Thames Water

Final Water Resources Management Plan 2015 - 2040

Main Report

Section 4: Current and Future Water Supply

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Section 4 Current and Future Water Supply

Our water supplies are derived from a combination of surface water (from rivers) and groundwater (water holding rock formations, known as aquifers, underground).

In this section we describe the amount of water which is currently available for water supply and how this has been assessed. The components of the term 'Water Available For Use' (WAFU) are explained and the base year values for the year 2011-12 are shown.

We describe the forecast of supply and the dual pressures of climate change and reductions in licence for environmental improvement.

We have included sustainability reductions in line with the NEP3 published by the Environment Agency (August 2013). We forecast our baseline supply will reduce by approximately 155 Ml/d by the end of the planning period.

We explain our involvement in the Water Resources in the South East (WRSE) Group and its examination of a regional water resources solution and set out our bulk supplies with neighbouring water companies.

The Thames basin is one of the most intensively used water resource systems in the world. Around 55% of effective rainfall is licensed for abstraction and 82% of that is for public water supply.

Our supplies are derived mainly through surface water abstraction in London (supported by a series of large bunded storage reservoirs) and groundwater in the Thames Valley. The proportions of supply are as follows:

- London: 80% surface water and 20% groundwater
- Thames Valley: 30% surface water and 70% groundwater

In a dry year we supply 2,100 Ml/d of water in London and 685 Ml/d in the Thames Valley at peak times.

Our baseline water supplies are forecast to reduce over the planning period due to the impact of climate change (~100 Ml/d) and sustainability reductions (21.2 Ml/d average in Table 4-8, with the potential for a further 179 Ml/d).

Together with growing demand as set out in Section 3, this leaves us with a considerable challenge to balance supply and demand in some zones, in particular, London.

The remainder of this section is structured as follows:

- Introduction
- Current Water Available for Use (WAFU)
- Baseline supply forecast
    - Sustainability Reductions
    - Climate change (further information in Section 5 and Appendix U)
- Water Resources in the South East Group (WRSE) (further information in Section 7)

4.1 Introduction

4.1.1 The Thames Basin

The Thames Basin is the largest river basin in the South East of England. The average rainfall for the Thames catchment is 737mm[1] in a year, substantially less than the average for England and Wales, 897mm.

Of the rain that falls, two thirds is either lost to evaporation or transpired by growing vegetation. Of the remaining 'effective' rainfall, approximately 55% is abstracted for use, making it one of the most intensively used river basins in the world. Of all the water abstracted, 82% is for public supply.

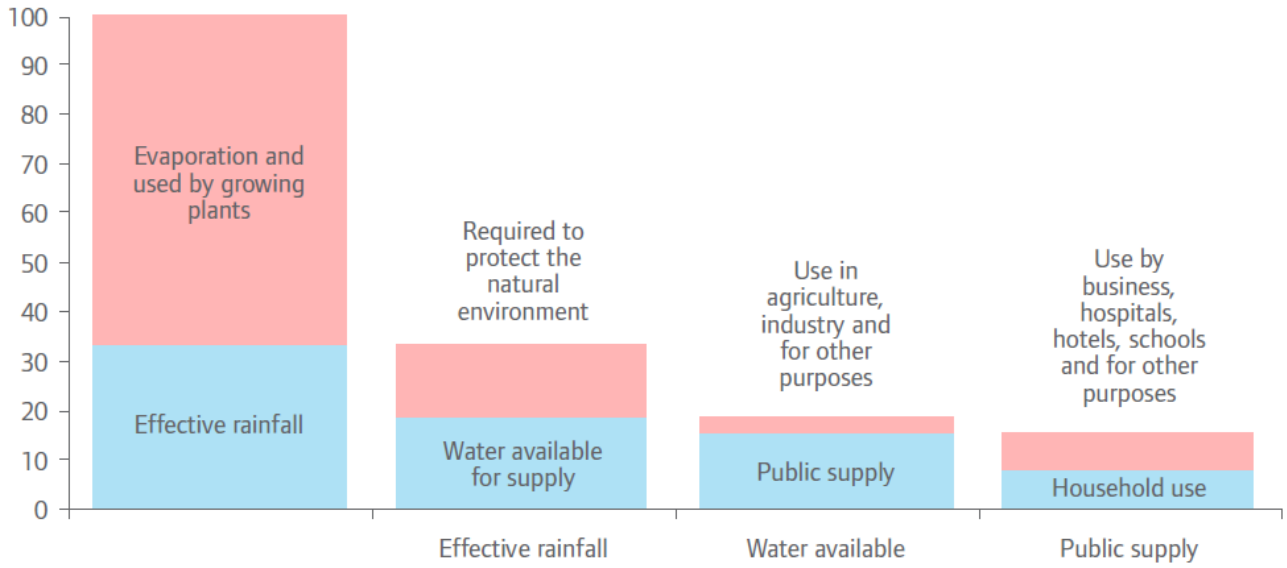


Figure 4-1: What happens to water in the Thames Basin [2]

[1] 129 year average used by Thames Water

4.1.2 Where we get our water supplies

Our water supplies are derived from a combination of surface water (from rivers) and groundwater (water holding rock formations, known as aquifers, underground). In London, the supply is primarily derived from the surface waters of the River Thames and River Lee, via reservoirs. In the zones in the Thames Valley, the majority of the water is derived from groundwater.

Figure 4-2: Existing water resources in the Thames catchment

[2] Taken from GLA (2011) Securing London's Water Future - The Mayor's Water Strategy for London

The amount of water we can put into supply (i.e. leaving our water treatment works and into our distribution network), is called Water Available for Use (WAFU) and is linked to many factors.

WAFU in the base year is evaluated according to the relationship below and describes the amount of water available to supply the demand for water:

WAFU = Deployable Output − Constraints − Outage +/− bulk supply imports/exports

We take into account increases and decreases to these components when forecasting WAFU over the planning period. Principally these are:

- the impact of climate change
- sustainability changes that require us to abstract less water for the benefit of the environment
- new schemes coming online or constraints released in the period to 2015 (as discussed in Section 2)

WAFU is then assessed against demand (Section 3) plus target headroom (Section 5) to understand whether a water resource zone (WRZ) is in surplus or deficit (Section 6).

4.2 Current Water Available for Use (2011/12)

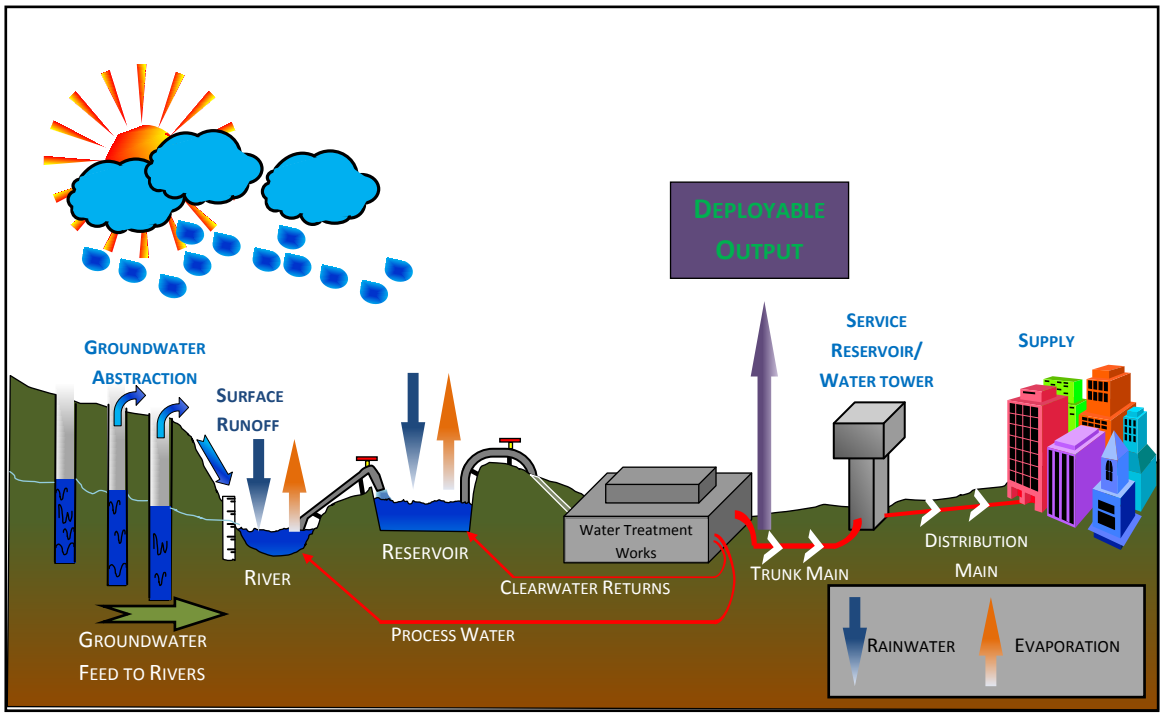
The individual components to calculate the amount of water available for supply are discussed briefly below.

4.2.1 Deployable Output

Deployable Output is the building block on which the assessment of WAFU is based. It is defined as the output of a commissioned source or group of sources or of a bulk supply for a given level of service as constrained by:

- Environment;
- Licence, if applicable;
- Pumping plant and/or well/aquifer properties;
- Raw water mains and/or aquifers;
- Transfer and/or output main;
- Treatment;
- Water quality.

This is expressed in Figure 4-3 below:



Source: Based on Water Resources Planning Tools 2012 Definitions

Figure 4-3: Definition of Deployable Output (DO)

DO is calculated using prescribed methodologies for surface and groundwater sources[3,4,5,6]. The assessment of DO also follows the principles for DO derivation as outlined in the 2012 UKWIR/EA report on Water Resources Planning Tools[7].

We have a complex supply system where in many areas surface and groundwater are mixed and operated together to increase yields over the year in reaction to antecedent weather and demand patterns. These are known as conjunctive use systems.

London's water comes from many sources but most is abstracted from the River Thames and stored in raw water reservoirs before being treated and put into supply. The raw water reservoirs provide a buffer for use in dry periods when abstraction from the Thames is restricted. The quantities that can be abstracted from the river depend on the relationship between the quantities stored in the reservoirs, the need to ensure a residual freshwater flow in the River Thames over Teddington weir, and the time of year. This is governed by the formal operating agreement between Thames Water and the Environment Agency (EA) under Section 20 of the Water Resources Act 1991, called the Lower Thames Operating Agreement (LTOA).

[3] Drayton & Lambert ,1995
[4] Environment Agency, 1997
[5] Beeson, van Wonderen & Mistear, 1995
[6] UKWIR & Environment Agency, 2000
[7] UKWIR & Environment Agency Water WR-27 Water Resources Planning Tools, 2012

DO for London is calculated using a simulation model entitled WARMS (Water Resources Management System). The LTOA is fundamental to the calculation of DO because it determines the relationship between the flow in the River Thames and the amount of water available to abstract for given levels of raw water storage in the London water storage reservoirs. This in turn defines the manner in which the abstractions from the Lower Thames are managed and therefore determines the supply capability for London. Due to the interconnectivity across London it also influences the operation of other strategic sources.

The Swindon & Oxfordshire (SWOX) water resource zone (WRZ) is the other conjunctive use zone within the Thames Water area, which is also modelled using WARMS. The remaining four zones of Kennet Valley, Henley, Guildford and Slough, Wycombe & Aylesbury (SWA) derive raw water supplies predominantly from groundwater sources, although Kennet Valley and Guildford have significant surface water sources at Fobney and Shalford, respectively.

Further information and discussion on the methodology for calculating DO, sensitivity analysis of DO and the impacts of levels of service is provided in Appendix I.

The DOs for 2011-12 and 2012-13, which are included in the Annual Return (AR) to OFWAT are shown in Table 4-1 below. Changes to the DOs between AR12 and AR13 are explained in Appendix I.

Table 4-1: Deployable Output 2011-12 and 2012-13 – Average Dry Year Annual Average (DYAA) and Peak Average Day Peak Week (ADPW)

WRZ	Deployable Output (Ml/d)			
	DYAA AR12	DYAA AR13	ADPW AR12	ADPW AR13
London	2146	2144	--	--
SWOX	326.6	319.5	381.9	373.9
Kennet Valley	141.6	137.1	165.8	160.1
Henley	25.7	25.7	26.3	26.3
SWA	188.2	186.3	220.3	215.1
Guildford	65.2	65.0	75.7	71.2
Total	2893.3	2877.6	870.0	846.6

Treatment Works Losses

An important element of deployable output is the amount of water used at treatment works. Abstracted water is treated within a water treatment works (WTW) before disinfection and being put into the supply network.

Many groundwater sources are good quality and may need only a simple treatment process with negligible waste. However the large surface water treatment works that treat water from our London raw water reservoirs need a variety of treatment processes. Treatment processes and WTWs require additional water for cleaning and maintaining plant.

This 'Process Water' contains contaminants and is then either treated and discharged to the river, discharged to sewer or where possible further treated and re-cycled back to the "head of the works" for re-use.

The route for disposal of process water depends upon the nature of the water treatment works, the source and quality of the raw water. The process for treating water means that there are potential losses of process water to the system unless there is an opportunity to re-cycle the water.

This can occur via a number of routes:

- Directly as at the Coppermills WTW, which recovers the majority of process water by treatment and recycling
- Indirectly via discharge into a watercourse or river, where it contributes to the flow available for abstraction or the "Hands Off Flows", as on the Lower Thames
- Indirectly via a sewage treatment works, which in turn may support downstream water available for abstraction or the "Hands Off Flows", as on the Lower Thames

The modelling of the water resources system through WARMS assumes that a percentage of additional water is needed to deliver a quantity into supply. For example to put 100 Ml/d into supply with a 10% process water requirement means that 110 Ml/d would need to be transferred to the WTWs and results in a 10 Ml/d process water loss.

The percentage of process water losses differs between works due to varying raw water quality and treatment processes.

Note the Coppermills WTWs has the facility to transfer 35 Ml/d of process water back upstream of the process plant for re-use

The percentages assumed for each WTWs in WARMS are shown in Table 4-2.

Table 4-2: Process Water Losses Assumptions in WARMS

WRZ	WTW's	Process Water Losses (%)
London	Ashford Common	3.0
	Hampton	6.1
	Kempton Park	7.2
	Walton	14.2
	Coppermills	8.0
	Hornsey	3.0
	Chingford	3.5
SWOX	Farmoor	8.4
	Swinford	3.3
Kennet Valley	Fobney	7.0
Guildford	Shalford	12.0

Process water losses have been analysed and revised using recently updated resilience models, the derivation for the key WTW in each water resource zone is discussed in Appendix K. The calculation of losses for Table 4-2 is also included in the appendix.

As part of our maintenance plans we are also examining the potential for reducing process water losses at our sites as part of continuous improvement.

4.2.2 Constraints

Constraints occur where existing infrastructure is not capable of distributing or treating all of the raw water that can be produced at a site. We have several projects underway in AMP5 to remove a number of identified network constraints and some have already been completed. All remaining constraints have been assessed to ascertain whether it is cost effective to implement schemes to remove them. Most network constraints are associated with small rural sources on the edge of our distribution network, feeding areas of local demand. All constraints have been examined as potential scheme options to increase water availability.

Network constraints are deducted from Deployable Output (in the same way as Climate Change impact and sustainability reductions) and are not included as an integral part of the Deployable Output assessment, as was the case for the WRMP09.

A summary of constraints for 2011-12 (AR12) and 2012-13 (AR13) is shown in Table 4-3 below. A review of constraints has been undertaken, which shows marginal changes in the constraints due to variation in demand. Note however that constraints in the SWOX zone will be less than 0.5 Ml/d by the end of 2015.

Table 4-3: Constraints by WRZ

WRZ	Constraints (Ml/d)			
	DYAA AR12	DYAA AR13	ADPW AR12	ADPW AR13
London	0	0	N/A	N/A
SWOX	4.73	4.77	4.74	4.74
Kennet Valley	0	0	0	0
Henley	0	0	0	0
SWA	5.20	5.20	5.20	5.20
Guildford	0	0	0	0

4.2.3 Outage

Outages are temporary reductions in DO, which can be caused by factors such as mechanical failure or pollution events. The methodology used for evaluating outage is compatible with and computationally identical to the latest UKWIR methodology used for assessing Headroom Uncertainty, see Appendix V. The method provides an assessment of the uncertainty surrounding outage within the supply demand balance, with a range of probabilities and confidence limits.

Table 4-4 summarises our outage allowances by WRZ for 2011/12 and 2012/13. The values used in the baseline forecast remain constant across the planning horizon and are the same for both the annual average and peak condition.

Table 4-4: Outage Allowances by WRZ

WRZ	Outage (Ml/d)	
	DYAA AR12	DYAA AR13
London	36.04	46.27
SWOX	15.04	14.88
Kennet Valley	1.77	1.85
Henley	1.08	1.05
SWA	11.97	12.53
Guildford	0.78	0.81
Total	66.68	77.39

4.2.4 Bulk Supplies

Efficient and effective use of water is vital in the southeast of England and bulk supplies form a part of that need. Bulk supplies are transfers of either raw or treated water into or out of the Company's supply area.

We have a number of bulk supply agreements with neighbouring water companies. These can be for temporary support in an emergency situation, or as a permanently available supply. It is the latter which are of importance to the WRMP as temporary support would not be required to be provided in a dry year.

Most of the bulk supply agreements are long-standing and are in perpetuity and terminable only by mutual consent. Variation is only possible through renegotiation. The supply of water is 'on demand', and up to the quantities specified in the agreements. A summary of the bulk supply arrangements is shown in Table 4-5.

All our neighbouring companies were consulted prior to the production of our draft WRMP14 and these discussions have continued resulting in modification to the assumed treated water bulk supply to Affinity Water since the public consultation on our draft Plan. Table 4-5 has been amended accordingly and is discussed below. Assumed volumes for the bulk supplies have been agreed for each year of the planning period under a dry year scenario.

The Essex and Suffolk bulk supply agreement offers the opportunity to have an option to temporarily reduce the size of the transfer by around 20 Ml/d. This is included in our options list (Section 7). As shown later in Section 9, this forms part of our preferred plan as it is a cost effective solution.

Whilst there are some minor bulk supply import/exports in the Thames Valley, London is the only WRZ where bulk supplies are a significant factor in the supply-demand balance.

Table 4-5: Bulk Transfers – Imports and Exports

WRZ	Imports	Exports	Total
London[8]	None	- 2 Ml/d raw water to Affinity Water Central - 0.2 Ml/d treated water to Affinity Water Central at Hampstead Lane - 10 Ml/d treated water to Affinity Water Central at Fortis Green. The Bulk Supply is set to increase over the planning period; in 2015 to 11.8 Ml/d in 2018 to 12.6 Ml/d in 2034 to 16.1 Ml/d	-12.2 to -18.3
SWOX	0.1 Ml/d from Severn Trent (included in DO calculation) 2.1 Ml/d from SWA (5 Ml/d on peak) -NB- internal transfer		+5
SWA	None	2.1 Ml/d to SWOX (5 Ml/d on peak) -NB- internal transfer	-5
Kennet Valley	None	None	
Guildford	None	2.3 Ml/d treated water to Affinity Water Central	-2.3
Henley	None	None	

Thames is a net exporter of water.

Transfers to Essex & Suffolk Water

The largest bulk supply export agreement covers the raw water transfer of up to 91 Ml/d average and 118.2 Ml/d peak, to Essex and Suffolk Water from our Lee Valley reservoirs. This export is included within the WARMS modelling and is taken into account in the calculation of Deployable Output and hence is not included in Table 4-5 as a bulk supply.

There is agreement to reduce export by 25% where Thames Water has implemented Temporary Use Ban restrictions and Essex and Suffolk Water has not.

[8] There is also a 91 Ml/d (118.2 Ml/d peak) renegotiation of an existing raw water transfer to Essex & Suffolk which is included in the DO calculation

We have been discussing the possibility of reducing this export through implementation of a new water trading agreement given the fact that following enlargement of its raw water storage reservoir at Abberton, Essex and Suffolk Water will temporarily have a supply demand surplus. This is discussed further in Section 9. The new trading agreement is included in our preferred plan.

Transfers to Affinity Water Central

There are three existing treated water bulk supply exports to Affinity Water Central:

1. from a supply point in the London Borough of Haringey, London WRZ (initially 10 Ml/d), known as Fortis Green;
2. from a supply point in the London Borough of Haringey, London WRZ known as Hampstead Lane (0.2 Ml/d); and
3. from a groundwater source in the Guildford WRZ (2.3 Ml/d).

The Fortis Green agreement allows for 27 Ml/d, although historically the amount agreed for water resources planning purposes has been 10 Ml/d. Since the consultation on the draft Plan, discussion with Affinity Water (Affinity) has continued and they have identified that they will need access to the full existing entitlement, 27Ml/d, of treated water bulk supply during peak conditions at various points throughout the planning period.

The assumptions relating to the Affinity bulk supply transfer at Fortis Green are based upon information provided by Affinity in their WRP Tables. The information presents usage over the planning period for both the DYAA and DYCP scenarios. The DYAA usage, however, has not been adjusted by Affinity to take account of the DYCP usage. DYAA is the critical condition for Thames Water, and thus Affinity's take under dry year conditions needs to be reflected in our DYAA forecasts, rather than peak. Affinity's DYCP use is variable throughout the planning period as it is naturally dependent on weather conditions but is also determined by the development of water supply options identified in their WRMP. To provide a consistent view on usage we have used the DYAA data provided by Affinity and added the annualised DYCP usage to increase the DYAA value. The DYAA usage then reflects the effect on the DYAA utilisation from DYCP. The amendment to the DYAA profile is based on a 56 day critical period that Affinity supplied for the period 1 April to 30 September. A summary of the subsequently adjusted DYAA profile is given in Table 4-5. The approach we have adopted to reflect Affinity's DYCP requirement in the DYAA forecast has been discussed with the Environment Agency. We have also confirmed to Affinity that their requirements have been included in our Plan.

Additionally, there is a raw water supply from two of our west London reservoirs to an Affinity Water Central treatment works of 2 Ml/d. This forms part of an agreement that permits Affinity Water Central to use our reservoir storage in the event of a serious pollution incident impacting their run-of-river source on the River Thames. The overall agreement is only for the duration of the pollution event but there is a provision for up to 10 Ml/d as a sweetening flow in the connecting pipeline, which can be interpreted as a raw water bulk supply.

Inspection of the records for this supply for recent years shows that average transfers are significantly less than the 10 Ml/d allowance. As reported in AR12, it has been agreed with Affinity that the bulk supply be reduced from 10 Ml/d to 2 Ml/d. The existing agreement has now been formally amended to reflect the reduced requirement.

4.2.5 Summary

The average and peak WAFU for the last reporting year (AR13) of 2012-13 in each WRZ is shown in Table 4-6 and Table 4-7, respectively. Note there are no sustainability reductions or scaled climate change impacts included.

Table 4-6: Average Water Available For Use 2012-13

WRZ (Units Ml/d)	DO	−	Constraints	−	Outage	+/−	Bulk Supplies	=	WAFU
London	2144	−	0.00	−	46.27	−	12.2	=	**2085.5**
SWOX	319.5	−	4.77	−	14.88	+	2.1	=	**301.9**
Kennet Valley	137.1	−	0.00	−	1.85	N/A	0.0	=	**135.2**
Henley	25.7	−	0.00	−	1.05	N/A	0.0	=	**24.6**
SWA	186.3	−	5.20	−	12.53	−	2.1	=	**166.5**
Guildford	65.0	−	0.00	−	0.81	−	2.3	=	**61.9**
Total	2877.6		9.97		77.39		18.5		**2775.8**

Table 4-7: Peak Water Available For Use 2012-13

WRZ (Units Ml/d)	DO	−	Constraints	−	Outage	+/−	Bulk Supplies	=	WAFU
London	N/A		N/A		N/A		N/A		**N/A**
SWOX	373.9	−	4.74	−	14.88	+	5.0	=	**359.2**
Kennet Valley	160.1	−	0.00	−	1.85	N/A	0.0	=	**158.2**
Henley	26.3	−	0.00	−	1.05	N/A	0.0	=	**25.3**
SWA	215.1	−	5.20	−	12.53	−	5.0	=	**192.4**
Guildford	71.2	−	0.00	−	0.81	−	2.3	=	**68.1**
Total	846.6		9.94		31.12		12.3		**803.2**

4.3 Baseline Supply Forecast

4.3.1 General

The baseline supply forecast is built from the base year values discussed above. Activity to the end of 2014/15 is as discussed in Section 2. Beyond 2015, the following assumptions are made in the baseline plan:

- No new resource development to increase DO
- No change in constraints
- Process losses are assumed to change in proportion to the movement in DO
- Outage is flat over the planning period
- Imports and exports are largely unchanged, with the exception of the Affinity Water bulk supply through Fortis Green

The only changes to WAFU are from reductions in DO due to:

- Sustainability reductions
- The impact of climate change on supplies.

4.3.2 Sustainability Reductions

Background

Water companies are required to include an allowance for sustainability reductions (SRs) in their draft Plans. SRs are reductions in abstraction that are required to provide environmental improvements, typically through increased flows in rivers which are identified as suffering from low flows due to the effects of abstraction.

Water companies do this through working closely with the Environment Agency to identify where abstraction may be having an adverse environmental impact and then putting plans in place to address this impact, if it is necessary to do so. The mechanism by which this is achieved is through the National Environment Programme (NEP), which is how the Environment Agency identifies and prioritises its requirements for water companies to undertake measures to improve the environment. The process by which the requirement for SRs is identified is described in Section 2. It also explains the SRs to be delivered before 2015.

The NEP classifies SRs in three ways:

- **Confirmed** - those for which a full investigation is complete and the Environment Agency is certain of the need for the SRs and the water company is in agreement in principle that they should be delivered.
- **Likely** - those where the investigations have reached a stage where there is sufficient information to include the need for SRs but the requirement for their delivery has not been agreed between the water company and the Environment Agency. In these cases the cost benefit assessment will be a factor in determining the need for their final delivery but the Environment Agency require water companies to make allowance for them in their WRMPs. Likely SRs are included in the baseline supply demand balance.
- **Unknown** – These are sites where the investigations have not reached a stage where they can be considered as confirmed or likely.

Confirmed and likely SRs are included within the baseline supply demand balance. Unknown SRs can only be assessed in the WRMP through the running of scenarios, to determine what impact on the WRMP they would have were they to be confirmed. However, even if the impact is potentially significant, the Water Resource Planning Guidelines (WRPG) does not permit any allowance for them to be included in the preferred plan and thus they do not trigger future investment.

It is assumed that the NEP is the sole initiative by which our WAFU or Headroom will be impacted. However, it should be noted that from our experience to date, the Catchment Abstraction Management Strategies (CAMS) process has the potential to result in not only SRs, but also a very serious limiting of future resource options.

Overall Policy

Our policy on SRs can be summarised as follows:

- The proposed reduction should be justifiable in terms of the three elements of sustainability (economic, environmental and social) and, where relevant, the cost-benefit case should be proven;
- Viable twin-track options to replace the loss of supply capability should be in place and operational before the licence reduction takes place;
- The investment needed to replace the loss to supply capability caused by the SR should be funded;
- Under no circumstances will we proceed with the implementation of a sustainability reduction programme if we are not convinced of the security to public water supplies.

We are disappointed that the WRPG does not allow a company to take adequate account of the potential impact of future SRs, where these have not been confirmed by the Environment Agency through the NEP. We consider the potential loss of supply to be a significant risk to the supply demand balance in view of the likely impact of the Water Framework Directive (WFD) and River Basin Management Plans (RBMP) on the future of abstraction licence volumes.

The WFD deadline of achieving 'good ecological status' in all water bodies by 2027 is fast approaching. Some of the measures that may have to be taken to comply with the WFD will take a long-time to fulfil and we do not wish to be in a situation where we are forced into short-term unsustainable options when there was the opportunity to take a longer term view.

We explore this further in Section 10 and show how our plan would change against different futures associated with varying levels of sustainability reductions after 2015.

The Environment Agency released the first summary of requirements 'NEP1' on 29 August 2012. This provided an indication of the potential SRs and investigations within our supply area. 'NEP2' was released on the 16 January 2013 confirming the requirement as to what should be included within our WRMP. The Environment Agency provided 'NEP3' on the 30 August 2013 which reconfirmed the sustainability reductions that should be included in our WRMP.

Table 4-8: Sustainability reductions in 'NEP3' post 2015 (Ml/d)

WRZ	Confirmed			Likely			Unknown		
	Source	Reduction		Source	Reduction		Source	Reduction	
		DYAA	ADPW		DYAA	ADPW		DYAA	ADPW
London	None			North Orpington	9	9	Lower Thames	50	50
							Lower Lee	100	100
							Sundridge	8	8
							Waddon	7	7
							Bexley	9	9
SWOX	Axford	4	6	Ogbourne	3	3.5			
				Childrey Warren	3.7	3.7			
SWA	None			None			Pann Mill	5.3	5.3
Kennet Valley							None		
Guildford									
Henley									
Total		**4**	**6**		**15.7**	**16.2**		**179.3**	**179.3**

Our plan includes total SRs of:

- 19.7 Ml/d average
- 22.2 Ml/d peak

Our plan excludes unknown reductions.

Confirmed Reductions

SWOX - Axford – (Implementation date – 2017/18); (4 Ml/d avg., 6 Ml/d peak)

During AMP3, an investigation was carried out into the impact of the Axford abstraction on the local groundwater regime and the flow in the adjacent River Kennet, which is designated as a Site of Special Scientific Interest (SSSI) in the vicinity of Axford. This investigation was completed in 2005 and concluded that the source has an impact both on the local groundwater regime and the River Kennet and that this impact has the potential to adversely affect the ecology of the River Kennet SSSI.

In light of this conclusion the Environment Agency determined that it required an investigation to be undertaken into the potential solutions available to address the environmental impact of the Axford source. Therefore, an options appraisal was undertaken to assess the options available for a range of potential future licence reductions. This was undertaken in 2007 and a draft report produced. The options assessed were primarily associated with increased transfer of resource from Farmoor Reservoir to Swindon with associated upgrade to the infrastructure through Swindon from north to south to enable areas previously supplied by Axford to be served from Farmoor. An alternative range of options involving provision of replacement resource through transfer up catchment from the Kennet Valley were also assessed including the potential to develop the existing emergency source at Shalbourne into a baseload source.

The Environment Agency has confirmed that it requires a licence reduction from the current level of 13.1 Ml/d peak and 11.1 Ml/d average to 6 Ml/d average and peak. It has also indicated that this reduction will be accompanied by a flow constraint on the licence set at 100 Ml/d, which will be the trigger for introduction of the lower licence volumes. This licence reduction will result in a reduction of the Deployable Output of 4 Ml/d average and 6 Ml/d peak.

This licence reduction will require a network infrastructure solution and will incorporate the delivery of the Ogbourne sustainability reduction because the solution is common to both reductions. The scheme was originally proposed to be funded through the Environment Agency's compensation scheme which meant that the scheme could not commence until the EA had secured sufficient funds to enable compensation to be paid. However, due to a change in legislation expected to arise from the Water Bill in spring 2014 it is highly likely that the provision of compensation as funding mechanism for such schemes will be removed. Therefore the scheme has now been included in our business plan for PR14. The scheme is planned for commencement in 2013 and is likely to take approximately three years before completion. We intend to commence work on the scheme through the transition funding arrangements in order to allow for commencement before AMP6.

Likely Reductions

London - North Orpington (potential implementation date 2019/20); (9 Ml/d average)

An investigation was undertaken in AMP4 into the impact of the sources at Orpington and North Orpington on the River Cray. The investigation concluded that the sources have the potential to impact the flows in the River Cray and that the North Orpington source has a more direct temporal and spatial impact. Therefore the Environment Agency required us to undertake an options appraisal to look at the potential benefit of reductions in the Orpington and North Orpington licences.

The options appraisal has been concluded and has indicated that the optimum solution to deliver increased flows for the River Cray is to reduce the North Orpington licence to zero. The source is licensed for 9.0 Ml/d average and 10.0 Ml/d peak and so the closure of the source would result in a loss of average source deployable output of 9.0 Ml/d.

However, the options appraisal concluded that the reduction of North Orpington to zero and the replacement of the loss of deployable output would not be cost beneficial. The Environment Agency has suggested that the North Orpington licence volumes could be reduced and an alternative provided through permanent renewal of the Bexley licence variation. However, we do not consider this to provide an alternative to the North Orpington source because the Bexley licence variation already contributes to the base deployable output for London. We are continuing discussions.

SWOX – Ogbourne (implementation date 2017/18); (3 Ml/d average and 3.5 Ml/d peak)

During AMP4, an investigation was carried out into the impact of the Ogbourne abstraction on the River Og. The requirement for a sustainability reduction at Ogbourne was identified followed by an options appraisal in AMP5 which was completed in 2013. The requirement identified was for a reduction of the licence to zero.

The scheme to deliver this licence reduction requires similar network modification to the licence reduction for Axford and so the solution for Axford will incorporate the requirements for the licence reduction at Ogbourne and the two reductions will be delivered to the same timescale.

This scheme will result in the loss of source deployable output of 3 Ml/d average and 3.5Ml/d peak.

SWOX - Childrey Warren (potential implementation date 2019/20); (3.7 Ml/d average and peak)

An investigation was also carried out in AMP4 into the impact of the Manor Road and Childrey Warren sources on the Letcombe Brook. This investigation confirmed that there is no requirement for a licence reduction at the Manor Road source because it does not have a significant impact on the Letcombe Brook. It also confirmed the known impact of the Childrey Warren source on the Letcombe Brook and so the Childrey Warren source requires an options appraisal. It is anticipated this options appraisal will be completed by the end of December 2014.

The licence reduction identified as required by the Environment Agency is to reduce the licence to zero. The source is licensed for 4.6 Ml/d average and 4.6 Ml/d peak. The closure of the source would result in a loss of source deployable output of 3.7 Ml/d.

Unknown Reductions (for scenario planning)

London – Lower Thames (50 Ml/d), Lower Lee (100 Ml/d), Sundridge (8Ml/d), Waddon (7Ml/d) and Bexley (9Ml/d) (Total 174 Ml/d by 2027)

SWA – Pann Mill (5.3 Ml/d by 2027)

Total All WRZs (179.3 Ml/d)

In our previous plan, WRMP09, we included an allowance for unknown sustainability reductions in London of 100 Ml/d. Following the 2010 public inquiry we were directed to remove this allowance. We have sought further guidance for dWRMP14 from the Environment Agency on the potential location and magnitude of any sustainability reductions that might arise as a result of the Water Framework Directive (WFD) or as a result of investigations undertaken in AMP5.

Both parties have agreed through the NEP process, reductions in deployable output to be used as the basis for scenarios to demonstrate the impact of potential sustainability reductions. These scenarios are only indicative, and the options appraisal being undertaken for AMP5 into the impact of abstraction on the Lower Thames and Thames Tideway as well as further work to understand the impact of abstraction in the Lee catchment will inform the requirement for actual reductions in the future.

The total volume of sustainability reductions for London arising from the ‘unknown’ category in the NEP is 174 Ml/d. This is explored through the scenario runs by looking at two scenarios to reflect the potential range of future reductions. These are reductions of 100 Ml/d and 175 Ml/d. We have also explored the option of a sustainability reduction of 5.3 Ml/d in the SWA WRZ arising from the potential requirement for a reduction in the Pann Mill licence.

However, should the investigations on the Thames, Thames Tideway and River Lee, confirm that there is a requirement for reduction in abstraction then the volume of reduction could be significant. The results currently available for the Lower Thames for which an options appraisal is nearing completion indicate that the requirement for a significant reduction in the Lower Thames abstraction is increasingly unlikely as it is very unlikely to be cost beneficial. However the potential for a sustainability reduction to be required cannot yet be excluded. Both of the scenarios for London are clearly significant, particularly when considered in context of the baseline supply demand balance for London, which is projected to be in a large deficit (Section 6).

In summary, we have developed two scenarios to explore the implications of potential sustainability reductions but reliable estimates of future sustainability reductions are required to enable robust long-term planning. Given the potential magnitude of these reductions, as indicated by the Environment Agency, a major resource development is likely to be required in order to enable the implementation of the reductions. The timing of that resource being available will dictate the time at which sustainability reductions can be accommodated.

We remain dependent upon the Environment Agency to clarify the position on future sustainability reductions. The decision on long-term sustainability reductions is pivotal to efficient long-term planning and without this decision customer levels of service could be put at risk or bills could end up being higher than they need to be.

The results of this scenario testing are discussed in Section 10.

4.3.3 Impact of Climate Change on Supply

Climate change is an important factor in long-term planning. The WRPG requires that the WRMP includes the impact of climate change on DO calculated for the mid-2030s, and specifies how the impact is scaled over the planning period.

Updated climate change scenarios were launched by the UK Climate Impacts Programme (UKCIP) in June 2009, known as the UK Climate Projections 2009 (UKCP09). They provide a large amount of information on how the UK climate may change over the next 100 years in response to different levels of greenhouse gas emissions.

The new projections are ‘probabilistic’ in the sense that they encapsulate a wide range of possible changes in climate based on observations, climate models and expert opinion. The methodology of the climate change impact assessment and how the UKCP09 data has been used is explained in Appendix U.

The central impact of climate change on DO has been determined together with the uncertainty around the data. The impact of climate change on DO has been updated since the dWRMP with the completion of the impact assessment on groundwater source deployable outputs for the 2030s. The best estimate value to 2035 is shown in Table 4-9, this is applied directly as a change in DO. A negative value indicates a reduction. A comparison is also shown with the data as in the draft plan, which has been updated following completion of the impacts on groundwater for the 2030s.

Table 4-9: UKCP09 Climate Change Impact on Deployable Output by 2035

WRZ	UKCP09 Climate Change Impact (Ml/d)			
	DYAA		ADPW	
	dWRMP	fWRMP	dWRMP	fWRMP
London	-82.2	-72.7	n/a	n/a
SWOX	-7.8	-8.5	-9.2	-9.9
Kennet Valley	-0.52	-0.58	-5.26	-5.00
Henley	0.00	0.00	0.00	0.00
SWA	-0.62	-1.13	-0.95	-2.5
Guildford	-0.06	0.00	0.09	-0.51

Notes: dWRMP – draft plan

fWRMP – final plan

The uncertainty around this figure is accounted for within Headroom. For more details see Section 5.

Perturbing the historical record of rainfall and evaporation to reflect future variations in climate may not capture the full magnitude of potential changes in climate; past weather patterns may not necessarily reflect what could occur in the future. We commissioned independent work by H R Wallingford[9] to examine the frequency of occurrence of extended drought periods in the future in order to use this information to test the resilience of the preferred programme as part of sensitivity analysis undertaken on the preferred plan. The analysis uses plausible future drought sequences from the Future Flows project, which was a major Natural Environmental Research Council NERC, Defra and Environment Agency funded research project that has produced time series of river flows and groundwater levels for England and Wales at a large number of sites up to 2100. The results of the sensitivity analysis are reported in Section 10.

The results show that climate change could result in more extreme events/increased probability of drought events. If droughts are more severe than the historical record it would reduce the forecast likelihood of our system meeting its level of service.

[9] HR Wallingford Thames Water Three Dry Winters Scenarios – Using Future Flows to test climate resilience January 2013

4.3.4 Summary

The following table shows WAFU changes over the planning period for the baseline scenario under DYAA conditions for London and ADPW conditions for the zones in the Thames Valley. The results show a steady decline due to the impacts of climate change and include some step changes due sustainability reductions.

Table 4-10: WAFU over the planning period - Baseline

WRZ	WAFU (Ml/d)						
	2011/12	2014/15	2019/20	2024/25	2029/30	2034/35	2039/40
London	2098	2079	2048	2029	2010	2002	1994
SWOX	365	362	346	344	341	340	339
Kennet Valley	164	153	151	150	149	148	148
Henley	25.2	25.3	25.3	25.3	25.3	25.3	25.3
SWA	198	192	191	191	190	190	190
Guildford	72.6	68.0	67.9	67.8	67.6	67.6	67.5
Total	2922.8	2879.3	2829.2	2807.1	2782.9	2772.9	2763.8

4.4 Identification of Bulk Supply Options with Other Water Companies

4.4.1 Bulk Supply Discussions with Neighbouring Water Companies

We have had detailed discussions with neighbouring water companies to determine the opportunities to either import or export water. These discussions have been undertaken to identify all options where resources may be shared. The process of identification of options has involved a systematic review of the potential for supply of water across the boundary with each of the companies bordering our supply area. In each case we have reviewed our supply network to identify the points where our infrastructure together with the infrastructure of neighbouring companies provides the best opportunity for the sharing of resources. The identification of potential opportunities for resource sharing has not been restricted to supplies from WRZs that are in surplus as this would constrain the opportunity of identifying potential future options that could be required if WRZs supply/demand balance status changes in the future.

The approach to assessing options from other water companies and third party organisations is the same for all options on the unconstrained options list taking into account economic, environmental and social costs, resource availability, risk and other parameters. The assessment methodology is outlined in Section 7.

If an option was identified as feasible and sufficient information had been provided (e.g. all economic, social and environmental costs could be quantified), it would be appraised alongside existing options. It was not anticipated that many options would reach this level of understanding for the WRMP14.

Some options would require the development of significant additional infrastructure by us to realise the proposed benefits. The financial, programme and environmental impacts of this additional infrastructure would require quantification before these could be added to the constrained options list. Whilst these options have not been taken forward for consideration on the constrained options list in the programme appraisal for the WRMP14, they will continue to be assessed under on-going resource planning and as part of our planned work for WRMP19.

We have undertaken further discussion with neighbouring companies to confirm the requirements for bulk supply options with other companies. This has resulted in an update to the bulk supply options we have included in our plan for neighbouring companies arising from discussions prompted by the outcomes of the WRSE modelling (Section 4.5 below). We have also included options arising from discussions with other water companies arising from OJEU submissions made prior to the submission of draft WRMP14 but for which insufficient information was provided to enable an option to be included in the draft WRMP14.

4.4.2 Options Identified

The discussions with neighbouring companies have resulted in the following options being identified and added to our feasible list of options.

1. Anglian Water - Thorpe Lodge to Overthorpe SR
2. Anglian Water - Whitchurch SR to Mursley
3. Anglian Water - Raw from Foxcote to Grimsby
4. Sutton & East Surrey - Wallington/S. Croyden to Sutton
5. Sutton & East Surrey - Epsom to Sutton
6. Sutton & East Surrey - Shalford to E. Surrey
7. Sutton & East Surrey - Merton to Sutton
8. South East Water - RZ5 Hindhead from Guildford
9. South East Water - RZ4 Buckhurst from Kennet
10. South East Water - RZ4 Surrey Hills to/from Guildford (15, 20, 25 variants)
11. South East Water - RZ4 Whitely Hill to/from Guildford (15, 20, 25 variants)
12. South East Water - RZ4 Wokingham from Kennet
13. South East Water - RZ4 Surrey Hills from Windsor (5, 10 variants)
14. South East Water - RZ4 Hogs Back to/from Guildford
15. South East Water - RZ4 Malders Lane from Henley (5,10 variants)
16. Bristol Water - SWOX to Purton sources

17. Southern Water - Kennet Valley, Newbury to Otterbourne
18. Southern Water - Kennet Valley, Reading to Otterbourne
19. Southern Water - Kent Medway, Honor Oak to Burham
20. Severn Trent Water - Severn to/from SWOX (existing potential)
21. Severn Trent Water – Severn to Thames (London) Raw water - two options
22. UU – Severn to Thames (London) Raw Water Transfer – two options (pipeline and canal)
23. Affinity Water to/from Guildford
24. Affinity Water to/from London
25. Affinity Water to/from SWA 1
26. Affinity Water to/from SWA 2
27. Affinity Water to/from SWA 3
28. Wessex Water - Minety to Flaxlands SR
29. Wessex Water - Minety to Ashton Keynes WTW
30. Wessex Water - Minety to Blunsden SR

Of these options the ones taken forward to the constrained options list following secondary screening are Sutton and East Surrey - Merton to Sutton, South East Water - RZ4 Surrey Hills from Windsor (5, 10 variants), Affinity Water to/from Guildford. All the other options have been screened out on the basis of risk and resilience criteria.

Further work on the potential for sharing resources with water companies in the south east of England has been undertaken through the WRSE group. This work is discussed below.

4.5 Water Resources in the South East (WRSE) Group

4.5.1 Purpose

We have been working with five other water companies (Portsmouth Water, South East Water, Southern Water, Affinity Water and Sutton and East Surrey Water), the Environment Agency, Ofwat, Natural England and consultant partners to identify potential opportunities for sharing of resources in the South East of England.

The overall aim of the WRSE group is:

> *'To determine a water resources strategy containing a range of strategic options to find the best solutions for customers and the environment in the South East of England.'*

The outcomes of this project have been designed to inform the participating water companies (supply areas shown in Figure 4-4), of potential resource sharing options for consideration in their own water resource management plans and to provide a regional framework for the requirement for strategic resource development for the South East of England. The group addresses all aspects of water resources planning and attempts to identify areas of common ground, which can then be adopted by the water companies for planning should they chose to do so.

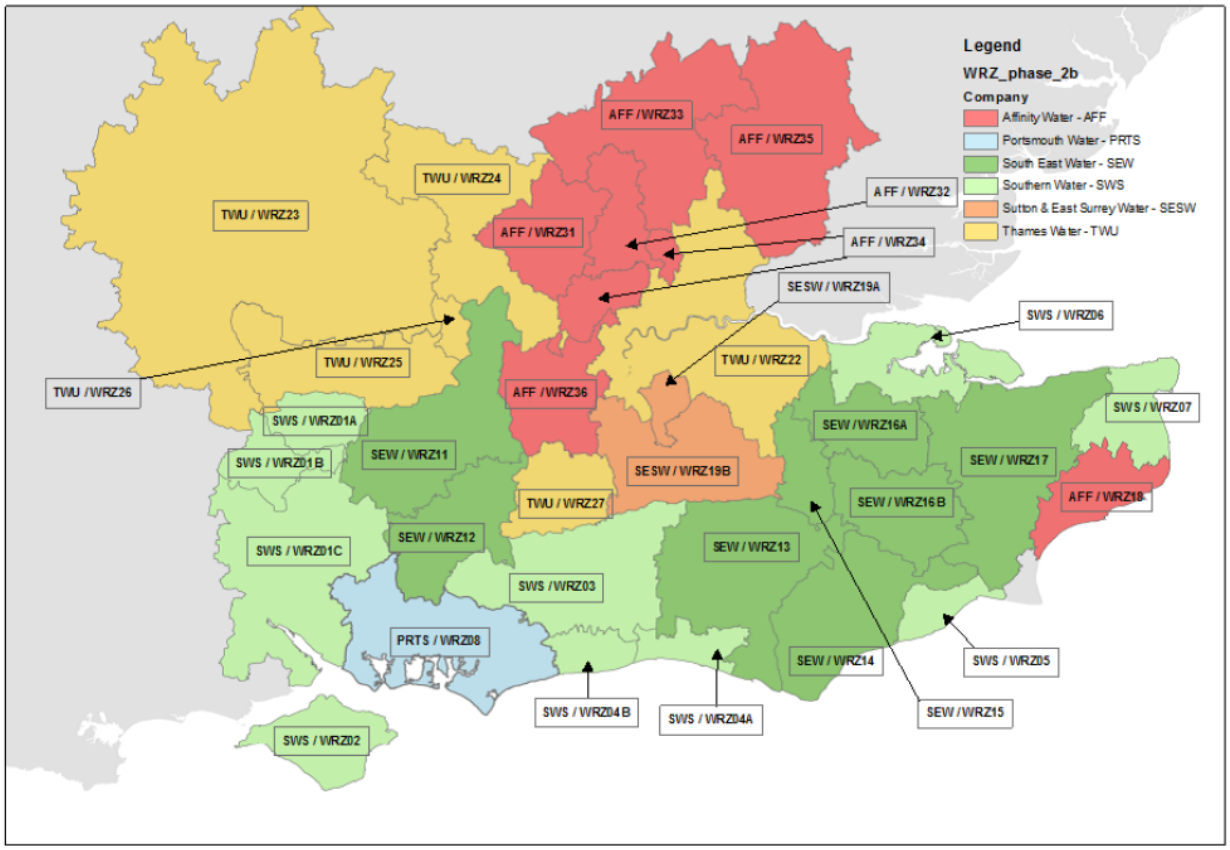


Figure 4-4: Water Companies participating in WRSE and their respective WRZs

4.5.2 Background

The WRSE work is focussed around building and applying a water resource planning options selection model, with the objective function of balancing supply and demand across the region at least cost. This model is constructed to satisfy the requirements and principles of the WRPG. It contains water resources planning options for all participating companies, including; various types of new resources, existing supply enhancements, demand management options (leakage reduction, household metering, household and non-household water efficiency) and transfers between resource zones and water companies.

The Environment Agency leads the Group and commissioned Halcrow to establish and apply the modelling consultancy package. Other parallel work packages undertaken by other consultants are:

- Independent project management
- Peer review of the model and its application
- Review of the consistency of the cost data supplied by the water companies

This WRSE work also aims to implement the conclusions and recommendations of the equivalent work undertaken between 2006 and 2010[10], of which we were a participative member.

4.5.3 Strategic transfer options to other companies

The options explored include:

- Bulk transfer by pipeline from our treated water network in SE London to Southern Water's network in Kent. A number of different volumes were available for transfer, of up to 50 Ml/d.
- Bulk transfer by pipeline from our treated water network in SE London to Sutton and East Surrey Water. A number of different volumes were available for transfer, of up to 30 Ml/d.
- Bulk transfer of water by pipeline from Guildford WRZ and/or SWA WRZ to South East Water
- Bulk transfer of water by pipeline from London, Guildford and SWA to Affinity Water

Additionally, options were explored involving flexible licensing of abstraction on the Middle and Lower Thames, between companies that take water directly from the River Thames - South East Water, Affinity Water and ourselves. As the company with the lowest abstraction points, we would gain DO if South East Water and Affinity reduced their abstractions. Similarly, if we had surplus, Affinity Water or South East Water could potentially abstract more.

4.5.4 WRSE Modelling

All companies provided their baseline supply and demand data and draft option costs for all water supply/demand options for modelling purposes in September 2012. It should be noted that these data sets were refined in the intervening months and so were not identical to those used in the dWRMP. Details of all our options can be found in Section 7 and in Appendix P.

[10] WRSE Group (2010) Progress towards a shared water resources strategy in the South East of England.

The project was divided into 3 phases:

- Phase 1 - model establishment
- Phase 2a - model development and run using WRMP09 data
- Phase 2b - model runs using as close to draft WRMP14 data as possible
- Phase 3 – model runs using data that companies used for the dWRMPs

Several scenarios were considered to explore the uncertainty inherent in forecasting future water resource development requirements. Further scenarios proposed by the companies and the Environment Agency have also been run to address specific issues that the companies wished to explore, in order to make best use out of this tool as possible. A total of 47 scenarios have been run as part of the Phase 2 modelling.

The full output from the WRSE modelling was not complete in time to be used in the preparation of our draft WRMP14. Therefore the options that were identified as viable for inclusion by us and neighbouring companies in our respective preferred plans were not included in our draft WRMP14 in a way that was consistent with our neighbouring companies' plans. Following publication of our draft plan we have discussed these options and confirmed which options should be included in our respective plans. Our WRMP is now consistent with the plans of our neighbouring companies. Where transfers have been agreed between us these are included in the results presented in Section 9.

Subsequent to the publication of all the relevant companies draft WRMPs for consultation the EA commissioned the modelling consultants to undertake Phase 3 of the planned WRSE work. The intention of the Phase 3 modelling was to allow water companies to assess consistency of the WRSE results with draft WRMPs, to understand the causes of any significant differences and to support companies in the submission of their final plans. The results of the Phase 3 modelling are discussed in Section 7.