as two-way transfers, to reduce risks from outage and events such as extreme droughts, heatwaves, freeze/thaw and pollution.

It is viewed as the first phase of a longer-term plan to increase water trading opportunities through ambitious demand reduction and the development of further regional infrastructure.

A Design and Build delivery approach is proposed, following a thorough review of alternative options, including a Direct Procurement for Customers model. Portsmouth Water will deliver the reservoir and some of the associated network upgrades, with the relevant costs recovered from us through the pricing of the bulk supply arrangement. Despite this being an exceptionally large project for Portsmouth Water, the Company will use the existing TOTEX and cost-sharing frameworks to manage the risk to customers.

10 Next Steps

After submission of the WRMP, Portsmouth Water will undertake further work to address areas of uncertainty. A series of work streams will be undertaken which will help ensure successful delivery of the Company's long-term plan.

The work streams will also provide better information enabling the assumptions underlying the plan to be revised and updated where necessary in readiness for the next round of WRMPs in 2024. The Annual Review of our WRMP, submitted in June each year to the Environment Agency, will be used to provide updates to the assumptions arising from these work streams. The activities proposed are highlighted in the following sub-sections.

10.1 Programme of Works for Water Resource Developments in the Final Plan

10.1.1 Source J Satellite Borehole

The options appraisal has identified that the option of maximising DO at Source J through construction of a satellite borehole will be required to enable the Company to provide a further bulk supply to Southern Water in 2024/25. To achieve this timetable, the programme of option development will need to be started in 2019. The timetable for this is as follows:

2019 Apply for Groundwater Investigation Licence

2020 Drill trial boreholes and carry out pumping test and environmental monitoring

2021 Carry out WFD No Deterioration Assessment

2022 Apply for Licence Variation

2023 Complete productive borehole and pipework

2024 (March) Commission.

10.1.2 Havant Thicket Winter Storage Reservoir

Havant Thicket Winter Storage Reservoir is required in 2029/30 to enable the Company to provide Southern Water with the additional bulk supply they require at that time. To meet this deadline, it is imperative that the environmental monitoring, habitat re-creation, planning application, customer engagement and commercial agreements are completed in 2019.

Portsmouth Water has met with the local planning authorities (LPAs) in recent months to discuss the form the planning application will take and to confirm the studies needed before the application is made. Extensive ecological survey work has already been commissioned and is underway.

In June 2018, the Company met with representatives from Natural England, the LPA ecologist, Forestry Commission, Hampshire County Council and the local wildlife trust to discuss the outline habitat mitigation and compensation strategy and to consult on the preparation of a more detailed strategy.

Several further studies also need to be completed in 2018/19 to provide greater certainty over the design scope and to inform the outline design. They include:

- Water quality study – to determine if pre-treatment of the spring water is required;
- Raw water transfer study – to determine if existing trunk mains can provide a resilient transfer of raw water to the treatment works and consideration of alternatives;
- Network resilience study – to confirm the scope of upgrades required to the Company's networks to distribute the additional water;
- Emergency discharge review – to confirm the design is appropriate to meet the requirements of the Reservoirs Act (1975) and the Environment Agency;

- Review of visitor centre and recreation facilities – to confirm that the scope of works still meets the expectations of the local planning authority and communities; and
- Agreement of commercial and operating arrangements for the reservoir and bulk supplies.

In tandem, Portsmouth Water and Southern Water will carry out modelling to ensure optimal resilience benefits are achieved from the overall project, to demonstrate benefits to customers and to apportion costs accordingly. This work will be subject to independent verification.

For full details of the programme see Appendix JJ.

10.2 Monitoring and Contingency Planning

10.2.1 Monitoring Risk

The preferred plan has a strong focus on demand management measures (leakage, metering and water efficiency) and the Company has set ambitious targets including a 20% reduction in leakage by AMP7. In addition to this, resource schemes are needed to meet the supply demand deficit. The sensitivity scenario testing presented in section 8 emphasised the need for the Company's resource side options to be in place to provide a continued supply of water to Portsmouth Water customers in addition providing Bulk Transfers to Southern Water. Option RO13 is required to provide a continued supply of water to Portsmouth Water customers, as a replacement for the existing Source A which will be used to provide the Bulk Transfer to Southern Water. The Company is also reliant on Option RO22a, to provide resilience.

It is important that the Company monitors progress and considers the risk of either supply or demand scenarios not being fully realised, the implications and what the contingency options would be.

The Company continually monitors progress on water efficiency, metering and outturn leakage and will use the Annual Review of WRMPs process to review progress against forecasts and targets. Where progress is behind forecast it will undertake the following actions:

1. Investigate reason and identify remediation (where appropriate).
2. Increase frequency of monitoring and review
3. Identify likely effect on the supply demand balance
4. If deficit, identify if other options are required
5. Provide early indication of any likely changes to the Environment Agency.

In addition, the Company will regularly review the programme of works for resource schemes and water resource developments (set out in Section 10.1) and report on progress in the Annual Review. In the event that any programme delays are identified, actions 1-5 (set out above) will be followed.

10.2.2 Contingency Planning

Table 74 presents a summary of the average annual yield savings from demand management measures throughout the planning period and the effect on the supply demand balance if these were not achieved. It can be seen that in all cases, there is sufficient flexibility in the supply demand balance if any single category failed to deliver. In fact, there is sufficient flexibility to cover the risk to delivery from all demand management measures in every AMP cycle except AMP6. The Company has set ambitious but realistic targets and therefore cannot foresee a scenario where there would be zero savings from demand management. The Company will monitor progress and risk (as set out in section 10.2.210.2).

	2019 - 2020	2024 - 2025	2029- 2030	2034- 2035	2039- 2040	2044- 2045
FP SDB (Ml/d)	9.1	12.7	15.8	17.0	17.4	17.8
Water efficiency annual average yield saving (Ml/d)	2.8	2.8	2.8	2.8	2.8	2.8
Metering annual average yield saving (Ml/d)	1.6	3.7	3.7	3.7	3.7	3.7
Leakage Water savings (Ml/d)	6.0	5.0	4.9	4.6	4.2	3.8
Total annual yield saving (Ml/d)	10.4	11.5	11.4	11.1	10.7	10.3
Net effect on SDB if no demand management measures	**-1.3**	**1.2**	**4.4**	**5.9**	**6.7**	**7.5**

Table 74 Demand Management Volumetric Savings Compared to Final Planning Supply Demand Balance

Table 75 presents a summary of the forecast annual yields from development of resource options and the effect on the supply demand balance if these were not achieved. It can be seen that in all cases, except for Havant Thicket Reservoir (R013), there is sufficient flexibility in the supply demand balance if any one of the resource options were not available, provided that demand management and drought conservation schemes are delivered as planned.

	2020 - 2021	2021 - 2022	2022 - 2023	2023 - 2024	2024 - 2025	2029- 2030	2034- 2035	2039- 2040	2044- 2045
FP SDB (Ml/d)	3.1	4.8	6.3	7.3	12.7	15.8	17.0	17.4	17.8
Havant Thicket Reservoir (R013)	0	0	0	0	0	23	23	23	23
Source J Boreholes (R022a)	0	0	0	0	12.5	12.5	12.5	12.5	12.5
Source C DO Recovery (R024a)	4	4	4	4	4	4	4	4	4
Source H DO Recovery (R023a)	2	2	2	2	2	2	2	2	2
Source O DO Recovery (R021a)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Source S Drought Permit (R068)	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Net effect on SDB if no Havant Thicket Reservoir	**3.1**	**4.8**	**6.3**	**7.3**	**12.7**	**-7.2**	**-6.0**	**-5.6**	**-5.2**

Table 75 Resource Options Volumetric Savings Compared to Final Planning Supply Demand Balance

As identified in the sensitivity testing (section 8.4), Options R013 and Option R022a are the most critical to the Company to meet customer demands and deliver planned bulk supplies. The Company has very few alternative options at its disposal to meet a supply-demand deficit in a 1 in 200 year drought scenario. In the event that these options are not fully available as planned or any supply-demand shortfall is predicted, the Company will undertake the actions listed below:

- Reduce outage – by addressing any shutdowns as a priority and mobilising emergency treatment units as required;
- Review and accelerate metering programmes as far as possible;

- Review and accelerate leakage programmes as far as possible.

Should these options not deliver sufficient yield to meet the deficit, the Company would safeguard its own customers and potentially might not be able to meet its bulk supply commitments to Southern Water in full. As set out in section 8.4, Company has committed to provide a bulk supply to Southern Water, subject to the yield at options RO22a and RO13. Portsmouth Water and Southern Water have discussed this eventuality and Southern Water are aware that the risk sits with them. Southern Water have developed contingency options within their own WRMP.

10.3 Improving Confidence in the WRMP

10.3.1 Consistency of Leakage Reporting

As identified in this WRMP (section 5.5), the Company will be adopting the new *Consistency of Reporting Performance Measures: Reporting Guidance* (UKWIR 2017) to calculate leakage levels for all reporting purposes (including to Ofwat) from 2020/21. It should be reiterated, however, that Portsmouth Water's WRMP19 is based on the new methodology.

10.3.2 'Not for Revenue' Smart Metering Trial

Under this option the Company will install smart meters at selected household properties and provide these customers with timely information and comparisons on their recent usage. A trial of 500 customers is already underway and the option selected as part of the preferred final plan will see another 500 meters installed each year throughout AMP7, with the aim of demonstrating to those customers selected that they could benefit from being charged on a measured basis. The trial should also provide valuable information to the Company regarding consumption and supply pipe leakage.

10.3.3 Improved Data for Deployable Output and Outage

To continually improve the quality of data used in future WRMP and annual reviews, the Company is committed to seeking to improve the data it uses for the basis of estimating deployable output and outage.

This will include an assessment of whether the activities being undertaken by the Company to reduce outage events in a normal year would also apply during different drought events. It will also include an investigation into the potential yield of the RO68 Source S Drought Permit during different drought events, to verify whether the estimate of the 1:1 ratio of licence increase to DO is appropriate.

10.3.4 Long-Term Aspiration for PCC

The PCC figures reported in this WRMP are those expected to result from the options delivered as part of the preferred final plan. However, the Company has a long-term aspiration to see PCC reach 100 l/h/d. Achieving this will require significant targeted effort by the Company, but also by developers, local authorities, NAVs and not least customers themselves.

As part of this, the Company is considering third party options and proposes to work with Albion Water to minimise the impact of significant new housing developments in the Company's supply area. This forms part of the Company's strategy to reduce the expected impact of growth on demand. Minimising water consumption in new homes is essential across the South East region in light of the expected high levels of property and population growth being forecast.

Portsmouth Water has plans to implement a low water use strategy with Fareham Borough Council at the Welborne development and will also seek to develop other relationships in our supply area. Working in partnership with Albion Water and other NAVs, the Company will

promote grey water re-use systems, which will contribute to the minimisation of consumption levels in new homes.

10.4 Delivering Environmental Enhancements

10.4.1 WINEP3 Investigations and the WFD

Under WINEP3, there are three investigations which the Company is required to undertake during AMP7 that could have an impact on this WRMP, as set out below:

- An investigation to determine the costs, impacts and technical feasibility of reaching or maintaining revised Common Standards Monitoring Guidance (CSMG) flow targets at Source A. This work will be conducted jointly with Southern Water and South East Water.
- An investigation to determine the costs, impacts and technical feasibility of reaching ASB3 in principle salmon rivers at Source A.
- An investigation into and options appraisal to determine improvements to, the hydrological regime required to meet WFD objectives at Source F.

It is proposed that these investigations are undertaken as soon as possible, to meet the deadline of March 2022. The results will determine whether further sustainability reductions at these sources or changes to licence conditions such as the minimum residual flow on the river are required. The results of the investigations and the impacts will be fed into the Annual Review of the WRMP.

10.4.2 Catchment Management

Portsmouth Water's innovative plans for catchment management and biodiversity are set out within the Company's Business Plan and will help provide environmental enhancements of relevance to the WRMP. Catchment interventions proposed by the Company for AMP7 include arable reversion, improved soil management, use of cover crops, a woodland creation scheme (through an innovative partnership with the Forestry Commission) and reduced cultivation systems.

Whilst ostensibly aimed at reducing nitrate and oil pollution, which will in turn deliver outage benefits (as described in section 4.5), the catchment management interventions proposed by the Company for AMP7, are expected to deliver wider environmental and biodiversity benefits associated with the following ecosystem services:

- *Provisioning services* – benefits in the form of goods or products that people use or are used in the production of other goods (e.g. crops, timber etc.);
- *Regulating services* – benefits through the control of natural processes such as water quality and flows, natural hazard protection and erosion control;
- *Cultural services* – non-material benefits that people derive from the natural environment such as recreation, spiritual values and aesthetic enjoyment; and
- *Supporting services* – natural processes that maintain the production of all other ecosystem services such as habitat provision, nutrient cycling, soil formation and water cycling.

The Company also proposes to establish a capital grant scheme for biodiversity or knowledge enhancement projects located within its catchment.

10.5 Delivering Leakage Reductions Through Innovation

10.5.1 Fixed Networks Using Permanently Installed Noise Loggers

The Company considers that reducing leakage by 20% by the end of AMP7 will require considerable improvements, efficiencies and innovation in leak detection and repair.

Portsmouth Water has actively trialled four different fixed network noise logger solutions from 3 manufacturers, including:

- HWM – PermaNet Fixed Network
- Primayer – Enigma 3m Fixed Network
- Primayer – Enigma 3 HyQ Fixed Network
- Gutermann – ZoneScan Fixed Network

Following successful trials, nearly £1.0m of Fixed Network loggers have been purchased to cover over 25.0% of the Company's network. This will help reduce leakage during AMP7.

10.5.2 Leakage efficiency

To improve leakage detection efficiency and reduce the time taken from knowledge of a problem to pinpointing of the leak, the Company have actively trialled a number of leakage and event management software solutions, including:

- Takadu - Takadu
- Servelec - Datective
- RPS – Waternet

Following successful trials, the Company have purchased both Datective and WaterNet to ensure the best possible efficiencies can be made. These purchases have led to a new leakage detection strategy and contract model to increase leaks detected per technician. The Company are also restructuring to increase focus on leakage at all levels of the Company. This will help reduce leakage during AMP7 and beyond.

10.5.3 Increased data collection

To increase understanding of leakage, the Company have increased investment in flow and pressure logging.

This has included a collaborative project with 'Barter for Things' to develop an Internet of Things Pressure Logger that will provide 15-minute data at lower cost than the established alternatives. This means the Company can economically deploy a far higher frequency of logging equipment in our network than ever before, thereby increasing the opportunities to detect leaks and bursts more quickly. This will help reduce leakage during AMP7 and beyond.

10.5.4 Satellite Imagery and drones

The Company have trialled both Satellite Imagery and InfraRed drones to better understand their value in reducing leakage. Whilst the trials successfully found leaks, the technology was not as cost effective as Fixed Networks. The Company is therefore not currently planning to adopt this approach. Its potential use will be reviewed for WRMP24.

10.5.5 Pressure optimisation

Currently 60% of the Company's network is covered by pressure management valves which remove excessive pressures and surges from the system, deliver consistent diurnal pressures to customers and reduce the stress on the pipe network. The Company have conducted a full review of pressures on our network and have discovered some opportunities for further pressure management. The Company are currently trialling new PRV monitoring technology and are expecting to spend over £100k in 2019/20 on further pressure investigation. If this proves successful, it will help reduce leakage during AMP7 and beyond.

10.5.6 Smart networks

As part of the meter not for revenue initiative to reduce PCC, the Company are actively investigating a range of smart network solutions to reduce supply pipe leakage. The Company are also heavily involved in industry projects on the use of smart networks to reduce leakage.

The results of the investigations and research will be reviewed to identify if this leakage reduction option can be included in WRMP24.

10.6 Continued Collaboration

10.6.1 The WRSE Group and Neighbouring Water Companies

The Company will continue to play an active role in the WRSE Group. This work to date has resulted in two bulk supplies to Southern Water which are currently in place and this WRMP includes further bulk supplies which were identified through WRSE modelling and which have resulted in the requirement for Portsmouth Water to build a new Winter Storage Reservoir at Havant Thicket. This resource development, which will be fully commissioned in 2029/30, will help build resilience across the South East region.

Portsmouth Water and Southern Water are committed to meeting on a regular basis to discuss ongoing investigations and the delivery of schemes in order to keep each other informed of emerging risks to each company's respective water resources strategies. This bilateral liaison will be in addition to discussions at a regional scale through the WRSE group of companies.

10.6.2 Working towards regulatory ambitions

Portsmouth Water fully supports and will aim to address, through its WRMP work streams, the challenges set out by the regulators (Defra, the Environment Agency, the Drinking Water Inspectorate and Ofwat) in their letter dated 9th August 2018. These challenges comprise the following five key areas:

- *Increasing ambition in the forthcoming business plans:* The regulators want companies and regional groups to use the PR19 regulatory period to demonstrate tangible progress in increasing collaboration and developing creative strategic water supply solutions.
- *Regional water resources planning, through greater coordination of water resource management plans:* The regulators recognise that the sector has been thinking about better ways to co-ordinate. They consider that water companies should take a genuinely regional approach to producing plans that transcend company boundaries and identify optimum solutions for the region as a whole. This planning should then provide the basis for individual water company plans.
- *Greater use of markets and competition*: The regulators will be looking for regional groups to fully explore the role of markets in delivering their strategic water resource solutions. Competition can reduce the cost of developing new resources and help deliver strategic and innovative solutions. Ofwat will lead work to facilitate new markets to support improved water resilience.
- *A clear direction from Government:* The Government is developing a national policy statement (NPS) for water resources and the Environment Agency will lead the development of a National Framework for water resources which will set clear challenges to the industry and develop tools to support collaboration between companies and with other sectors.
- *A responsive regulatory approach:* To meet the challenges facing water resources, the regulators have committed to listening to any issues raised by the sector and working in a joined-up way with companies to help overcome any real challenges identified. They are already working to refine the water resources management planning process and other regulatory incentives.

The Company believes its WRMP, which includes further bulk supplies to neighbouring companies and a new resource bringing improved regional resilience, demonstrates an important step towards addressing these challenges. It is committed to working with other water companies and regulators to create a regional solution at future reviews and to working within new policy frameworks that may be set by the regulators.

10.6.3 Annual Reviews of WRMPs

As mentioned previously, the Company will use the Annual Review of WRMPs process to consider and review the following specific outcomes:

- Forecast population and properties against actual number on the Company's billing database;
- Demand savings achieved by water efficiency and metering schemes against those forecast in the WRMP;
- Progress against the targets for change of occupier meter installation numbers;
- Update on progress against PCC reduction targets;
- Actual outturn leakage against target leakage levels forecast in the WRMP; and
- Review of WINEP3 progress, including WFD status and likelihood of sustainability reductions.

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