Water Resources Management Plan 2019

Annex 1: Pre-consultation and problem characterisation

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Version 1

from Southern Water

Contents

1. Executive summary

This annex sets out one of the first steps in the derivation of our Water Resources Management Plan (WRMP), as set out in the WRMP process diagram. One of the initial key steps is to characterise the problem that we have to address to enable us to select the most appropriate technical methods to use in order to help derive a preferred plan.

This annex sets out several aspects that have influenced and shaped how we have constructed our Water Resource Management Plan and our decision making process. It is comprised of five components:

- A 'problem characterisation' review that assesses the strategic challenges we face and our selection of appropriate decision making tools to address these challenges (section 2)
- Our water resource zone (WRZ) integrity assessment (section 3) that delineates our supply areas into WRZs that share a common risk of failure to meet demand
- A climate change vulnerability assessment section that evaluates the risk and vulnerability of each WRZ to the forecast effects of climate change
- A summary of our pre-consultation with customers, stakeholders and regulators (section 5) to capture their priorities and views on the development of our plan so that we can build them into our decision making
- Our levels of service (section 6), which sets out the standards of supply and drought resilience we plan to provide to our customers

We have summarised each of these sections below and more details are in the sections referenced above.

1.1 Problem characterisation

We have undertaken a 'problem characterisation' assessment for each of our three supply areas as the first step in developing plan. The method for the assessment is set out in recent UKWIR (2016a, 2016b) guidance. The problem characterisation step requires water companies to address a number of prompted questions and assign scores. The questions consider our strategic risks, and the complexity of the supply, demand and investment issues we face. The process helps us to select appropriate decision making tools that reflect our main challenges.

Each supply area comprises of a number of WRZs with some transfers between them. There are no transfers of water from area to area.

We carried out our assessment in a formal review between four water resource planners. Each planner selected an individual score. These scores were discussed and consolidated into an overall 'company' score for each answer. We recorded individual views and comments to show the range of opinions and to provide an audit trail.

All of our areas, and the company as a whole, scored 'medium' in terms of strategic need and 'high' for complexity factor (Table 1). Our Western area has the greatest strategic need and overall complexity. This reflects significant concerns over future sustainability reductions to available supplies. These will require complex and costly solutions to resolve future supply deficits. Significant concerns over drought sensitivity, climate change and water quality affect the Central and Eastern areas. Complex and costly investment solutions such as water reuse or desalination may be required to meet future demand. We have moderate concerns over demand that reflect uncertainty in future growth and socio-economic changes.

Table 1 Collated results from each area and the overall problem characterisation score

Area	Strategic needs score	Complexity factors score			
		Supply	Demand	Investment	Overall
Western	5 (Medium)	6	3	8	17 (High)
Central	4 (Medium)	6	3	7	16 (High)
Eastern	4 (Medium)	6	3	6	15 (High)
Company	4.33 (Medium)	6	3	7	16 (High)

The problem characterisation shows that our plan would benefit from using a more complex 'extended' decision making approach. We believe that adopting an aggregated risk approach allows us to best account for uncertainty in our investment decisions. This will allow our plan to accommodate large stepped changes and uncertainty in supplies. The investment solutions required are likely to be highly complex with long lead and development times (e.g. desalination). Investments are likely to have multiple dependencies and interconnections with other options (e.g. network enhancement, water supply works upgrades etc.).

The problem characterisation assessment guides selection of a suitable risk principle. We have chosen to develop a ‘fully risk based’ plan (see UKWIR, 2016b). This is consistent with the complex challenges we face. Our key decision making tool uses a 'real options' analysis (ROA) method. Our approach allows us to recognise risk and uncertainty, and to make appropriate 'no-regret' investments. We have described the methods we have used in our supply and demand forecasts in more detail in Annex 2 Demand Forecast, Annex 3 Supply Forecast and Annex 5 Baseline supply demand balance. We discuss our innovative real options analysis methodology in more detail in Annex 8 WRMP strategy. We will further refine and enhance our decision making tools in the future.

1.2 Water resource zone integrity assessment

The WRZ defines an area within which managing supply and demand for water is largely self-contained (apart from defined bulk transfers of water); where the resource units, supply infrastructure and demand centres are such that customers in the WRZ experience the same risk of supply failure (Environment Agency and Natural Resources Wales, 2016). As part of the development of this plan, we are required to review the definition of our WRZs with the Environment Agency (EA) and ensure they meet the WRZ definition. We submitted our proposed WRZs to the EA in early 2017 and our subsequent discussions with the Agency led to the final versions summarised in this plan

Sustainability reductions in our former Hampshire South WRZ have affected our abstractions from the Rivers Test and Itchen and present a significant challenge to the supply-demand balance and change the balance of risk. Characterising this WRZ as a single WRZ is no longer appropriate because constrictions between sub-zonal areas within the WRZ may cause customers in different sub-zones to experience different levels of risk. Previously, we managed any issues in different parts of the network by taking up the headroom from the River Test or Itchen. The recent licence changes have made it more challenging for us to move water from other parts of the network to these locations to compensate. The existing network configuration does not allow us to manage these requirements, with the trunk mains tending to point away from these sources rather than towards them.

Because of this fundamental change in the supply-demand balance in this area, we have had to revisit the configuration of the WRZs to reflect the altered balance of risk caused by the potential loss of the two largest sources in the former Hampshire South WRZ.

Compared to our previous plan (WRMP14) we have divided the Hampshire South WRZ into four new WRZs. The names for the new WRZs are Hampshire Rural (HR), Hampshire Winchester (HW), Hampshire Southampton West (HSW) and Hampshire Southampton East (HSE). We have defined the new zonal boundaries based on key transfer locations between discrete zones, with the boundaries being either at valves or at booster stations (Figure 1, Appendix A).

The other change to our WRZs is in the Kent Medway WRZ. There is an existing natural east-west division at our major source from the River Medway Scheme near Rochester. We can pump water from here to the east or west normally allowing us to balance in supplies in either direction.

In our previous plan, we recognised that there is 'locked-in' deployable output (DO) in the eastern part of the Kent Medway WRZ, whereby the total DO for a number of sources exceeds the demand within that part of the network. A scheme is currently being implemented that will allow for better distribution of the water available from the sources in the eastern part of the WRZ. This represents a good opportunity to rezone the Kent Medway WRZ to reflect the imbalance in the resource availability between the east and west.

We believe it is sensible to divide the WRZ into two - Kent Medway East (KME) and Kent Medway West (KMW) (Figure 3, Appendix A). An existing booster station will form the boundary between the two WRZs, supplying water from west to east. The benefits of this change will be to have a smaller number of sources in the separated WRZs, demonstrate the movement of water from the KMW WRZ to KME WRZ, and assist with identifying any further locked-in DOs or resilience risks.

The risk to supplies in all of our other WRZs is unchanged.

1.3 Climate change vulnerability assessment

We have completed our climate change vulnerability assessment in line with the current Water Resource Planning Guideline (WRPG) (Environment Agency, and Natural Resources Wales 2017, Charlton and Watts, 2017). This tells us about the likelihood and size of climate change impacts on water resources across each of our areas.

Our initial assessment (Table 2) suggests that most of our WRZs are of low overall vulnerability to climate change. Two WRZs, Sussex North (SN) and Sussex Hastings (SH), are highly vulnerable and several others are of medium vulnerability. We have carried out an advanced analysis of climate change impacts on water supplies in these WRZs.

Forecasts from our previous plan (WRMP14) suggested that the most likely impacts upon supply would be only minor up to the 2040s (less than 5% of WRZ DO). However, a wide range of uncertainty exists between wetter or drier futures that we must reflect in our modelling approach for this plan.

Our groundwater sources are generally resilient to climate change but are more vulnerable where we have coastal aquifers or shallow well and adit sources. These sources may be vulnerable to saline intrusion from rising sea level and to more severe droughts. We are most vulnerable to climate change in WRZs where surface water supplies are greater.

National climate change forecasts developed for the whole of the United Kingdom ('UKCP09') are available. We also have water resource models that cover nearly all of our surface and groundwater sources. For WRMP14 we adopted a climate change impact assessment method suitable for highly

vulnerable WRZs. We sampled the UKCP09 probabilistic data to perturb input rainfall and potential evapotranspiration (PET) sequences to our water resource models.

In this plan, we have examined climate change factors from the UKCP09 probabilistic datasets for the period 2070-2099. Our approach recognises the medium to high vulnerability of some water resources zones. This approach also meets or exceeds the minimum requirements of current planning guidance.

Table 2 Initial climate change vulnerability based on the modelling undertaken for our 2014 WRMP

Water resource zone	Post WRMP 2014 climate change vulnerability (After Atkins, 2013b)		
	Peak deployable output (PDO)	Minimum deployable output (MDO)	Overall vulnerability
Hampshire Kingsclere	Low	Low	Low
Hampshire Andover	Low	Low	Low
Hampshire South (Hampshire Southampton East, Hampshire Southampton West, Hamshire Rural, Hampshire Winchester)	Medium	Low	Medium
Isle of Wight	Low	Low	Low
Sussex North	Medium	High	High
Sussex Worthing	Low	Low	Low
Sussex Brighton	Low	Medium	Medium
Sussex Hastings	Low	High	High
Kent Medway (Kend Medway East, Kent Medway West)	Low	Medium	Medium
Kent Thanet	Medium	Low	Medium

. We have extended our supply forecasts to use UKCP09 climate change projections for the period from 2070 to 2099. This horizon is consistent with our 50-year plan out to 2070. We have sampled our climate change factors from all emission scenarios. UKCP09 considers each scenario as equally probable but some may have greater water resource impact.

Each emissions scenario comprises 10,000 probabilistic projections of climate variables. Modelling this many scenarios is not practical with our current water resource models. Instead, we have employed a rapid screening procedure to reduce these data to a smaller number of scenarios. This process will estimate climate change impacts on our main drought and resource indicators of rainfall and recharge. We then 'smartly' sample the data to produce a smaller set of climate change factors that reflects the parent data. We have used consistent samples to assess climate change impacts on both supply and demand and have reflected climate change uncertainty in our supply demand balance.

1.4 Pre-consultation

Between May 2015 and October 2017 in preparation of our plan, we engaged with stakeholders and customers. We wanted to learn about their priorities, views on the development of our plan, find opportunities for collaboration and learn from examples of best practice. We also engaged with our regulators to keep them informed on the developments of our plan, to explain our methods approaches and report results.

We held county-specific stakeholder workshops, formed stakeholder panels and sent a WRMP pre-consultation letter to all our stakeholders (Appendix E).

We have taken into account our understanding of customer preferences from our previous plan. We have also assessed whether those preferences had changed, and collected more data through a scheme preference online survey, willingness to pay research and scheme preference workshops.

Our key findings from stakeholders include:

- Stakeholders are keen to work with us on catchment management and to support us doing more of it
- We should work with landowners to help slow and manage flows
- Water efficiency should be the first option we implement to increase the amount of water available, followed by further leakage reduction
- Stakeholders want us to consider water efficiency options before implementing new supply options such as transfers and water reuse
- After demand reduction options, water reuse is the most popular supply option

Our main findings from customers include:

- Customers are averse to accepting reductions in service levels in exchange for lower bills
- Underground water storage was our customers preferred measure for maintaining a supply-demand balance
- Leakage improvements are a high priority to customers amongst the water service measures
- For the majority of customers a bill increase to help implement schemes is reasonable

Our pre-consultation was important to understand customers' views. It has informed us on appropriate levels of service and, together with stakeholders, their views on the supply and demand management options. It has contributed to the development and formulation of our preferred strategy by excluding options that were not likely to meet customer or regulator expectations in the options appraisal. We have reflected customer preferences in our decision making methodology.

1.5 Levels of service

Levels of service set out the standard of service that customers receive or can expect to receive from their water company. The objective of a WRMP is to ensure that there is enough water available to meet anticipated demands in all WRZs up to a defined level of service and resilience.

We have developed a 'fully risk based' plan in keeping with our adopted risk principal (See our 'problem characterisation' section). We have therefore considered a wide range of droughts based on statistical generation of synthetic weather sequences. These weather data are consistent with the observed climate within each WRZ, but allow us to simulate many synthetic drought events. We use these events to evaluate resilience, the levels of service we can achieve and any options we might need to implement to maintain or improve our service.

Our pre-consultation research looked at willingness to pay for changes to our previous levels of service. Specifically the frequency of Temporary Use Bans (TUBs) and of Emergency Drought Orders leading to rota cuts in supply. Our customers appear to disfavour any reduction in level of service relative to water supply and only weakly prefer an improvement to levels of service, we consider this to be a strong signal that there is limited customer support to change to our current levels of service.

Our target levels of service set out what we aim to achieve. We use two themes of levels of service that are relevant to water resource planning:

- Customer target levels of service – which relate to the frequency and nature of restrictions that customers may experience (in the form of TUBs) restricting different categories of water use, and Drought Orders on non-essential water use during drought conditions); and
- Environmental target levels of service – which relate to the frequency we would use Drought Permits and Orders to allow modified abstraction regimes outside normal licence conditions at some of Southern Water's sources.

Table 3 shows our target levels of service. We have shown these as an average annual probability and as a return period. From these it is possible to estimate the chance of at least one occurrence of each event within the lifetime of our plan.
We anticipate that, on average, we will only have to apply Temporary Use Bans for fewer than six periods in the next 50 years. We also anticipate that, on average, we will only have to apply Non Essential Use (NEU) bans two or three times in the next 50 years.

If we deliver our preferred strategy over the next 50 years, we are confident that, on average, we will need to apply for temporary abstractions beyond normal environmental safeguards 2 or 3 times during the lifetime of our 50-year plan. However, there is almost an 80% chance that we will not need to implement these measures at all.

Following the **River Itchen, River Test and Candover abstraction licence Public Inquiry**', the licence changes and adoption of the Section 20 agreement between Southern Water and the Environment Agency (2018) mean that in our Western area, we may need to implement TUBs more frequently until 2029. This could be up to four times in the next ten years. To ensure resilient supplies we will also be more reliant on Drought Permits and Orders in these areas. We may also need to apply for temporary abstractions beyond normal environmental safeguards up to four times in the Western area during the next ten years until we can deliver additional supply solutions.

Our investment proposals mean we expect there to be a less than 10% chance that we will have to resort to restrictions such as rota cuts or standpipes over the 50-year planning period of the WRMP. Our exploration of the impact of severe droughts has suggested that in the longer term we will not require use of environmental Drought Permits and Orders to increase abstractions beyond licenced quantities out to at least a 1 in 200-year drought (0.5% annual probability). Although such Drought Orders and Permits may be required for more extreme events (out to 0.2% annual probability, or 1 in 500 year droughts), Emergency Drought Orders for standpipes and rota cuts will not. Our drought resilience means that we plan to meet and exceed the 'reference level of service' required by current guidance.

Table 3 Our current target levels of service

Type of restriction or measure	Annual probability	Return period	Probability of at least 1 occurrence within our 50 year planning period
Customer target levels of service			
Advertising to influence water use	20%	1 in 5 year	100%
Temporary Use Ban on different categories of water use	10%	1 in 10 year[1]	99%
Drought Order (NEU) to restrict water use	5%	1 in 20 year[1]	92%
Emergency Drought Order to restrict water use	0.2%	Only in a civil emergency (1 in 500 years)	10%
Environmental target levels of service			
Drought Permit/Order to increase supplies through relaxation of licence conditions, increase in licensed quantities, or other measures[2]	0.5%	1 in 200 year	22%

[1] Frequency of first implementation but would be introduced via a phased approach

[2].For Hampshire Southampton East and Hampshire Southampton West WRZs we expect the short term level of service for these Drought Permits and Orders to be less than our target

2. Problem characterisation (Stage 3 of UKWIR 2016a)

2.1 Introduction

The EA's Water Resources Planning Guideline (WRPG) (2016) sets an expectation that in developing their WRMP. Water companies should follow the UKWIR 'decision making process' framework and the 'risk based planning' (UKWIR, 2016a, 2016b) guidance. We have adopted this methodology to:

- Understand the problems we need to solve ('problem characterisation') in order to select an appropriate decision making (options appraisal) method for our problem
- Decide on the approach to including risks in our plan and the methods that will be used for evaluating drought risk (risk composition)
- Decide on supply, demand, outage and headroom methods appropriate for the chosen options appraisal method and risk composition

This chapter describes the 'problem characterisation' assessment that we have undertaken and our selection of appropriate decision making methodologies to address these problems in our WRMP. Our assessment therefore follows Stage 3 and Stage 4 of the UKWIR (2016a, 2016b) 'decision making process'. We have provided more details of our methodology and these techniques in Annexes 2, 3, 5 and 8.

The problem characterisation assessment is intended to be a means for water companies to determine their vulnerability to various strategic issues, risks and uncertainties (UKWIR, 2016a). The characterisation, along with the decision making process also steers water companies to develop a proportional response to those risks and uncertainties, in terms of the effort and cost of the selected decision making approach. Following the problem characterisation and decision making process also provides a documented and auditable trail which water companies can use to explain decisions to regulators and stakeholders.

2.2 Problem characterisation – evaluate strategic needs and complexity

The UKWIR (2016a) 'problem characterisation' step requires water companies to address a number of prompted questions that reflect the perceived strategic risks and uncertainties. The assessment addresses four main themes:

1. An evaluation of the strategic WRMP risks
2. Assessment of the supply side complexity
3. Assessment of the demand side complexity
4. Assessment of the investment program complexity

We have chosen to apply the problem characterisation step at the level of our three strategic supply areas; Western, Central and Eastern. Each supply area consists of multiple WRZs in the same geographical area where there is some connectivity of supplies between each WRZ. We have provided more detail on the arrangement of our major water supply areas in our Technical Overview report. We discuss the characteristics of each WRZ further in our Water resource zone integrity assessment.

Table 4 to Table 15 summarise the outcome of a workshop held in July 2016 involving four water resources planning specialists (Johnathan Burke, Simon Cook, Meyrick Gough and Nicholas Price). Each specialist used expert judgement based on their water resources planning and company

specific knowledge to assess each strategic risk and complexity factor. The rationale for the selected levels of significance is also included in the tables below.
By the nature of the assessment some responses are subjective and opinions varied between individual specialists, and we addressed this by the following approach:

- Where there were differences of opinion, the number of votes for different scores are shown
- An overall company position reflecting the majority position is provided in the right hand column
- Where votes were tied between different options a conservative approach was adopted and the higher response/score selected.
- The final outcome of each assessment is shown in the “Final Score” column of Table 4 to Table 15

The scores assigned against each assessment are aggregated both by supply area and then at an overall company level in order to inform the selection of an appropriate risk based planning methodology for our WRMP.
As these assessments were undertaken in July 2016, the response reflects the views and perceived strategic risks of Southern Water at that time. However, in some cases risks and uncertainties have materialised or become more certain, for example the timing and magnitude of some sustainability reductions in the Western area (see Annex 3). As these risks were generally already perceived, at the time the problem characterisation and decision making process we have adopted already appropriately reflects these risks. However, to demonstrate the procedure we have not modified the responses in the tables in response to these changes.

2.2.1 Western area

Table 4 Assessment of the 'Strategic Needs' for WRMP purposes; *"How big is the problem?".* Western area total score = 5

Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
S. Level of concern that customer service could be significantly affected by current or future **supply side** risks, without investment	**0 Votes**	**0 Votes**	**4 Votes** **Justification:** *Large certain sustainability reduction for the R.Itchen, potentially large sustainability reductions for the R.Test.* *Potential for further uncertain sustainability reductions in relation to Itchen Valley Site of Special Scientific Interest and application of Common Standards Monitoring Guidance targets; and from Water Framework Directive risk of deterioration* *Candover scheme may not provide resilience if EA does not renew licence* **We have very significant concerns over potential large step changes to supply in the Western area as a result of potential licence changes or sustainability reductions**	**2**
D. Level of concern that customer service could be significantly affected by current or future **demand side** risks, without investment	**0 Votes**	**4 Votes** *Hotspot growth in Eastleigh and around Southampton* *Investment on Isle of Wight currently driven by peak summer demand due to tourism - risks around forecasting peak demands in dry years* *Differences between growth forecasts from DCLG and Local Authorities (LA) wanting lower growth.* *More uncertainty over 50 years*	**0 Votes**	**1**

		We have moderately significant concerns over demand side risks arising from uncertainty in growth forecasts and peak demand in the Western area		
I. Level of concern over the acceptability of the cost of the likely **investment programme**, and/or that the likely investment programme contains **contentious options** (including environmental/planning risks)	**0 Votes**	**0 Votes**	**4 Votes** *The scale of investment programme needed to ensure sustainable Test and Itchen catchments will be costly and will likely contain contentious options such as desalination, water reuse, the Candover Augmentation Scheme and/or transfers from neighbouring water companies who also abstract from the Chalk.* *Risk of planning inquiry due to above.* **We have very significant concerns over the cost and acceptability of the investment programme required in the Western area to ensure our abstractions are sustainable. The options required to solve the scale of deficit are also likely to be contentious.**	**2**

Table 5 Assessment of the 'Supply Side' complexity for WRMP Purposes. Western area total score = 6

S	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
S(a)	Are there concerns about **near term supply system performance**, either because of recent level of service failures or because of poor understanding of system reliability/resilience under different or more severe droughts than those contained in the historic record? Is this exacerbated by uncertainties about **the benefits of operational interventions contained in the Drought Plan**?	**0 Votes**	**3 Votes** *Benefits of operational drought interventions are uncertain given this area has not experienced droughts in recent times.* **We have moderately significant concerns over supply system performance in the Western area. Although the 'stochastic' work we have undertaken to examine the impacts of more extreme droughts is beneficial in determining system reliability, when considered in combination with potential sustainability reductions indicates potential large reductions in DO. Drought interventions (Drought Orders and Permits) have historically not been required in Hampshire and thus their reliability is untested.**	**1 Vote** *Poor understanding of system reliability in severe drought events.*	**1**
S(b)	Are there concerns about **future supply system performance**, primarily due to uncertain impacts of **climate change** on vulnerable supply systems, including associated source deterioration (water quality, catchments etc.), or poor understanding?	**0 Votes**	**3 Votes** *Uncertain future impact of raw water quality changes including nitrate pollution* *and climate change* ***We have moderately significant concerns over future supply system performance primarily arising from concerns over water quality (nitrates)***	**1 Votes** *20Ml/d DO reduction due to breach of nitrate levels* *Lack of evidence to fully understand risks*	**1**

S	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
S(c)	Are there concerns about the potential for **'stepped' changes in supply** (e.g. sustainability reductions, bulk imports etc.) in the near or medium term **that are currently very uncertain**?	**0 Votes**	**0 Votes**	**4 Votes** *Significant concerns due to nitrates (e.g. Twyford), and SRs (e.g. Test Surface Water, Alresford)* ***We have very significant concerns over large potential stepped changes in supply arising from sustainability reductions in the Western area***	**2**
S(d)	Are there concerns that the '**DO' metric might fail to reflect resilience** aspects that influence the choice of investment options (e.g. duration of failure), or are there **conjunctive dependencies between new options**(i.e. the amount of benefit from one option depends on the construction of another option).These can both be considered as ***non-linear problems.***	**0 Votes**	**2 Votes** *Catchment management solutions could be very beneficial in mitigating low flows and impact of abstraction* *New schemes likely to be non-linear.*	**2 Votes** *Significant and complex interdependencies between options e.g. Test Surface Water scheme and Candover augmentation scheme* ***We have very significant concerns over the conjunctive dependencies of existing and future options for the Western area***	**2**

Table 6 - Assessment of the 'Demand Side' complexity for WRMP Purposes. Western area total score = 3

D	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
D(a)	Are there concerns about **changes in current or near term demand**, e.g. in terms of demand profile, total demand, or changes in economics/demographics or customer characteristics?	**0 Votes**	**4 Votes** *Outturn demand is currently lower than forecast (at company level) partly due to greater than expected savings from Universal Metering Programme (UMP) Some uncertainty around UMP 'bounce back' effect; Uncertain impact of Brexit on near term Non-Household (NHH) demand.* **We have moderately significant concerns over current and near term demand arising from the effects of metering and political uncertainty**	**0 Votes**	**1**
D(b)	Does **uncertainty associated with forecasts** of demographic / economic / behavioural changes over the planning period cause concerns over the level of investment that may be required?	**0 Votes**	**4 Votes** *Some uncertainty around impact of Brexit on immigration / growth and NHH demand from an economic growth perspective (but possibly bigger issue in Eastern area than Western area).* *General uncertainty about economic forecast and how this might impact demand - potentially a 20Ml/d drop due to downturn in economy? Esso demand is uncertain. Ford plant closure has an impact but could it return?* **We have moderately significant concerns over potential demographic and economic changes which could lead to step changes non household consumption**	**0 Votes**	**1**

D(c)	Are there concerns that a simple **'dry year/normal year' assessment of demand is not adequate**, e.g. because of high sensitivity of demand to drought (so demand under severe events needs to be understood), or because demand versus drought timing is critical.	**1 Vote** *We have reasonable confidence that it is adequate*	**2 Votes** *Although some uncertainty around dry year and peaking factors following UMP. We are reviewing these. Drought timing is critical in the Western area – often high demands occur in winter with high resource constraint* **We have moderately significant concerns over dry year demand owing to the effects of metering and that demands under severe and extreme droughts are poorly characterised. Historic high winter demands have been associated with severe winters (from mains bursts).**	**1 Votes** *Some uncertainty around impact of severe droughts of demand*	**1**

Table 7 - Assessment of the Investment Programme complexity for WRMP purposes. Western area total score = 8

I	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
I(a)	Are there **concerns that capex uncertainty** (particularly in relation to new or untested technologies) could compromise the company's ability to select a 'best value' portfolio over the planning period?	**0 Votes**	**1 Vote** *Desalination options and necessary mitigation for these is untested in this part of the country.* *Catchment management options have inherent uncertainties around cost and benefit*	**3 Votes** *Southern Water (SWS) has never built a desalination plant and is aware of problems experienced by Thames Water.* *SWS does not have membrane treatment for desalination or water reuse schemes. Nor does it have any panel engineers for building reservoirs.* *Recent experience only in bulk transfers.* **We have very significant concerns over the cost and environmental impact of options (desalination) likely to be required to address potential supply deficits in the Western area**	**2**
I(b)	Does the nature of feasible options mean that **construction lead time or scheme promotability** are a major driver of the choice of investment portfolio?	**0 Votes**	**0 Votes**	**4 Votes** *Potentially a very significant influence – large schemes likely to be needed but will have a long lead in time due to design, consenting, construction, and promotion so a trade off with drought options could be needed. These might be acceptable in short term, but might be less so in the longer term* **We have very significant concerns over the both the construction lead times and promotability of options required in the Western area owing to the magnitude of volumes required.**	**2**
I(c)	Are there **concerns that trade-offs between costs and non-monetised 'best value' considerations** (social, environment) are so complex that they require quantified analysis	**0 Votes**	**1 Vote** *Some concerns due to impacts / benefits of options that cannot be monetised*	**3 Votes** *The Benefits Assessments Guidance (BAG) methodology doesn't monetise environmental costs very well.* *We were discouraged from developing our proposed approach to environmental forecasting by regulators. Challenges around incorporating / monetising*	**2**

	(beyond SEA) to justify final investment decisions.			*landowner constraints and wider stakeholder views. Environmental constraints are evolving and difficult to quantify.* **We have very significant concerns that customer and environmental preferences are not well captured by existing cost-benefit methods**	
I(d)	Is the investment programme sensitive to assumptions about the utilisation of new resources, mainly because of large differences in variable opex between investment options?	**0 Votes**	**0 Votes**	**4 Votes** *Yes when considering desalination and water reuse options likely to be needed in this area.* *Frequency of use in different types of drought is a consideration; TWUL have learnt they need a sweetening flow for membranes. So base flow opex implications.* **We have very significant concerns over investment utilisation given our existing assessment of DO to more severe, but plausible low probability droughts beyond the historic record.**	**2**

2.3.1 Central area

Table 8 - Assessment of the 'Strategic Needs' for WRMP purposes; *"How big is the problem?".* Central area total score = 4

Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
S. Level of concern that customer service could be significantly affected by current or future **supply side** risks, without investment	**0 Votes**	**4 Votes** *Rising nitrate levels likely to reduce supply availability* *Concern around resilience of supplies to more severe (different duration and intensity) drought events* *Potential impact of Water Framework Directive risk of deterioration* **We have moderately significant concerns over supply availability. Recent modelling to define drinking water protected areas and nitrate trends at abstraction sources has identified impacts at 7 groundwater sources. Further impacts are expected for pesticides at 2 surface water sources. These are likely to require nitrate or other treatment if effects on supplies are to be avoided.**	**0 Votes**	**1**
D. Level of concern that customer service could be significantly affected by current or future **demand side** risks, without investment	**0 Votes**	**4 Votes** *If supply remained constant, demand increases would drive investment later in the planning period. Some differences between DCLG and LA growth expectations but not as much as Western area; However growth hotspots expected.* **We have moderately significant concerns over the demand forecast which indicates investment is likely to meet rising demand within the planning period.**	**0 Votes**	**1**
I. Level of concern over the acceptability of the cost of the likely **investment programme**, and/or that the likely investment programme contains	**0 Votes**	**2 Votes** *Some concern around cost and acceptability of Ford water re-use scheme planned for AMP8*	**2 Votes** *Risks around costs, promotability, and benefit of water re-use, desalination and*	**2**

contentious options (including environmental/planning risks)	*Potential planning and benefit uncertainty around aquifer storage and recovery (ASR)*	*ASR schemes given these are untested in this area by SWS* **We have very significant concerns over some investment solutions that may be required for Central area and the technical viability of such solutions which are currently unproven (e.g. ASR).**

Table 9 - Assessment of the 'Supply Side' complexity for WRMP purposes. Central area total score = 6

S	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
S(a)	Are there concerns about **near term supply system performance**, either because of recent level of service failures or because of poor understanding of system reliability/resilience under different or more severe droughts than those contained in the historic record? Is this exacerbated by uncertainties about **the benefits of operational interventions contained in the Drought Plan**?	**0 Votes**	**2 Votes** *Some concern around supply performance in severe or different intensity / duration droughts*	**2 Votes** *Brighton and Worthing groundwater model improves our ability to understand system resilience to drought but is untested (i.e. we have no observation data for events outside the historic record)* *Historically level of service has been less than 1 in 10 years for restrictions.* *Currently the WRMP14 supply assessment and GW model do not agree on all sources.* **We have very significant concerns over supply system performance. Use of synthetic droughts and recent modelling experience suggests some source DOs may reduce significantly under extreme drought.**	**2**
S(b)	Are there concerns about **future supply system performance**, primarily due to uncertain impacts of **climate change** on vulnerable supply systems, including associated source deterioration (water quality, catchments etc.), or poor understanding?	**0 Votes**	**2 Votes** *Impact of rising nitrates on supply availability*	**2 Votes** *Risks around water quality deterioration (e.g. nitrates) and catchment pressures (e.g. changing flood risk management strategy in the River Arun)* **We have very significant concerns, especially relating to water quality, primarily nitrates. We are actively engaged in catchment management across the Central area but recent modelling of nitrate trends have suggest impacts on DO at several sources. There are further risks from saline intrusion associated with sea level rise.**	**2**
S(c)	Are there concerns about the potential for **'stepped' changes in supply** (e.g. sustainability reductions, bulk imports etc.) in the near or medium term **that are currently very uncertain**?	**0 Votes**	**3 Votes** *No imminent large SRs or changes in bulk supplies expected but potential for Water Framework Directive related SRs in medium term*	**1 Vote** *Concern over impact of Water Framework Directive risk of deterioration upon DOs*	**1**

S	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
			We have moderately significant concerns that the central area will be subject to future sustainability reductions associated with Water Framework Directive drivers.		
S(d)	Are there concerns that the '**DO' metric might fail to reflect resilience** aspects that influence the choice of investment options (e.g. duration of failure), or are there **conjunctive dependencies between new options**(i.e. the amount of benefit from one option depends on the construction of another option).These can both be considered as ***non-linear problems.***	**0 Votes**	**3 Votes** *Some concern around relationship between DO and true resilience of Area* **We have moderately significant concerns that the DO metric does not fully represent the flashy nature of the Brighton and Worthing Chalk aquifer and the traditional concept of "leakage and storage" conjunctive source operation is unproven.**	**1 Vote** *Significant concern that the current DO metric overstates resilience of Brighton and Worthing Chalk Block sources*	**1**

Table 10 - Assessment of the 'Demand Side' complexity for WRMP purposes. Central area total score = 3 (average specialist score = 3.25)

D	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
D(a)	Are there concerns about **changes in current or near term demand**, e.g. in terms of demand profile, total demand, or changes in economics/demographics or customer characteristics?	**0 Votes**	**4 Votes** *Outturn demand is currently lower than forecast (at company level) partly due to greater than expected savings from Universal Metering Programme (UMP)* *Some uncertainty around UMP bounce back' effect;* *Uncertain impact of Brexit on near term Non-Household (NHH) demand.* **We have moderately significant concerns around near term demand largely relating to the uncertain effects of metering**	**0 Votes**	**1**
D(b)	Does **uncertainty associated with forecasts** of demographic / economic / behavioural changes over the planning period cause concerns over the level of investment that may be required?	**0 Votes**	**4 Votes** *Some uncertainty around impact of Brexit on immigration / growth and NHH demand from an economic growth perspective (but possibly bigger issue in Eastern area than Central area).* *General uncertainty about economic forecast and how this might impact demand* **We have moderately significant concerns over potential demographic and economic changes which could lead to step changes non household consumption**	**0 Votes**	**1**
D(c)	Are there concerns that a simple **'dry year/normal year' assessment of demand is not adequate**, e.g. because of high sensitivity of demand to drought (so demand under severe events needs to be understood),	**0 Votes**	**3 Votes** *Some uncertainty around how dry year and peaking factors could be different following UMP. However we are reviewing these.* **We have moderately significant concerns over dry year demand owing to the effects of metering and**	**1 Votes** *Significant concern in how severe drought could impact upon demand, existing dry year and peak demands are based on historic data and no data exist for severe droughts.*	**1**

	or because demand versus drought timing is critical.	**that demands under severe and extreme droughts are poorly characterised**

Table 11 - Assessment of the Investment Programme complexity for WRMP purposes. Central area total score = 7 (average specialist score = 6.25)

I	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
I(a)	Are there **concerns that capex uncertainty** (particularly in relation to new or untested technologies) could compromise the company's ability to select a 'best value' portfolio over the planning period?	**0 Votes**	**0 Votes**	**4 Votes** *Over a 50 year planning horizon, options such as desalination will likely be selected. Southern Water (SWS) does not have experience of building desalination plants and is aware of problems experienced by Thames Water.* *SWS does not have membrane treatment for desalination or water reuse schemes. Nor does it have any panel engineers for building reservoirs. Recent experience only in bulk transfers.* **We have very significant concerns over the cost and environmental impact of options (desalination) likely to be required to address potential supply deficits in the Central area**	**2**
I(b)	Does the nature of feasible options mean that **construction lead time or scheme promotability** are a major driver of the choice of investment portfolio?	**0 Votes**	**2 Votes** *Moderate concern that limited options available that can be implemented quickly, and alternative schemes have an uncertain lead time e.g. Ford water reuse*	**2 Votes** *Potentially a very significant influence – large schemes likely to be needed but will have a long lead in time due to design, consenting, construction, and promotion.* *Planned schemes including Ford water reuse and ASR will come under close public scrutiny and could result in an inquiry.* **We have very significant concerns over the both the construction lead times and promotability of options required in the central area owing to the magnitude of volumes required based on our WRMP14 submission.**	2

I	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
I(c)	Are there **concerns that trade-offs between costs and non-monetised 'best value' considerations** (social, environment) are so complex that they require quantified analysis (beyond SEA) to justify final investment decisions.	**0 Votes**	**4 Votes** *Some concerns due to impacts / benefits of options that cannot be monetised* *The Benefits Assessments Guidance (BAG) methodology does not monetise environmental costs very well.* *Environmental constraints are evolving and difficult to quantify.* **We have moderately significant concerns that customer and environmental preferences are not well captured by existing cost-benefit methods. Overall we feel that the Central area is less sensitive to these factors compared to the Western area, hence the lower score.**	**0 Votes**	1
I(d)	Is the investment programme sensitive to assumptions about the utilisation of new resources, mainly because of large differences in variable opex between investment options?	**0 Votes**	**1 Vote** *Moderate concern around frequency of use of schemes such as water reuse in different types of drought.*	**3 Votes** *Yes, significant, when considering options such as water reuse and desalination which will likely be needed in this Area over the 50 year planning horizon.* **We have very significant concerns over investment utilisation given our existing assessment of DO to more severe, but plausible low probability droughts beyond the historic record.**	2

2.3.2 Eastern area

Table 12 - Assessment of the 'Strategic Needs' for WRMP purposes; "How big is the problem?". Eastern area total score = 4

Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
S. Level of concern that customer service could be significantly affected by current or future **supply side** risks, without investment	**0 Votes**	**4 Votes** *Rising nitrate levels likely to reduce supply availability* *Concern around resilience of supplies to more severe (different duration and intensity) drought events* *Potential impact of Water Framework Directive risk of deterioration* **We have moderately significant concerns regarding supply side risks in the Eastern area. Primarily arising from water quality impacts in Kent Thanet WRZ, drought sensitivity and ensuring sustainable abstractions**	**0 Votes**	**1**
D. Level of concern that customer service could be significantly affected by current or future **demand side** risks, without investment	**0 Votes**	**2 Votes** *If supply remained constant, demand increases would drive investment later in the planning period* *Some differences between DCLG and LA growth expectations but not as much as Western area; However growth hotspots expected.*	**2 Vote** *Significant concern around impact of Brexit upon demand and predicting future demand in light of uncertain political and economic outlook* **We have very significant concerns over demand side risks in the Eastern area. The Eastern area has a greater degree of agricultural water use and the impacts of Brexit, agricultural and abstraction reform are likely to be most keenly felt here.**	**2**
I. Level of concern over the acceptability of the cost of the likely **investment programme**, and/or that the likely investment programme contains **contentious options** (including environmental/planning risks)	**0 Votes**	***3 Votes*** *Some concern around cost and acceptability of Medway water reuse scheme planned for AMP7* **We have moderately significant concerns over likely investment options required for the Eastern area. Primarily these relate to the water reuse scheme at Medway**	**1 Votes** *Risks around costs, promotability, and benefit of water reuse and desalination schemes given these are untested in this area by SWS and likely to be needed over the 50 year planning horizon.*	**1**

Table 13 - Assessment of the 'Supply Side' complexity for WRMP purposes. Eastern area total score = 6

S	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
S(a)	Are there concerns about **near term supply system performance**, either because of recent level of service failures or because of poor understanding of system reliability/resilience under different or more severe droughts than those contained in the historic record? Is this exacerbated by uncertainties about **the benefits of operational interventions contained in the Drought Plan**?	**0 Votes**	**1 Vote** *Moderate uncertainty around the benefit of groundwater Drought Permit options*	**3 Votes** *Historically level of service has been less than 1 in 10 years for restrictions and applying for Drought Permits / Orders.* *Reliability of the River Medway Scheme is subject to uncertainties around the hydrological sequences used which are based upon rainfall-runoff models - these are currently being reviewed.* **We have very significant concerns in the Eastern area around the levels of service of drought measures and our current hydrological models in determining supply side risks**.	**2**
S(b)	Are there concerns about **future supply system performance**, primarily due to uncertain impacts of **climate change** on vulnerable supply systems, including associated source deterioration (water quality, catchments etc.), or poor understanding?	**0 Votes**	**3 Votes** *Concern over impact of water quality deterioration including rising nitrates and pesticides on supply availability* **We have moderately significant concerns, especially from water quality impacts in Kent Medway WRZs (Metaldehyde) and nitrates in Kent Thanet. Additional monitoring, catchment management, smart abstraction trials are underway but treatment solutions may still be required.**	**1 Vote** *Significant concern over increased vulnerability of catchments to climate change driven pressures such as increased salinity, increased use of pesticides and nitrates; as well as more extreme weather patterns.*	**1**

S	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
S(c)	Are there concerns about the potential for **'stepped' changes in supply** (e.g. sustainability reductions, bulk imports etc.) in the near or medium term **that are currently very uncertain**?	**0 Votes**	**1 Votes** *No imminent large SRs or changes in bulk supplies expected but potential for Water Framework Directive related SRs in medium term*	**3 Votes** *Concern over impact of Water Framework Directive risk of deterioration upon DOs* *Potential for changes in bulk supplies depending on strategies of neighbouring water companies e.g. SEW and whether it promotes Broad Oak Reservoir* **We have very significant concerns over a number of known Water Framework Directive investigations in the Eastern area and a large number of NEP schemes in order to ensure sustainable abstraction. Uncertainty over future bulk supply arrangements raises further concerns**	**2**
S(d)	Are there concerns that the '**DO' metric might fail to reflect resilience** aspects that influence the choice of investment options (e.g. duration of failure), or are there **conjunctive dependencies between new options**(i.e. the amount of benefit from one option depends on the construction of another option).These can both be considered as ***non-linear problems.***	**0 Votes**	**3 Votes** *Some concern around relationship between DO and true resilience of area* **We have moderately significant concerns over both the resilience of the Eastern area and the conjunctive use of future options. This relates to Levels of Service concerns with regard to operation of the River Medway scheme and its future interaction with WRMP14 options (e.g. Medway water reuse).**	**1 Vote** Significant concern around conjunctive relationship / benefit between the River Medway Scheme, Medway water reuse, groundwater sources and potential new SEW schemes e.g. Broad Oak Reservoir	**1**

Table 14 - Assessment of the 'Demand Side' complexity for WRMP purposes. Eastern area total score = 3 (average specialist score = 3.5)

D	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
D(a)	Are there concerns about **changes in current or near term demand**, e.g. in terms of demand profile, total demand, or changes in economics/demographics or customer characteristics?	**0 Votes**	**4 Votes** *Outturn demand is currently lower than forecast (at company level) partly due to greater than expected savings from Universal Metering Programme (UMP).* *Some uncertainty around UMP ' bounce back' effect.* *Uncertain impact of Brexit on near term Non-Household (NHH) demand.* **We have moderately significant concerns around near term demand largely relating to the uncertain effects of metering.**	**0 Votes**	**1**
D(b)	Does **uncertainty associated with forecasts** of demographic / economic / behavioural changes over the planning period cause concerns over the level of investment that may be required?	**0 Votes**	**3 Votes** *Some uncertainty around impact of Brexit on immigration / growth and NHH demand from an economic growth perspective.* *General uncertainty about economic forecast and how this might impact demand* **We have moderately significant concerns over potential demographic and economic changes which could lead to step changes non household consumption**	**1 Vote** *Significant concern over impact of Brexit and future economic outlook upon immigration and NHH demand.*	**1**
D(c)	Are there concerns that a simple **'dry year/normal year' assessment of demand is not adequate**, e.g. because of high sensitivity of demand to drought (so demand under severe events needs to be understood), or because	**0 Votes**	**3 Votes** *Some uncertainty around how dry year and peaking factors could be different following UMP. However, we are reviewing these.* **We have moderately significant concerns over dry year demand owing to the effects of**	**1 Vote** *Significant concern in how severe drought could impact upon demand*	**1**

	demand versus drought timing is critical.	**metering and that demands under severe and extreme droughts are poorly characterised**

Table 15 - Assessment of the Investment Programme complexity for WRMP purposes. Eastern area total sore = 6 (average specialist score = 5.75)

I	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
I(a)	Are there **concerns that capex uncertainty** (particularly in relation to new or untested technologies) could compromise the company's ability to select a 'best value' portfolio over the planning period?	**0 Votes**	**3 Votes** *Moderate concern that Southern Water (SWS) does not have membrane treatment for desalination or water reuse schemes. A water reuse scheme is planned in AMP7 and desalination could be needed over the 50 year planning horizon.* **We have very significant concerns over the cost and environmental impact of options (water reuse) likely to be required to address potential supply deficits in the Eastern area. There remains a possibility that desalination could be required but is generally thought to be less than Western and Central areas.**	**1 Vote** *Significant concern that future schemes such as water reuse are untested in this area and there is considerable uncertainty surrounding capital and opex costs.*	**1**
I(b)	Does the nature of feasible options mean that **construction lead time or scheme promotability** are a major driver of the choice of investment portfolio?	**0 Votes**	**2 Votes** *Moderate concern that limited options available that can be implemented quickly and easily, and alternative schemes have a long and uncertain lead time e.g. Medway water reuse.*	**2 Votes** *Potentially a very significant influence – large schemes likely to be needed over the 50 year planning horizon but will have a long lead in time due to design, consenting, construction, and promotion.* *Significant concern around recent delays experienced with consenting new schemes in Eastern area e.g. RMS and Sittingbourne licence variations* **We have very significant concerns over both the construction lead times, planning consents and promotability of options required in the Eastern area**	**2**

I	Strategic WRMP risks	No significant concerns (Score = 0)	Moderately significant concerns (Score = 1)	Very significant concerns (Score = 2)	Final Score
				owing to the magnitude of volumes required based on our WRMP14 submission and experience.	
I(c)	Are there **concerns that trade-offs between costs and non-monetised 'best value' considerations** (social, environment) are so complex that they require quantified analysis (beyond SEA) to justify final investment decisions.	**0 Votes**	**3 Votes** *Some concerns due to impacts / benefits of options that cannot be monetised. The Benefits Assessments Guidance (BAG) methodology does not monetise environmental costs very well. Environmental constraints are evolving and difficult to quantify.* **We have moderately significant concerns that customer and environmental preferences are not well captured by existing cost-benefit methods. Overall we feel that the Eastern area is less sensitive to these factors compared to the Western area, hence the lower score.**	**1 Vote** *More significant concern that it is difficult to monetise wider environmental impacts and benefits of schemes*	**1**
I(d)	Is the investment programme sensitive to assumptions about the utilisation of new resources, mainly because of large differences in variable opex between investment options?	**0 Votes**	**1 Vote** *Moderate concern around frequency of use of schemes such as Medway water reuse in different types of drought, and how it would be used conjunctively with other sources.*	**3 Votes** *Yes, significant, when considering options such as water reuse and desalination which will likely be needed in this area over the 50 year planning horizon.* **We have very significant concerns over investment utilisation given our existing assessment of DO to more severe, but plausible, low probability droughts beyond the historic record.**	**2**

2.4 Summary of problem characterisation results

The outcome of the problem characterisation assessment is a total 'strategic needs' score, and a total 'complexity factor' score for each supply area. In line with the decision making guidance these are combined in Table 16 and Table 17 below to understand the level of vulnerability faced and the resulting complexity of decision making tool ('modelling complexity') that is therefore justified.

The final results totalled for each area and expressed as an overall mean value for the company are presented in Table 16. Generally supply side factors were predominantly of very significant concern across all supply areas. Demand side complexity factors were considered to be less significant, but still of moderate concern. Investment complexity was also of very significant concern across all areas. This concern was largely a consequence of the likely high cost investment solutions required to meet supply side risks and, in some cases, the uncertain viability of options.

Table 16 – Collated results from each area and the overall problem characterisation score

		Complexity Factors Score			
Area	Strategic Needs Score	Supply	Demand	Investment	Overall
Western	5	6	3	8	17
Central	4	6	3	7	16
Eastern	4	6	3	6	15
Company	4.33	6	3	7	16

The Western area scored highest in terms of strategic needs and complexity followed by Central and Eastern area. The scores for all three areas, and consequently the company categorised them as 'medium' in terms of strategic need and 'high' in terms of complexity.

Under the UKWIR guidance (UKWIR 2016a) the appropriate level of modelling complexity is established by comparing the strategic needs score and the complexity factors score to the risk thresholds in the guidance (Table 17).

Table 17 – Assessment of modelling complexity

		Strategic Needs Score ("How big is the problem?")			
		0-1 (None)	2-3 (Small)	4-5 (Medium)	6 (Large)
Complexity Factors Score ("How difficult is it to solve?")	Low (<7)				
	Medium (7-11)				
	High (11+)			Central area Eastern area Western area **Company**	

2.5 Selecting an appropriate modelling method (Stage 4 of UKWIR 2016a)

Having undertaken the problem characterisation step (Stage 3 of UKWIR 2016a) the next stage is to use the outcome of the assessment to select appropriate risk based modelling methods and a decision making process.

2.5.1 Modelling method (Stage 4.2 of UKWIR 2016a)

The problem characterisation has established that given our strategic needs and the complexity of the problems we need to solve it would be appropriate for Southern Water to adopt an extended approach to water resource planning. The next stage (Stage 4.2 of UKWIR 2016a) is to consider whether an aggregated, system simulated or hybrid modelling method will be adopted.

For WRMP19 it is anticipated that the planning approach will be a hybrid approach to some extent, as the minimum requirement will be to perform a conventional Economic Balance of Supply and Demand (EBSD) assessment. This is to allow benchmarking and comparison against previous plans and other companies (Environment Agency and Natural Resources Wales, 2017). If 'extended' or 'complex' approaches are adopted, these can be used to further refine options and determine the 'best value' decision (UKWIR, 2016a).

Examining the problem characterisation quantitatively, the key complexity factor questions (I(a), I(b), I(d), S(a), S(b), S(c), D(a) and D(b)) that would favour an aggregated approach (UKWIR 2016a) have mostly highlighted very significant concerns. In contrast those questions that would favour a system simulated approach (I(c), I(d), S(b), S(c), S(d), D(b), D(c)) have mostly suggested more moderately significant concerns. Consequently, having reflected on the UKWIR (2016a) guidance, we have elected to adopt a dominantly aggregated approach but which includes some methodologies associated with both conventional and system simulation approaches. This conclusion is based on the following assessments:

- As part of the overall objectives for the WRMP we wish to consider Multiple Criteria Analysis (MCA) to inform the options selection process. This reflects the planning requirement to achieve an adequate supply-demand balance but also a regulatory expectation and company desire to better represent customer views in selection of future schemes. In addition there is a need to develop an increase in overall resilience and to achieve sustainable environmental outcomes in addition to selecting least cost options where appropriate
- There exists very significant concerns over the complexity of the investment programme, particularly in the Western area but also to a slightly lesser degree in Central and Eastern area (characterisations I(a), I(b), I(d)). These reflect concerns over capex uncertainty, scheme promotability and future utilisation of options, especially as large water reuse or desalinisation schemes might be required based on our submission for WRMP14
- Very significant concerns exist over both near term and future supply system performance across all areas. Potentially large stepped changes in deployable output (DO) because of sustainability reductions and deterioration in water quality are also possible in all areas within the planning period, most notably in the Western area. The Eastern area was also previously classified in WRMP14 to have a high vulnerability to the impacts of climate change (characterisations S(a), S(b), S(c).) and this concern remains
- Water quality concerns, particularly over the impact of nitrates, but also to a lesser extent pesticides such as metaldehyde are likely to impact supplies. These concerns will need to be addressed through our ongoing programme of catchment management, enhanced monitoring and behavioural change (e.g. smart abstraction) but it is likely that treatment solutions will be required to protect some resources.
- There are moderate concerns that DO metrics do not reflect the overall resilience of each area, most notably in the Central and Eastern area as the DO may overstate available groundwater storage at some sources. In the Western and Eastern area there are also significant concerns over the potential interdependencies of some supply options

(characterisation S(d)). There may also be resilience benefits arising from catchment management solutions that are not well demonstrated by DO.

- Overall, the demand side presents mostly moderate concerns but there remain issues relating to wider socio-economic factors and political uncertainty that increases overall near and medium term uncertainty in the demand estimates (characterisations D(a), D(b)).

We believe that adopting an aggregated risk approach offers us greater ability to account for the uncertainty in the selection and scheduling of future water resource options. This will allow our plan to accommodate large stepped changes in supplies primarily for the Western area but also from water quality concerns and sustainability changes elsewhere. The investment solutions required to accommodate such large step changes are likely to be highly complex with long lead and development times (e.g. desalination) and have multiple dependencies and interrelationships with other options (e.g. network enhancement, water supply works upgrades etc.). The flexibility offered by a Real Options approach will also allow plans to adapt to alternative pathways depending on future outcomes and support earlier adoption of 'no-regret' options that will help to provide better customer value for money.

Whilst system simulated approaches such as robust decision making offer an optimised and resilient plan against a given metric or set of metrics, they are generally poorer at providing an idea of scheduling and allowing flexibility in the near term. System simulation methods also tend to be better at addressing significant demand side concerns. Whilst we have identified some moderately significant concerns over demand, these tend to be relatively small compared to the supply and investment problems we face.

Although we will primarily adopt an aggregated approach we will continue to incorporate some system simulation methods within our overall planning as existing AQUATOR models will be used to model the distribution of supply system resources under drought conditions in order to help define DO.

2.6 Our planning horizon

Under our statutory obligations as a water supplier, we are required to produce a water resource management plan that covers at least the statutory minimum period of 25 years into the future. However, based on the outcomes of our problem characterisation we have elected to extend our planning horizon to 50 years, covering the period from 2020 to 2070. This will allow us to better address some of the strategic risks and challenges that we face, including:

- To allow us to consider the long term environmental impacts of our abstractions and options and to achieve sustainable solutions
- To allow us to explore and account for a wider range of uncertainty in our decision making, for example regarding the impacts of climate change or the growth of demand and therefore develop a more resilient plan

Some of our feasible options have long lead times for implementation and longer asset lives. A longer planning horizon will allow us to better consider the lifetime costs and environmental impacts of each.

2.7 Adopted risk principle

In addition to the selection of an appropriate decision making methodology the UKWIR guidance (2016b) recommends water companies adopt a stated 'risk principle' for their WRMP which outlines their performance commitments in terms of Levels of Service to customers (in respect of the frequency of demand restrictions) and resilience to droughts.

We will be adopting a fully risk based plan (risk principle 3) consistent with our extended decision making modelling approach to address the company strategic needs and complexity. That is to say that the methods employed will be appropriate to determine how risk of supply-demand deficits and/or demand restrictions will be determined probabilistically across a range of potential droughts. Additionally the WRMP will be linked to intervention measures described within the Drought Plan. In

accordance with the risk principle the following methods will be employed for the supply and demand forecasts. These are also described in more detail in Annexes 2 and 3.

2.7.1 Supply side assessment

To determine drought resilience, Southern Water are intending to further refine the stochastic weather generator approach used to derive synthetic severe drought sequences. A refinement plan has been agreed with the EA and a method statement stating how a range of plausible severe droughts will be selected was submitted to the EA in October 2016.

Droughts will initially be quantified using climatic metrics, expressed in terms of Standard Precipitation Indices (SPI's) but also additional metrics that consider the overall duration of rainfall deficits and the peak intensity of the drought event (maximum and accumulated rainfall deficits).

A library of droughts will be simulated from a very long stochastic time series (100,000 years) and water supply systems will be tested against a range of possible drought types as measured by different durations, intensities and probability of occurrence.

These droughts will be used in conjunction with existing water resource models to determine both hydrological metrics (flows, groundwater levels) and system stress metrics (DO) under a range of severe drought conditions. This will enable exploration of the variability of supply system response to different styles of drought and may indicate the critical style of drought for each WRZ taking account of different modes of conjunctive use of the available resources (e.g. surface water and groundwater).
Return periods for climatic metrics can be readily derived from the very long synthetic time series and as a consequence can be used to estimate return periods of system stress (DO). However it should be noted that this methodology is technically an event based drought analysis as it is impractical to run the very long time series through all of the water resource models. Analysis of the droughts thought to constrain supply availability at different levels of probability will be conducted. The point of such analysis is to allow the response to different styles of drought event be evaluated and compared across our WRZs

2.7.2 Demand side assessment

Southern Water's demand forecast incorporates some climatic drivers (rainfall and temperature) to estimate demands. Generally demand is forecast to fall under severe drought conditions and owing to the penetration of the metering programme across Southern Water's supply area is not thought to be a major driver of risk. Theoretically our demand forecast could be directly coupled with our synthetic drought sequences (see Annex 3) to generate temporally coherent demand forecasts but this has not been carried out for the current WRMP.

However, given the effect of metering in reducing overall demand, the impact of demand restrictions is uncertain, especially as there are limited historic drought data in the recent period on which to base any estimates. As a consequence, there is an increased risk that the impacts of demand restrictions may be less pronounced for Southern Water than for other water companies and hence investment and drought planning may be driven towards supply side interventions rather than further demand or efficiency measures.

2.7.3 Links to levels of service

For WRMP14, Southern Water adopted a probabilistic integrated risk model to estimate headroom and uncertainties which is consistent with the methodology required to follow a fully risk based plan (risk principle 3). Hence Southern Water will adopt the same approach for WRMP19.
The development of the integrated risk model was influenced by the presence of WRZs with tight supply demand balances (e.g. Isle of Wight) and historic failures in levels of service relating to drought restrictions and application of Drought Permits and Orders, particularly in Southern Water's Eastern area.

Uncertainty was incorporated through a target headroom figure that reflected both defined levels of service (i.e. 1 in 10 year frequency of demand restrictions) and uncertainty in the supply and demand forecasts arising from factors such as climate change, outage or population growth.

Based on the supply and demand side modelling that will be undertaken Southern Water will be able to define an appropriate resilience statement that reflects the risk (as a probability) of demand restrictions, Drought Permits and Orders, and rota cuts/standpipes during the planning period (forecast of 50 years to 2070).

In keeping with the preferred aggregated approach of the risk based planning methodology (UKWIR, 2016b), a relationship between yield, drought severity and benefits of interventions will be calculated. The use of a library of different drought styles will help to define whether a critical balance point exists for each WRZ and how that might vary for droughts of different duration and intensity.

2.8 Selection of preferred decision making tools (Stage 4.3)

Southern Water's preferred outcomes defined in terms of the four elements of decision making tools defined by UKWIR (2016a) and based on an assessment of modelling complexity required (Stage 4.1 high vulnerability, extended or complex approach) and the selection of modelling method (Stage 4.2, aggregated approach) are set out in Table 18.

Table 18 Preferred elements of decision making tools to be adopted

Element	Our Preferred Approach
Objectives (What do we want to achieve?)	Multi-Criteria Analysis (customer representation)
Approach (How do we structure the problem?)	Aggregated / hybrid approach
Selection (How do we choose a solution?)	Ranking, mathematical programming
Solution (What form of investment plan is preferred?)	Adaptive strategy

Under the conventional EBSD approaches these criteria are most closely met by Multi Criteria Analysis (Table 8, UKWIR, 2016a) but this methodology can also be integrated with the more complex and extended approaches.

Given the results of Southern Water's Stage 3 problem characterisation and the modelling complexity required (extended or complex) of the extended approaches described by UKWIR (2016a) these criteria are most closely met by two decision making tools (based on a review of Table 9, UKWIR, 2016a):

- Real Options Analysis using modified EBSD models
- Adaptive pathways

Of the two, the adaptive pathways methodology is most closely aligned with our adopted Risk principal, preferred approach and key challenges. There are a number of key uncertainties that are yet to be resolved either in the magnitude of their impact on our supply demand balance, the timing of impacts, or both. An adaptive pathways methodology would explicitly recognise that such uncertainties exist and track them. As the uncertainties are resolved the plan and subsequent future actions could then be appropriately adapted to ensure optimal cost-benefit plan given the current state of the world. However, as noted by UKWIR (2016a) this methodology has not yet been applied to a water resources problem and hence the techniques remain untested and highly uncertain.

Based on our previous experience we recognise that allocation of weights across multiple criteria is a challenging aspect of real options analysis and hence this will be subject to additional research during the planning period and may require extensive sensitivity analysis. A more detailed description of the real options methodology and its application can be found in Annex 6 Options Appraisal.

In addition to the preferred real options approach for this plan we will also instigate a research project to further investigate how an adaptive planning methodology can be developed and applied in the context of water resources planning in the United Kingdom with an aim of further developing the approach in our next WRMP.

2.9 Risks and challenges

Our risk based planning methodologies are highly complex and inherently require discussion of probabilistic reasoning and mathematical modelling that can be challenging for regulators, stakeholders (both internal and external) and customers to understand. Use of these techniques, particularly where they may suggest and select potentially controversial options such as desalination, will require careful stakeholder management and engagement throughout the process. Although the computational techniques may be complex many of the underlying assumptions are not and hence engagement should endeavour to be as transparent as possible. Where relevant, advice on the communication of probabilistic risks (e.g. in UKWIR 2016b) should be used to frame risks in relative and real terms (e.g. impact upon bills).

By adopting advanced methods to estimate DO for the supply side, Southern Water has already extended existing planning horizons for the supply side (based on weather generator outputs) to incorporate risks of severe drought at return periods greater than 100 years. The use of very low probability (high return period) events to drive planning can also potentially make risk modelling more unstable and will need to be carefully considered when compiling the supply demand balance (UKWIR, 2016b).

Given that these models are conditioned on historic data, the uncertainty associated with the likely magnitude, duration and probability of occurrence is very large. Robustly demonstrating the plausibility of these events and the associated uncertainty in probabilistic levels of service and resilience statements will need to be outlined. Further work in this regard has been undertaken in collaboration with Newcastle University to better quantify the likely uncertainty associated with drought events outside the historic record. We also commissioned a Met Office study to assess overall risk of severe droughts of different magnitudes and intensities at low probabilities which can further constrain uncertainty in the integrated risk model.

Internal engagement will be especially key, as experience from WRMP14 has indicated a disconnect between the high level planning in the WRMP for 1 in 200 year events compared to daily operational

reality under normal conditions. To achieve success, options selected by the decision making tools will need to be developed through coordination across multiple departments of the business.

Recently we have faced a challenging outage situation with operational headroom substantially reduced in some WRZs as a consequence. The current levels and likely future levels of outage are outside the ranges forecast for WRMP14. The effects of increased outage will need to be carefully considered as part of the integrated risk modelling and its compounding effects upon the supply demand balance. Any options to reduce outage will need to be carefully developed in collaboration with internal stakeholders. Future resilience options should seek to reduce likelihood of further outages, especially given that existing DOs are already constrained by severe droughts outside the historic record and to achieve a surplus of supplies in such a situation will require more reliable operation of sources.

Adaptive planning is untested in the context of water resources planning in the UK and requires a substantial volume of work in order to both demonstrate the robustness of the technique to regulators and customers and to refine the procedure of selecting appropriate metrics. To address these uncertainties we have commissioned a review of the adaptation pathways techniques and consider how these methodologies might be applied to the current water resource planning framework. This review will consider:

- The availability and suitability of modelling tools to support this framework
- How adaptation pathways can be mapped to UK water resource planning methods
- How adaptation tipping points or decision points can be defined and suitable metrics identified to track outcomes against such decision points

The review will recommend how the techniques might be applied to a pilot study of one of our existing WRZs or areas within the planning period for WRMP19, however, adaptive planning is not expected to be considered as part of our decision making methodology until at least WRMP24.

3. Water resource zone integrity assessment

The WRZ integrity assessment is fully presented in Appendix A of this document. This appendix includes maps and site names and is therefore restricted from general release. A summary of the assessment is below.

The WRZ defines an area within which managing supply and demand for water is largely self-contained (apart from defined bulk transfers of water); where the resource units, supply infrastructure and demand centres are linked such that customers in the WRZ experience the same risk of supply failure (Environment Agency and Natural Resources Wales, 2016). As part of the development of this plan we are required to review the definition of our WRZs with the EA and ensure they meet the WRZ definition. Our proposed WRZs were originally submitted to the EA in early 2017 and the final versions summarised in this plan are based on subsequent discussions we have held with the EA.

Potential sustainability reductions in our former Hampshire South WRZ affecting our abstractions from the rivers Test and Itchen present a significant challenge to the supply-demand balance and change the balance of risk. Characterising this zone as a single WRZ is no longer appropriate because constrictions between sub-zonal areas within the WRZ may cause customers in different sub-zones to experience different levels of risk. Previously, any issues in different parts of the network could be managed by taking up the headroom from the River Test or Itchen. Any loss of DO of these two sources will increase challenges in moving water from other parts of the network to these locations to compensate. The network is not currently configured to manage these requirements, with the trunk mains tending to point away from these sources rather than towards them.

Because of this fundamental change in the supply-demand balance in this area, we have had to revisit the configuration of the WRZs to reflect the altered balance of risk caused by the potential loss of the two largest sources in the former Hampshire South WRZ.

Compared to our previous plan (WRMP14) we have divided the Hampshire South WRZ into four new WRZs. The proposed names for the new WRZs are Hampshire Rural (HR), Hampshire Winchester (HW), Hampshire Southampton West (HSW) and Hampshire Southampton East (HSE). The new zonal boundaries have been identified on the basis of key transfer locations between discrete WRZs, with the boundaries being either at valves or at booster stations (Figure 1, Appendix A).

The other change to our WRZs is in the Kent Medway WRZ. There is an existing natural east-west division in the WRZ at our major source from the River Medway Scheme (Burham WSW). Water here can be pumped to the east or west normally allowing us to balance in supplies in either direction. In our previous plan it was recognised that there is ‘locked-in’ DO in the eastern part of the Kent Medway WRZ, whereby the total DO for a number of sources exceeds the demand within that part of the network. A scheme is currently being implemented that will allow for better distribution of the water available from the sources in the eastern part of the WRZ. This represents a good opportunity to rezone the Kent Medway WRZ to reflect the imbalance in the resource availability between the east and west.

We believe it is sensible to divide the WRZ into two; Kent Medway East (KME) and Kent Medway West (KMW) (Figure 3, Appendix A). An existing booster station will form the boundary between the two WRZs, supplying water from west to east. The benefits of this change will be to have a smaller number of sources in the separated WRZs, demonstrate the movement of water from the KMW WRZ to KME WRZ, and assist with identifying any further locked-in DOs or resilience risks.
There are no major changes in any of our other WRZs that we consider have substantially changed the risk to supplies.

4. Climate Change Vulnerability Assessment

4.1 Introduction

The current water resources planning guideline (Environment Agency and Natural Resources Wales, 2017) requires water companies to include the impacts of climate change in their WRMP. Supply forecasts must consider impacts of climate change on DO (river flows and groundwater resources). Demand forecasts should also consider the effects of climate change, e.g. through potential changes to temperature and rainfall patterns.

A methodology for carrying out a climate change vulnerability assessment is set out in Environment Agency (2013). We have followed this guidance to carry out a basic climate change vulnerability assessment for our WRZs. We have used this analysis to select a suitable methodology to determine the potential impacts of climate change on our plan.

4.2 Basic assessment

We have carried out a basic climate change vulnerability assessment following the method set out by the Environment Agency (2013) and using data from our WRMP14. The vulnerability of each of our WRZs is determined by its position on a magnitude versus sensitivity plot. The plots (Figure 1) show the range in predictions of climate change impacts. The x-axis shows the range between "wet" and "dry" climate change forecasts of DO. The y-axis shows the mid-range prediction. Units on both axes are percentage of WRZ DO. The two plots show vulnerability at different metrics of DO: the peak deployable output (PDO) and the minimum deployable output (MDO). An overall assessment using a conservative (i.e. the worst case) vulnerability based on these previous data for each WRZ is also shown. These data are also presented in a tabular summary (Table 19).

Table 19 Initial climate change vulnerability based on the modelling undertaken for our previous (2014) WRMP

Water Resource Zone	Post WRMP 2014 Climate Change Vulnerability (After Atkins, 2013b)		
	Peak deployable output (PDO)	Minimum deployable output (MDO)	Overall Vulnerability
Hampshire Kingsclere	Low	Low	Low
Hampshire Andover	Low	Low	Low
Hampshire South (Hampshire Southampton East, Hampshire Southampton West, Hampshire Rural, Hampshire Winchester)	Medium	Low	Medium
Isle of Wight	Low	Low	Low
Sussex North	Medium	High	High
Sussex Worthing	Low	Low	Low
Sussex Brighton	Low	Medium	Medium
Sussex Hastings	Low	High	High

Kent Medway (KME, KMW)	Low	Medium	Medium
Kent Thanet	Medium	Low	Medium

The plot data are derived from Appendix D2 of WRMP14 and the associated planning tables. We have used the EA guidance (2017) to determine the vulnerability classification of each WRZ. Note that some WRZs have been split into new WRZs since WRMP14. Section 3, which sets out the WRZ integrity assessment) and so the data reflect the previous layout.

Our modelling for WRMP14 forecasts low (<5%) climate change impacts on DOs for all WRZs under the Mid Scenario. The range of impacts between the wet and dry scenarios causes some WRZs to be classified as medium or high vulnerability:

- The critical period for Hampshire South WRZ identified a range of over 36Ml/d between the wet scenario (+8.2Ml/d) and the dry scenario (-28Ml/d) suggesting a medium sensitivity to the impacts of climate change. The WRZ is therefore of medium vulnerability during the peak demand period. Forecast sustainability reductions dominate the effects of climate change during the minimum DO period
- Sussex North (NS) WRZ has a high vulnerability during minimum DO periods with a range (Wet-Dry) of 8Ml/d. During peak demand periods it has medium vulnerability with a range of 5.4Ml/d. These climate change impacts affect river flows at Pulborough restricting DO of this strategic source
- Sussex Hastings (SH) WRZ (Wet-Dry range of 6.7Ml/d) is at high vulnerability for the MDO period largely arising from impacts on surface water flows.
- Overall Kent Medway (KM) WRZ groundwater was found to be generally resilient to climate change, but is of medium vulnerability during MDO periods owing to the impacts of climate change on surface water flows
- Kent Thanet (KT) WRZ was found to be more resilient to climate change impacts than previously considered (Atkins, 2013a) owing to groundwater storage but remains at medium vulnerability at peak demand periods and on the whole groundwater levels were found to reduce for all climate scenarios

To support the basic vulnerability assessments we have conducted a further review of each WRZ (Table 20 to Table 29). Our review has included the outcomes of the previous WRMP and drought plan to determine the overall sensitivity and vulnerability of each WRZ.

Figure 1 Climate Change Vulnerability Classifications at peak deployable output (PDO) and minimum deployable output (MDO) periods for Southern Water's WRZs

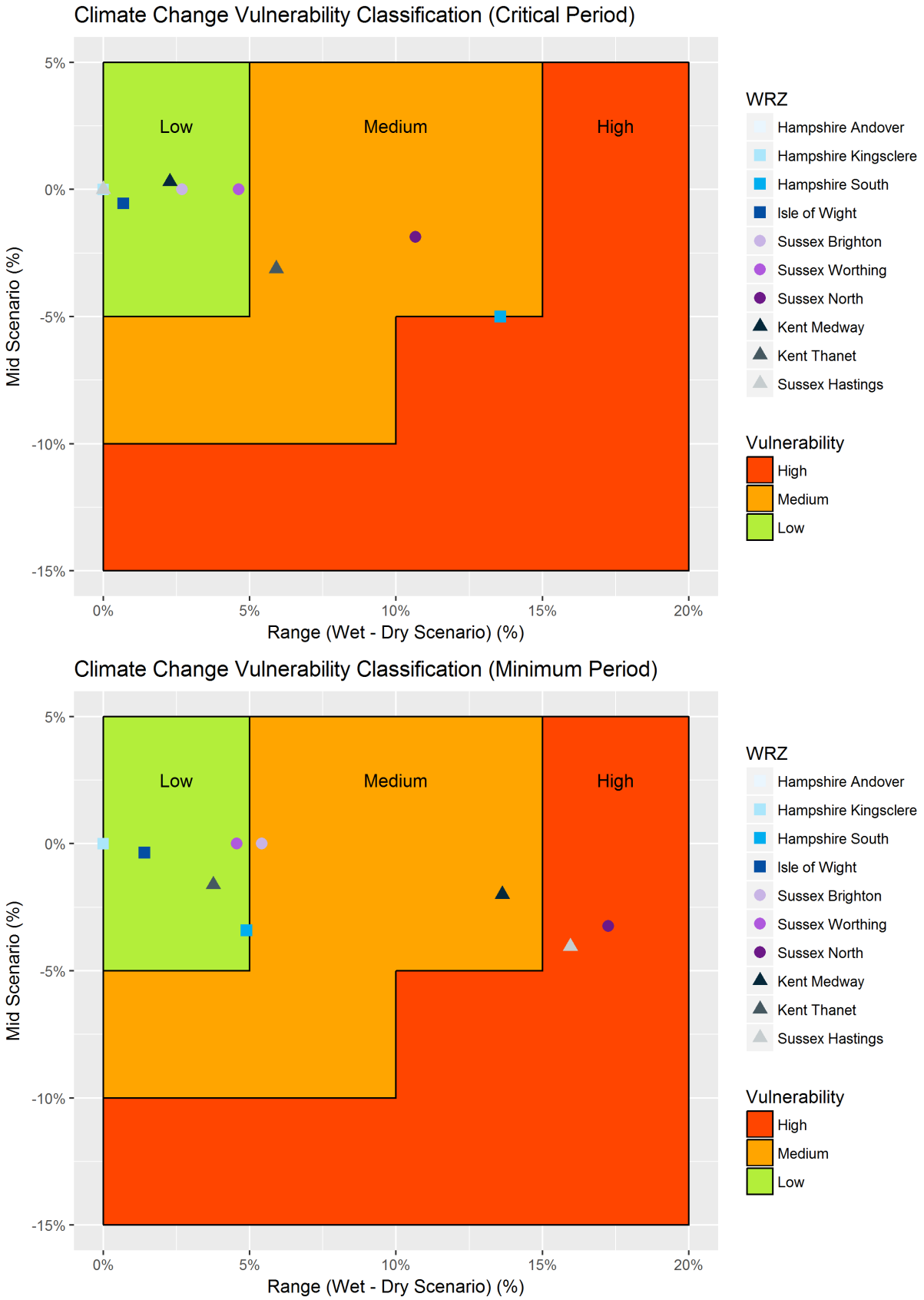


Table 20 Summary of information for basic vulnerability analysis for Hampshire Kingsclere (HK) WRZ

Description	Data Source	Data	Comment
Critical drought years	WRMP14	1920-22, 1976, 2004-06 (Historic)	Sources are licence constrained, not drought sensitive
Types of sources	WRMP14/Drought Plan	100% Groundwater	The Chalk aquifer is reasonably resilient to single dry winter, but can be significantly affected in multiple year events.
Period used for analysis	2000 year stochastic data set	1 in 125 year stochastic drought	
Supply-demand balance (base year)	WRMP14 Baseline DO	Baseline PDO = 9.5Ml/d Baseline MDO= 8.7Ml/d 0.3Ml/d surplus at DYCP 2.6Ml/d surplus at MDO	Forecast DYCP deficit after 2036 MDO Surplus in baseline out to 2040
Critical climate variables (e.g. summer rain, winter recharge	Drought Plan	Winter recharge (two dry year severe drought)	
Climate change DO impacts (Dry, Mid, Wet Scenarios)	WRMP14	No impact occurs at both PDO and MDO based on rainfall-runoff and groundwater model outputs	DO is constrained by abstraction licence not groundwater level/yield
Adaptive capacity	WMRP14, Drought Plan	TUBs/NEU Tankering	
Sensitivity (low/medium/high)		Low, source yields have been shown to be robust in historic droughts	

Action needed

Table 21 Summary of information for basic vulnerability analysis for Hampshire Andover (HA) WRZ

Description	Data Source	Data	Comment
Critical Drought Years	WRMP14	1920-22, 1976, 2004-06 (Historic)	Sources are generally licence constrained, not especially drought sensitive
Types of Sources	WRMP14/Drought Plan	100% Groundwater	The Chalk aquifer is reasonably resilient to single dry winter, but can be significantly affected in multiple year events.
Period Used for Analysis	2000 year stochastic data set	1 in 125 year stochastic drought	
Supply-demand balance (Base year)	WRMP14 Baseline DO	Baseline PDO = 28.4Ml/d Baseline MDO= 22.7Ml/d 3.29Ml/d surplus at DYCP 2.5Ml/d surplus at MDO	Forecast DYCP and MDO Surplus in baseline out to 2040
Critical Climate Variables (e.g. summer rain, winter recharge	Drought Plan	Winter recharge (two dry year severe drought)	
Climate Change DO Impacts (Dry, Mid, Wet Scenarios)	WRMP14	No impact occurs at both PDO and MDO based on rainfall-runoff and groundwater model outputs	
Adaptive Capacity	WMRP14, Drought Plan	TUBs/NEU Tankering Leakage reductions and water efficiency	

Sensitivity (low/medium/high)	Low, source yields have been shown to be robust in historic droughts
Action Needed	None

Table 22 Summary of information for basic vulnerability analysis for Hampshire South (Combined HR, HW, HSE, HSW) WRZs

Description	Data Source	Data	Comment
Critical Drought Years	WRMP14	1920-22, 1976, 2004-06 (Historic)	
Types of Sources	WRMP14/Drought Plan	37% Surface Water 63% Groundwater	Chalk Aquifer and baseflow dominated rivers The Chalk aquifer is reasonably resilient to single dry winter, but can be significantly affected in multiple year events.
Period Used for Analysis	2000 year stochastic data set	1 in 125 year stochastic drought	
Supply-demand balance (Base year)	WRMP14 Baseline DO	Baseline PDO = 267Ml/d Baseline MDO= 249.3Ml/d 36.06Ml/d surplus at DYCP 71.86Ml/d surplus at MDO	Baseline DO does not include forecast sustainability reductions
Critical Climate Variables (e.g. summer rain, winter recharge	Drought Plan	Winter recharge (two dry year severe drought)	
Climate Change DO Impacts (Dry, Mid, Wet Scenarios)	WRMP14	Using UKCP09 with rainfall-runoff and groundwater model outputs DYCP Dry=-28.0Ml/d (-10%), Mid=-13.3Ml/d (-5%), Wet=+8.2Ml/d (+3%)	

Description	Data Source	Data	Comment
		MDO Dry=-8.5Ml/d (-3%), Mid=-8.5Ml/d (-3%), Wet=+3.7Ml/d (+1%)	
Adaptive Capacity	WMRP14, Drought Plan	Asset Enhancement, Recommission abandoned sources Intra-company transfers River Augmentation TUBs/NEU Drought Orders and Permits Desalination Inter-company transfers Tankering Leakage reductions and water efficiency	
Sensitivity (low/medium/high)		Medium at Critical Period Low at Minimum Period,	Climate change impacts in combination with sustainability reductions increase vulnerability
Action Needed		Examine in combination effects of climate change and sustainability reductions	

Table 23 Summary of information for basic vulnerability analysis for Isle of Wight (IOW) WRZ

Description	Data Source	Data	Comment
Critical Drought Years	WRMP14	1920-22, 1976, 2004-06 (Historic)	
Types of Sources	WRMP14/Drought Plan	23% Surface Water 47% Groundwater 30% Bulk Transfer	Chalk, Upper Greensand And Lower Greensand Aquifer Cross Solent transfer from Hampshire WRZs Eastern Yar River with augmentation Chalk is aquifer reasonably resilient to single dry winter, but can be significantly affected in multiple year events.
Period Used for Analysis	2000 year stochastic data set	1 in 125 year stochastic drought	
Supply-demand balance (Base year)	WRMP14 Baseline DO	Baseline PDO = 36.5Ml/d Baseline MDO = 28.4Ml/d -13.4Ml/d deficit at DYCP -9.6Ml/d deficit at MDO	The Isle of Wight is dependent on the Cross Solent transfer from Hampshire to meet peak demands
Critical Climate Variables (e.g. summer rain, winter recharge	Drought Plan	Winter recharge (two dry year severe drought)	

Description	Data Source	Data	Comment
Climate Change DO Impacts (Dry, Mid, Wet Scenarios)	WRMP14	Using UKCP09 rainfall-runoff model outputs DYCP Dry=-0.05Ml/d (-0.1%), Mid=-0.2Ml/d (-0.5%), Wet=+0.2Ml/d (+0.5%) MDO Dry=-0.3Ml/d (-1%), Mid=-0.1Ml/d (-0.3%) Wet=+0.1Ml/d (+0.4%)	
Adaptive Capacity	WMRP14, Drought Plan	Asset Enhancement Improve Intra-company transfers Recommission abandoned sources River Augmentation Rest Groundwater Sources if possible TUBs/NEU Drought Orders and Permits Desalination Tankering Leakage reductions and water efficiency	

Description	Data Source	Data	Comment
Sensitivity (low/medium/high)		Low	Risk of saline intrusion to coastal (lower greensand aquifer) Storm events (intense rainfall) may become more frequent and cause water quality problems in surface waters Resilience concerns over Cross-Solent transfer with Hampshire sustainability reductions
Action Needed			

Table 24 Summary of information for basic vulnerability analysis for Sussex North (SN) WRZ

Description	Data Source	Data	Comment
Critical Drought Years	WRMP14	1921-22, 1976, 1989-92 (Historic)	
Types of Sources	WRMP14/Drought Plan	35% Groundwater, 59% Surface Water, 6% Transfers	Lower Greensand Aquifer, River Rother, River Arun and one impoundment reservoir Bi-directional transfer to Sussex Worthing External transfer to South East Water
Period Used for Analysis	2000 year stochastic data set	1 in 200 year stochastic drought	
Supply-demand balance (Base year)	WRMP14 Baseline DO	Baseline PDO = 75.0Ml/d Baseline MDO =46.4Ml/d -0.22Ml/d deficit at DYCP -9.5Ml/d deficit at MDO	Initial DYCP deficit is met and surplus occurs out to 2020. Baseline deficits (up to ~20Ml/d) forecast out to 2040 thereafter. MDO Deficit in baseline DO forecast out to 2040, up to ~30Ml/d.

Description	Data Source	Data	Comment
Critical Climate Variables (e.g. summer rain, winter recharge	Drought Plan	Rainfall and PET. Surface water source subject to single seasonal events (limited storage). Small Lower Greensand aquifer, sources potentially vulnerable to single dry winter events. Reservoir has limited catchment area so also vulnerable to single dry year.	
Climate Change DO Impacts (Dry, Mid, Wet Scenarios)	WRMP14	Using UKCP09 DYCP Dry=-4Ml/d (-5.3%), Mid=-1.4Ml/d (-1.9%), Wet=+4.0Ml/d (+5.3%) MDO Dry=-6Ml/d (-12.9%), Mid=-1.5Ml/d (-3.2%) Wet=+2.0Ml/d (+4.3%)	
Adaptive Capacity	WMRP14, Drought Plan	Asset Enhancement Intra-company transfers Inter-company transfers Rest Groundwater Sources if possible TUBs/NEU Drought Orders and Permits Tankering	

Description	Data Source	Data	Comment
		Water reuse Leakage reductions and water efficiency	
Sensitivity (low/medium/high)		Medium (PDO), High (MDO)	Storm events (intense rainfall) may become more frequent and cause water quality problems in surface waters WWTW discharge improve resilience of River Arun abstraction
Action Needed			

Table 25 Summary of information for basic vulnerability analysis for Sussex Worthing (SW) WRZ

Description	Data Source	Data	Comment
Critical Drought Years	WRMP14	1921-22, 1976, 1989-92 (Historic)	
Types of Sources	WRMP14/Drought Plan	100% Groundwater	Chalk is aquifer reasonably resilient to single dry winter, but can be significantly affected in multiple year events. Well and adit sources especially vulnerable to low groundwater levels.
Period Used for Analysis	2000 year stochastic data set	1 in 200 year stochastic drought	
Supply-demand balance (Base year)	WRMP14 Baseline DO	Baseline PDO = 64.83Ml/d Baseline MDO = 54.76Ml/d 2.23Ml/d surplus at DYCP 4.12Ml/d surplus at MDO	DYCP and MDO surplus occurs out to 2016-17, deficit occurs thereafter Bi-directional transfer to Sussex North, transfer to Sussex Brighton External transfer to South East Water
Critical Climate Variables (e.g. summer rain, winter recharge	Drought Plan	Winter Recharge	
Climate Change DO Impacts (Dry, Mid, Wet Scenarios)	WRMP14	Using UKCP09 DYCP	

Description	Data Source	Data	Comment
		Dry=-1.5Ml/d (-2.3%), Mid= 0Ml/d (0%), Wet=+1.0Ml/d (+1.5%) MDO Dry=-2Ml/d (-3.6%), Mid=-0Ml/d (0%) Wet=+1.0Ml/d (+1.8%)	
Adaptive Capacity	WMRP14, Drought Plan	Asset Enhancement Optimise intra-company transfers between SW, SN and SB Inter-company transfer Asset improvement of groundwater sources Rest Groundwater Sources if possible TUBs/NEU Drought Orders and Permits Tankering Desalination Water reuse Leakage reductions and water efficiency	Additional abstract ion in any one drought year will impact yield in subsequent years
Sensitivity (low/medium/high)		Low	Saline Intrusion and rising sea level may impact yield of some sources

Description	Data Source	Data	Comment
			Groundwater sources are susceptible to single to multiple year drought events. SW WRZ is most sensitive to the effects of short, two year severe droughts. Inter-company transfer may be less reliable owing to demand in SN.
Action Needed			

Table 26 Summary of information for basic vulnerability analysis for Sussex Brighton (SB) WRZ

Description	Data Source	Data	Comment
Critical Drought Years	WRMP14	1921-22, 1976, 1989-92 (Historic)	
Types of Sources	WRMP14/Drought Plan	100% Groundwater	Chalk aquifer is reasonably resilient to single dry winter, but can be significantly affected in multiple year events. Well and adit sources especially vulnerable to low groundwater levels.
Period Used for Analysis	2000 year stochastic data set	1 in 200 year stochastic drought	
Supply-demand balance (Base year)	WRMP14 Baseline DO	Baseline PDO =111.3Ml/d Baseline MDO = 92.4Ml/d -7.91Ml/d deficit at DYCP 4.12Ml/d surplus at MDO	DYCP deficit occurs throughout baseline supply demand balance) MDO deficit form 2016-17 in baseline Bi-directional transfer to Sussex North, transfer to Sussex Brighton External transfer to South East Water
Critical Climate Variables (e.g.	Drought Plan	Winter Recharge	

Description	Data Source	Data	Comment
summer rain, winter recharge			
Climate Change DO Impacts (Dry, Mid, Wet Scenarios)	WRMP14	Using UKCP09 DYCP Dry=-2.0Ml/d (-1.8%), Mid= 0Ml/d (0%), Wet=+2.0Ml/d (+1.8%) MDO Dry=-3Ml/d (-3.2%), Mid=-0Ml/d (0%) Wet=+1.0Ml/d (+1.8%)	
Adaptive Capacity	WMRP14, Drought Plan	Asset Enhancement Optimise intra-company transfers between SW, SN and SB Asset improvement of groundwater sources Rest Groundwater Sources if possible TUBs/NEU Options for Drought Orders and Permits limited Tankering Desalination Leakage reductions and water efficiency	Additional abstraction in any one drought year will impact yield in subsequent years
Sensitivity (low/medium/high)		Low at DYCP, medium at MDO	Saline Intrusion and rising sea level may impact yield of some sources

Description	Data Source	Data	Comment
			Groundwater sources, mostly well and adit sources are susceptible to single to multiple year drought events. SB WRZ is most sensitive to the effects of short, two year severe droughts. Inter-company transfer may be less reliable owing to demand in SN.
Action Needed			

Table 27 Summary of information for basic vulnerability analysis for Sussex Hastings (SH) WRZ

Description	Data Source	Data	Comment
Critical Drought Years	WRMP14	1900-03, 1921-22, 1976, 1989-92, 2004-06 (Historic)	
Types of Sources	WRMP14/Drought Plan	95% Surface Water 5% Groundwater	Dominantly reservoir resources, minor groundwater from Ashdown formation
Period Used for Analysis	2000 year stochastic data set	1 in 200 year stochastic drought	
Supply-demand balance (Base year)	WRMP14 Baseline DO	Baseline PDO = 51.5Ml/d Baseline MDO = 42.0Ml/d 5.6Ml/d base year surplus at DYCP 12.89Ml/d surplus at MDO	DYCP and MDO forecast surplus throughout planning period to 2040 Intra company transfer to reservoirs from Kent Medway
Critical Climate Variables (e.g. summer rain, winter recharge	Drought Plan	Rainfall	
Climate Change DO Impacts (Dry, Mid, Wet Scenarios)	WRMP14	Using UKCP09 DYCP Dry= 0.0Ml/d (0%), Mid= 0Ml/d (0%), Wet= 0.0Ml/d (0%) ADO	

Description	Data Source	Data	Comment
		Dry=-4.4Ml/d (-10.5%), Mid=-1.7Ml/d (-4%) Wet=+2.3Ml/d (+5.5%)	
Adaptive Capacity	WMRP14, Drought Plan	Asset Enhancement Optimise intra-company transfers from KMW TUBs/NEU Options for Drought Orders and Permits Tankering Leakage reductions and water efficiency	
Sensitivity (low/medium/high)		Low at DYCP, high at ADO	Reservoirs are prone to the effects of shorter duration droughts
Action Needed			

Table 28 Summary of information for basic vulnerability analysis for Kent Medway East (KME) and Kent Medway West (KMW) WRZs

Description	Data Source	Data	Comment
Critical Drought Years	WRMP14	1900-03, 1920-22, 1976, 1989-92, 2004-06 (Historic)	
Types of Sources	WRMP14/Drought Plan	75% Groundwater 25% Surface Water	Dominantly Chalk Aquifer with minor Lower Greensand. Surface Water and reservoir system
Period Used for Analysis	2000 year stochastic data set	1 in 200 year stochastic drought	
Supply-demand balance (Base year)	WRMP14 Baseline DO	Baseline PDO = 206.6Ml/d Baseline MDO = 160.8Ml/d 16.5Ml/d surplus at DYCP, 29.4Ml/d surplus at MDO	DYCP forecast surplus to 2023-24 and MDO forecast surplus to 2030's at MDO Inter-company export to South East Water Intra company transfer to KT and SH and from KMW to KME
Critical Climate Variables (e.g. summer rain, winter recharge	Drought Plan	Rainfall (surface water), winter recharge (groundwater)	
Climate Change DO Impacts (Dry, Mid, Wet Scenarios)	WRMP14	Using UKCP09 DYCP Dry= -3.7Ml/d (-1.8%), Mid= 0.6Ml/d (0.3%), Wet= 1.0Ml/d (0.4%)	

Description	Data Source	Data	Comment
		ADO Dry=-13.7Ml/d (-8.5%), Mid=-3.2Ml/d (-2%) Wet=+8.2Ml/d (+5.1%)	
Adaptive Capacity	WMRP14, Drought Plan	Asset enhancement and network improvements Optimise intra-company transfers from KMW TUBs/NEU Drought Orders and Permits for surface water but few groundwater options. Tankering Leakage reductions and water efficiency Catchment Management Water re-use Licence Trading	Chalk aquifer reasonably resilient to single dry winter, but can be significantly affected in multiple year events.
Sensitivity (low/medium/high)		Low at DYCP, Medium at ADO	Reservoirs are prone to the effects of shorter duration, single season droughts. Saline intrusion and rising sea level may impact yield of some sources
Action Needed			

Table 29 Summary of information for basic vulnerability analysis for Kent Thanet (KT) WRZ

Description	Data Source	Data	Comment
Critical Drought Years	WRMP14	1900-03, 1920-22, 1976, 1989-92, 2004-06 (Historic)	Critical drought 1900-1903, extended three year drought
Types of Sources	WRMP14/Drought Plan	77% Groundwater 2% Surface Water 21% Transfers	Predominantly Chalk Aquifer, minor run of river abstraction and intra-company transfer from KMW
Period Used for Analysis	2000 year stochastic data set	1 in 200 year stochastic drought	
Supply-demand balance (Base year)	WRMP14 Baseline DO	Baseline PDO = 61Ml/d Baseline MDO = 55.9Ml/d 6.3Ml/d deficit at DYCP, 3.86Ml/d surplus at MDO	DYCP deficit forecast for duration of planning period through to 2040s MDO surplus out to 2024, deficit thereafter Inter-company export to South East Water Intra company transfer to KT and SH and from KMW to KME
Critical Climate Variables (e.g. summer rain, winter recharge	Drought Plan	Rainfall (surface water), winter recharge (groundwater)	

Description	Data Source	Data	Comment
Climate Change DO Impacts (Dry, Mid, Wet Scenarios)	WRMP14	Using UKCP09 DYCP Dry= -3.6Ml/d (-5.9%), Mid= -1.9Ml/d (-3.1%), Wet= 1.0Ml/d (1.6%) ADO Dry=-2.1Ml/d (-3.8%), Mid=-0.9Ml/d (-1.6%) Wet= 0Ml/d (0%)	
Adaptive Capacity	WMRP14, Drought Plan	Asset Enhancement and Network Improvements Optimise intra-company transfers from KMW TUBs/NEU Drought Orders and Drought Permits for surface water but few groundwater options. Tankering Leakage reductions and water efficiency Catchment Management Water re-use Licence Trading	Chalk aquifer reasonably resilient to single dry winter, but can be significantly affected in multiple year events. Wastewater treatment works discharge helps to support surface water flows close to abstraction

Description	Data Source	Data	Comment
Sensitivity (low/medium/high)		Medium DYCP, Low at ADO	Reservoirs are prone to the effects of shorter duration, single season droughts Well and Adit sources vulnerable to low groundwater levels Storm events (intense rainfall) may become more frequent and cause water quality problems in surface waters Saline Intrusion and rising sea level may impact yield of some sources
Action Needed			

4.3 Overall summary of climate change vulnerability

The quantitative assessment of climate change impacts on WRMP14 DO (Table 19, Figure 1) in combination with the qualitative assessments for each WRZ (Table 20 to Table 29) is presented in Annex 3 Supply Forecast.

Most of our WRZs are of low overall vulnerability to climate change for either the peak demand (PDO) period, minimum deployable output (MDO) period, or both. The magnitude of the mid / most likely range of predictions is generally less than 5% of total zonal DO. Departures from low vulnerability generally occur because of the range between the wet and dry scenarios. This suggests that whilst the overall magnitude of climate change impacts is likely to be low, a high degree of uncertainty exists as to the direction of the impact.

4.4 Selection of an appropriate climate change modelling methodology

4.4.1 Southern Water's WRMP14 approach to climate change assessment

For WRMP14 a climate change vulnerability assessment was undertaken according to the Environment Agency (2013) guidance. The assessment was reported as a separate appendix (Atkins, 2013a) to WMRP14. This report indicated the majority of WRZs were considered to be of low vulnerability to climate change, with only those in the Eastern area (KM, KT and SH WRZs) classified as being highly vulnerable. Following the vulnerability assessment, a more detailed description of our climate change modelling and associated results were presented as an appendix to WRMP14 (Atkins, 2013b). A summary of the key steps undertaken in our analysis is provided below and in Figure 2.

At the time of preparing WRMP14, two principal climate prediction data sets were openly available in the United Kingdom suitable for use in water resource planning; The United Kingdom Climate Projections (2009) (UKCP09) and the Future Flows sequences (Haxton *et al*, 2012). Both data sets remain valid for determining the impacts of climate change under current guidance (Environment Agency, 2013, Environment Agency and Natural Resources Wales, 2016).

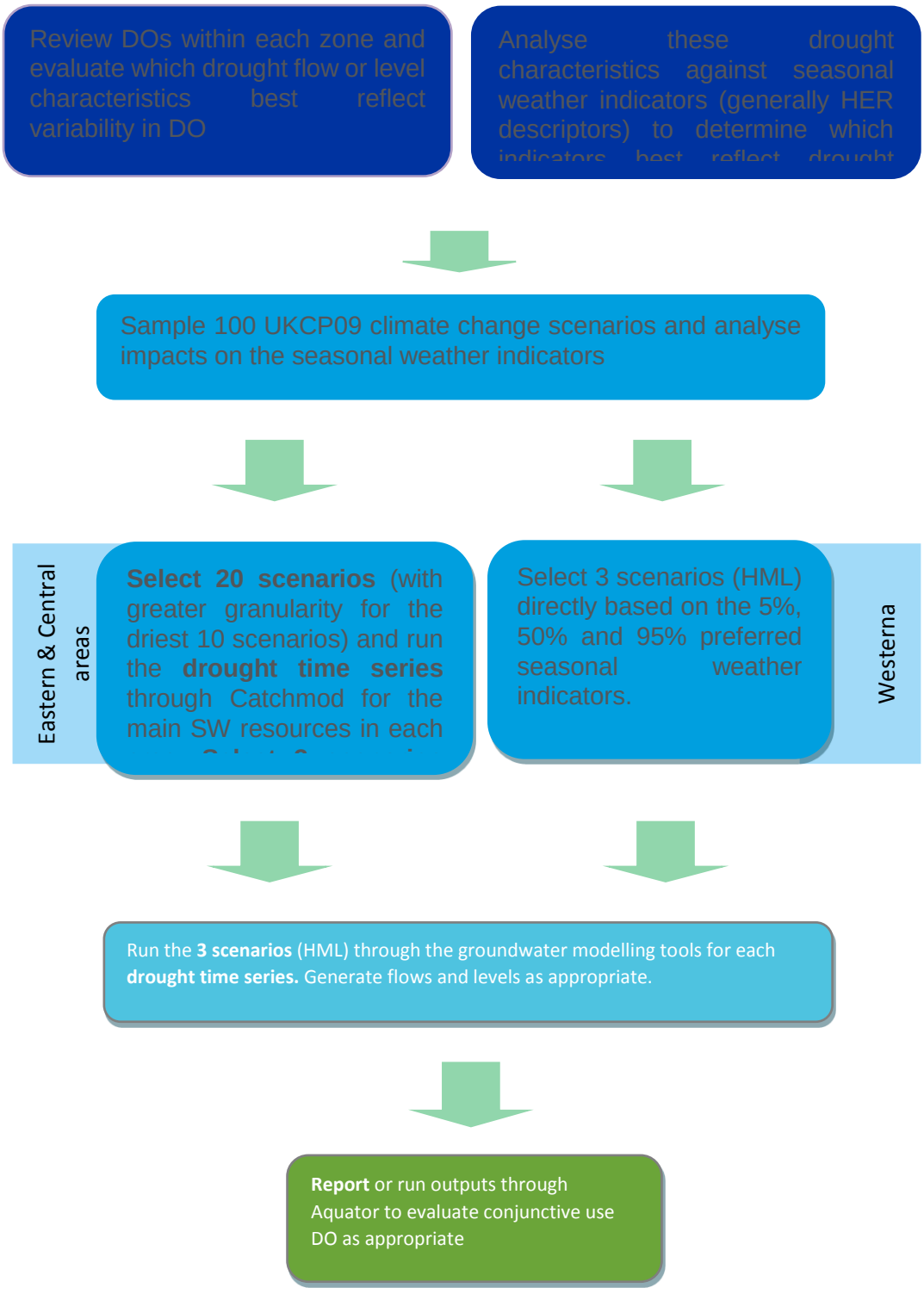
Our WRMP14 climate change assessment used the UKCP09 probabilistic climate change projections. These datasets contain 10,000 projections for each of three carbon dioxide emissions scenarios; high medium and low. The emissions scenarios are consistent with B1, A1B and A1F1 respectively, as defined by the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2000). Our WRMP14 assessment considered only the medium emissions scenario.

The UKCP09 dataset was sub-sampled to reduce the number of model runs required. This was especially important for WRZs where large numbers of model runs are impractical owing to computational resource constraints and run times (e.g. for large distributed groundwater models or Aquator simulations).

To accomplish the sub-sampling, seasonal weather indicators and drought characteristics were examined to determine those that best reflected the variability in DO. Initially 100 samples from the UKCP09 dataset were evaluated and from these data a 'smart' sampling regime was employed that selected 10 samples across the range of the data and a further 10 samples targeted specifically at the drier end of the range to reflect drought conditions. These 20 scenarios were run through rapidly executed surface water recharge-runoff models developed in Catchmod in order to estimate impacts on flows.

For more complex modelling e.g. where groundwater also substantially contributes to WRZ DO, or where system simulations were required the 100 UKCP09 samples were reduced to three from the UKCP09 factors, reflecting the computational difficulties in undertaking multiple complex model runs using extremely long time series. The selection of these samples were based on 5%, 50% and 95% simulated impacts on seasonal weather indicators (Western area) or drought flow characteristics (Eastern and Central areas).

Figure 2 Summary of climate change modelling undertaken for WRMP 2014 (Atkins, 2013b).



4.4.3 Current guidance for the 2019 WRMP

The recent guideline (Environment Agency and Natural Resources Wales, 2017) states that the impact of climate change must be addressed in WRMPs. The guidance states that the method previously developed for WRMP14 by the Environment Agency (2013) should be followed to determine climate change vulnerability and impact on water supplies. This methodology has also been supplemented by additional guidance (Charlton and Watts, 2017). These amendments replace certain elements of the assessment for surface water flows and how scaling factors should be applied to DO.

4.4.4 Guidance for surface water flows

Under the Charlton and Watts guidance (2017) for surface water a tiered modelling assessment is prescribed that increases in complexity with increasing vulnerability of the WRZs:

- A 'Tier 1' analysis if climate change vulnerability is low and there are no rainfall runoff models
- A 'Tier 2' analysis if climate change vulnerability is medium or if there are available rainfall-runoff models
- A 'Tier 3' analysis for where there is high vulnerability to climate change of if the company has an existing methodology using the UKCP09 methods from WRMP14

Tier 3 assessments are required for surface water if a WRZ has a high vulnerability to the impacts of climate change. In this case impacts of climate change should be sampled from the UKCP09 probabilistic projections e.g. as conducted for the 2014 WRMP. Tier 3 assessments are required as a minimum in the two WRZs with high climate change vulnerability: SN and SH.

For other WRZs, HSE and HSW have large surface water sources, the former of which is supported by groundwater abstractions. SN, KME and KMW all have large surface water sources, including reservoirs. KT has small groundwater sources, but is reliant on intra-company transfers from KME. The Isle of Wight also has a single large surface water source.

Rainfall-runoff models (and/or) associated groundwater models exist for all of Southern Water's surface water abstractions in these WRZs bar two: the River Arun (SN) and Stourmouth (KT). For both the River Arun and DO is met by upstream wastewater treatment works discharges and these sources are therefore likely to be insensitive to climate change (Atkins, 2013b) impacts. Other WRZs, e.g. SB, SW and some Hampshire WRZs are entirely reliant on groundwater resources.

As existing rainfall runoff and/or groundwater models exist for nearly all of Southern Waters surface water abstractions, the minimum assessment we would be required to undertake is to employ a Tier 2 analysis (Charlton and Watts, 2017) (Table 30). A Tier 2 analysis uses the 11 climate data scenarios from the UKCP09 datasets which provide "spatially coherent projections" (SCP) on a 25km gridded basis across the entire United Kingdom. The projections are in the form of monthly and seasonal climate change factors for a range of climate variables, including rainfall and temperature.

Table 30 Summary of water resource zones with surface water inputs for climate change

Water Resource Zone	Proportion of Surface Water	Climate Change Vulnerability		Existing Resource Model	Tiered Approach (Minimum)
		PDO	MDO		
Hampshire South (Hampshire Southampton East, Hampshire SouthamptonWest)	63%	Medium	Low	Test and Itchen GW Model	Tier 2
Isle of Wight	23%	Low	Low	IoW Runoff Recharge Model	Tier 2
Sussex North	51%	Medium	High	Catchmod, Aquator and GW Model	Tier 3
Sussex Hastings	79%	Low	High	Catchmod and Aquator	Tier 3
Kent Medway	25%	Low	Medium	Catchmod, Aquator, GW Recharge Model	Tier 2
Kent Thanet	2%	Medium	Low	East Kent GW Model (GW only)	Tier 2

4.4.5 Guidance for climate change and groundwater

Several of our WRZs (HA, HK, HR, HW, SB, SW) have no surface water resources and are dominated by groundwater supplies. Some limited guidance for groundwater is presented by the Environment Agency (2013) though this largely makes reference to the existing methodology developed by Southern Water for the 2009 WRMP.

The method used climate change perturbed rainfall and PET sequences (based on the Future Flows data set) as inputs to recharge or groundwater models in order to either estimate changes to recharge or modelled groundwater levels that could be related to groundwater DO via the conventional curve shifting methodology (UKWIR, 2002).

This methodology was further refined by Southern Water for use with the UKCP09 data in estimates of groundwater DO under climate change for the 2014 WRMP as previously described (Atkins, 2013b). Environment Agency (2013) guidance suggests an alternative approach using the future flows to assess climate change impacts rather than the UKCP09 projections. These data contain transient projections for impacts on rainfall, PET and groundwater levels which could be used to perturb existing DO calculations or water resources models.

For groundwater Southern Water intend to utilise their existing approach from WRMP 14, consistent with the WRPG, and which is based on stochastic rainfall and PET sequences, existing water resource models and which samples from the UKCP09 probabilistic projections.

4.5 Proposed approach for 2019 WRMP

For WRMP19 we intend to utilise our existing climate change modelling approach developed over the previous two water resource management plan cycles (2009 and 2014). The established methodology meets or exceeds existing WRPG for climate change being equivalent to a Tier 3 approach as defined by Charlton and Watts (2017) for surface water sources and is consistent with approach 2.2 of Environment Agency (2013) for medium/high vulnerability WRZs and for groundwater.

However, there remain areas where the WRMP14 approach could be, or is required to be, further refined. Principally these relate to the required period for which projections must be made and to consider the use of the spatially coherent projections, which were recommended for the 2019 WRMP under the recent Risk Based Planning methodology (UKWIR, 2016) and under a "Tier 2" assessment (Charlton and Watts, 2017).

4.5.1 Selection of time period for climate projections

The water resource planning guidelines (Environment Agency, 2016, 2017) state that for medium and high vulnerability WRZs the 2080s time period should be used for climate change impact assessments on surface water (Charlton and Watts, 2017).

The use of UKCP09 scenarios for the 2080's time slice would also be generally consistent with our decision to extend the current water resource planning interval from a 25 year forecast to a 50 year span (i.e. 2020 – 2070) compared to the previous forecast horizon of 2040.

To meet this minimum requirement Southern Water have used the UKCP09 projections for the 2080's (2070-2099 30 year period) for all water supply climate change impact assessments.

4.5.2 Selection of spatial scale for climate projections

The UKCP09 projections relevant to water resource planning are available in two key formats:

- Probabilistic projections (10,000 samples for each emissions scenario) based on an ensemble of 12 climate models and designed to include key known drivers of uncertainty in future climate change. The data are generated at a 25km gridded resolution but do not exhibit spatial coherency between grid cells (or aggregated areas) i.e. scenario 50 from one grid cell would not necessarily be coherent with scenario 50 from an adjacent grid square
- Spatially coherent projections (SCP), scaled from an ensemble of 11 regional climate models with spatially coherent data available at a 25km resolution across the United Kingdom. Spatial coherence means that multiple spatial samples can be directly compared or averaged between different scenarios e.g. it is possible to directly compare projection 1 for Hampshire, to projection 1 for Kent.

The UKCP09 climate change probabilistic projections are available at a number of different spatial resolutions each being derived from the underlying 25km grid. For WRMP14 the aggregated probabilistic projections at a river basin scale (approximately based on Water Framework Directive river basin catchments) were used. For Southern Water's supply area these assessments primarily utilised the range of projections for South East England. However, the Kent Medway WRZ lies outside of this dataset and for this WRZ the probabilistic projections for the Thames River Basin were used, it should be noted that, as with the underlying gridded data, the river basin datasets are not spatially coherent e.g. projection 1 for the South East is not related to projection 1 for Thames.

The spatially coherent projections offer a number of advantages for water resource modelling (i.e. spatial coherency, relatively low number of replicates and hence more suitable for computationally intensive models). The UKWIR (2016) guidance also recommends the use of the UKCP09 SCP datasets for assessing climate change impacts.

In selecting an appropriate UKCP09 dataset for WRMP19 we have undertaken a review of the different spatial scales at which climate projections are available (Table 31).

Table 31 Summary of the key advantages and disadvantages of different spatial resolutions of the UKCP09 climate change projections

UKCP09 Location Dataset	Description	Key Advantages	Key Disadvantages
South East England Regional Probabilistic Projections	Spatially Aggregated predictions of climate change impacts over the whole of South East England (10,000 replicates)	Single set of probabilistic samples could be used for all of Southern Waters WRZs Use of the Probabilistic projections exceeds minimum requirements of WRPG	Lacks spatial resolution of differential impacts across different WRZs (e.g. between Eastern area and Western area)
River Basin Probabilistic Projections	Spatially Aggregated predictions of climate change impacts over the whole of South East England (10,000 replicates)	More refined spatial resolution focusing on most, but not all of the River Basins where SWS abstract water Use of the Probabilistic projections exceeds minimum requirements of WRPG Datasets utilised for WRMP14	Requires use of separate data sets for the South East and Thames River Basin to cover whole supply area. The projections from these data sets will not exhibit spatial coherence. Lacks spatial resolution of differential climate change impacts across different WRZs (e.g. Same projections used for Kent Thanet and Hampshire South)
25km Gridded Data Sets	Gridded data set comprising 25km squares covering all of the United Kingdom (10,000 replicates)	Higher spatial resolution projections at sub-catchment scale Use of the Probabilistic projections exceeds minimum requirements of WRPG	Projections are not spatially coherent and would need some spatial aggregation across large catchments / Models (e.g. Kent Medway, Test and Itchen) Most intensive dataset in terms of data handling and processing
Spatially Coherent Projections (SCP)	25km Gridded datasets (11 replicates)	Projections exhibit spatial coherence across different grid squares thus providing	Low number of replicates and hence under-samples the range of uncertainty compared to

		consistent projections at high resolution across all of Southern Water's supply area Meets minimum WRPG standard for low and medium vulnerability WRZs	the probabilistic projections Some spatial averaging would still be required to determine catchment impacts (but is simpler to apply than for other data sets) Spatially coherent projections are not recommended within WRPG for high vulnerability WRZ's

The climate change vulnerability assessment based on water resource modelling undertaken for the WRMP14 has shown that Sussex North WRZ has a high vulnerability to the impacts of climate change. Consequently, the use of the spatially coherent projections in isolation would fall below the minimum required standard set by the WRPG for surface water resources in this WRZ. To meet the minimum standard set by the WRPG for these WRZs use of the UKCP09 probabilistic projections would be required.

The UKCP09 projections will soon be superseded by a new set of climate projections (UKCP18) due in 2018. However, these data were not available in time to inform our WRMP. A new climate change methodology will need to be developed for UKCP18 and it would be inefficient to develop an entirely new methodology for WRMP19 given that an existing procedure, which exceeds the minimum WRPG standards, exists

Following the review of different spatial scales of available climate change projections, Southern Water intends to utilise the river basin scale probabilistic projections from UKCP09 for WRMP19 on the basis of the following:

- The climate change assessment for the 2019 WRMP will be based on the 2080's (2070-2099 projection period) consistent with our 50 year plan. To allow this, new samples from the UKCP09 projections (compared to those used in the previous plan) will be required using data from the 2080's. This period is also consistent with that required by current planning guidance (Environment Agency, 2016, 2017, Charlton and Watts, 2017)
- Sampling from the UKCP09 probabilistic projections meets and exceeds the minimum standards set out by the WRPG (Environment Agency, 2016, 2017)
- The river basin scale projections were the data set utilised for the climate change predictions within the 2014 WRMP. Use of these predictions is therefore consistent and existing water resource models, data handling and sampling procedures can be utilised to use the new projections with existing water resource models
- The South East England river basin projection dataset covers all of Southern Water's WRZs except for Kent Medway. This spatial coverage eliminates the need to conduct any spatial aggregation of the data set. However it should be acknowledged that there could be smaller scale differential spatial impacts of climate change within Southern Water's supply area, e.g. for the Western area vs Eastern area not represented by these data
- As previously, climate change factors for Kent Medway groundwater sources will be determined from the Thames River Basin projections. These will be compared to those for the South East River Basin to assess the potential differences in the spatially aggregated data
- Sensitivity to this uncertainty could be explored through sampling from the higher resolution 25km grid though the lack of spatial coherence in these projections will complicate this assessment. As an alternative, a sensitivity assessment using the spatially coherent projections could be undertaken, though again a simple comparison with the probabilistic projections is complicated by the differences between these two data sets.

4.5.3 Selection of emissions scenario

The UKCP09 probabilistic projections are available for three emissions scenarios; high (A1F1), medium (A1B1) and low (B1) as designated by the Intergovernmental Panel on Climate Change (IPCC, 2000).

The WRPG requires companies to consider the medium (A1B1) scenario as a minimum requirement. UKCP09 data sets explicitly do not assigned probabilities to the emissions scenarios but the range allows exploration of the uncertainty.

The UKCP09 datasets broadly indicate that by the 2080s winter months will generally be wetter whilst summer months will generally be drier.

When comparing the emissions scenarios there are some low emission scenarios that might have a greater water resource impact than medium or high emission scenarios owing to generally greater variance in spring months (Figure 3). There are also months in which the opposite is true (greater variance under higher emissions).

For more robust water resource planning it would be sensible to sample from each of the emissions scenarios to evaluate climate sensitivity as long as computational resources of the water resource models allow.

Figure 3 Distribution of rainfall changes for the 2080's for the three UKCP09 emission scenarios (example for March)

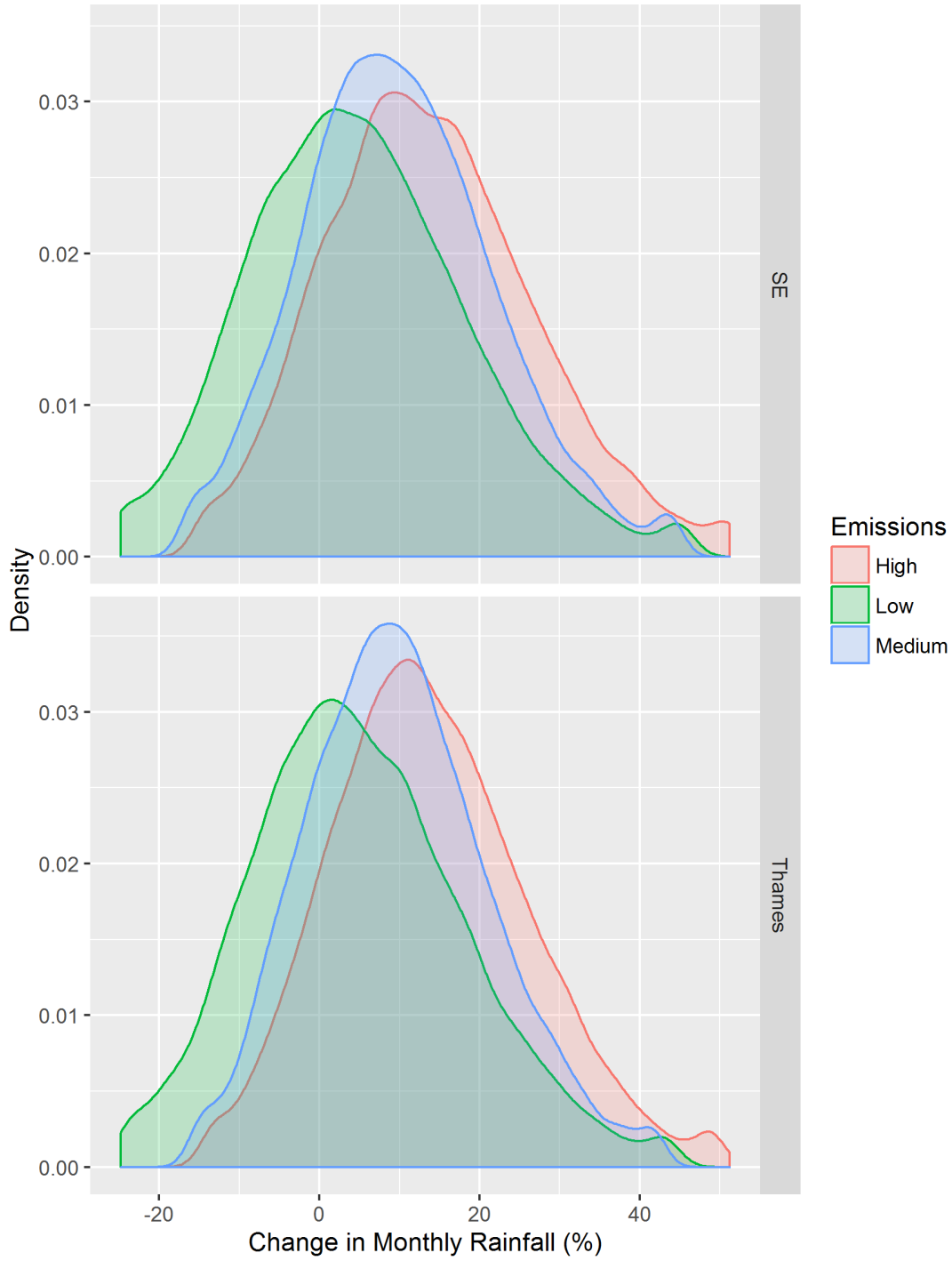


Table 31 Summary of the key advantages and disadvantages of different spatial resolutions of the UKCP09 climate change projections

UKCP09 Location Dataset	Description	Key Advantages	Key Disadvantages
South East England Regional Probabilistic Projections	Spatially Aggregated predictions of climate change impacts over the whole of South East England (10,000 replicates)	Single set of probabilistic samples could be used for all of Southern Waters WRZs Use of the Probabilistic projections exceeds minimum requirements of WRPG	Lacks spatial resolution of differential impacts across different WRZs (e.g. between Eastern area and Western area)
River Basin Probabilistic Projections	Spatially Aggregated predictions of climate change impacts over the whole of South East England (10,000 replicates)	More refined spatial resolution focusing on most, but not all of the River Basins where SWS abstract water Use of the Probabilistic projections exceeds minimum requirements of WRPG Datasets utilised for WRMP14	Requires use of separate data sets for the South East and Thames River Basin to cover whole supply area. The projections from these data sets will not exhibit spatial coherence. Lacks spatial resolution of differential climate change impacts across different WRZs (e.g. Same projections used for Kent Thanet and Hampshire South)
25km Gridded Data Sets	Gridded data set comprising 25km squares covering all of the United Kingdom (10,000 replicates)	Higher spatial resolution projections at sub-catchment scale Use of the Probabilistic projections exceeds minimum requirements of WRPG	Projections are not spatially coherent and would need some spatial aggregation across large catchments / Models (e.g. Kent Medway, Test and Itchen) Most intensive dataset in terms of data handling and processing
Spatially Coherent Projections (SCP)	25km Gridded datasets (11 replicates)	Projections exhibit spatial coherence across different grid squares thus providing consistent projections at high resolution across all of Southern Water's supply area	Low number of replicates and hence under-samples the range of uncertainty compared to the probabilistic projections

		Meets minimum WRPG standard for low and medium vulnerability WRZs	Some spatial averaging would still be required to determine catchment impacts (but is simpler to apply than for other data sets) Spatially coherent projections are not recommended within WRPG for high vulnerability WRZ's

4.5.4 Sampling from UKCP09

Monthly precipitation and temperature change factors have been downloaded from the UKCP09 user interface for the South East and Thames river basins for the 2080s period under the low, medium and high emissions scenarios. These each comprise all 10,000 samples from the probabilistic projections.

As with WRMP14 a sampling procedure has been employed to reduce the number of samples down to a more practical number for use with water resource models. In order to do this robustly a similar procedure to that used for WRMP14 has been employed.

Hydrologically effective rainfall (Rainfall – PET) was estimated for a historic drought sequence of precipitation and temperature, converted to PET using the Penman-Montieth equation following the procedure outlined in the Food and Agriculture Organisation of the United Nations (FAO) methodology (FAO, 1998).

Input data sets for rainfall will be taken from the Met Office Hadley Centre South East England precipitation (SEE) dataset. This is an aggregated rainfall data set of approximately the same spatial extent as the South East England River Basin dataset in UKCP09. Historic temperature data will be taken from the Met Office Central England Temperature Series.

These data will therefore provide a baseline which can be perturbed rapidly through application of climate change factors sampled from the large UKCP09 data set in order to determine the overall potential climate change impacts on historic drought events (e.g. 1918-1922) across our area. The climate change impacts are ranked from wet to dry and subsequently sampled using a “smart” Latin Hypercube sampling procedure in order to reduce the number of climate change scenarios modelled in our water resource models. This sample reduction will follow the procedure set out for WRMP14 shown in Figure 2. Following this methodology, the approach taken to simulate climate change impacts for each WRZ is set out in Table 32. This sub-sampling procedure and application to water resource and supply forecasts is discussed in more detail in Annex 3.

Table 32 Summary of modelling methods used to determine the impacts of climate change in our plan

Area	WRZ	WRZ Vulnerability	Water Resource (Model)	WRMP 2014 Methodology		WRMP 2019 Methodology	
				Hydro/geological Climate Change Approach	WRZ System Simulation Analysis	Hydro/geological Climate Change Approach	WRZ System Simulation Analysis
Western	Isle of Wight	Low	Sandown (Eastern Yar Catchmod)	20 UKCP09 Samples (A1) (2040)	3 Samples Through Aquator	20 “smart” UKCP09 Samples (2080, South East)	3 Samples (Wet-Mid- Dry) through Aquator
			Medina (Catchmod)	20 UKCP09 Samples (A1) (2040)		20 “smart” UKCP09 Samples (2080, South East)	
			Central Downs Chalk / Upper Greensand (4R Recharge Model)	3 Samples selected from the 20 UKCP09 samples (A1) (2040)		3 samples (Wet – Mid – Dry) selected from the 20 UKCP09 “smart” samples (2080 South East)	
			Cross-Solent Main	Based on Hants South Assessment		Based on Hants South Assessment	
	Hampshire Rural, Winchester, Southampton East, Southampton West	Medium	Test and Itchen (Groundwater Model)	3 Samples selected from the 20 UKCP09 samples (A1) (2040)	Spreadsheet based on 3 groundwater model runs	3 samples (Wet – Mid – Dry) selected from the 20 UKCP09 “smart” samples (2080 South East)	Spreadsheet based on 3 groundwater model runs
	Hampshire Andover	Low	Test and Itchen (Groundwater Model	11 FFGWL samples for Clanville Lodge Gate (A4)	Only if impact within licence	3 samples (Wet – Mid – Dry) selected from the 20 UKCP09 “smart” samples (2080 South East)	Only if impact within licence
	Hampshire Kingsclere	Low	Test and Itchen (Groundwater Model	11 FFGWL samples for Clanville Lodge Gate (A4)	Only if impact within licence	3 samples (Wet – Mid – Dry) selected from the 20 UKCP09	Only if impact within licence

						“smart” samples (2080 South East)	
Central	Sussex North	Medium	Arun (Catchmod)	20 UKCP09 Samples (A1)	3 Samples Through Aquator (and spreadsheet analysis for Sussex Coast)	20 “smart” UKCP09 Samples (2080, South East)	3 Samples Through Aquator (and spreadsheet analysis for Sussex Coast)
			Rother at Pulborough (Catchmod)	20 UKCP09 Samples (A1)		20 “smart” UKCP09 Samples (2080, South East)	
			Weir wood (Catchmod	20 UKCP09 Samples (A1)		20 “smart” UKCP09 Samples (2080, South East)	
			Lower Greensand (Pulborough Groundwater Model)	Not Modelled		3 samples (Wet – Mid – Dry) selected from the 20 UKCP09 “smart” samples (2080 South East)	
	Sussex Brighton	Medium	Chalk (4R & Brighton Regression Model) Brighton and Worthing Groundwater Model Used for WRMP19	3 samples selected from the 20 UKCP09 samples, but based on Sussex North critical droughts (A1**)		3 samples (Wet – Mid – Dry) selected from the 20 UKCP09 “smart” samples (2080 South East)	
	Sussex Worthing	Low	Chalk - Brighton and Worthing Groundwater Model Used for WRMP19	As with the Sussex Brighton, but translated using appropriate scaling factors		3 samples (Wet – Mid – Dry) selected from the 20 UKCP09 “smart” samples (2080 South East)	
Eastern area	Sussex Hastings	High	Rye (Catchmod)	100, filtered to 20 ‘smart’ UCKP09 Samples (B1/B2)	3 Samples through Aquator	3 samples (Wet – Mid – Dry) selected from the 20 UKCP09 “smart” samples (2080 South East)	3 Samples (Wet-Mid- Dry) through Aquator

		Rother at Robertsbridge (Catchmod)	100, filtered to 20 ‘smart’ UCKP09 Samples (B1/B2)	20 “smart” UKCP09 Samples (2080, South East)
		Darwell Reservoir Inflow (Catchmod)	100, filtered to 20 ‘smart’ UCKP09 Samples (B1/B2)	20 “smart” UKCP09 Samples (2080, South East)
		Powdermill Reservoir Inflow (Catchmod)	100, filtered to 20 ‘smart’ UCKP09 Samples (B1/B2)	20 “smart” UKCP09 Samples (2080, South East)
Kent Medway	Medium	Bewl Water inflow (Catchmod)	100, filtered to 20 ‘smart’ UCKP09 Samples (B1/B2)	20 “smart” UKCP09 Samples (2080, South East)
		Teise at Stonebridge (Catchmod)	100, filtered to 20 ‘smart’ UCKP09 Samples (B1/B2)	20 “smart” UKCP09 Samples (2080, South East)
		Medway at Teston	100, filtered to 20 ‘smart’ UCKP09 Samples (B1/B2)	20 “smart” UKCP09 Samples (2080, South East)
		Chalk Canterbury (Recharge + Level Regression Model)	3 Samples from UKCP09 selected based on findings for Surface Water Sources (B1/B2*)	3 samples (Wet – Med – Dry) selected from the UKCP09 “smart” samples Probabilistic Projections (2080, Thames)
Kent Thanet	Medium	East Kent Chalk (Groundwater Model)	3 Samples selected based in pre-analysis using winter hydrologically effective rainfall (B1/B2**)	3 samples (Wet – Mid – Dry) selected from the 20 UKCP09 “smart” samples (2080 South East))

4.5.5 Application of monthly climate change factors

The principal inputs to our water resource models (Recharge-runoff and groundwater) and those variables most sensitive to climate change are rainfall and potential evapotranspiration.

The supply forecast methodology Annex 3) describes out procedure for generating synthetic monthly rainfall sequences of severe and extreme droughts sampled from an extremely long (~100,000 year) record. This long record is then sub-sampled into coherent 2000 year samples from the very long time series.

Once sampled the climate change factor will be applied to the stochastically generated monthly rainfall time series (see Annex 3). Initially these time series are generated as monthly outputs from a synthetic weather generator and drought classification and selection algorithms.
However, existing water resource models typically require input of daily rainfall and PET time series. Once sub-sampled from the UKCP09 datasets the climate change factors are applied at the stochastic time series after the monthly time series have been generated but prior to further disaggregation to daily time series. This procedure is described in more detail in Annex 3.

4.5.6 Climate change and headroom

Further discussion on how we have incorporated uncertainty from climate change into our headroom and integrated risk modelling is provided in Annex 5.

5. Pre-consultation

5.1 Introduction

In accordance with Section 37A (8) of The Water Industry Act 1991, water companies must undertake pre-consultation with Ofwat, the EA, the Secretary of State and any licensed suppliers in its supply area.

Besides pre-consultation with regulators and licensed suppliers in our supply area, the company considers that stakeholder and customer engagement is crucial to developing a plan which has taken account of their views. In particular it is important to consider customers' views on levels of service and, together with stakeholders, their views on the supply and demand management options proposed for the WRMP, contributing to the development and formulation of the draft WRMP. One of the criteria applied during the screening of the unconstrained list of options was if the option was likely to meet customer, stakeholder and regulator expectations. See Annex 6 Options appraisal, section 'Unconstrained list of options'.

Pre-consultation began as early as June 2014 when we outlined our proposed strategy for updating the WRMP to the EA. An overview of the pre-consultation with regulators, stakeholders and customers is show in Figure 4.

5.2 Regulatory engagement overview

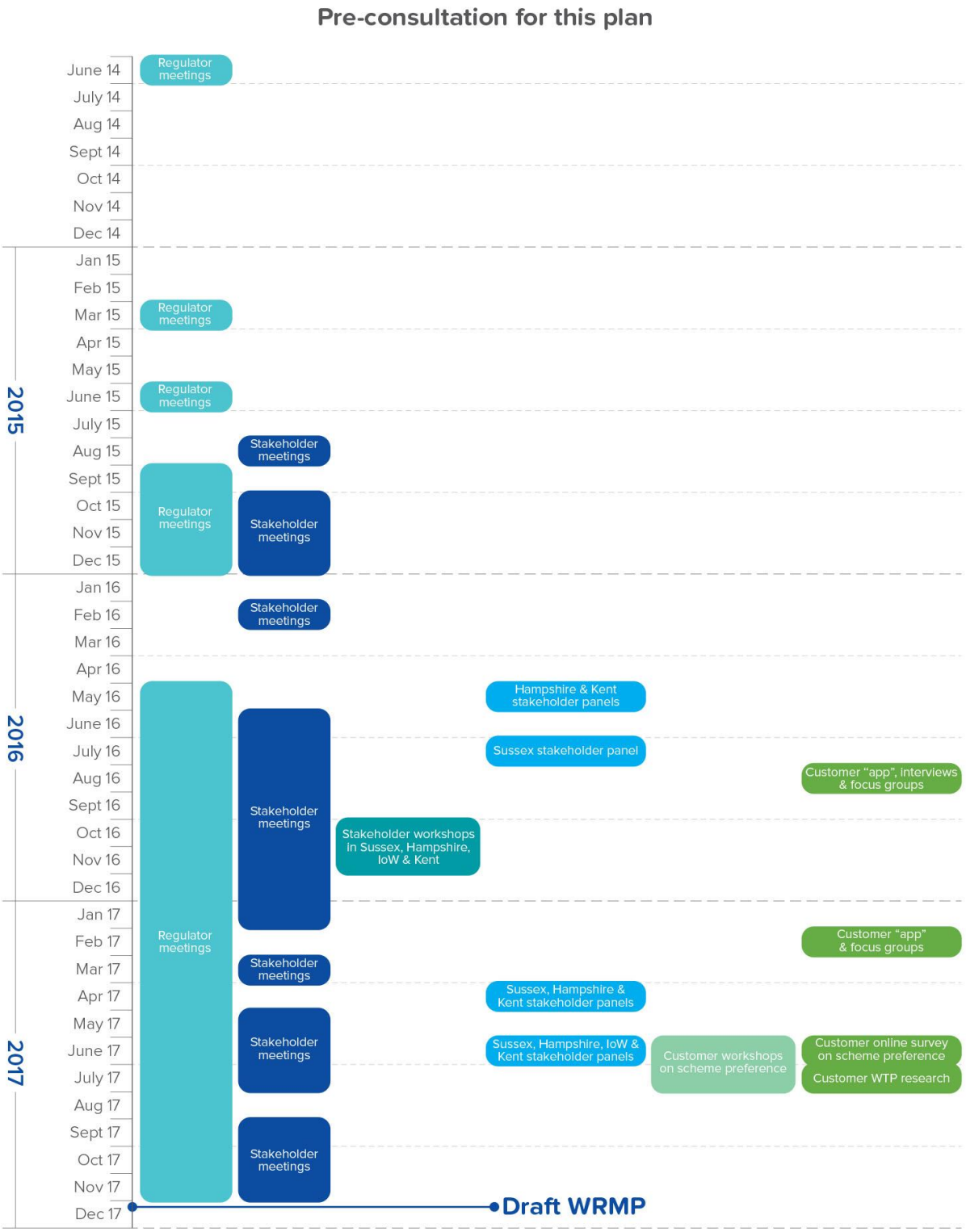
During the pre-consultation phase, meetings were held with the EA, Natural England and Ofwat to report on the status of developments of the draft WRMP, to explain approaches and report results. A record of all the meetings with regulators is documented in Appendix B.

A series of method statements were written to provide the EA with visibility of the technical approaches we have followed to develop our draft plan. The WRMP 'methods discussion' has allowed a structured dialogue with the EA and other regulators during the development of the plan. The purpose of the method discussion is to ensure regulators are sighted are on our approach in order to reduce the need for significant changes to the plan later in the process. As specified in section 2.2 of the WRPG, the method statements we have produced have not been signed off as regulators will need to review the plan as a whole once published. Southern Water has produced 14 method statements during the development of this draft plan and these are listed in Appendix C. In light of comments received on some of these statements we have refined our technical approaches.

We have also consulted Natural England on the potential impact of our plan on designated sites covered by international and national environmental legislation. Seeking Natural England input during the pre-consultation phase of the WRMP is important for Southern Water given the high number of freshwater and marine designated sites in or nearby our supply areas which could be impacted by the plan.

Two pre-consultation meetings were held with Ofwat to provide the economic regulator with information on how we have developed our draft plan and the key challenges we face. The information was provided against a standard checklist prepared by Ofwat, which can be found in Appendix D.

Figure 4 Pre-consultation timeline for this plan



5.4 Stakeholder engagement overview

We work with our stakeholders to understand their priorities, help develop our plans, identify opportunities for collaboration and look for examples of best practice.

Since 2015 the company has met with stakeholders from hundreds of organisations – including environmental groups, regional MPs and senior representatives from local authorities. We also use stakeholders' publications, public statements and feedback from meetings to develop an understanding of their views on issues.

In autumn 2016, we held four county-specific stakeholder workshops (Westbourne, 2016a, 2016b, 2016c, 2016d. These were attended by approximately 160 stakeholders from 100 different organisations including parish, borough and county councils, environmental groups (such as WWF and rivers trusts), business groups (such as the NFU) and our regulators (Ofwat, Consumer Council for Water, Natural England and the EA). A range of topics were discussed including our future business priorities, sewer flooding, water resources, planning for future growth and bathing water quality. Post-workshop reports, can be found on our website.

In addition, in 2016 we formed five stakeholder panels – four county-specific, i.e. one for each county and a strategic environmental panel. Members include regional and national representatives from county and borough councils, interest groups, our regulators and business groups. Minutes of the panel meetings can be found on our website.

Members of our Strategic Environment Panel include a range of national level stakeholders:

- WF-UK, South Downs National Park Authority, WWF-UK, Kent County Council, Defra, South East Rivers Trust, EA, Green Alliance, NFU, South East Regional Flood and Coastal Committee, Consumer Council for Water, RSPB and the Marine Conservation Society
- Members of our County Stakeholder Panels include:
  - Hampshire and Isle of Wight Wildlife Trust, EA, Salmon and Trout Conservation, Hampshire County Council, Natural England, Campaign to Protect Rural England, New Forest National Park Authority, Wessex Chalk Stream and Rivers Trust, Southampton City Council, PUSH/Fareham Borough Council, IW Council, AONB, Footprint Trust, Natural Enterprise, Local Growth Solent LEP, Kent Invicta Chamber of Commerce, Thanet & East Kent Chamber of Commerce, Kent County Council, Dover District Council, Little Stour & Nailbourne River Management Group, Thanet Destination Management Plan, Kent Wildlife Trust, South East Rivers Trust, Thames Gateway Kent Partnership, Kent and Essex IFCA, Kent & Medway Economic Partnership, Land & Business Association. CPRE Kent, Sussex Wildlife Trust, Arun and Rother Rivers Trust, CRPE Sussex, Brighton and Hove City Council, East Sussex County Council, Country Land and Business Assocation, Rother District Council, Chichester District Council, National Flood Forum, Ouse and Adur Rivers Trust.

We have used the insight from these workshops and panels – and other feedback from stakeholders – to help develop our thinking, improve our current performance and shape our plans for the future.

In March 2017 we sent a WRMP pre-consultation letter to all our stakeholders, which contained an update of the Drought Plan and WRMP and invited them to have their say on our approach. The letter can be found in Appendix E. There was limited feedback from this letter – only one local authority replied in relation to how the company planned for housing growth, and we responded to this comment.

We have identified two licensed water suppliers in our supply area whom supply premises via our supply system. We will send our draft WRMP to these suppliers and we intend to have further engagement with them during the consultation period.

5.5 Key findings from the stakeholder workshops

The key findings from the workshops were grouped into four main priority areas: customer service, protecting and improving the environment, reducing water wastage and investing for future generations. Further details of the findings under each of these areas is outlined below.

5.5.1 Customer service

This section covers the services we provide to our domestic customers. In April 2017, we stopped providing retail services to non-household customers.

For Ofwat, great customer service means ensuring customers receive the same levels of service from monopoly providers as in other sectors and they are active participants in their water and wastewater services. Affordable bills means companies ensure bills are affordable now and in the future and do more to identify and help customers in vulnerable circumstances. There were four main sub-themes that we had feedback on, namely customer service, affordability, vulnerability and communication.

In respect to affordability, Blueprint for Water (BfW) wants companies to do more to support customers, particularly around increased uptake of social tariffs.

5.5.2 Protecting and improving the environment

This section summarises stakeholders' views on how we should manage, protect and improve the environment. Some stakeholders feel we should play a stewardship role over the environment we operate in.

This section is relevant to Ofwat's themes of resilience and innovation. The resilience of our natural assets is critical to supporting our operations in the future and many of the ways we will achieve this is through innovative methods – either capital projects or new ways of working like catchment management and drainage strategy frameworks.

- Natural capital
  - Defra is keen for water companies to develop natural capital thinking and has directed Ofwat to encourage companies to use natural capital thinking
    - In its draft SPS to Ofwat, Defra said the regulator should "encourage the sustainable use of natural capital by water companies" by considering the wider benefits of our activities to the economy, society and the environment
    - This was included in Ofwat's draft PR19 methodology
  - BfW wants companies' plans to consider the value of water and the natural environment and commit to assessing companies' natural capital with the intent to grow it and integrate it into decision making
  - Regional environmental stakeholders are keen to work with us on natural capital projects
- Catchment management
  - Stakeholders from across the spectrum are keen to work with us on catchment management projects and support our continued work on them
    - National Flood Resilience review said Defra's 25 year environment plan will look to manage "whole river catchments intelligently"
    - The EFRA committee called for catchment management to be adopted on a much wider scale
    - BfW want companies to play a greater "stewardship" role in catchments

- At our stakeholder workshops, stakeholders told us we should work with landowners to help slow and manage flows
    - It was also considered an option for managing water resources and improving water quality
- Michael Gove's "unfrozen moment" speech outlined his priorities for environmental protection and CAP reform post Brexit – leaning towards a "payment for ecosystems services" style approach
    - This has been (broadly) supported by the NFU, CLA, other countryside groups, environmental groups and think-tanks such as Policy Exchange – though with some variations around the nature of subsidies for food production

- SuDS & the automatic right to connect
    - There is broad support for the increased use of Sustainable Drainage Systems (SuDS) but there are different opinions about the role of water companies in their construction, adoption and maintenance
    - Local authorities are keen to explore working in partnership to help resolve drainage issues with limited funding available. Government wants to encourage the wider use of SuDS and is due to be reviewing legislation relating to SuDS and the automatic right to connect in 2017. The EFRA committee wants the review to set out how SuDS will be deployed to maximum effect in all new English developments and recommends water companies take ownership of them. It also called for an end to the automatic right to connect. In Defra's draft SPS to Ofwat, it said adoption of SuDS and co-investing in flood risk management should be considered as part of "an innovative and strategic mix of solutions" to meet wastewater needs and increase flooding protection. Stakeholders have expressed similar concerns to us about the ongoing maintenance and liability for SuDS. Many stakeholders and groups support removing the automatic right to connect surface water drainage to mains sewers
- Water resources & abstraction reform
    - Environmental groups are generally supportive of the real-options appraisal and multi-criteria analysis approach which the company in adopting to develop this WRMP
    - BfW want companies' plans to commit to completing the Restoring Sustainable Abstraction programme and increase the uptake of Ofwat's Abstraction Incentive Mechanism (AIM) scheme
    - BfW also want companies to "ensure no overall increase in the amount of water abstracted" despite climate change and population growth
    - NFU want to create links between water and food security. They also want an abstraction system which gives farmers and growers a fair share of water, particularly during times of increase water scarcity
    - Regional stakeholders are generally supportive of our approach to water resources planning

5.5.3 Reducing water wastage (including water reuse)

This section summarises the feedback we have received about leakage reduction, helping customers use less water at home and one of our key strategic water resources options, water reuse. This section is relevant to three of Ofwat's themes – affordable bills, resilience and innovation. We will need to invest in innovative methods to find and fix leaks quicker and more efficiently than we do currently. Helping customers reduce the amount of water they use at home will help make more water available for supply and keep customers' bills affordable.

- Water efficiency & per capita consumption (PCC)
    - Michael Gove wrote to all water company CEOs challenging them to do more to bring average PCC down
    - The Committee on Climate Change has called for more ambitious reductions in PCC
    - BfW wants companies to develop and implement tariffs and schemes which reward customers and communities for reducing their water consumption

        - BfW also thinks water efficiency is “an essential part of a package to tackle affordability and vulnerability” as well as reducing the amount of water taken from the environment for public supply
        - They also want companies to work with developers to increase the water efficiency of new developments
    - Local authorities have told us they are keen to support our water efficiency programmes
    - Stakeholders told us water efficiency should be the first option we implement to increase the amount of water available
- Leakage
    - In Michael Gove’s letter to water companies, he also challenged companies to do more to tackle leakage
        - In Defra’s draft Strategic Policy Statement to Ofwat, it expects the regulator to promote action to reduce leakage and PCC – where this represents the best value for money
    - Ofwat is proposing reducing leakage as an ODI common to all water companies as part of PR19 – and want companies to set “more stretching” targets than at PR14
    - BfW also want companies to focus on leakage reduction
    - Leakage reduction was the second highest preferred option amongst stakeholders for securing water supplies at our 2016 workshops
        - Previous customer and stakeholder research / insight / feedback shows they feel addressing leakage is the “right thing to do” and that, if we are encouraging customers’ to reduce consumption, we should do the same
- Water reuse
    - After demand reduction options, water reuse was the most popular supply option at our 2016 workshops
        - This included both effluent reuse and domestic grey water reuse
        - Stakeholders felt the perceived customer opposition to water reuse can be overstated
    - Feedback from government to water reuse has been mixed – reservoirs are seen as a more resilient solution
    - BfW want companies to fully consider demand reduction options before implementing supply-side options such as water reuse

5.5.4 Investing for future generations

- Resilience
    - “Long-term resilience in water and wastewater supply is at the centre” of Ofwat’s approach to PR19
    - BfW want companies to set out how we will deliver and report on long-term resilience. This should be tied to the resilience of the natural infrastructure we rely on.
    - In the National Flood Resilience Review, government said it wanted to see temporary improvements to resilience by December 2016 and permanent increases to resilience of all our sites serving more than 20,000 people
    - The Committee on Climate Change recommended all critical assets are resilient to 1 in 200 year events
        - This was supported by the Environmental Audit Committee
- Water
    - Stakeholders told us we should plan for a level of water resources resilience which caters for customers views, the economy and the environment
        - Stakeholders said it was difficult to single one priority out as they are all interlinked
    - Stakeholders want us to consider demand reduction options before implementing new supply options such as transfers and water reuse

- Michael Gove said he wants to see evidence companies are working together to reduce the long-term risk from drought
    - This was particularly in areas where an area could be at risk of drought while a neighbouring area has a surplus of water
    - Ministers / government have historically preferred more reservoirs and capital schemes. In Michael Gove's letter he explicitly references co-operation with neighbouring water companies and inter-company transfers from areas of surplus to drought

- Housing growth and new development
    - Government expects water companies to play our part in supporting economic growth by "ensuring timely connections of new developments"
        - In both the consultations on the housing white paper and industrial strategy, the water industry was mentioned specifically as a potential blocker for housing growth
        - Defra expects companies to have clear views of the current and future needs of development in their regions
    - The EFRA committee has called for water companies to become statutory consultees on planning applications
    - Our capacity to support housing growth is a key area of concern for many of our local stakeholders
        - Stakeholders have told us they want more clarity around the role we play in supporting development and greater visibility of how we play the role – including engaging with the national debate around house building
        - Regional stakeholders and developers have told us they want us to be more involved earlier in the process
    - The House Builders Federation has been critical of our ability to support their members in meeting government housing targets

5.6 Customer engagement overview

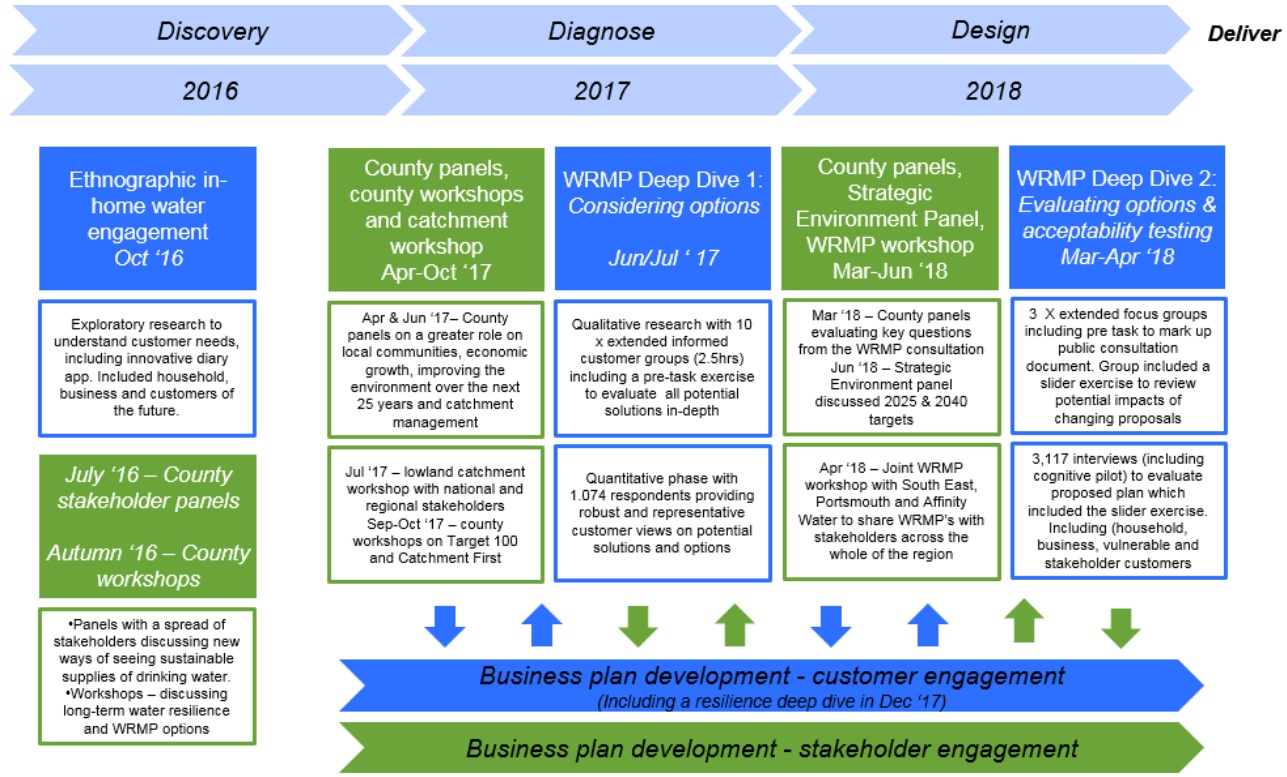
Our engagement approach for the WRMP has followed the same process structure as for the PR19 Business Plan. In our engagement we focus on three key areas to collaborate in the design of a customer-led plan as shown below in Table 33.

Table 33 Stages of customer engagement for the PR19 Business Plan

Stage	Objective	Key features of our approach
Discover	To articulate what we mean by "customers" and to develop a deep understanding of the needs, behaviours and preferences of our diverse range of customers	• Broader definition of customer • Exploratory research and stakeholder engagement
Diagnose	To develop a deep understanding of the priorities of our customers, and of the range of priorities reported by our different customer groups, as well as to develop an understanding on key topics, e.g. resilience	• Breadth and depth of approaches • Collaborated to understand the priorities • Developed deep understanding of relative priority of categories and of differences in priorities between customer groups
Design	To co-create our Business Plan with our customers, to understand how customers want us to deliver on their priorities and how much they are willing to pay for service improvements	• Understood desire and willingness to pay for service improvements in priority areas • Understand how customers want their services to be delivered and collaborated to co-create initiatives to deliver on their priorities

Customer insight for the WRMP was sought in conjunction with the business plan customer insight programme as set out in the timeline below. Figure 5 also shows the consultation undertaken on the draft WRMP, the outcomes from which are covered in the Statement of Response Report.

Figure 5 WRMP19 and PR19 Business Plan customer and stakeholder insight timeline



In summary:

- In 2016 we began our engagement programme which included open dialogue discussions with our customer stakeholders about their needs and future priorities for a resilient future
- Through 2017 our focus became more bespoke to the WRMP reviewing potential options in-depth, to understand customer preferences
- 2018 then focused on collaborating with customers to design the final stages of the proposed WRMP

We have also built upon the customer engagement undertaken for WRMP14 which provided key insights on long term priorities, preferences for different supply schemes and demand management activities as well as the Levels of Service and resilience that the company should plan for.
Throughout the whole process continuous engagement from our stakeholders and PR19 customer participation has fed into our understanding to inform the WRMP. In order to more explicitly incorporate customer views into this plan we have developed the following approach:

- A Multi-Criteria Analysis (MCA) methodology - a technique for assessing options against a number of distinct objectives which requires the objective function to solve for more than one criterion at once (rather than just minimising monetised costs or maximising monetised benefits subject to constraints)
- Started regulatory engagement earlier – following a change in the water resources planning methodology, which encourages companies to consider more advanced decision making techniques depending on their circumstances requiring more time for the regulators to understand the new method chosen

5.6.1 Summary of the approach

Initially customer engagement was focussed on determining customers' priorities across all areas of the business in the short and longer term:

- August 2016 - An ‘app’, 1:1 interviews and focus groups were used to capture customers long term priorities; 1:1 interviews were also held to capture businesses long term priorities
- February 2017 - An ‘app’ and focus groups were used to capture the long term priorities of customers of the future (ages 11-18)

More specific to the development of the WRMP the company also carried out the following customer research:

- Scheme preference online survey
  - Using a self-completion online methodology, 1,074 Southern Water customers were interviewed between the dates of 20 June to 27 June 2017.
  - A sample of customers was sourced from the YouGov online research panel. People were invited at random to the survey based on their post code. Only those who receive water and / or wastewater services from Southern Water were used to compile the initial post code list.
  - A screening question within the survey was used to identify those who were solely or jointly responsible for paying the water bill in their household. Only those who met these criteria were allowed to proceed with the interview.
  - The focus of the pre-consultation was to understand scheme preferences at a generic scheme level. In the exercise customers were asked to solve a 200Ml/d deficit in the supply demand balance, which they could achieve by dragging schemes into the solution basket. As they did this, customers could see how much the scheme would cost (Capex and Opex), the impact on their bill, and the impact on the environment (SEA rankings).
  - Before consulting with customers we took the customer survey questions through our Customer Challenge Group (CCG), who helped shape the final survey that was used with customers.
  - Customers were presented with 10 different measures for maintaining a supply-demand balance. There were:
    - Water saving devices and gadgets
    - Sea water (desalination)
    - Underground water storage
    - Reservoirs
    - Helping people use water more wisely
    - Catchment management
    - Water re-use
    - Reducing leaks
    - Tariffs
    - Trading water
  -
- Willingness to pay research
  - Survey applied to a full (unweighted) sample of dual-service and wastewater only household customers, completed between 12 and 25 July 2017. To understand customers’ priorities across a wide range of potential service improvements and their willingness to pay (WTP) to see them implemented.
  -
- Scheme preference workshops
  - In addition to the quantitative survey work with YouGov we also took the same questionnaire and presented it to a series of customer groups across the region (Breathe Research, 2017). This provided us with a richness of additional qualitative assessments.
  - 10 pre-placed group discussions of 2-2.5 hours conducted between 10 June and 10 July 2017 in the counties of Kent, Sussex, Isle of Wight and Hampshire. The groups were categorised by lifestyle, i.e. ‘pre-kids’, ‘young families’, ‘older families’, ‘empty families’ and ‘older families’.

- Customers were provided with an update on the context for water supply in their area. For example, they were told where water comes from in Sussex.
- The company considers that the participants in the panel sessions were not fully representative of the company's customer base, both geographically and demographically. Therefore, the findings from the workshops were not used to inform the MCA work.

5.7 Key findings from the customer engagement

5.7.1 Current domestic and business customer priorities relating to water supply:

- Effective management of water as a resource is essential
- Clean safe drinking water is a primary concern for all
- Water usage emerged as a partnership issue in which the consumer has expectations of a guardianship role from Southern Water and the expectation of support in enabling effective domestic usage
- Important that bills are accurate and kept at an acceptable levels, but far lower concern vs. other utilities. For water dependent companies contingency supply arrangements are essential
- Essential for people that Southern Water is not polluting, and is protecting the environment.
- Customers pleased about Southern Water's leakage performance, but feel too much water is still being lost
- Customers do not feel threated by drought and feel the current contingencies available to mitigate the risk are satisfactory (e.g. TUBs, NEU restrictions).
- Desire is to maintain the same level of provision of service that we currently have with minimal impact on the environment

5.7.2 Future customer priorities:

- Core desire is consistent with that of adults: to maintain the same level of service, but with a significant focus on supporting the environment, stopping pollution, and dealing with the negative impacts of global warming (drought)
- The environment and pollution are key issues; and enabling effective usage of water to support this
- There is a much stronger sense of planetary responsibility
- There is a real desire for Southern Water to inform and support future customers in their personal usage of water
- Young people are interested in Southern Water using new technology and initiatives to help people use water more efficiently e.g. recycling waste water in homes that is currently just flushed away
- There is felt to be a need for education, both within school, in the context of the PHSE curriculum, and also in the wider arena.

5.7.3 Scheme preference online survey

- When each of the 10 measures are compared directly against one another, underground water storage is ranked 1st. This is followed by catchment management (2nd), helping people to use water more wisely (3rd), reducing leaks (4th) and water saving devices & gadgets (5th) as presented in Table 34
- When asked to trade off the extent to which measures Southern Water should prioritise against potential impact on the individual's bill as well as the impact on the environment, the overall ranking based on the average amount allocated to each measure closely followed the ranking described above. Further points to note:
  - 51% thought the bill increase was reasonable (the overall average bill increase was £49.75) while 38% thought it was not reasonable
  - The point at which more people consider the bill increase to be unreasonable vs. reasonable is approximately £80

- Overall, 42% of those surveyed made an allocation which resulted in a 'good' impact upon the environment. This compares to 49% who made choices which had a 'neutral' impact while only 8% prioritised measures which had a 'poor' overall effect on the environment
- On average, a 'good' environmental choice resulted in a significantly higher increase to their bill

- When asked to state the extent they were 'for' or 'against' each of the 10 measures, underground water stores and catchment management (the 1st and 2nd ranked in direct comparison) are the two measures for which the majority surveyed said they were 'for' rather than 'against' helping to validate their position as the top two measures
- The influence these rankings had on the selection of the preferred strategies is presented in Table 35. This shows whether the selection of options increased, stayed the same or decreased compared to the least cost plan. Further details of how the preferred strategies were defined can be found in Annex 8
- The survey also provided some interesting insight into customers' personal knowledge, motivation and habits regarding saving water:
  - Turning off the tap when brushing teeth, having a shower rather than a bath and only washing full loads of laundry are very widely recognised as water saving actions. However, 1 in 10 said they thought only drinking bottled water fell into this category.
  - Overall, word of mouth and information disseminated via the media are the two most common sources people have learned about water saving actions.
  - The vast majority (86%) have made a decision to save water over the past 3 years. This is most commonly driven by a feeling that it is common sense to do this and also a desire to save money on the water bill.
  - As might be expected, the most common water saving activities undertaken closely matches awareness of water saving actions (see above).

Table 34 Overview of ratings of options presented in the scheme preference online survey

Rank order	Option
1	Underground water stores
2	Catchment management
2	Helping people to use water more wisely
4	Reducing leaks
5	Water-saving devices and gadgets
6	Reservoirs
7	Water re-use
8	Trading water
9	Reward and penalty tariffs
10	Seawater (desalination)

Table 35 Overview of ratings of options presented in the scheme preference online survey

Option	Influence on draft WRMP least cost strategies
Underground water stores	No change as maximum potential volume selected
Catchment management	More catchment schemes were added
Helping people to use water more wisely / water-saving devices and gadgets	A more ambitious water efficiency target was included
Reducing leaks	More ambitious leakage targets were included
Reservoirs	No change as options limited to increase number.
Water re-use	More water reuse schemes are selected instead of desalination schemes
Trading water	No change: existing and future bulk supply options selected to support policy of maximising trading opportunities
Reward and penalty tariffs	Tariffs were de-selected but will be investigated further to better understand customer concerns and preferences.
Seawater (desalination)	Selected if there are no alternatives of if alternatives are much more expensive.

5.7.4 Willingness to pay (WTP) research (relating to water supply service only)

- Dual service households considered a reduction of leaked water per household on average 1.34 times as high a priority for them as a 3% increase in the generation of renewable energy
- Leakage improvements were found to be of the highest priority to customers amongst the water service measures
- Customers were highly averse to accepting reductions in service in exchange for lower bill
- On average, households were willing to pay a maximum of £1.40 per year on top of their current water bills, in real terms, for a reduction in the number of cases of 'Non-ideal taste and smell of tap water for a few days' per 10,000 customers

5.7.5 Scheme preference workshops

- A Water Resource Management Plan was seen as a necessity by the majority. People anticipated greater demand for water in the future due to climate change and increased population
- Anticipated future with more drought and floods making resilience a key criteria for evaluating future options (must still be cost effective)
- Impact on the environment is also an important factor. Not damaging nature and wildlife is more of a priority for people than carbon impact
- People believe that green energy will be able to mitigate options that use a lot of energy in their processes

- Gaining new water is a priority (of the three options only water reuse and desalination are seen to be resilient, as we'll always have wastewater and seawater; whereas trading is too vulnerable a choice)
- Preference for water reuse over desalination due to less impact on the environment and more perceived flexibility in scaling
- Using underground water stores is valued even though it delivers relatively little water (4%) as it is environmentally friendly and cheap
- Combinations of using water more wisely and catchment management as educational / behavioural tools are chosen to deliver the 16% of need not fulfilled by the primary choices
- Finding new sources of water is the first element that people look to as a foundation for building a future solution
- Introduction of universal metering is seen as an essential step to reducing water usage
- Majority add in using water more wisely, with some using a combination of this and catchment management
- Majority are prepared to pay more for solutions that are resilient and environmentally friendly
- Storage solutions:
  - Are easily understood
  - Fit in with the perception that we have a lot of water but that capturing it and keeping it isn't happening
  - Drought / flood scenarios envisioned in the future make this seem an obvious solution to people
  - Are solid and tangible
- Water reuse:
  - There is a high level of enthusiasm for water reuse
  - Many believe that water reuse is already happening: it's the primary choice for building a plan as it provides 80% of the need in a way that is reliable and resilient
- Underground stores:
  - Feels like a 'no-brainer' as using a natural resource at low cost
- Helping people use water more wisely
  - Expectation is of an ongoing comprehensive programme which uses a range of media to consistently communicate with customers, seen as a clear role for educating the next generation
- Catchment management:
  - Concept of working with farmers / landowners is broadly well received, as it provides a cost effective solution (an educational / partnership process with a different audience group)
  - However, catchment management is not telegraphic as a term
- Trading water:
  - Initial perceptions of good value are quickly undermined by concerns about price stability and vulnerability during times of low supply. This quickly shifts this measure to a short term 'top up' role
- Reservoirs:
  - Conceptually a good idea, but fraught with practical issues because of land availability in the South
- Seawater (desalination):
  - Often assumed to be the answer, especially by men, before the research exercise; but feels a bit 'all or nothing' (overkill for 'where we are now'; but may be a valid option further in the future)
- Water-saving fittings and gadgets:
  - Seen to be a very expensive way to generate behaviour change vs. education, with some doubts about people's willingness to participate
- Reward tariffs:

- Framework of reward vs. punishment is more positive, but still seen as unlikely to have sufficient impact on people's behaviour

- Penalty tariffs:
  - An overly complex solution, which is seen to be negative in focus, and potentially dangerous
- Reducing leaks:
  - It is liked conceptually but it is considered uneconomic

6. Levels of service

Levels of service set out the standard of service that customers receive or can expect to receive from their water company. The objective of a WRMP is to ensure that there is enough water available to meet anticipated demands in all WRZs up to a defined level of service and resilience.

Water supply systems become most constrained during drought events. In our area, these most commonly occur when there has been a lack of rainfall during the autumn and winter. Often the effects of such a 'meteorological drought' can be exacerbated by subsequent high demand as a result of hot and dry summer conditions which can potentially lead to a shortage of supplies. These conditions do not occur often, and therefore the process of water resources planning usually has to simulate how the water supply system might have behaved during a drought event.

In order to develop a system that is resilient to drought, due consideration must be given to the optimum balance of the type of resources in any given WRZ and how they are likely to respond under a variety of planning scenarios. This should be an important factor in the choice of supply and demand management options. For instance, we could meet a forecast deficit at times of peak demand through increased treatment capacity, whereas average or minimum resource period deficits may require the development of more storage or the provision of a drought resilient solution such as water reuse or desalination.

Prior to our 2014 WRMP we based the assessment of water supplies during drought only on those droughts that had been observed in the historic record. There are several historic droughts that we normally use to represent design events, such as those experienced during 1900-03, 1920-22, 1930-33, and sometimes 1976. A limitation of this approach is that data are only available for drought events that we have observed over a relatively short period (around one hundred years). This does not allow a robust test of the system; nor does it take account of different types of drought that could occur in future, or could have occurred in the past. Other limitations of a historical drought approach are uncertainties in the observed data (e.g. rainfall) used to describe each drought, especially those that occurred several decades ago.

All drought events are different, and so basing the WRMP on consideration of one drought event only (the worst in the historic record) may mean that the designed supply system is not as resilient as it could be. A different type of drought, with different lead-in conditions and low rainfall duration and extent, may present a more severe threat to supplies.

We have developed a 'fully risk based' plan in keeping with our adopted risk principal (Section 2). We have therefore considered a wide range of droughts based on statistical generation of synthetic weather sequences. This approach supports the generation of synthetic weather data that are entirely consistent with the current climate within each WRZ, but allow us to simulate many more drought events and evaluate resilience and levels of service (see Annex 3 for further details). These droughts have allowed us to determine how sensitive our existing resources are to droughts of different characteristics.

Defining levels of service is a requirement of the WRMP (England) Direction 2017 s. 3(b). Based upon our modelling, and our pre-consultation with stakeholders and customers, this section presents our levels service for our final plan.

Our target levels of service set out what we aim to achieve. We use two themes of levels of service that are relevant to water resource planning:

- Customer target levels of service – which relate to the frequency and nature of restrictions that customers may experience (in the form of Temporary Use Bans (TUBs)) restricting different categories of water use, and Drought Orders on non-essential water use during drought conditions)
- Environmental target levels of service – which relate to the frequency of Drought Permits and Drought Orders allowing modified abstraction regimes outside normal licence conditions at some of Southern Water's sources

For Customer Target levels of service, the WRMP (England) Direction 2017 requires us to specify the average annual risk of restrictions during the first 25 years of the plan under each of the following measures:

- Section 76 of the Water Industry Act 1991 which relates to TUBs (colloquially "Hosepipe Bans")
- Section 74(2)(b) of the Water Resources Act 1991 relating to ordinary Drought Orders to restrict water use, otherwise referred to within this document as "Non Essential Use (NEU" Bans
- Section 75 of the Water Resources Act 1991 relating to Emergency Drought Orders to restrict water use, for example stand pipes and rota cuts

Our plan has been tested against scenarios which exceed the required reference level of service stated in the WRPG (Environment Agency and Natural Resources Wales, 2016, 2017) (see section 6.4). If our preferred plan is delivered, we consider that our supplies can be resilient without Emergency Drought Orders (rota cuts and standpipes) to at least a 1 in 500 year drought event.
Because of the recent licence changes in our Westerna area under some of the potential planning scenarios we have considered (Annex 8) we cannot meet our target levels of service in the first ten years of our plan until alternative supply options to replace the lost DO become available. This is most relevant to environmental Drought Orders and Permits to increase abstraction beyond normal licence limits.

6.1 Stakeholder and customer preferences for levels of service

We have undertaken a variety of engagement with our customers and other stakeholders to understand their preferences in terms of our resilience, levels of service and the options we consider. We have presented details of our pre-consultation with customers and stakeholders in section 5.
As part of our pre-consultation our recent customer 'willingness to pay' research considered the views of approximately 1600 household customers. This study included two questions explicitly related to levels of service for water supply (Accent and PJM, 2017a, 2017b) (see Table 36 below). These considered willingness to pay for an increase or decrease in our current target levels of service relating to the frequency of TUBs and Emergency Drought Orders (including rota cuts), specifically:

- Customer preference for a change in the probability of TUBs being needed from 1 in 10 years (10% annual probability) to between 1 in 8 and 1 in 15 years
- Customer preference for a change in the probability of rota cuts (based on restrictions occurring for 3 hours a day for two months during summer) from the current level of 1 in 200 (0.5% annual probability) to between 1 in 140 year (0.7% annual probability) and 1 in 300 years (0.3% annual probability).

In both cases, customers desired large bill reductions (£9.70 to £13.30 per household per annum) for a reduction in the current level of service. Conversely, improvements to levels of service were not favoured proportionally (<£1.00 per household per annum). Overall, analysis of customer priorities (Accent and PJM, 2017b) indicated that improvement to our levels of service for supply

restrictions (TUBs and Rota Cuts) compared to WRMP14 were considered the lowest priority (favoured by only around 5% of customers) of our water services. Our customers considered that reducing leakage, incidents of non-ideal taste and odour, improvements to water efficiency and reducing planned, non-drought related interruptions were all a higher priority for improvement.

Table 36 Summary of customer willingness to pay with respect to water supply levels of service (After Accent and PJN, 2017a, 2017b).

	Level of service attributes	Temporary Use Ban put in place for five months from May to September (chance per year)	Water supply restricted to 3 hours per day for two months during a dry summer (change per year)
Levels of service	Relaxed	12.5% (1 in 8 years)	0.7% (1 in 140 years)
	Current	10% (1 in 10 years)	0.5% (1 in 200 years)
	Improved	8.3% (1 in 12 years)	0.4% (1 in 250 years)
	Most improved	6.7% (1 in 15 years)	0.3% (1 in 300 years)
Willingness to pay (£ / household / year)	Relaxed	£-15.30	£-20.90
	Improved	£0.60	£0.60
	Most improved	£0.00	£0.00

Overall, the results from our willingness to pay research found that our customers were unwilling to accept deteriorations in service for reasonable reductions in their bills. There was also little appetite for seeking extensive improvements to services (Accent and PJM, 2017). We therefore consider that there is limited evidence to support a change to our current levels of service with regard to drought resilience and demand restrictions.

A key stated preference by both our customers and current guidance is that the water supply system should be 'resilient'. In keeping with this, we have assessed our DOs out to extremely low probability droughts out to 0.2% annual probability (1 in 500 years). A 1 in 500 year extreme drought event could be considered a reasonable worst-case drought (Met Office, 2016). We plan for these low probability droughts to ensure that there is not an unacceptable risk that the supply system might fail to balance supply and demand have on the drought intervention measures and the stated levels of service for each of the supply areas.

In addition to the preferences of our customers, we also look to stakeholder guidance. Recently the Committee on Climate Change has recommended that all critical assets are resilient to 1 in 200 year (0.5% annual probability) events. The Environmental Audit committee also supported this approach (after Southern Water, 2017).

6.2 Levels of service and drought triggers

Our levels of service are inherently probabilistic and we have specified them as the annual probability or an estimated return period of a given event. The probabilities associated with levels of service are not consistent as those for DOs for the drought events we consider. When assessing system

capabilities for a given drought, the DO is calculated assuming that the system 'fails' on the last day of a drought. However, levels of service interventions are put in place based on forecasts of what might realistically occur as the drought develops, and are therefore not related to the actual 'point of failure' for any given drought (which cannot be known in advance).

This is because the conditions that indicate a potential drought occur much more frequently than an actual drought. In many cases, drought conditions will ease within the period between preparing and submitting an application for a Drought Permit or Order and when the Permit is actually granted because of interim rainfall and recharge. We would only implement the Drought Permit or Order if the water resource situation continued to deteriorate. This means that, to ensure security of supplies, interventions such as Drought Permits will need to be prepared, and owing to the lead times involved, potentially put in place far more frequently than the 'post event' drought would have required. This issue is discussed in detail in Appendix C02 of our 2014 WRMP (Southern Water 2014) and is also discussed, with examples in the UKWIR Risk based planning guidance (2016).

We learned a key lesson in this regard from the 2011-12 'drought'. By March 2012 rainfall deficits of over 40% compared to the long-term average accumulation over a six to twelve month period had occurred, approaching the worst drought on record. However, subsequent heavy rainfall and recovery from April 2012 showed that droughts could break at any time, even in the summer. From a water resource planning perspective, the severity of a drought is largely irrelevant until it actually affects water resources (normally during the summer or autumn / early winter periods). Nonetheless, because of the potential severity of the drought, in March 2012 (i.e. before the drought broke) Southern Water, along with all other companies in the South East, began to implement a range of drought intervention measures (TUBs and Drought Permits / Orders) to protect the environment and water supplies. The actual outcome of the event was that none of these interventions were required.

A similar, but less severe, example occurred in the winter of 2017-18. We prepared, applied for and the EA granted a Drought Permit to refill Bewl Reservoir that had declined to low levels owing to a dry early winter period. However, subsequent late winter and spring rainfall was sufficient to refill the reservoir without requiring use of the Drought Permit.

Our River Test Drought Permit application in the Autumn of 2019 also followed a similar pattern in that although flows receded very close to the point at which they might have impacted abstraction rainfall then occurred which caused flow to recover before the Drought Permit was required. We know that this situation is very likely to occur again in the next 10 years.

Figure 6 Schematic showing possible drought evolution through monitoring triggers based on synthetic weather generator output

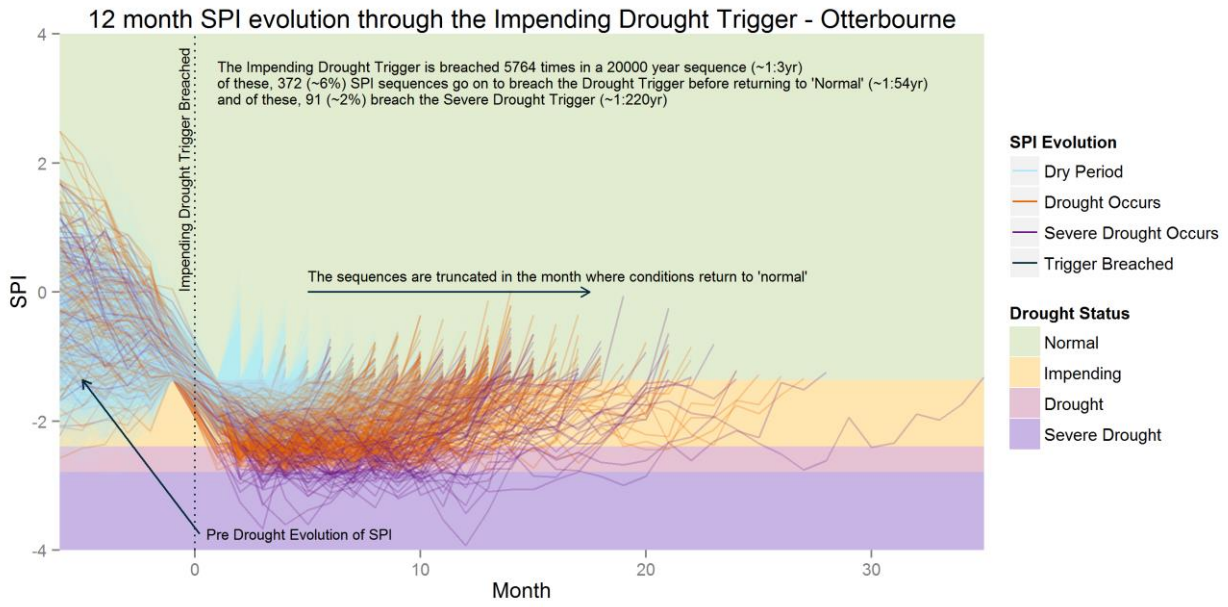


Figure 6 illustrates an example of these phenomena. Based on observed rainfall data up to a particular point (March 2012) a synthetic rainfall sequence (see Annex 3) was examined for similar sequences. The subsequent evolution of rainfall patterns over the next 2 years were then tracked in order to assess the likelihood of our drought triggers for rainfall being breached. Approximately half the future cases (~55%) breached the impending drought trigger by 2023. The result of this analysis is to show that breaching of drought indicator triggers occurs relatively frequently. Thus to ensure supplies are maintained, preparations must, pragmatically, begin to ensure any required Drought Permits and Orders are in place early enough to be used when needed.

We have used our synthetic water resource modelling (Annex 3) alongside our Drought Plan (Southern Water, 2019) to develop design scenarios and drought triggers that reflect our target levels of service (Table 37). These design scenarios represent what Southern Water considers the appropriate level of resilience required to ensure that we will not trigger drought interventions more frequently than required under the stated levels of service and are in line with our customer preferences.

We have considered available supplies over a wide range of drought events (see Annex 3 and Annex 5) ranging from typical normal dry year (50% annual probability) all the way to extreme droughts (~0.2% annual probability), far worse than those in the historic record. By planning for these extreme events, we consider that our plan will reduce the likelihood of recourse to Emergency Drought Orders, which restrict water use to an absolute reasonable worst case minimum.

Our levels of service for demand restrictions (TUBs, and NEU bans) are much lower than for loss of supplies because the conditions that indicate a severe (e.g. 1 in 200 or 1 in 500 year) drought event may occur happen much more frequently than the drought event itself. If required, we will implement demand restrictions in a phased approach, to minimise impact on businesses; and our research (Smale, 2018) has shown that such restrictions are not likely to have a significant economic impact in our area, compared to potential social and environmental costs of not using Drought Permits and orders in this way.

At our target level of service, it is effectively guaranteed (99% chance) that we will need to apply restrictions on water use at some time during the lifetime of our plan over the next 50 years. In our modelling, we have considered all demand restrictions (TUBs and NEUs) as options such that would consider alternative planning scenarios where such measures would be unavailable. However, our preferred plan requires that some restrictions on water use will be in place, both to reduce demand, but also to uplift DOs by preserving stored water, in our reservoirs and aquifers. Our plan assumes that demand restriction measures will available to us at our stated target level of service and we would implement them based on our drought triggers and the measures set out in our Drought Plan (Southern Water, 2019).

Under our planning scenarios (see Annex 6) and preferred strategy (Annex 8) we have only allowed the use of Drought Permits and Orders to increase supplies through relaxation of licence conditions to be selected for drought events beyond a 1 in 200 drought in the long term. However, as noted previously, we cannot achieve this target for some scenarios in the Western and Central areas in the short term over the next 5 to 10 years. Our final preferred plan (Annex 8) and Drought Plan (Southern Water, 2019) set out where and how we will implement these measures and the monitoring and remedial action we will take.

We have tested our investment proposals against a range of plausible future droughts, and we are confident they represent a good balance between cost, environment and resilience to severe droughts.

By considering this wide range of future scenarios (Annex 6, Annex 8) our modelling and preferred strategy suggests that we will not need to resort to standpipes and rota cuts out to at least an approximately 1 in 500 year drought, in excess of the reference level of service (Environment Agency and Natural Resources Wales, 2017). However, before any consideration of such an event, Southern Water also considers that there would likely be prior government designation of some form of national or regional emergency. As well as providing a methodology that is designed to meet the levels of service commitments for more frequent interventions (TUBs, Drought Permits/Orders), our approach is designed to ensure that extreme measures such as Emergency Drought Orders for standpipes or rota cuts will not be implemented as a result of perceived risk during ongoing drought situations. This is a key part of the expressed customer preference for a resilient system. We can only achieve this if the method links WRMP assumptions for DO to the drought management measures in our Drought Plan (Southern Water, 2019).

6.3 Target levels of service

The target levels of service sets out what we aim to achieve and we have based these on our previous levels of service (Southern Water, 2014) and our pre-consultation with customers and stakeholders.
We have presented our current target levels in Table 37 below. We have expressed them both as an average annual probability and as a return period. From these we have estimated the probability of at least one occurrence of each event within the duration of our 50 year planning horizon.

However, under some of the planning scenarios we have considered (Annex 8) we cannot meet our targets, particularly for environmental Drought Orders and Permits to increase abstraction beyond normal licence limits immediately because of the DO we have lost following the March 2019 licence changes to the River Test and Itchen sources. It is unlikely that we will be able to meet the target levels of service in the short to medium term (over the next 5 to 10 years) until alternative supply options to replace the lost DO become available.

Following the 2019 sustainability reductions in our Western area, there is a chance that we may also need to implement TUBs more frequently, up to four times in the next ten years. We may also need to apply for temporary abstractions beyond normal environmental safeguards once or twice in our

Western and Central areas during the next 5 to 10 years until we can deliver additional supply solutions.

In our Central and Eastern areas, we anticipate that we will require the use of environmental Drought Orders and Permits in the early stages of our plan (until 2025) during severe droughts (0.5% annual probability, or 1 in 200 year events). These Permits and Orders are required to ensure that we can maintain supplies in the face of proposed sustainability reductions and water quality related reductions in supply.

In our Western area, we have aligned our levels of service with the s20 Agreement reached with the EA at the Western area Public Inquiry. After 2027 we aim not to use the River Itchen Drought Order and aim to only use the River Test Drought Permit/Order in extreme (<0.5% annual probability) drought events. This strategy is to reduce abstraction pressures on sensitive receptors in these catchments. The s20 Agreement specifies the phasing of TUBs and NEU bans in the affected WRZs. TUBs are required before implementation of the River Test Drought Permit and partial implementation of NEU bans is required before we can apply for the River Test or River Itchen Drought Orders. We have incorporated the expected frequency and probability of these events into our forecast levels of service.

In the longer term, under all of our planning scenarios we consider that, if our preferred plan is delivered, we will not require the use of environmental Drought Permits and Orders to increase abstractions beyond licenced quantities out to droughts more severe than 1 in 200 year drought (0.2% annual probability) in any WRZ. Emergency Drought Orders for standpipes and rota cuts will not be required unless faced with extreme drought (<0.2% annual probability) beyond a 1 in 500 year event.

Our target levels of service In accordance with the Water Resource Management Plan (England) Direction 3(b) 2017 are set out in Table 37. We have also presented these levels of service on a supply area basis in Table 38, Table 39 and Table 40. The tables are split into 5 intervals that show how our forecast levels of service will change during the course of our plan. The annual probability stated is the same for all years within each interval (e.g. 2020-2027).

These tables also indicate our historic performance against each of the targets since 1989. The tables present our target and forecast levels of service for the duration of our plan out to 2070. .

We have expressed our levels of service both as an average annual probability and as a return period. As a consequence of the need for more frequent restrictions and environmental Drought Permits and Orders in the early part of our plan, our forecast and target levels of service differ. After 2027, we expect to be able to meet our target levels of service in all areas.

Where restrictions on demand are shown, the target level of service (e.g. 1 in 10 years) for TUBs indicates the frequency of first implementation, however, demand restrictions would be introduced via a phased approach to reduce the economic and social impacts. We would introduce restrictions on businesses through TUBs (under s76 of the Water Industry Act 1991) during the first phase of a drought and could further be extended via a Drought Order if the drought develops further. Our initial objectives will be to maximise water savings in the first phase of drought, while mitigating the impact on the local economy and employment. We will phase restrictions and exemptions maintain supplies for essential services and businesses as long as possible. Businesses can apply to Southern Water for an exemption if they would suffer hardship.

Table 37 Our current target levels of service

Type of restriction or measure	Annual probability	Return period	Probability of at least 1 occurrence within	
			The first 25 years of our plan	Our 50 year plan
Customer target levels of service				
Advertising to influence water use	20%	1 in 5 year	99%	100%
Temporary Use Ban on different categories of water use (Section 76)[3]	10%	1 in 10 year[1]	92%	99%
Drought Order (Non Essential Use Ban on different categories of water use) to restrict water use (Section 74(2)(b))[4]	5%	1 in 20 year[1]	72%	92%
Emergency Drought Order to restrict water use (rota cuts and standpipes) (section 75)[4]	0.2%	Only in a civil emergency (1 in 500 years)	5%	10%
Environmental target level of service				
Application for Drought Permit/Order to increase supplies through relaxation of licence conditions, increase in licensed quantities, or other measures[2]	5%	1 in 20 year	72%	92%

Type of restriction or measure	Annual probability	Return period	Probability of at least 1 occurrence within	
			The first 25 years of our plan	Our 50 year plan
Implementation of Drought Permit/Order to increase supplies through relaxation of licence conditions, increase in licensed quantities, or other measures[2]	0.5%	1 in 200 year	12%	22%

[1] Frequency of first implementation but would be introduced via a phased approach
[2] For Hampshire Southampton East and Hampshire Southampton West WRZs we expect the short term level of service for these Drought Permits and Orders to be less than our target (see
[3]The Water Industry Act, 1991, HMSO
[4]The Water Resources Act, 1991, HMSO

Compared to WRMP14, our levels of resilience to Emergency Drought Orders has only changed in our Western area where it has increased from 1 in 125 years to at least 1 in 200 years for our baseline preferred planning scenario. However, inclusion of a 1 in 500 year drought events within our planning scenarios has indicated that we can be resilient to such an event with normal demand restrictions, Drought Permits and Orders in place. Customers supported our increase in resilience (already included in WRMP14) in our pre-consultation (see section 6.1). The increase in resilience in our Western area also allows us to provide greater protection to the environment; specifically the River Test and River Itchen by allowing us to be less reliant on Drought Orders and Permits as we deliver our preferred plan.

Our plan includes alternative levels of environmental resilience as we explore the impact of allowing Drought Permits and Orders in different states of the world. However, our preferred plan is to maintain current (WRMP14) levels of resilience (to 1 in 500 year event or equivalent 0.5% annual probability). We are not planning to explore different levels of service for restrictions. Current levels are strongly supported and owing to the small marginal benefits of restrictions, (see Annex 3) there is unlikely to be a significant impact upon our plan.

6.4 Reference level of service

Current planning guidance (Environment Agency and Natural Resources Wales, 2016, 2017) requires us to demonstrate how we might achieve a 'reference level of service'. This is equivalent to being able to ensure resilient supplies without recourse to Emergency Drought Orders or rota cuts during drought events of at least an approximate 0.5% annual probability. This is equivalent to a 1 in 200 year return period drought event and thus is consistent with both our previous plan (Southern Water, 2014) and our design strategy for this plan (Annex 6). A 0.5% annual probability drought event would have approximately a 22% chance of occurring within the lifetime of our 50 year plan.

Our target level of service and baseline planning scenario for a 1 in 200 year drought sets out that we can meet and exceed the required reference level of service for Emergency Drought Orders. If our preferred plan, or any strategic alternatives are delivered, we will be able to maintain supplies, potentially with demand restrictions and environmental Drought Orders and Permits in place, but without requiring Emergency Drought Orders to implement rota cuts and standpipes, out to a drought of 1 in 500 year probability.

We expect to be able to achieve the reference level of service from the first year of our plan (as it is effectively consistent with our existing levels of service).
We have set out how we have modelled these severe and extreme droughts and included them in our supply forecast and supply demand balance in annexes 3 and 5. We discuss our selection of appropriate options to provide resilience to these events further in Annex 6 (Options appraisal) and Annex 8, which presents our preferred strategy.

Our research into customer preferences and willingness to pay (Section 5, Section 6.1) has indicated a strong preference for no change in our current target levels of service. Consequently, the reference level of service scenario would effectively represent a derogation in level of service and, as such, we have not considered such a separate scenario explicitly within our plan.

Table 38 Forecast Levels of Service in our Western area over the lifetime of our plan

Type of Restriction or Measure	Forecast Level of Service						
	Historic Performance (1989-2018)	2020-2027	2027-29	2029-2045	The first 25 years (2020-2045)	2045-2070	Our 50 Year Plan (2020-2070)
Advertising to influence water use	No data available	90% chance in period (25% annual probability, 1 in 4 year return period)	44% chance in period (25% annual probability, 1 in 4 year return period)	96% chance in period (20% annual probability, 1 in 5 year return period)	100% chance in period (22% annual probability, ~1 in 5 year return period)	100% chance in period (20% annual probability, 1 in 5 year return period)	100% chance in period (21% annual probability, ~1 in 5 year return period)
Temporary Use Ban on different categories of water use (Section 76)[3]	No events in period (<3% annual probability, >1 in 30 year return period)	90% chance in period (25% annual probability, 1 in 4 year return period)	23% chance in period (12.5% annual probability, 1 in 8 year return period)	79% chance in period (10% annual probability, 1 in 10 year return period)	98% chance (15% annual probability, ~1 in 7 year return period)	93% chance (10% annual probability, 1 in 10 year return period)	100% chance in period (12% annual probability, 1 in 8 year return period)
Drought Order (Non Essential Use Ban on different categories of water use) to restrict water use (Section 74(2)(b))[4]	No events in period (<3% annual probability, >1 in 30 year return period)	34% chance in period (5% annual probability, 1 in 20 year return period)	10% chance in period (5% annual probability, 1 in 20 year return period)	54% chance in period (5% annual probability, 1 in 20 year return period)	72% chance in period (5% annual probability, 1 in 20 year return period)	72% chance in period (5% annual probability, 1 in 20 year return period)	92% chance in period (5% annual probability, 1 in 20 year return period)
Emergency Drought Order to restrict water use (rota cuts and standpipes) (section 75)[4]	No events in period (<3% annual probability, >1 in 30 year return period)	2% chance in period (0.2% annual probability, 1 in 500 year return period)	0.4% chance in period (0.2% annual probability, 1 in 500 year return period)	3% chance in period (0.2% annual probability, 1 in 500 year return period)	5% chance in period (0.2% annual probability, 1 in 500 year return period)	5% chance in period (0.2% annual probability, 1 in 500 year return period)	10% chance in period (0.2% annual probability, 1 in 500 year return period)
Drought Permit/Order to increase supplies	No events in period (<3% annual	90% chance of application in period (25% annual	19% chance of application in period (10%	3% chance in period (0.2% annual probability,	92% chance of application in period (9% annual	5% chance in period (0.5% annual probability,	93% chance of application in period (5% annual

through relaxation of licence conditions, increase in licensed quantities, or other measures[2]	probability, >1 in 30 year return period)	probability, 1 in 4 year return period) 34% chance of implementation in period (5% annual probability, 1 in 20 year return period)	annual probability, 1 in 10 year return period) 2% chance of implementation in period (1% annual probability, 1 in 100 year return period)	1 in 500 year return period)	probability, 1 in 11 year return period) 37% chance of implementation in period (1.8% annual probability, 1 in 56 year return period)	1 in 500 year return period)	probability, 1 in 22 year return period) 40% chance of implementation in period, (1% annual probability, 1 in 100 year return period)

[1]Frequency of first implementation but would be introduced via a phased approach

[2]For Hampshire Southampton East and Hampshire Southampton West WRZs we expect the short term level of service for these Drought Permits and Orders (up to 2027) to be less than our target

[3]The Water Industry Act, 1991, HMSO

[4]The Water Resources Act, 1991, HMSO

Table 39 Forecast Levels of Service in our Central area over the lifetime of our plan

Type of Restriction or Measure	Forecast Level of Service					
	Historic Performance (1989-2018)	2020-2025	2026-2045	The first 25 years (2020-2045)	2045-2070	Our 50 Year Plan (2020-2070)
Advertising to influence water use	No data available	67% chance in period (20% annual probability, 1 in 5 year return period)	98% chance in period (20% annual probability, 1 in 5 year return period)	100% chance in period (20% annual probability, 1 in 5 year return period)	100% chance in period (20% annual probability, 1 in 5 year return period)	100% chance in period (20% annual probability, 1 in 5 year return period)
Temporary Use Ban on different categories of water use (Section 76)[3]	4 events on record (13% annual probability, 1 in 7.5 year return period)	41% chance in period (10% annual probability, 1 in 10 year return period)	88% chance in period (10% annual probability, 1 in 10 year return period)	93% chance (10% annual probability, 1 in 10 year return period)	93% chance (10% annual probability, 1 in 10 year return period)	99% chance in period (10% annual probability, 1 in 10 year return period)
Drought Order (Non Essential Use Ban on different categories of water use) to restrict water use (Section 74(2)(b))[4]	No events in period (<3% annual probability, >1 in 30 year return period)	34% chance in period (5% annual probability, 1 in 20 year return period)	58% chance in period (5% annual probability, 1 in 20 year return period)	72% chance in period (5% annual probability, 1 in 20 year return period)	72% chance in period (5% annual probability, 1 in 20 year return period)	92% chance in period (5% annual probability, 1 in 20 year return period)
Emergency Drought Order to restrict water use (rota cuts and standpipes) (section 75)[4]	No events in period (<3% annual probability, >1 in 30 year return period)	2% chance in period (0.2% annual probability, 1 in 500 year return period)	3% chance in period (0.2% annual probability, 1 in 500 year return period)	5% chance in period (0.2% annual probability, 1 in 500 year return period)	5% chance in period (0.2% annual probability, 1 in 500 year return period)	10% chance in period (0.2% annual probability, 1 in 500 year return period)
Drought Permit/Order to increase supplies through relaxation of licence conditions, increase in licensed quantities, or other measures[2]	1 event on record (3% annual probability, 1 in 30 year return period)	2% chance in period (0.5% annual probability, 1 in 200 year return period)	4% chance in period (0.2% annual probability, 1 in 500 year return period)	3% chance an application in period (0.3% annual probability, 1 in 385 year return period)	5% chance in period (0.2% annual probability, 1 in 500 year return period)	11% chance in period (0.2% annual probability, 1 in 435 year return period)

[1]Frequency of first implementation but would be introduced via a phased approach

[2] For our Central area WRZs we expect the short term level of service for these Drought Permits and Orders to be less than our target

[3]The Water Industry Act, 1991, HMSO

[4]The Water Resources Act, 1991, HMSO

Table 40 Forecast Levels of Service in our Eastern area over the lifetime of our plan

Type of Restriction or Measure	Forecast Level of Service					
	Historic Performance (1989-2018)	2020-2025	2025-2045	The first 25 years (2020-2045)	2045-2070	Our 50 Year Plan (2020-2070)
Advertising to influence water use	No data available	67% chance in period (20% annual probability, 1 in 5 year return period)	98% chance in period (20% annual probability, 1 in 5 year return period)	100% chance in period (20% annual probability, 1 in 5 year return period)	100% chance in period (20% annual probability, 1 in 5 year return period)	100% chance in period (20% annual probability, 1 in 5 year return period)
Temporary Use Ban on different categories of water use (Section 76)[2]	4 events on record (13% annual probability, 1 in 7.5 year return period)	41% chance in period (10% annual probability, 1 in 10 year return period)	88% chance in period (10% annual probability, 1 in 10 year return period)	93% chance (10% annual probability, 1 in 10 year return period)	93% chance (10% annual probability, 1 in 10 year return period)	99% chance in period (10% annual probability, 1 in 10 year return period)
Drought Order (Non Essential Use Ban on different categories of water use) to restrict water use (Section 74(2)(b))[2]	No events in period (<3% annual probability, >1 in 30 year return period)	34% chance in period (5% annual probability, 1 in 20 year return period)	58% chance in period (5% annual probability, 1 in 20 year return period)	72% chance in period (5% annual probability, 1 in 20 year return period)	72% chance in period (5% annual probability, 1 in 20 year return period)	92% chance in period (5% annual probability, 1 in 20 year return period)
Emergency Drought Order to restrict water use (rota cuts and standpipes) (section 75)[3]	No events in period (<3% annual probability, >1 in 30 year return period)	2% chance in period (0.2% annual probability, 1 in 500 year return period)	3% chance in period (0.2% annual probability, 1 in 500 year return period)	5% chance in period (0.2% annual probability, 1 in 500 year return period)	5% chance in period (0.2% annual probability, 1 in 500 year return period)	10% chance in period (0.2% annual probability, 1 in 500 year return period)
Drought Permit/Order to increase supplies through relaxation of licence conditions, increase in licensed quantities, or other measures	3 events in period (10% annual probability, 1 in 10 year return period)	2% chance in period (0.5% annual probability, 1 in 200 year return period)	4% chance in period (0.2% annual probability, 1 in 500 year return period)	3% chance an application in period (0.3% annual probability, 1 in 385 year return period)	5% chance in period (0.2% annual probability, 1 in 500 year return period)	11% chance in period (0.2% annual probability, 1 in 435 year return period)

[1]Frequency of first implementation but would be introduced via a phased approach

[2]The Water Industry Act, 1991, HMSO
[3]The Water Resources Act, 1991, HMSO

6.5 Drought Resilience

Section 39B of the Water Industry Act (1991) sets out the duty of a Water undertaker is to "*to supply adequate quantities of wholesome water, with as little recourse as reasonably possible to drought orders or drought permits*". Our target levels of service have been set out with this in mind and we will only require supply side Drought Permit and order interventions for events more severe than a 0.5% annual probability (1 in 200 year) event.

Our preferred plan also anticipated that we would not require the use of Emergency Drought Orders to restrict water use (for example by use of rota cuts or standpipes) except under conditions more severe than a 0.2% annual probability (1 in 500 year) event.

Although these probabilities appear low on face value in any given year, the encounter probability, which describes the chance of such an event occurring within a given time frame, for example when considered over the lifetime of our plan (25 or 50 years) is relatively high.
A severe drought, 0.5% (1 in 200 year) annual probability event has around a one in ten (11%) chance of at least one occurrence in a 25 year period and more than a one in five (22%) chance over the lifetime of our 50 year plan. Similarly, at least one extreme drought (0.2% annual probability, 1 in 500 year return period) has around a 5% chance of occurrence in the next 25 years and nearly 10% chance in the next 50 years.

Given our statutory duty to provide a supply water, over the lifetime of our plan these risks are not small and therefore provide a further basis for our plan and levels of service to consider such events.

The National Infrastructure Commission (NIC) have also recently considered these risks (NIC, 2018) and have stated that current planning guidance that sets a minimum standard to ~1% annual probability (equivalent to the worst historic drought) may not be adequate. In the event of a more severe or extreme event the economic, environmental and social impacts of large scale restrictions, rota cuts and standpipes and Drought Orders would be likely be significantly greater compared to the cost of increased resilience. NIC (2018) estimate the costs of such emergency measures would be in the region of £20-40 billion (weighted by probability of occurrence) nationally. In comparison, the NIC (2018) estimated the costs of building resilience to severe and extreme events at some £18-21 billion, so are at least comparable and at best offer a considerable saving.

We consider that our preferred plan and target levels of service align with the strategic goals of NIC (2018) report. Our preferred plan meets the severe and extreme resilience scenarios covered by the NIC and our strategy will restrict the use of supply side Drought Orders and Permits to only within an extreme drought.

Our preferred strategy includes several schemes to increase transfers both between other water companies and between our WRZs. We also plan to further increase meter penetration from already high levels. The NIC (2018) also recommended increased transfers and metering.

In the longer term, we will consider the feasibility of improving our levels of service further. In this plan we have already considered a sensitivity strategy (Annex 8) for the type of solutions that might be required to avoid demand restrictions and supply side drought interventions entirely, recognising that these may still have unacceptable environmental and economic impacts that could be avoided.

To effectively reduce the risk of emergency drought measures to negligible levels entirely, taken as being <1% chance over the average lifetime (80 years) of our customers we estimate that we would need to plan for a level of drought resilience broadly equivalent to a 1 in 10,000 year event. We are not yet at that level of resilience but this degree of planning is comparable to that used in other critical

infrastructure for example in the transport and nuclear sectors. We will keep our levels of resilience under review and consider if it is reasonable and feasible to plan to similar levels.

Our level of service and drought resilience statements

The UKWIR Risk based planning guidance (UKWIR, 2016a, 2016b) requires us to make two key statements regarding our levels of service and drought resilience following the 'fully risk based' methodology we have employed. These statements aid communication of risks to stakeholders and customers given the probabilistic nature of the forecasts we have made. The information provided in both statements has already been set out in preceding sections and we have based them on our preferred strategy in Annex 8. For clarity, both statements are set out below:

6.5.1 UKWIR (2016) Level of service statement

We are confident that, on average, we will only have to apply TUBs for fewer than 6 periods in the next 50 years. We are also *confident that, on average, we will only have to apply NEU bans 2 or 3 times in the next 50 years.*

If we deliver our preferred strategy over the next fifty years, we are confident that, on average, we may only need apply for temporary abstractions beyond normal environmental safeguards once during the lifetime of our 50 year plan. However, there is almost an 80% chance that we will not need to implement these measures at all.

Following the Western area planning inquiry, the licence changes and adoption of Section 20 Agreement between Southern Water and the Environment Agency (2018) mean that in our Western area, we may need to implement TUBs more frequently until 2029. This could be up to four times in the next ten years. To ensure resilient supplies we will also be more reliant on Drought Permits and Orders in these areas. We may also need to apply for temporary abstractions beyond normal environmental safeguards up to four **times** in the Western area during the next ten years until we can deliver additional supply solutions.

6.5.2 UKWIR (2016) Drought resilience statement

Our investment proposals mean we expect there is a less than 10% chance that we will have to resort to restrictions such as rota cuts or standpipes over the 50 year planning period of the WRMP.

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Annex 1: Pre-consultation and Problem Characterisation

Appendix A: WRZ Integrity Assessment

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RESTRICTED INFORMATION IN SEPARATE PDF, AVAILABLE UPON REQUEST

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Annex 1: Pre-consultation and problem characterisation

Appendix B: Pre-consultation meetings

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Table 1 Summary of pre-consultation meetings with regulators

Date	Regulator	Event / purpose
27/06/2014	Environment Agency	First WRMP19 presentation
17/03/2015	Environment Agency	SSD Quarterly EA meetings
24/03/2015	Environment Agency	Advance techniques for WRMP24
23/06/2015	Environment Agency	SSD Quarterly EA meetings
30/06/2015	Environment Agency	SSD catchment scheme update
23/09/2015	Environment Agency	SSD Quarterly EA meetings
15/10/2015	Environment Agency	KSLES WQ NEP meeting
04/11/2015	Environment Agency	SSD DrWPA water quality meeting
09/12/2015	Environment Agency	SSD Quarterly EA meetings
01/05/2016	Environment Agency	Meeting to discuss new techniques for WRMP19
04/05/2016	Natural England	Pre-consultation discussion - awareness of WRMP19 process / timetable
06/06/2016	Environment Agency	SSD DrWPA liaison
09/06/2016	Environment Agency	Site visits - preliminary discussions around challenges and methods (Sussex and Kent)
10/06/2016	Environment Agency	Site visits - preliminary discussions around challenges and methods (Sussex and Kent)
04/07/2016	Environment Agency	SSD DrWPA liaison
07/07/2016	Environment Agency	Site visits - preliminary discussions around challenges and methods (Hampshire)
14/07/2016	Environment Agency	KSLES DrWPA liaison
15/07/2016	Environment Agency	Workshop: Decision Making Process: Problem Characterisation Step
28/07/2016	Environment Agency	Meeting - WRMP supply forecast method discussion / WRMP liaison
09/08/2016	Environment Agency	KSLES DrWPA liaison teleconference
17/08/2016	Natural England	Natural England advice on Drought Plan SEA, HRA and EARs
07/09/2016	Environment Agency	Meeting - WRMP options selection approach; HRA/SEA/WFD assessment of DP and WRMP; EARs of DP
26/09/2016	Environment Agency	KSLES DrWPA liaison
29/09/2016	Environment Agency	KSLES & SSD DrWPA liaison
30/09/2016	Environment Agency	Workshop - Review Drought Permit / Order options with Area (KSLES);
03/10/2016	Environment Agency	Meeting - WRMP supply forecast - review hydrology / Catchmod models
04/10/2016	Environment Agency	Meeting - WRMP demand forecast method discussion
05/10/2016	Environment Agency	Workshop - Review Drought Permit / Order options with Area (SSD);
06/10/2016	Environment Agency	KSLES DrWPA liaison with Amec
07/10/2016	Environment Agency	SSD DrWPA liaison with Amec
18/10/2016	Environment Agency	Meeting - GW modelling strategy
30/10/2016	Environment Agency	Kent and South London Drought Options - discussion on KSLES Drought Options in the 2018 DP
31/10/2016	Environment Agency	KSLES & SSD DrWPA risk assessment liaison
01/11/2016	Environment Agency	Meeting - Outage reporting, recovery plan and allowance for WRMP19

Date	Regulator	Event / purpose
02/11/2016	Environment Agency	Workshop - review screening of WRMP unconstrained options
08/11/2016	Environment Agency	KSLES & SSD DrWPA liaison
10/11/2016	Environment Agency	Workshop - review screening of WRMP unconstrained options
23/11/2016	Environment Agency	Meeting - Sustainable catchments - review EA risk assessments
24/11/2016	Environment Agency	KSLES & SSD DrWPA liaison
29/11/2016	Environment Agency	Meeting - Sustainable catchments - National Workshop
13/12/2016	Environment Agency	Meeting - Sustainable catchments - review EA risk assessments
14/12/2016	Natural England	Meeting with NE - comments on HRA screening and initial EARs
14/12/2016	Environment Agency	Meeting - GW modelling strategy
16/12/2016	Environment Agency	Meeting - Options appraisal update and Drought Plan progress
16/01/2017	Environment Agency	KSLES & SSD NEP meeting
18/01/2017	Environment Agency	Teleconference - Review problem characterisation method statement (AM); Stochastic refinement approach (PM)
19/01/2017	Natural England	Teleconference with NE - comments on EAR screening reports
24/01/2017	Environment Agency	Workshop - Drought Plan to cover EARs, SEA, HRA, WFD, and monitoring plan. Review screening of WRMP unconstrained options
25/01/2017	Environment Agency	SSD NEP teleconference
31/01/2017	Environment Agency, Natural England	Workshops - Drought Plan to cover EARs, SEA, HRA, WFD, and monitoring plan. Review screening of WRMP unconstrained options
07/02/2017	Environment Agency	Teleconference - General WRMP process / timetable
08/02/2017	Environment Agency	Meeting - Sustainable catchments - review EA risk assessments
10/02/2017	Environment Agency	Meeting - Sustainable catchments - review EA risk assessments
15/02/2017	Environment Agency	Meeting - SWS / EA SSD 'working together' liaison meeting
22/02/2017	Environment Agency	Meeting - WRZ integrity; supply side, climate change and demand forecast method statements
06/03/2017	Natural England	Meeting - Drought Plan EAR wash-up session
08/03/2017	Environment Agency	Meeting - Sustainable Catchment queries
08/03/2017	Environment Agency	Meeting - Sustainable Catchment queries
08/03/2017	Environment Agency	Meeting - Drought Plan EAR wash-up session
10/03/2017	Environment Agency	Meeting - Drought Plan EAR wash-up session
16/03/2017	Environment Agency, Natural England	Meeting - Drought Plan HRA
21/03/2017	Environment Agency	Meeting - Investment modelling and approach to headroom / uncertainty
22/03/2017	Environment Agency	Teleconference - Drought Plan - Bowcombe Drought Permit option
22/03/2017	Natural England	Teleconference - Drought Plan - Lower Itchen Drought Order option

Date	Regulator	Event / purpose
29/03/2017	Environment Agency	Meeting - Outage - response to Defra and allowance for WRMP19 Sustainable catchments - implications of EA policy and risk assessments on WRMP19
03/04/2017	Environment Agency, Natural England	Meeting - Drought Plan HRA
20/04/2017	Environment Agency	Meeting - SWS / EA SSD 'working together' liaison meeting
20/04/2017	Environment Agency	SSD NEP/ water quality meeting
27/04/2017	Environment Agency	KSLES DrWPA review meeting
02/05/2017	Environment Agency	Teleconference - WRMP19 / DP18 progress update
04/05/2017	Environment Agency	KSLES DrWPA review meeting
12/05/2017	Environment Agency	Teleconference - WRMP19 review actions
22/05/2017	Ofwat	Meeting - WRMP19 pre-consultation with Ofwat
24/05/2017	Natural England	Teleconference - NE role in WRMP19 options appraisal
25/05/2017	Environment Agency	Meeting - Environmental forecast & Scenario testing
08/06/2017	Environment Agency, Natural England	Workshop - Options appraisal with EA KSLES Area
08/06/2017	Environment Agency	KSLES ‘at risk’ DrWPA update
09/06/2017	Environment Agency, Natural England	Workshop - Options appraisal EA SSD Area
14/06/2017	Natural England	Meeting - Review feasible options (Eastern / Central Area)
22/06/2017	Environment Agency	Meeting - Investment modelling update
26/06/2017	Natural England	Meeting - Review feasible options (Western Area)
27/06/2017	Environment Agency	SSD DrWPA liaison
29/06/2017	Environment Agency	Meeting - Review of WRMP progress / actions and next steps
30/06/2017	Environment Agency	KSLES & SSD NEP meeting
04/07/2017	Environment Agency	KSLES WINEP meeting
14/07/2017	Environment Agency	Meeting – WRMP19 / DP18 progress update
27/07/2017	Environment Agency	Teleconference – WRMP19 / DP18 progress meeting
07/08/2017	Environment Agency	KSLES WINEP meeting
08/08/2017	Environment Agency, Natural England	Meeting - Scope of revised drought plan
09/08/2017	Environment Agency	KSLES & SSD WINEP meeting
16/08/2017	Environment Agency	Meeting – WRMP19 / DP18 progress meeting
24/08/2017	Environment Agency	Teleconference – WRMP19 / DP18 progress meeting
12/09/2017	Environment Agency, Natural England	Meeting - Scope of revised drought plan
13/09/2017	Ofwat	Meeting - WRMP19 pre-consultation with Ofwat
13/09/2017	Environment Agency	Meeting – WRMP19 / DP18 progress meeting
22/09/2017	Environment Agency	Meeting - WRMP19 / DP18 progress meeting
04/10/2017	Environment Agency, Natural England	Meeting - DP HRA meeting
04/10/2017	Environment Agency, Natural England	Meeting - WRMP investment modelling meeting with EA / NE
05/10/2017	Environment Agency, Natural England	Meeting - WRMP investment modelling meeting with EA / NE
11/10/2017	Environment Agency	Teleconference – WRMP19 / DP18 progress meeting
16/10/2017	Environment Agency	KSLES & SSD WINEP meeting

Date	Regulator	Event / purpose
23/10/2017	DWI	Meeting – Water quality schemes in the WRMP
03/11/2017	Environment Agency	Teleconference – WRMP19 / DP18 progress meeting

Table 2 - Summary of pre-consultation meetings with stakeholders

Date	Stakeholder	Event / purpose
27/08/2015	Environment Agency, SEW, SESW	Medway joint water company meeting
21/10/2015	SEW, SESW	Medway joint water company meeting
18/11/2015	Anglian Water / Thames Water	Stochastic Modelling Approach – knowledge sharing with water companies
04/12/2015	Oxford University	Meeting with the MarIUS project team to discuss climate modelling
23/02/2016	Environment Agency, SEW, SESW	Medway joint water company meeting
07/06/2016	SEW, SESW	Medway joint water company meeting
18/07/2016	SEW, SESW	Medway joint water company meeting
19/07/2016	Affinity Water	Water resources options - Seek clarification on water resources options between the two companies
22/07/2016	Portsmouth Water	Water resources options - Seek clarification on water resources options between the two companies
04/08/2016	South East Water	Water resources options - Initial discussion on bulk supplies and joint water resource options
13/09/2016	Waterwise	Southern Water water efficiency workshop with Waterwise
07/10/2016	South East Water	Water resources options – bulk supplies and joint water resources schemes
04/11/2016	SEW, SESW	Medway joint water company meeting
25/11/2016	Medway Council	Update on water resources planning and preparation for WRMP19
02/12/2016	South East Water	Water resources options – bulk supplies and joint water resources schemes
08/12/2016	Hampshire Water Resources Group	Water resources planning / option review with Hampshire stakeholders
27/01/2017	South East Water	Water resources options – bulk supplies and joint water resources schemes
02/03/2017	Hampshire Water Resources Group	Water resources planning / option review with Hampshire stakeholders
10/03/2017	South East Water	Water resources options – bulk supplies and joint water resources schemes
27/03/2017	Thames Water	Water resources options review – bulk supply options
10/05/2017	SEW, SESW	Medway joint water company meeting
18/05/2017	Hampshire Water Resources Group	Water resources planning / option review with Hampshire stakeholders
02/06/2017	South East Water	Water resources options – bulk supplies and joint water resources schemes
06/07/2017	South East Water	Water resources options – bulk supplies and joint water resources schemes
25/07/2017	East Sussex Planning Managers	Presentation at meeting - Update on dWRMP19 - how we have incorporated growth forecasts and what feasible options are being considered

Date	Stakeholder	Event / purpose
26/07/2017	Portsmouth Water	Western area strategy and bulk import options
27/07/2017	PUSH Planning Officers Group	Presentation at meeting - Update on dWRMP19 - how we have incorporated growth forecasts and what feasible options are being considered
08/09/2017	Kent Planning Officers Group	Presentation at meeting - Update on dWRMP19 - how we have incorporated growth forecasts and what feasible options are being considered
21/09/2017	South East Water	Finalising representation of bulk supply and shared resource options in WRMPs
27/09/2017	Hampshire Water Resources Group	Water resources planning / option review with Hampshire stakeholders
23/10/2017	DWI	Update meeting on WRMP, PR19 and catchment management
01/11/2017	Hampshire Partnership	Update on water resources planning challenges in Hampshire
02/11/2017	WWF	Update on water resources planning challenges in Hampshire
07/11/2017	Fareham Borough Council	Update on WRMP19 to support Local Plan publication

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Annex 1: Pre-consultation and problem characterisation Appendix C: Method statements for WRMP

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from Southern Water

Table 1 Method statements sent to the Environment Agency for this plan

Date submitted	WRMP19 Method statement
01/09/2016	SEA, HRA & WFD methodology and screening criteria & EAR templates (WRMP & DP)
06/09/2016	Options appraisal - methodology and screening criteria
26/09/2016	Demand forecast (including Climate Change)
27/10/2016	Supply forecast - stochastic refinement and drought scenarios
09/12/2016	Problem characterisation Step
21/12/2016	Water resource zone integrity
08/02/2017	Climate change
09/02/2017	Supply forecast - resource modelling, DO assessments
20/02/2017	Updated demand forecast (including Climate change)
20/02/2017	Updated water resource zone integrity
07/03/2017	Impact of demand upon restrictions
20/03/2017	Options selection / headroom uncertainty
24/03/2017	Outage allowance
12/05/2017	Environmental forecast (including consideration of sustainability reductions)

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Appendix D: Ofwat briefing pack

December, 2019

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Briefing pack

Ofwat WRMP19 pre-consultation meeting company template

- ☐ As set out in our letter dated 8 December 2016, the pre-consultation process will allow us to provide early feedback, challenge and identify areas where more justification is required.
- ☐ We are interested how you are integrating the WRMP19 process into the development of your business plan. This will help us to target our reviews appropriately as part of our risk based approach.
- ☐ Below we set out our expectations for the material that company WRMP19 pre-consultation presentations shall include. These are presented as themes and their sub-components.
- ☐ This briefing pack and the expectations outlined for the pre-consultation meetings reflect our current thinking – these may change over time as the process progresses.
- ☐ To support collaborative working and to aid transparency we will also be inviting a representative from the relevant environmental regulator (Environment Agency and/or Natural Resources Wales (NRW)) to attend the arranged pre-consultation meetings.
- ☐ To ensure we are able to cover all the material in the meeting the presentation shall contain a **maximum of 40 slides.** Companies are free to allocate the number of slides to each theme and sub-component as they wish, but the presentation should follow the structure below.
- ☐ The 40 slides and any extra pre-meeting supporting material referenced in the slides should be sent a week in advance of your meeting to wrmp@ofwat.gsi.gov.uk

1. Introduction to company water resources and summary of WRMP19 approach

- Key changes since WRMP14
- Summary of company/zonal problem characterisation(s)
- Level of service decision
- Key drivers for WRMP19 (in terms of scale and timing)
- Water Resource Zones – summary and changes

2. Supply forecast (including supply scenarios)

- Deployable Output assessment approach
- Climate change forecast
- Drinking water quality impact
- Environmental impacts (Water Framework Directive – WFD, National Environment Programme - NEP, Restoring Sustainable Abstractions - RSA, Abstraction Reform, Invasive Non-Native Species - INNS)
- Outage assessment approach
- Supply scenario generation (including the final 'most likely' planning scenario decision)

3. Demand forecast (including demand scenarios)

- Forecasting household demand – population, properties, occupancy and household consumption
- Forecasting non-household consumption
- Forecasting leakage
- Other components of demand
- Metering impacts
- Impacts of climate change on demand
- Demand scenario generation (including the final 'most likely' planning scenario decision) e.g. house building, water efficiency, leakage reduction, population growth, demographic changes

4. Supply-Demand Balance (including overarching and combination scenarios)

- Headroom assessment and profile (supply, demand and options uncertainty)
- Methods to combine individual scenarios
- Central 'most likely' planning scenario decision process

- Overarching scenarios and future assumptions (consistent with business plan)
- Scenario sensitivity approach (sensitivity analysis)
- Residual risk areas (unable to plan for)
- Planning horizon (25 years or further ahead – rationale)

5. Resilience

- Resilience as a feature throughout the plan
- Level of service and drought resilience improvement
- Resilience measurement – supply-demand balance level of service, resilience metrics, etc.
- Resilience links to the business plan and Drought Plan

6. Decision making and options

- Decision support tool(s) used and link to problem characterisation
- EBSD and complex decision support tool output comparison (where applicable)
- Preferred programme decision approach
- Solution costing (including uncertainties – especially solutions that may not have been undertaken in the recent past)
- Unconstrained to feasible options list (process and assessment criteria)
- Solution resilience assessment (both drought resilience and general service risk)
- Demand option list and generation process (e.g. metering, water efficiency, leakage reduction)
- Different (more stretching) leakage metric (e.g. lower socially acceptable level of leakage)
- Transfer solutions (e.g. third parties, neighbouring companies)
- Catchment management solutions
- Supply option list and generation process
- Regional solutions (where applicable)
- Drought Plan options - requiring investment through WRMP or business plan (where applicable)
- Consideration of new technologies and innovation for options

7. Stakeholder Engagement

- Incorporation of customer views throughout the plan (including ensuring these views are not influenced by the engagement approach)
- Resilience discussion with customers
- Assessment of customers' willingness to pay
- Engagement approach with neighbouring water companies, and third parties (export and import)
- Engagement with regional groups including accounting for any regional water resource strategies (where applicable)
- Consideration of Defra Guiding Principles (where applicable)
- Reflection of Welsh Government priorities (where applicable)
- EA/NRW engagement – management of engagement and outcomes
- Price Review customer challenge group (CCG) engagement and outcomes

8. Links to business plan

- Approach to linking WRMP to your business plan (including consistent assumptions)
- Special cost factor considerations
- Consideration and identification of outcomes

9. Board Assurance

- Board assurance of plan and development of your WRMP

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Annex 1: Pre-consultation and problem characterisation

Appendix E: Consultation letter

December, 2019

Version 1

from Southern Water

Sent by email

10 March 17

Dear Sir/Madam

Southern Water's water resources planning and consultation

I would like to update you on Southern Water's current work to update our Drought Plan and Water Resources Management Plan and invite you to have your say on our approach.

We are due to submit our Drought Plan 2018 to Defra on April 28, 2017, with a view to holding an eight-week public consultation in June and July, 2017. This will be closely followed by submission of our long-term Water Resources Management Plan (WRMP) by December 1, 2017, with a view to holding a 12-week public consultation in January to March 2018.

This will coincide with a consultation on our Business Plan for 2020-25 and therefore make it easier for our customers and stakeholders to give feedback on a wide range of topics at the same time.

Why we are updating our plans

As you may be aware, we have a legal duty to prepare and maintain these plans, as set out in the Water Industry Act 1991. Our current Drought Plan was published in 2013, and our current WRMP in 2014 and both these plans need to be updated every five years.

Consultation

We are already holding conversations with our regulators and neighbouring water companies. We have also held stakeholder workshops and are carrying out research with customers to gather early views and consider them as we draw up our plans. We are keen to hear a wide range of views and would welcome your feedback in this process

Drought Plan

Our Drought Plan sets out the actions we would take to secure essential supplies during drought conditions. Changes in the draft plan we are developing include:

- Environmental assessments for Drought Permits and Orders
- Updates to the implementation of Temporary Use Bans (TUBs) and exemptions
- A new approach to plan for more severe droughts in the future
- The introduction of new Drought Orders in Hampshire.

If you would like to receive a hard copy of our summary draft Drought Plan when it is published for consultation this summer, please let us know on wrmp@southernwater.co.uk and provide your address. The summary and technical documents will also be available to download online at southernwater.co.uk/haveyoursay.

Water Resources Management Plan

Our WRMP sets out how we plan to secure water supplies in the long-term, while considering the challenges of climate change impact, population and housing growth and the impact of future restrictions on abstraction licences.

Previously we have developed a 25-year plan, but this time we are planning to look 50 years ahead. This will help us deliver on one of the Government's key policy expectations - to take a long-term strategic approach to increase resilience.

Key areas of change in the draft WRMP we are developing include:

- Increasing the number of Water Resource Zones in our region from 10 to 14 - to better reflect the way we move water around
- Generating and planning for a greater range of potential droughts - to increase resilience
- Considering resilience to other risks which could affect water supply e.g. power cuts or pollution
- Adopting methods to ensure our plan is adaptable to uncertainties in the future and takes account of a range of objectives
- Planning for possible licence changes – particularly in Hampshire
- Testing how climate change may increase the environmental pressure on abstraction.

Environmental assessments

We will prepare a Strategic Environmental Assessment (SEA) for both our plans, and we have already consulted on the scope of this for our Drought Plan. A consultation for the scope of the SEA for our WRMP is now running – visit southernwater.co.uk/SEA for more information.

Get in touch

If you would like to find out more or input into the development of our plans at this stage, please get in touch at wrmp@southernwater.co.uk. You can also follow our progress and take part in consultations at southernwater.co.uk/haveyoursay.

Yours sincerely,

Nick Price
Water Resources Planning Manager
Southern Water