Thames Water Draft Water Resources Management Plan 2024

Statement of Response

Appendix:
Defra Request for Further Information

July 2024

Version History

Version 1	April 2024	Version submitted to Regulators
Version 2	July 2024	Updated for correction to column headings in table 19 page 93. In the April submission, the column headings were incorrectly labelled to show leakage reductions being delivered per calendar year between 2025 and 2030, when instead they should present savings being delivered per AMP cycle between 2025 and 2050.

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Introduction

0.1 In February 2024, Defra requested more information to support our Water Resources Management Plan 2024 (WRMP24). The request states that this information is needed before our plan could be referred to the Secretary of State for a decision and that this information would form part of our Statement of Response. As such, we have produced this Appendix to our Statement of Response which details the information requested and our response.

0.2 We subsequently received an Annex from the Environment Agency in which some of the issues raised were elaborated upon.

0.3 The request for information sets out fourteen issues. We have considered all the requests for information raised by Defra in relation to the revised draft WRMP24. In this Appendix we present each of the Issues raised, copying text from the letter sent to us by Defra, alongside any further elaboration given in the Annex or clarification from further correspondence.

0.4 In most cases, each issue raised more than one request for information. We have divided this document according to the issue raised and according to the specific information requested.

0.5 When responding to representations raised in response to our draft WRMP24, we published a revised draft WRMP24 to accompany the Statement of Response. As such, in our Statement of Response we often referred to document sections in which content had been added/changed in response to representations raised. We have not produced a further revised draft to accompany this request for information. As such, where we will make changes to our final WRMP24, we have stated more precisely the text which will be added or amended.

0.6 Where we have made changes to our plan which require the inclusion of new/revised Tables/Figures, in the captions of these Tables/Figures within this document we have not provided a Table/Figure number, as these will be updated in the final WRMP. We have labelled these Tables/Figures as Table/Figure X.

Issue 1: Provide greater confidence to the regulators that the company is managing the risks identified at the beginning of the planning period

Text from request:

1.1 There are a number of risks in the first 7 years of the Thames Water plan that require assessing and controlling. These include; whether it can deliver WRMP19 plan commitments, the potential impact of the River Thames Scheme (a flood alleviation scheme on the Lower Thames which is likely to divert water away from the company's lower Thames abstractions) and continued issues at its Gateway desalination plant.

1.2 The company must also deliver on its WRMP19 demand reduction commitments to ensure security of supply at the beginning of its plan. The company has limited options if it does not deliver its demand management programme which poses a drought resilience risk, especially for London. The drought in 2022 tested Thames Water, and we are concerned that the company would need to use drought measures earlier than planned.

1.3 Ofwat also stated that the level of per capita consumption reduction in the first five years of the plan is unambitious.

1.4 Thames Water has not met its leakage target which has consequently meant that the 200,000 smart meters in the Thames Valley have not been funded. This represents a further risk to the company achieving its demand management reductions prior to the beginning of the plan. The company needs to understand the impact this will have on its plan, and in particular, the Swindon and Oxfordshire resource zone.

1.5 To manage these risks, we expect the company to:

- demonstrate it is taking sufficient mitigating actions for the delivery of its programmes each year pre-plan, so it starts the new planning round in a good position. It should provide these actions on a year-by-year basis.
- provide its outstanding transformation/reduction leakage plan to show how it will catch up and meet its planned leakage levels. It should also ensure its future long-term ambition is sufficiently ambitious comparing its proposals to the relative levels of leakage delivered by others both within and outside of the UK. The company should provide compelling evidence to justify delivery of lower levels of leakage improvements than other companies in the long-term. The company must demonstrate it has confidence it can deliver what it has planned.
- identify the actions it will take if it does not meet its planned leakage levels at the start of the plan. These should be shown in an adaptive pathway. Thames Water should consider whether there are any further options available to the company, should the demand management programme not be delivered.
- provide its project plan for the Gateway desalination plant with key milestones to assure of increase in deployable output to 75 Ml/d from the tested 25 Ml/d. The company needs to ensure this plant is used regularly so that it is ready for the next drought. We remain concerned that the plant cannot achieve the stated 75 Ml/d and that will cause resilience issues for east London.
- proactively explore all possible mitigation options for the River Thames flood relief scheme, including new pipelines between reservoirs, to minimise the potential impact of this

scheme. The company should report on this work in the annual reviews of its plan, or sooner, if possible.

- identify the impact on the supply-demand balance of the withdrawal of the Green Economic Recovery funding for 200,000 smart meters in the Thames Valley. The company should set out what actions it will take to mitigate any impact. Update and resubmit its WRMP24 planning tables to the Environment Agency, to include impacts of the Green Economic Recovery funding change, and any mitigating actions from the company, into the baseline tables of each water resource zone. If the impact results in supply-demand deficit at water resource zone level the company must describe options to bring the zone(s) back in balance. The company should include a narrative on the impact to supply-demand balance, and any resulting change to its AMP8 metering strategy, in the plan's text.

Issue 1.1

Request

1.6 Thames Water should demonstrate it is taking sufficient mitigating actions for the delivery of its [demand management] programmes each year pre-plan, so it starts the new planning round in a good position. It should provide these actions on a year-by-year basis.

Further elaboration of request given in annex, or clarification given subsequently

1.7 No further elaboration in Annex.

Our consideration of the points raised

1.8 We recognise the importance of starting the WRMP24 planning period in a good position. We will include updates on the delivery of our demand management programmes in AR24 and AR25 with inclusion of mitigating actions where we are not meeting or expecting to meet forecasts.

1.9 Our demand management programme consists of leakage reduction, metering and the promotion of water efficiency.

1.10 Table 1 summarises the demand reductions delivered by these programmes during AMP7.

Table 1 – Demand reduction WRMP19 forecast and actuals[1]. Metering and water efficiency values are in-year benefits, not cumulative. Negative values indicate demand reduction while positive values indicate demand increase.

		2020-21	2021-22	2022-23	2023-24	2024-25
Metering	WRMP19 forecast	-0.65	-6.64	-8.29	-8.29	-7.75
	Outturn	-0.40	-4.43	-8.50		
	Variance	0.25	2.21	-0.21		

[1] WRMP19 forecasts are the sum of all WRZs lines 61.1, 61.2, 61.3, 61.4, 61.6-10 in WRMP19 data tables. Metering and water efficiency outturn values align with those reported in AR23 data table scheme delivery tab with the exception of the 'smart CSL' element of water efficiency which is currently unreported. Leakage levels are dry year annual average values aligned with those in AR23.

Water efficiency (inc. smart CSL)	WRMP19 forecast	-4.09	-8.01	-7.50	-7.00	-6.47
	Outturn	-16.68	-26.73	-23.48		
	Variance	-12.59	-18.72	-15.98		
DYAA total leakage levels (Ml/d)	WRMP19 forecast	623.11	603.47	580.83	558.18	540.26
	Outturn	607.23	605.86	629.86		
	Variance	-15.88	2.39	49.03		

1.11 In summary:

- **Leakage** – Our leakage levels in 2020-21 and 2021-22 were closely aligned with WRMP19 forecasts. Our leakage level in 2022-23 exceeded our WRMP19 forecasts. We have a leakage turnaround plan in place which is improving leakage performance and expect to be close to forecast levels by the end of 2024/25 (see response to Issue 1.2 for further details).
- **Metering** – Metering installations have been impacted by the effects of COVID-19, the global shortage in microprocessors and budget pressures following a challenging PR19 final determination. These factors have led to fewer new meters being installed compared to WRMP19 forecasts.
- **Water efficiency** – We have over-delivered compared to WRMP19 forecast primarily due to the success of our 'Smart customer side leakage' projects – alerting customers to internal leaks and helping them to repair them - and Smarter Business Visits programmes which are delivering more Ml/d than forecast.

1.12 Regarding consumption reduction overall, our over-delivery on water efficiency exceeds the under-delivery on metering with 80.22 Ml/d of demand reduction delivered in the first 3 years of AMP7, exceeding our WRMP19 AMP7 forecast of 64.68 Ml/d and so putting our metering and water efficiency demand reduction programme in a strong position.

1.13 As discussed in our response to Issue 1.2, recovering our leakage performance is a high priority and a key part of our company turnaround plan. We are planning to get our leakage levels at or close to forecast levels by the end of 2024/25. We therefore expect to be in a good demand reduction position at the end of 2024/25 to start AMP8 in a strong position.

Meter Installations

1.14 Our original meter installation volumes outlined in WRMP19 pre-date the PR19 Final Determination which did not allocate the funding amount requested to deliver the WRMP19 volumes. We have endeavoured to deliver the demand reductions outlined in WRMP19, through targeting meter installations in key areas, targeting water efficiency interventions and new innovative engagement approaches that enhance measurable demand reduction volumes to cover the meter installation difference between WRMP19 and actual. Due to this funding shortfall, alongside the impacts of Covid-19 and the global microprocessor shortage, our progressive meter installations are behind the original WRMP19 and rdWRMP24 forecast.

1.15 We will not be able to catch up the shortfall by the end of AMP7 and expect to be around 57,000 meters behind forecast at AR25. This reduction in metering has a relatively small impact on our supply-demand balance, an impact of 3.75 Ml/d[2], and will be offset by the above-forecast benefit delivered by metering and water efficiency demand reduction programme as a whole.

1.16 Combined with the impact of stopping GER, our meter penetration in 2024/25 is expected to be around 58.2%, compared to a forecast of 62.63% at WRMP19 and 64.45% at rdWRMP24. Although this impact on meter penetration is undesirable, we are on track to deliver and exceed the AMP7 metering and water efficiency demand reductions included in WRMP19 and rdWRMP19, demonstrated in Table 1.

1.17 In our final WRMP24 and PR24 tables, we will re-profile our AMP8 and AMP9 meter installations to incorporate the forecast meter installations not delivered in AMP7 and the meter installs originally in the GER scope, including insight gained from meter installation surveys.

Summary

1.18 In summary, whilst we do not expect to install the number of meters set out in our WRMP19 and rdWRMP24, we expect to over deliver on our water efficiency programme and catch up our leakage reduction to forecast levels to deliver the demand reductions included in rdWRMP24 and be in a good position to start our AMP8 demand reduction programme.

1.19 We do, however, acknowledge that the volume of demand reduction which we are aiming to deliver in the coming year is ambitious, and that there is an associated risk that we may not achieve these reductions. In our response to Issue 1.4 and our Monitoring Plan (Appendix C) we have described the actions we will take should we not achieve the reductions that we have set out.

Changes made to the rdWRMP24

1.20 We have updated the Section entitled “Baseline Demand Management” within WRMP24 Section 3 (in rdWRMP24 this section included paragraphs 3.139-3.143, and Tables 3-18 – 3-20). The information in the “Baseline Demand Management” section will be deleted and replaced with information set out in response to this issue, issue 1.2, and issue 1.8.

1.21 We will also update our WRMP Tables for the final WRMP24 to ensure alignment with current delivery plans.

1.22 Please note that updating our AMP7 demand management programme will mean that some charts/figures in Section 3 (Demand forecast) and Section 6 (Supply-demand balance), for example the baseline demand forecast for each WRZ (rdWRMP24 Figures 3-37 and 3-38) and the baseline supply-demand balance (e.g., rdWRMP24 Figure 6-26 for the London WRZ), will be very slightly misaligned with figures presented in our WRMP tables. Our consideration is that these changes are immaterial and so we will work to update these figures for the final WRMP24 but have not updated them for this submission.

Changes to Baseline Demand Management sub-section within rdWRMP24 Section 3

Metering and Water Efficiency

1.23 Planned activity for AMP7 is shown in Table 3-X below. This sets out the activity which is being delivered according to funding provided in the PR19 business plan. For the year 2022-23, the

[2] 57,000 * 13% * 507 l/h/d = 3 .75 Ml/d

data presented is actual delivered meter installs and reduction volumes, while from 2023-24 onwards the data is either a forecast or part forecast.

1.24 We continue to support our customers and encourage efficient use of water, through a range of water efficiency initiatives on households and businesses.

1.25 Our ability to expand our delivery field-based programmes and GreenRedeem household water efficiency incentive in line with WRMP projections was impacted significantly by the Government's Covid-19 restrictions – resulting in a suspension of all in-home water efficiency and wastage fix activities.

1.26 Our ability to digitally / electronically engage with customers to promote water efficiency incentives was also impacted by updated Privacy and Electronic Communication Regulations ruling under data protection laws, requiring greater levels of customer consent.

1.27 We are now changing our in-home and in-business water efficiency visits to utilise smart meter data for improved targeting of delivery and engagement activities with customers, however we do not expect to be able to achieve PCC targets as set out in WRMP19.

1.28 [see Issue 1.8 response for further text which will be included, relating to the GER programme]

Leakage

1.29 [see Issue 1.2 response for further text which will be included]

1.30 This includes additional activity which is being delivered as part of the conditional allowance programme. The conditional allowance programme is due to extend beyond AMP7 but is considered as part of the baseline for the purposes of the WRMP. Leakage reduction due to be delivered through the conditional allowance is included in Table 3-X.

1.31 [A revised version of rdWRMP24 Table 3-18 will be included. As per the comment above regarding WRMP Tables, this will be produced for the final PR24 and final WRMP24 submissions]

Issue 1.2

Request

1.32 Thames Water should provide its outstanding transformation/ reduction leakage plan to show how it will catch up and meet its planned leakage levels.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue 1

1.33 Thames Water should provide the leakage transformation/reduction plan from current to levels at the beginning of the WRMP24 and risk around alternative options should demand savings not deliver.

Our consideration of the points raised

1.34 We have plans in place to reduce leakage from current levels to the levels forecast for each WRZ at the beginning of rdWRMP24.

1.35 In 2022/23, our annual average leakage at the company level was 619.7 Ml/d. The Dry Year Annual Average (DYAA) equivalent was 629.86 Ml/d[3]. Since the 2022/23 reporting year, we have implemented our turnaround plan and leakage has reduced significantly to the lowest annual average we have achieved during AMP7, closely aligning with our expected 585 Ml/d outturn for 2023/24 that was shared in our Service Commitment Plan in January 2024[4]. We will report on this leakage reduction in our Annual Review of our WRMP and our Annual Performance Report.

1.36 Table 2 shows leakage figures across our supply area for the 2022/23 year, average leakage levels which are currently forecast for the 2023/24 reporting year (noting that these are subject to audit and assurance yet to be undertaken), and our rdWRMP24 forecast leakage levels for 2024/25 (YR5). Our predicted 2024/25 outturn, based on the activity delivered in YR4 and that planned for YR5, closely align with our rdWRMP24 forecast. The outturn level of leakage will be impacted by weather conditions in that year, but the DYAA value stated is one which we forecast would be experienced under an 80th percentile year.

1.37 We note that our predicted annual average outturn in SWOX is close to our rdWRMP24 forecast DYAA value but the WRZ will remain in supply demand surplus.

Table 2: Leakage values at AR23, predicted outturn values at AR24 and AR25, and AR25 rdWRMP24 forecast values.

	2022/2023 outturn leakage (Ml/d)	Provisional AR24 leakage outturn (Ml/d)[5]	2024/25 forecast leakage outturn (Ml/d)	rdWRMP24 2024/25 DYAA
Company	619.7 (629.9 DYAA)	586	508.0	522.0
London	445.7 (452.6 DYAA)	412.9	368.4	378.5
SWOX	78.9 (79.6 DYAA)	72.3	59.1	60.78
Guildford	18.8 (18.4 DYAA)	18.9	15.7	16.1
SWA	47.2 (47.0 DYAA)	48.2	37.4	38.5
Kennet Valley	27.3 (27.7 DYAA)	28.3	23.5	24.1
Henley	5.3 (5.2 DYAA)	5.38	3.9	4.0

1.38 While it is clearly right to ensure that leakage reduction is planned in such a way as to ensure the security of supply at the WRZ level, it is also notable that planning in this way can be inefficient when viewed at the company level. The most efficient way of delivering leakage reduction at the

[3] In the calculation of this value, we identify the impact that the weather had on our leakage during the reporting year and remove that impact; we then apply an uplift to ensure that the leakage value included in our supply-demand balance calculations is representative of a "1 in 5-year" severity (this is put alongside a "1 in 5-year" consumption to ensure an approximate "1 in 10-year" overall demand). In 2022/23, the weather was relatively severe and so the uplift was modest.

[4] https://www.thameswater.co.uk/about-us/performance/service-commitment-plan

[5] These numbers are unassured. We will provide assured values in our AR24.

company level is to target leakage reduction where it is most cost efficient. Having been awarded no enhancement expenditure to reduce leakage as part of the PR19 determination, while at the same time being set challenging performance commitments, reducing leakage across our company in the most efficient way possible has been our goal during AMP7, and this is what is incentivised by the performance commitments which have been set. The economic incentive created by the performance commitment therefore does not encourage leakage reduction to be undertaken to ensure the security of supply (with security of supply existing at the WRZ level). Greater alignment in the objectives and incentives set for us by our regulators would help in ensuring the best outcomes for customers.

1.39 Our response to Issue 1.4 outlines our approach to manage risks to the supply-demand balance if planned leakage levels are not met at the start of the plan.

Our Leakage Plan for 2024/25

1.40 To reduce company-wide leakage to the levels forecast in rdWRMP24, we need to consider the amount of leak repairs which will be necessary just to stop leakage increasing, alongside the reduction required. In total, we forecast that we will need to deliver 359 Ml/d of leak repairs to maintain our current leakage position. We forecast that we will need to deliver 500 Ml/d of leakage activities in total to achieve the outturn levels set out in Table 2. This demonstrates the significant challenge that simply maintaining current leakage levels, let alone reducing them, poses. Our year 5 leakage delivery plan includes the activities as set out in Table 3 below; this will be reviewed as we deliver our plan to maximise efficiency. We forecast that our planned leakage activities for YR5, as well as those that have already been delivered, will reduce leakage to the levels in Table 2 at WRZ level which are closely aligned to those forecast in our rdWRMP24.

1.41 Our company-level plan described in Table 3 is translated into regional and zonal delivery plans such that leakage reduction will be delivered in the WRZs where it is needed to achieve the rdWRMP24 forecast position for each zone.

Table 3: Planned leakage activities for YR5

Leakage activities in 2024/25	Leakage offset/reduction (Ml/d)
Find and fix	444
Calm Systems	4
Pressure Management	8
Metering customer side leakage	26
New Bulk meter installations	3
Bulk meter recurrence	4
Trunk Mains	10
Lead Pipe Replacement	1
Total	**500 Ml/d**

Our Leakage Turnaround Plan

1.42 Leakage is one of the top priority initiatives within our company-wide Turnaround Plan. Our leakage turnaround plan aims to drive sustainable leakage reduction through understanding of consumption, targeting of detection activities, prioritisation of repairs and more efficient field options. It includes the following activities which enable and enhance the delivery of the workstreams in Table 3;

- Leak grading and new repair service level agreements prioritising leak repair by volume
- Availability and operability process improvements
- New detection contract based on volumetric leakage reduction
- No dig repairs for customer side leakage (Aquapea)
- No dig repairs for communications pipes (Origin trial)
- Dynamic demand
- Campaign management and associated analytical tools deployed
- Smart metering customer alarm process improvements

1.43 We will continue delivery in line with the PALM framework;

- Prevent – Asset Health improvements: continue with our capital delivery programme to replace mains & pressure optimisation to reduce leaks occurring
- Awareness – Maximise the intelligence from our smart meter data to understand customer usage & therefore improve the targeting and prioritisation of high leakage areas
- Locate – Use sensors where available to improve detection efficiency; up-skill detection teams to be more effective; innovate – use of fibreoptic network to pinpoint leakage issues on our trunk mains systems
- Mend – Continue to prioritise the repairs that matter most and reduce the run time of leaks

1.44 Our leakage turnaround plan is backed by our Board with external support to provide challenge and assist with pace of delivery. It has already delivered significant improvements in leak cycle times, reducing the average cycle time of active leaks from 67 to 16 days and reducing visible leaks from 16 to 6 days. Our total outstanding leaks have reduced by 52%.

1.45 We track leakage performance on a weekly basis, feeding into operational meetings, including daily and weekly area performance meetings, weekly regional performance meetings as well as weekly senior and Executive director-led oversight meetings. The oversight meetings are attended by key workstream leads and include the fortnightly leakage task force (LTF) focusing on strategic medium to long term issues. We track performance against delivery plans and target leakage levels through the year, with quarterly Water Balance calculations providing calibration of our weekly tracking and opportunities to reforecast and review delivery plans.

Changes made to the rdWRMP24

1.46 We will add the following text to our rdWRMP24 Section 3 (Demand Forecast), at the end of the Section entitled "Baseline Demand Management" (in the rdWRMP24 this begins with paragraph 3.3.139). This will be in a new sub-section, entitled "Leakage Reduction".

1.47 In the year 2022/23, due to the impacts of a cold winter and dry summer, our leakage was much higher than we planned. The uplifted "DYAA" leakage value was 629.9 Ml/d, at the company level.

1.48 *Since the 2022/23 reporting year, we have implemented our turnaround plan and leakage has reduced significantly to the lowest annual average we have achieved during AMP7, closely aligning with our expected 585 Ml/d outturn shared in our Service Commitment Plan in January 2024*[6].

1.49 *To reduce company-wide leakage to the levels forecast in the WRMP, we also need to consider the amount of leakage fixes which will be necessary just to stop leakage increasing. In total, we forecast that we will need to deliver 359 Ml/d of leakage fixes in order to maintain our current leakage position. We forecast that we will need to deliver 500 Ml/d of leakage fixes in total, in order to achieve the levels set out in our WRMP24. This demonstrates the significant challenge that simply maintaining current leakage levels, let alone reducing them, poses.*

1.50 *Our year 5 leakage delivery plan includes the activities as set out in Table X below. The company-level plan described in the Table X is translated into regional and zonal delivery plans such that leakage reduction will be delivered in the WRZs where it is needed to achieve the rdWRMP24 forecast position for each zone.*

Table X: Planned leakage activities for YR5

Leakage activities in 2024/25	*Leakage offset/reduction (Ml/d)*
Find and fix	*444*
Calm Systems	*4*
Pressure Management	*8*
Metering customer side leakage	*26*
New Bulk meter installations	*3*
Bulk meter recurrence	*4*
Trunk Mains	*10*
Lead Pipe Replacement	*1*
Total	***500 Ml/d***

1.51 We will ensure our final WRMP24 tables align with the leakage reduction plan outlined here, noting that other changes (e.g., re-profiling of the GER programme and our response to issue 7.1 on our leakage ambition in SWOX) will result in changes to the tables.

[6] https://www.thameswater.co.uk/about-us/performance/service-commitment-plan

Issue 1.3

Request

1.52 Thames Water should also ensure its future long-term ambition is sufficiently ambitious comparing its proposals to the relative levels of leakage delivered by others both within and outside of the UK.

1.53 The company should provide compelling evidence to justify delivery of lower levels of leakage improvements than other companies in the long-term.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue OF14

1.54 The company proposes to meet long-term and interim targets

1.55 The company does not propose to meet its PR19 PCL [performance commitment level].

1.56 In terms of normalised leakage, the company is the worst performer compared to the rest of the sector, ranked 17 out of 17 based on normalising leakage against distribution input, connected properties and mains length.

1.57 Thames Water is forecasting to reduce leakage to ~14.9% of distribution input (DI) by 2049/50. At present in 2022-23 three companies already achieve this level.

1.58 Thames Water's proposal for a 15.3% reduction in leakage over the 2025-20 period (2019-20 annual average baseline) is the second highest reduction of the companies we have reviewed to date.

Clarification following discussion

1.59 Following discussion with the Environment Agency, it has been clarified that we do not need to compare our leakage levels with those outside the UK. There is no international agreed standard for the measurement of leakage, and the measurement of leakage in the UK is undertaken in a different way to many countries[7]. For example, in many countries, customer-side leakage would not be counted within leakage figures and would be incorporated into PCC, while in the UK customer-side leakage is incorporated into leakage via complex calculations. As such, international comparisons can be misleading.

Our consideration of the points raised

1.60 Leakage reduction continues to be a high priority for Thames Water and is a core priority of both our company turnaround plan and our service commitment plan. The aim of our leakage turnaround plan is to drive sustainable leakage reduction through better understanding of consumption, targeting of detection activities, prioritisation of repairs, and more efficient field operations. Our planned AMP8 leakage reduction is the third largest out of the 17 companies by percentage reduction delivered as shown in Table 4.

[7] Water UK, A Leakage Routemap to 2050, 2022, www.water.org.uk/wp-content/uploads/2022/03/Water-UK-A-leakage-Routemap-to-2050.pdf

Table 4: Total Leakage (Ml/d) and % reduction in AMP8 in companies rdWRMP24 submissions

Water Company	2024-25	2029-30	% Reduction
SES Water	20.5	16.3	20.50%
Cambridge Water	13.2	10.8	18.20%
Thames Water	**522**	**428.6**	**17.90%**
South West Water	99	82.3	16.90%
Severn Trent Water	345.8	289.7	16.20%
Portsmouth Water	24	20.3	15.60%
Affinity Water	148.5	126.1	15.10%
Southern Water	76.9	66.7	13.30%
United Utilities	380.6	330.6	13.10%
South East Water	81	70.5	13.00%
Yorkshire Water	256.3	223.8	12.70%
Wessex Water	63.8	56.1	12.00%
South Staffordshire Water	61.5	54.6	11.30%
Northumbrian Water	114.6	105.2	8.20%
Bristol Water	32.1	29.5	8.20%
Anglian Water	164.2	151.6	7.70%
Essex and Suffolk Water	53.8	51.1	5.10%

1.61 For longer-term targets, we note that all water companies have been required by the Water Resources Planning Guideline and Environmental Improvement Plan to plan to:

- Reduce leakage by 50% from 2017/18 levels by 2050
- Reduction per capita consumption (PCC) to 110 l/h/d by 2050
- Reduce non-household demand by 9% by 2038

1.62 By 2049/50, our leakage reduction, compared with the 2017/18 baseline, meets the EIP 50% reduction target. The percentage leakage reduction we have planned is 5th largest of the 16 companies compared in Table 5. This reduction is formed of an ambitious combination of metering, system optimisation and pipe rehabilitation work and includes expected innovation to be developed over the next 25 years.

Table 5 - Total Leakage (Ml/d) and % reduction by 2037/38 and 2049/50 in companies' rdWRMP24 submissions

Water Company	2017-18	2037-38	% Reduction	2049-50	% Reduction
SES Water	24.2	12.2	49.30%	10.5	56.40%
Northumbrian Water	137.1	90.3	34.10%	61.1	55.40%
Portsmouth Water	32.9	16.7	49.30%	15.2	53.80%
Bristol Water	46.6	25	46.40%	22	52.90%
Thames Water	**685.4**	**383.7**	**44.00%**	**331.3**	**51.70%**
United Utilities	453.8	275.1	39.40%	224	50.60%
Cambridge Water	14.4	8	44.30%	7.3	49.30%
Severn Trent Water	443	246.5	44.40%	224.6	49.30%
South Staffordshire Water	72.4	45.2	37.60%	36.8	49.20%
Affinity Water	173.9	106.3	38.90%	89.1	48.80%
Yorkshire Water	300.3	189.9	36.80%	161.6	46.20%
South East Water	87.7	59.8	31.80%	47.4	46.00%
Wessex Water	67.7	49.1	27.50%	38.5	43.10%
South West Water	107.2	68.7	36.00%	64	40.40%
Essex and Suffolk Water	66.2	46.7	29.40%	40.1	39.30%
Anglian Water	182.7	135.9	25.60%	118.5	35.20%

1.63 Our consideration is that using forecasts of distribution input, connected properties and/or mains length to 'normalise' planned leakage reductions is misleading and not a reliable way to benchmark ambition between companies. This is for the following reasons:

- Distribution Input is comprised of leakage, household consumption, and non-household consumption. Our plans for significant consumption reduction lead to DI reduction, and thus influence the forecast of leakage as a percentage of forecast DI.
- Many factors within a network (e.g. mains age, mains depth, urbanicity) can affect leakage and reduction efforts, meaning a strict normalisation of DI, properties or length does not provide a strong basis for comparison between companies.

1.64 An alternative metric to compare the level of ambition in leakage reduction programmes is to compare the planned leakage reductions as a proportion of current DI levels. Thames Water plans 275 Ml/d of leakage reduction between 2022 and 2050, which is 10.7% of 2021-22 Distribution Input. By this measure, our leakage reduction programme is the most ambitious in the industry (Table 6).

Table 6 - Total Leakage Reduction from 2021-22 to 2049-50 as a percentage of 2021-22 Distribution Input

Water Company	**Leakage reduction as a proportion of 2021-22 DI**
Thames Water	**11%**
United Utilities	10%
Yorkshire Water	10%
South Staffordshire Water	10%
Northumbrian Water	10%
Southern Water	8%
South East Water	8%
Wessex Water	7%
Cambridge Water	7%
SES Water	7%
Affinity Water	7%
Portsmouth Water	6%
Bristol Water	5%
Anglian Water	5%
South West Water	4%
Essex & Suffolk Water	4%
Veolia Water Projects Limited	1%

1.65 As explained in Section 8 of the rdWRMP, we have appraised a demand management programme which includes a faster (50% reduction by 2037/38) and larger (40 Ml/d lower leakage by 2050) leakage reduction programme. As is noted on p.13 of Appendix B of our Statement of Response (Response to Ofwat representations), this programme would involve an additional c.£2.7bn of expenditure on leakage reduction efforts for the delivery of only an additional 40 Ml/d and would require relying on as-yet unknown leakage reduction techniques to a greater degree (as per Tables 8-58 and 8-59 in the rdWRMP), as well as requiring more mains rehabilitation (3,800km of mains rehabilitation for leakage reduction purposes in our preferred plan as opposed to 5,800km in the "High+" programme).

1.66 As per paragraph 11.27 of our rdWRMP24, further leakage reduction above the programme included in our WRMP24 is therefore, cost prohibitive. The cost and carbon emissions associated with these programmes are shown in Tables 5a and 5b, with the "High+" programme clearly resulting in significantly greater costs and carbon emissions.

Changes made to the rdWRMP24

1.67 As described, our consideration is that the leakage plan included in our WRMP24 is ambitious. Furthermore, in our rdWRMP24 we have demonstrated that additional leakage reduction above that which is planned would not be best value for customers.

1.68 To ensure that we have demonstrated that the leakage reduction plan presented is best value, we have added the following text after the current rdWRMP24 Section 11 paragraph 11.27:

1.69 Adopting the "high plus" leakage reduction programme would deliver an additional 40 Ml/d of leakage reduction for an additional £2.7bn by 2050. This is expensive in comparison to new supply options, and so we do not consider that additional leakage reduction beyond what is in our plan would represent best value to our customers. Furthermore, this plan would rely on as-yet unknown leakage reduction techniques to a greater degree (as per Tables 8-58 and 8-59 in the rdWRMP), increasing deliverability risks of our plan.

1.70 Additionally, we will add the following text to the current rdWRMP24 paragraph 11.38:

1.71 The leakage reduction planned between 2022 and 2050 is 10.7% of 2021-22 Distribution Input. By this measure, our leakage reduction programme is (as of the rdWRMP24, March 2024) the most ambitious in the industry.

Issue 1.4

Request

1.72 Thames Water should identify the actions it will take if it does not meet its planned leakage levels at the start of the plan. These should be shown in an adaptive pathway. Thames Water should consider whether there are any further options available to the company, should the demand management programme not be delivered.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue 1

1.73 Thames Water should deliver on its demand reduction commitments in PR19 and identify any impacts on its plan should it not reach the starting point for leakage. It should clearly outline what actions it will take.

1.74 Thames Water should identify and clearly describe alternative options to mitigate risks around demand, both in getting to the starting point for and maintaining, the leakage position at the start of WRMP24. This would be in addition to Didcot RWE as the company needs to achieve 49 - 60 ML/d per year reduction for the rest of the AMP.

1.75 Thames Water should provide the leakage transformation/reduction plan from current to levels at the beginning of the WRMP24 and risk around alternative options should demand savings not deliver. Clearly state the time frame around decisions as well as adaptive pathways.

Our consideration of the points raised

1.76 We acknowledge that reaching the rdWRMP24 leakage position for the year 2024/25 presents a challenge. As discussed in response to Issue 1.2, we have a plan that we forecast will mean that we hit the 2024/25 leakage targets in our plan. Leakage reduction is a key component of our turnaround plan.

1.77 As noted in the various issues raised within the wider Issue 1, there are several risks which our plan faces in the short-term, and we recognise the need to ensure the security of supply for our customers. To manage this risk, we have identified measures which could form an adaptive plan should some of the short-term risks faced in our plan materialise.

1.78 The RWE Didcot, Addington Groundwater and Horton Kirby ASR schemes were included within our preferred plan to mitigate these short-term risks, but we acknowledge that further risk mitigation measures may be required.

1.79 To identify the level of supply-demand balance risk in our plan, as a representative high-risk scenario, we have identified the supply-demand balance for AMP8 and AMP9 in each of our WRZs under a scenario in which 50% of our planned leakage reduction is achieved from 2022/23 onwards. The results are shown in Table 7 below[8].

Table 7: Supply-demand balance under a scenario in which 50% of forecast leakage reduction is achieved from 2022/23 onwards. This forecast is used as a representative "high-risk" scenario to establish the magnitude of the short-term risks in our plan.

Zone/Scenario	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
London	*2.7*	*-2.7*	*-7.4*	*-13.7*	*-43.9*	*-38.3*	*-35.7*	*-87.3*	*-70.9*	*-68.7*
SWOX DYAA	*18.6*	*16.4*	*15.2*	*13.6*	*11.5*	*13.6*	*12.6*	*-2.2*	*2.8*	*5.0*
SWOX DYCP	*9.5*	*6.6*	*4.9*	*3.2*	*1.6*	*3.3*	*1.9*	*-10.5*	*-7.6*	*-7.9*
Guildford DYAA	*17.9*	*17.9*	*17.9*	*17.9*	*16.5*	*21.9*	*22.0*	*20.0*	*20.2*	*20.5*
Guildford DYCP	*13.8*	*13.7*	*13.6*	*13.7*	*19.2*	*24.2*	*24.2*	*24.3*	*24.6*	*25.0*
Henley DYAA	*7.5*	*7.5*	*7.5*	*7.6*	*7.6*	*13.3*	*13.3*	*13.4*	*13.5*	*13.5*
Henley DYCP	*4.2*	*4.2*	*4.2*	*4.2*	*4.2*	*9.8*	*9.9*	*9.9*	*10.0*	*10.0*
Kennet Valley DYAA	*41.2*	*40.9*	*40.4*	*39.9*	*37.9*	*41.2*	*40.9*	*30.5*	*30.4*	*25.3*
Kennet Valley DYCP	*40.1*	*39.7*	*39.1*	*38.4*	*36.3*	*39.5*	*38.8*	*40.5*	*40.3*	*35.1*
SWA DYAA	28.37	27.77	27.27	19.83	19.12	18.77	18.47	18.39	18.50	18.34
SWA DYCP	45.20	43.97	43.46	36.01	35.61	34.93	34.34	30.85	31.19	33.92

1.80 As is demonstrated by the figures in this table, our supply-demand balance situation in most zones is secure even under a scenario in which only 50% of our leakage reduction is achieved. However, there is a level of supply-demand risk in our London and SWOX WRZs. As is set out in our revised monitoring plan, recognising these risks alongside the more recent resilience issues experienced in Guildford WRZ, we have identified adaptive plan measures which are available to us in the London, SWOX and Guildford WRZs.

Changes made to the rdWRMP24

1.81 We have revised our Monitoring Plan (Annex C: Monitoring Plan). Please see the "Adaptive Plan: Demand Management" section for details of changes made to our plan which mitigate the short-term risks in our plan associated with demand management.

[8] Please note that, while the leakage reduction profile included in the rdWRMP24 is relatively smooth, factors in our WRMP forecasts mean that the supply-demand balance forecasts are not smooth. The significant changes in the supply-demand balance forecast are: 2029-30 (London only) sustainability reduction at NNRW sources, 25 Ml/d; 2032-33 move to 1 in 200-year resilience level.

Issue 1.5

Request

1.82 Thames Water should provide its project plan for the Gateway desalination plant with key milestones to assure of increase in deployable output to 75 Ml/d from the tested 25 Ml/d.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue 1

1.83 Thames Water should provide a project plan for the Gateway desal plant with key milestones to provide assurance in the increase in DO to 75Ml/d from 25Ml/d. (related to previous recommendation 5).

1.84 Thames Water should update its documentation, specifically Table 13 in Section 4, as requested previously in recommendation 5.2, currently the information does not accurately represent the capability of the desalination plant.

Our consideration of the points raised

1.85 We understand the concerns around the output of Gateway desalination plant and the potential risk to resilience in east London during a drought. We remain committed to delivering the improvements required at Gateway to achieve the outputs stated in our rdWRMP24.

1.86 The Gateway desalination plant is unique within the UK and has a range of complex issues that are difficult to resolve. We have been open and transparent about the challenges we face at Gateway in the regular updates we have provided to our regulators, and we have included appropriate outage allowances in our plan to reflect this.

1.87 We are undertaking a programme of maintenance and capital improvements to ensure that, by 2031, the scheme is reliably available at 75Ml/d during drought periods. Our current Capital Delivery AMP7 project is on track and will provide additional resilience at the plant. Our focus for the remainder of this AMP period is to ensure a reliable 50 Ml/d output from the plant is achievable. A number of significant maintenance upgrades will be delivered which will improve the reliability and output of the existing plant. The main components include:

1. Improvements to the chemical dosing systems. We are putting in place new dosing rigs, dosing points, and chemical delivery and storage facilities, as we have suffered repeated leaks at multiple points in the current dosing configuration system. This has prevented the plant from ongoing running due to health and safety issues, limiting access to specific areas of the site to chemical suits, and required repeated repairs and maintenance to repair the issues. Whilst we expect the bulk of this work to be completed during AMP7 there may be some aspects that could run into the initial part of the AMP8 period.
2. A new chiller. A new standby chiller unit is being installed to support the existing chiller during periods of high ambient temperature, and/or if the other unit breaks down. Since Spring 2023 we have had a hired unit in place and the new one is due to be delivered in Autumn 2024. We will continue using the hired unit as a back-up until then, with the new one being installed during the winter months.
3. A new chemical clean in place (CIP) system. This will replace the current very manually intensive operational process and will help extend the life of the existing Ultra-Filtration (UF) membranes, by allowing specialist cleaning to preserve the membranes during plant

shutdowns. It will allow us to use specific targeted chemicals to clean the UF membranes by removing contaminants and preventing fouling. The current operation has limitations due to the manual handling of the UF membranes and safety issues dealing with the required chemicals. Allowing for outages, we expect this work to be completed during the initial period of AMP8.

1.88 As explained to the EA at our recent meeting on 13 February 2024, the Regulation 31 approved reverse osmosis (RO) membranes that are needed to meet the legal DWI requirement are not currently available to purchase. We have the funding available to procure these membranes as soon as they become available. We have been pushing, and will continue to proactively push, the laboratories to resolve this matter but it is not a situation that is directly within our control. Our most recent engagement showed that whilst there has been some progress, as yet none of the laboratories have been assessed by UKAS (United Kingdom Accreditation Service) so it will still be many months before the membranes are available. Our latest correspondence indicates that this is likely to be in 2025. Without the approved RO membranes we are unable to operate the plant at 75Ml/d. As explained to the EA in February we do, however, intend to restart the plant at the end of June and run it at 25Ml/d, and to test it up to 50Ml/d.

1.89 In our PR24 business plan we have included funding of £50M for AMP8 to enable us to continue our programme of planned improvements at Gateway which will replace life-expired components and deliver the upgrades required to reliably achieve the 75 Ml/d output by 2030. We have also commissioned a peer review to validate our proposed scope of renewals. A summary of the notional programme of works for AMP8 (subject to change based on actual performance/risk and the peer review of proposed scope) is:

- Complete work on the new chemical clean-in-place (CIP) system for the existing ultrafiltration (UF) membranes (requires main building extension). Details on the scope of the work, which was commenced in AMP7, are given above.
- Complete work on the new bulk chemical storage and transfer systems for the CIP system and for the chemically enhanced backwash (CEB) of the existing UF membranes
- Enhance existing chemical systems
- Replace/refurbish water-cooled motor control centres (MCCs)
- Replace chemical dosing lines
- Install biofoul prevention
- Assessment on lime hardening extension based on performance in AMP7

1.90 Our Capital Delivery team are currently developing the scope and programme for this, and we will share our milestone project plan with our Regulators when it is available, which will likely be towards the end of 2024 as it will be informed by the work which is currently being delivered, together with the output of the peer review.

1.91 We will continue to provide regular updates on Gateway as outlined in our Monitoring Plan. We will do this formally as part of our Annual Review and six-month update which are followed by Tripartite meetings with Defra, Ofwat and the Environment Agency. We will also provide updates as part of our drought preparedness planning and at regular meetings with the Environment Agency.

Changes made to the rdWRMP24

1.92 We have highlighted in our Monitoring Plan (see Annex C: Monitoring Plan for exact wording) that we will provide project updates to the Environment Agency.

1.93 We will replace the text which currently follows paragraphs 4.77 (bulleted list, paragraphs 4.78-79 and other bulleted lists) with the information presented in our consideration of the issue raised, as above.

1.94 We have produced a table which transparently demonstrates the WAFU contribution of the Gateway desalination plant and how this is represented in the WRMP Tables. This table is shown below and will be accompanied text (also included below), and is included after the current rdWRMP24 paragraph 4.80. We will make reference to this table where relevant in Section 4, including following Table 4-13. Table 4-13 shows the DYAA Outage Allowance values and is correct for the base year (2021-22), but different values for outage are included through the planning period; the Table below shows this transparently.

1.95 In order to ensure full transparency, and in order to aid in the understanding of our WRMP Tables, the Table below shows how we have accounted for the capability and outage allowance of the Gateway desalination plant through the planning period.

Table X: WAFU Contribution of Gateway Desalination Plant in rdWRMP24

	2021-22	*2022-23 to 2029-30*	*2030-31 onwards*
Deployable Output of Gateway to “Deployable Output Before Forecast Changes” (7.4BL)	*100.00*	*100.00*	*100.00*
Change in DO from prolonged outage reduction (7.6BL)	*0.00*	*-50.00*	*-25.00*
*Contribution of Gateway desalination plant towards outage allowance**	*55.29*	*21.74*	*30.29*
WAFU contribution of Gateway desalination plant	***44.71***	***28.26***	***44.71***

** Estimated – as described in Appendix J (Outage Allowance), Outage Allowance is calculated using Monte Carlo analysis, and so a deterministic contribution cannot be calculated*

Issue 1.6

Request

1.96 Thames Water should ensure this plant [the Gateway desalination plant] is used regularly so that it is ready for the next drought. We remain concerned that the plant cannot achieve the stated 75 Ml/d and that will cause resilience issues for east London.

Further elaboration of request given in annex, or clarification given subsequently

1.97 No further elaboration.

Our consideration of the points raised

1.98 We have committed to using the plant regularly so that it is ready for the next drought.

1.99 This year we intend to restart the site so that it is in operation at the end of June – the time at which a drought would normally become obvious. The plan is to run it at 25Ml/d and to test it up to 50Ml/d. We will run it for as long as is necessary. However, our water supply forecasts suggest that it is extremely unlikely that we will need to use Gateway this year because of the high volume of rain over the winter – our key reservoirs are full, and groundwater is recharged.

1.100 Over the next few years, as we work to improve the plant's resilience, there will be times when we will need to take the plant out of service for an extended period in order to undertake maintenance and capital improvements. Any long-duration periods in which the plant is taken out of service will be risk assessed according to catchment conditions.

1.101 Once the works are complete (i.e., 2030 onwards), we commit to testing the plant at a low level every year (regardless of drought conditions), in order to demonstrate operational readiness.

Changes made to the rdWRMP24

1.102 No changes requested as part of this request, so no changes made.

Issue 1.7

Request

1.103 Thames Water should proactively explore all possible mitigation options for the River Thames flood relief scheme, including new pipelines between reservoirs, to minimise the potential impact of this scheme. The company should report on this work in the annual reviews of its plan, or sooner, if possible.

Further elaboration of request given in annex, or clarification given subsequently

No further elaboration.

Our consideration of the points raised

1.104 We recognise the importance of proactively exploring all possible mitigation options for the River Thames Flood relief scheme, in collaboration with the project team from the developers of the River Thames Scheme (RTS). This is why, as part of our efforts to understand the scheme's impact on our system, we have included it in our two commissioned studies. These two studies are focussed on:

1. Lower Thames Study: Better understanding the role that river levels play in abstraction management on the Lower Thames
2. Abstraction Options Development: Finding and developing solutions to problems which are identified in study 1.

1.105 The main goals of the two studies are to understand the problems we faced during the 2022 drought, using this information to inform our future decision-making, and to develop robust solutions to ensure water can be abstracted during drought periods.

1.106 The Lower Thames Study covers the issues mentioned in Appendix CC of the rdWRMP24, lessons we learned from the drought (CC.36) and the possible risks of introducing the RTS. This study investigates why we could not abstract water to the licensed volume limit during the summer of 2022 despite the flow records at Kingston gauge consistently exceeding the Teddington Target Flow (TTF). We will examine the water resources available in the river's lower reaches and answer some of the questions raised in Section 11 of the rdWRMP24, point 11.83 - 3 related to the RTS and the risk of its introduction that could exacerbate the drought problems experienced in 2022.

1.107 In the initial phase of the survey, which has now been completed, hydrological and mass balance assessments of the River Thames were undertaken in order to compare the 2022 drought with previous drought events.

1.108 The next phase of the project, which is currently underway, aims to update and then use models to identify abstraction constraints associated with management of river levels, and then test the impact of the RTS. Use of these models will allow us to test and develop operational strategies for managing abstraction during normal and drought conditions. The outcomes will be shared with the second study, the Abstraction Options Development.

1.109 The second study, which runs parallel with the Lower Thames Study, is the Abstraction Option Development. This project investigates options to address the issues identified in the Lower Thames Study. To streamline this process, we are working with contractors to coordinate the parallel workstreams. We will use the results of both studies to develop solutions.

1.110 The Abstraction Options Development project will identify and screen options. Options considered in this study include new pipelines/tunnels, new abstraction points, refurbishing or increasing the capacity of abstraction points, making changes at pumping stations (e.g., introducing new or smaller pumps, or introducing variable speed drives on existing pumps), improving connections with water treatment works, and new digital tools to optimise operational efficiency. As of March 2024, the project is in stage 3, where unconstrained options are reviewed. Options will be screened using the updated WRMP19 methodology (see paragraphs 7.44-7.53), as has been the case for other WRMP24 options. The options identified may progress as Strategic Resource Options (SROs) or non-SROs.

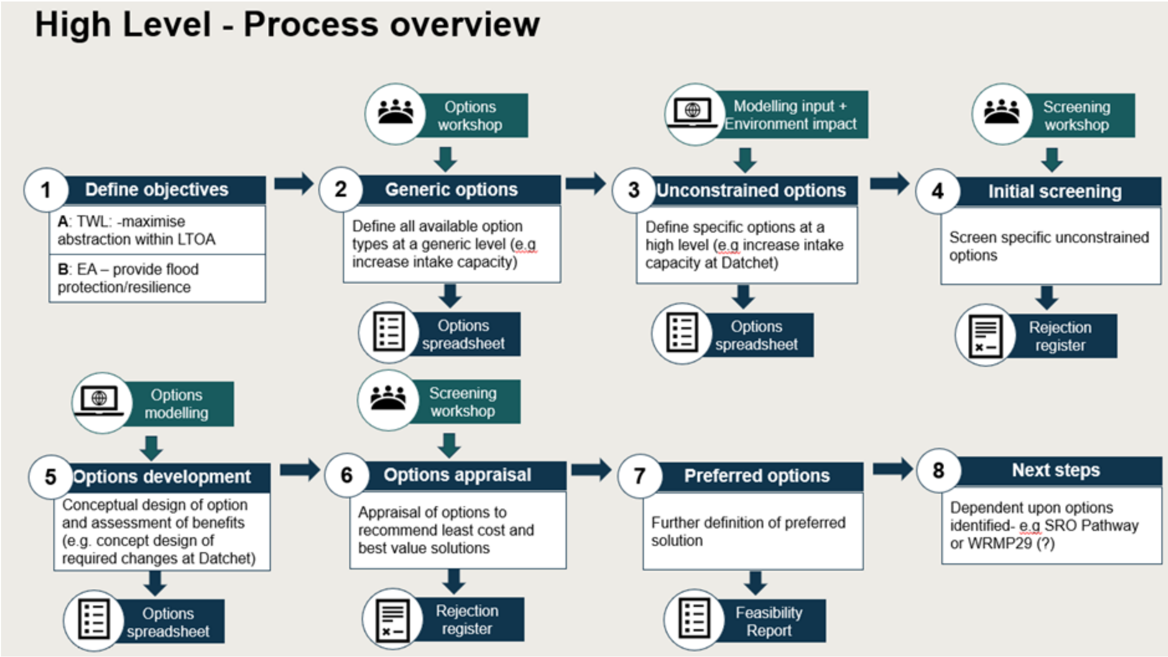

Figure 1-1: Screening Process Overview

1.111 We recognise the significance of reporting on this work, and will provide updates in annual reviews of our plan, or sooner if feasible. In both projects, we plan workshops where different stakeholders are engaged to contribute and give feedback on the progress and results of the studies.

1.112 We are committed to maintaining regular communication with all relevant stakeholders throughout both projects to ensure that our mitigation strategies align with their needs and concerns, and indeed several workshops have already been held with the Environment Agency. Our approach to identifying and resolving risks surrounding the Lower Thames is guided by a fundamental principle of collaborating with transparency. We are dedicated to finding sustainable solutions together, with the aim of mitigating the risks to find the best value solution to any issues or risks which are identified.

River Thames Scheme Consultation

1.113 A statutory pre-application consultation was undertaken for the RTS between January and March 2024. In the case of developments such as the RTS, it is incumbent upon the scheme promoter (i.e., the Environment Agency and Surrey County Council) to ensure that negative impacts associated with the development of a new scheme are identified, managed and mitigated.

1.114 As stated in our consultation response, we have been raising the risks that the scheme poses to our water resources since 2018 and have seen little response from the scheme promoter in investigating these issues until recently (2023). Whilst we are proactively exploring the risks and possible solutions associated with the RTS alongside other risks and issues in the Lower Thames, our consideration is that the RTS project team should have done more to investigate these issues when we initially raised them.

1.115 Furthermore, and as stated in our consultation response, Thames Water's right to abstract from the River Thames is protected under the Water Resources Act 1991. According to Section 39 of the Water Resources Act 1991, a licence for abstraction should not be granted by the

Environment Agency where it would derogate the abstraction rights of an existing licence holder, unless the existing licence holder consents. The augmentation flow in new channels which would be created as part of the RTS would limit our ability to abstract, increasing drought risk to those living in the London WRZ, and derogating our abstraction rights. If mitigation in the form of engineering intervention is identified as being required (our consideration is that it is likely that such mitigation will be required), then without this mitigation Thames Water would need to object to an abstraction licence application made in relation to the RTS, in addition to objections raised through the DCO process.

1.116 As such, while the RTS would pose risks to our water resources should it go ahead, our consideration is that the scheme would not go ahead if these risks are not mitigated by the scheme promoter. We consider that unless these issues with the RTS can be overcome the scheme is highly unlikely to receive the necessary consents and therefore the risk to our WRMP24 is small.

Changes made to the rdWRMP24

1.117 We have added the following text to the rdWRMP24 paragraph 11.359:

1.118 We have commissioned two studies to investigate issues on the Lower Thames, including the River Thames Scheme. These are known as the "Lower Thames Study" (better understanding the role that river levels play in abstraction management on the Lower Thames), and "Abstraction Options Development" (Finding and developing solutions to problems which are identified in the Lower Thames Study). The Abstraction Options Development project will identify and screen options. Options considered in this study include new pipelines/tunnels, new abstraction points, refurbishing or increasing the capacity of abstraction points, making changes at pumping stations (e.g., introducing new or smaller pumps, or introducing variable speed drives on existing pumps), improving connections with water treatment works, and new digital tools to optimise operational efficiency. We will report on the progress of these projects through our Annual Review process, and ensure that our regulators are updated on both projects as they progress.

Issue 1.8

Request

1.119 Thames Water should identify the impact on the supply-demand balance of the withdrawal of the Green Economic Recovery funding for 200,000 smart meters in the Thames Valley. The company should set out what actions it will take to mitigate any impact.

Further elaboration of request given in annex, or clarification given subsequently

1.120 No further elaboration.

Our consideration of the points raised

1.121 In the rdWRMP24, our Green Economic Recovery (GER) programme included 18.67 Ml/d demand reduction split over SWOX, Guilford, SWA, Kennet Valley and Henley WRZs, to be delivered in AMP7 with 7.04 Ml/d of the benefit to be realised in year 1 of AMP8.

1.122 The GER programme included installation of more meters than was set out in our PR19 plan, with meter installation targeted in our Thames Valley region, where PCC rose during and after the Covid-19 pandemic.

Table 8 – Forecast benefits of Green Economic Recovery programme

	Total demand reduction (Ml/d)	Consumption reduction (Ml/d)	Leakage reduction (Ml/d)
Company	18.67	14.86	3.81
London	0.00	0.00	0.00
SWOX	7.93	6.31	1.62
Guildford	1.38	1.10	0.28
SWA	4.30	3.42	0.88
Kennet Valley	4.60	3.66	0.94
Henley	0.46	0.36	0.09

1.123 Considering Ofwat's decision not to adjust the funding conditions to reflect the impact of the summer 2022 drought and December 2022 freeze-thaw events on our leakage performance, we were left with no alternative but to stop the GER programme. The removal of the GER programme will negatively impact our supply-demand balance at the beginning of the planning period (Table 8).

1.124 We have taken, or are taking, the following actions to mitigate the impact of the removal of this programme on our supply demand balance:

- 300,000 advanced meter install surveys and 20,000 household digs to prepare for meter installation have already taken place in AMP7 as preparatory work for GER meter installations.
- 1,500 small bulk meters, 200 large bulk meters and 1,502 NHH meter replacements were installed before the decision to stop the GER programme was made.
- In year 5, 2024/25, we plan to install 45,000 HH new smart meters and 7,700 NHH smart replacements in our Thames Valley WRZs by reprofiling meter installations planned in London WRZ.
- We will continue delivery of our smart meter communication solutions in year 5 so that all smart meters installed are live from the point of installation.

1.125 The change to our year 5 programme prioritises delivering meter installations in our water resources zones with the current lowest supply demand balance to ensure security of supply. This change brought forward ~1.29 Ml/d of leakage benefit from AMP8 to AMP7 due to delivering external new meters in Thames Valley in place of internal meter installations in London. Meter installations planned in London were due to be internal meters whereas meters in Thames Valley can be external. Internal meters have a lower leakage benefit due to the location of the meter (internal meters cannot be used to detect customer-side leakage).

1.126 These mitigating actions mean that there is no significant impact on our supply demand balance in AMP7 and AMP8 and no impact after AMP8 (Table 9).

Table 9 – Impact of changes to GER programme on supply demand balance in 2024/25

WRZ	Impact on DYAA supply demand balance in 2024/25
London	SDB reduced by -3.41 Ml/d to 60.79 Ml/d (due to movement of new meter installations out of London)
SWOX	SDB reduced by -1.55 Ml/d to 25.00 Ml/d (would have been reduced by -5.66 Ml/d to 20.89 Ml/d without changes to year 5 metering programme)
Guildford	SDB reduced by -0.39 Ml/d to 19.63 Ml/d (would have been reduced by -0.99 Ml/d to 19.04 Ml/d without changes to the year 5 metering programme)
SWA	SDB reduced by -2.81 Ml/d to 30.64 Ml/d
Kennet	SDB reduced by -1.97 Ml/d to 42.42 Ml/d
Henley	SDB reduced by -0.20 Ml/d to 7.84 Ml/d

1.127 Additional to the impact on supply demand balances, there is also a predicted 0.73 l/p/d impact on PCC in 2024/25 and a 1.00 Ml/d impact on leakage in 2024/25. The impacts on PCC and leakage are mitigated by delivery of the GER meter installations in AMP8.

1.128 We will reprofile our AMP8 and AMP9 meter installations to incorporate the forecast meter installations not delivered in AMP7 and the meter installs originally in the GER scope including insight gained from meter installation surveys and reflect these changes in our final WRMP24 and PR24 tables.

Changes made to the rdWRMP24

1.129 We will update our data tables to reflect the change in meter installation profiles due to stopping GER in AMP7 (see issue 1.11), alongside other changes (e.g., response to 1.2).

1.130 As per our response to Issue 1.1 and 1.2, we have updated the Section entitled “Baseline Demand Management” within WRMP24 Section 3 (in rdWRMP24 this section included paragraphs 3.139-3.143, and Tables 3-18 – 3-20). The information in the “Baseline Demand Management” section will be deleted and replaced with information set out in response to this issue, issue 1.1, and issue 1.2.

1.131 Please note that updating our AMP7 demand management programme will mean that some charts/figures in Section 3 (Demand forecast) and Section 6 (Supply-demand balance), for example the baseline demand forecast for each WRZ (rdWRMP24 Figures 3-37 and 3-38) and the baseline supply-demand balance (e.g., rdWRMP24 Figure 6-26 for the London WRZ), will be very slightly misaligned with figures presented in our WRMP tables. Our consideration is that these changes are immaterial and so we will work to update these figures for the final WRMP24 but have not updated them for this submission.

Changes to Baseline Demand Management sub-section within rdWRMP24 Section 3

1.132 This text will be added in the “Baseline Demand Management” section, following the current rdWRMP24 paragraph 3.143

Green Economic Recovery.

1.133 *In our rdWRMP24 we included a programme of meter installations known as the Green Economic Recovery scheme, along with resultant customer-side leakage fixes and water efficiency activities. Funding for this scheme was made contingent on hitting our leakage targets. In light of Ofwat's decision not to adjust the funding conditions to reflect the impact of the summer 2022 drought and December 2022 freeze-thaw events on our leakage performance, we were left with no alternative but to stop the GER programme. The removal of the GER programme will negatively impact our supply-demand balance at the beginning of the planning period.*

1.134 *We have taken, or are taking, the following actions to mitigate the impact of the removal of this programme on our supply demand balance:*

- *300,000 advanced meter install surveys and 20,000 household digs to prepare for meter installation have already taken place in AMP7 as preparatory work for GER meter installations.*
- *1,500 small bulk meters, 200 large bulk meters and 1,502 NHH meter replacements were installed before the decision to stop the GER programme was made.*
- *In year 5, 2024/25, we plan to install 45,000 HH new smart meters and 7,700 NHH smart replacements in our Thames Valley WRZs by reprofiling meter installations planned in London WRZ.*
- *We will continue delivery of our smart meter communication solutions in year 5 so that all smart meters installed are live from the point of installation.*

1.135 *These mitigating actions mean that there is no significant impact on our supply demand balance.*

WRZ	*Impact on DYAA supply demand balance in 2024/25*
London	*SDB reduced by -3.41 Ml/d to 60.79 Ml/d (due to movement of new meter installations out of London)*
SWOX	*SDB reduced by -1.55 Ml/d to 25.00 Ml/d (would have been reduced by -5.66 Ml/d to 20.89 Ml/d without changes to year 5 metering programme)*
Guildford	*SDB reduced by -0.39 Ml/d to 19.63 Ml/d (would have been reduced by -0.99 Ml/d to 19.04 Ml/d without changes to the year 5 metering programme)*
SWA	*SDB reduced by -2.81 Ml/d to 30.64 Ml/d*
Kennet	*SDB reduced by -1.97 Ml/d to 42.42 Ml/d*
Henley	*SDB reduced by -0.20 Ml/d to 7.84 Ml/d*

Table X – Impact of changes to GER programme on supply demand balance in 2024/25

1.136 *Additional to the impact on supply demand balances, there is also a predicted 0.73 l/p/d impact on PCC in 2024/25 and a 1.00 Ml/d impact on leakage in 2024/25. The impacts on PCC and leakage are mitigated by delivery of the GER meter installations in AMP8.*

1.137 Additional to changes made in rdWRMP24 Section 3, changes will be required in Section 8 and Section 11 of our rdWRMP24.

1.138 Changes in Section 8 will be to:

- Either update existing tables detailing the benefits and costs of our PMP programme (Tables 8-9 and 8-10), SHV programme (Tables 8-23 and 8-24) and CSL programmes (Table 8-44), or include a new table which lists out the costs and benefits of activities which will be undertaken to “catch up” with the previously planned GER programme.

1.139 Changes in Section 11 will be to:

- Amend numbers and figures as required to ensure alignment with the WRMP Tables e.g., Figure 11-4 (Household meter penetration), Table 11-1 (Preferred plan, demand management programme).
- Delete the current paragraph rdWRMP 11.40

Issue 1.9

Request

1.140 Thames Water should update and resubmit its WRMP24 planning tables to the Environment Agency, to include impacts of the Green Economic Recovery funding change, and any mitigating actions from the company, into the baseline tables of each water resource zone. If the impact results in supply-demand deficit at water resource zone level the company must describe options to bring the zone(s) back in balance. The company should include a narrative on the impact to supply-demand balance, and any resulting change to its AMP8 metering strategy, in the plan’s text.

Further elaboration of request given in annex, or clarification given subsequently

1.141 No further elaboration.

Our consideration of the points raised

1.142 As described in response to Issue 1.8, the removal of the GER programme does not result in any deficits in any of our WRZs.

1.143 We will revise our tables to account for this change, as requested.

Changes made to the rdWRMP24

1.144 As agreed with the Environment Agency, we will submit revised WRMP Tables at the time of final WRMP submission.

1.145 Narrative regarding supply-demand balance change given in response to Issue 1.8.

Issue 1.10

Request

1.146 PCC Reduction plan for first five years of the plan is unambitious.

Further elaboration of request given in annex, or clarification given subsequently

1.147 No further elaboration is given.

Our consideration of the points raised

1.148 We do not consider this statement to be balanced or justified and we have explained in the following paragraphs why we consider our programme to be ambitious. As shown in Table 10 our 2029/30 forecast PCC of 138 l/p/d is comparable with other companies and in line with the Government's EIP target to achieve 110 l/p/d by 2050. The statement does not recognise that in a national geographical context PCC is recognised as being higher in the South East.

Table 10 – PCC reduction in AMP8 (l/p/d), from rdWRMP24

Water Company	2024-25	2029-30
Yorkshire Water	128	122
Severn Trent Water	130	123
Anglian Water	134	126
Cambridge Water	133	126
South Staffordshire Water	138	129
United Utilities	136	130
South East Water	141	131
Southern Water	139	132
Wessex Water	144	134
Northumbrian Water	151	136
Thames Water	143	138
Essex and Suffolk Water	153	138
SES Water	148	139
Affinity Water	145	140
Bristol Water	153	140
South West Water	151	142
Portsmouth Water	163	147

1.149 Thames Water has already completed nearly nine years of smart meter rollout activity, significantly ahead of the rest of the water sector. The demand reduction volumes calculated from AMP8 smart metering and water efficiency activities are evidence-based and build upon these delivered activities. Other companies beginning to install smart meters may have different assumptions around the demand reduction their metering programmes will deliver, and this may go some way to explaining their larger PCC reductions. This does not reflect a lack of ambition by Thames Water but rather reflects that our plan is built on realistic and robust demand reduction data gained from our established programmes.

1.150 The demand reduction volumes calculated for our AMP8 programme are generated from actual smart meter datasets and analysis, as well as measured savings from the long standing and award-winning Smart Home Visits (SHV) and wastage fix programmes.

1.151 Our programme for AMP8 includes over 900k smart meter installations on household properties which will be supported by the sector's largest water efficiency programme of targeted water efficiency visits and digital engagement on high usage and continuous flow households. This programme of household smart meter installations is significantly larger that our AMP6 and AMP7 programmes and focuses on smart metering remaining available and meterable properties, and using smart meter data to target water savings opportunities, using activities within water company control.

1.152 Our demand reduction volumes have been accurately calculated using bottom-up water savings values, all generated from real-life demand reduction values measured through smart meter data and on-site visits. Differences in water savings per household property are driven by the split of meter installation location (internal vs external) and remaining housing stock yet to be smart metered (new vs replacement). These housing stock and meter location splits are incorporated in our total demand reduction projections, which will part influence the overall PCC % reduction calculations.

1.153 All our supporting household demand reduction activity in AMP8 will be data-driven, using smart meter consumption data to deliver targeted and effective water savings across all London and Thames Valley water resource zones.

1.154 For any assessment of proposed AMP8 demand reduction activities, we recommend that Ml/d of demand reduction is a more appropriate metric, and regulatory evaluation of demand reduction effort should not focus on PCC reduction alone. The volume of Ml/d reduction should be assessed, taking into account the scale of smart metering and water efficiency activity that is reasonably available through water company led activities.

1.155 The PCC reduction values are a calculation output influenced by multiple data inputs, including population growth forecasts, occupancy estimations, housing stock data and Ml/d reductions from both wholesaler-led interventions and external policy/regulation factors. The specific PCC % reduction value should not be interpreted as a direct measure of the scale of household Ml/d reduction volumes and efforts proposed from water company-led interventions and influences.

1.156 A significant proportion of the demand reduction volumes required to achieve greater PCC reduction will be reliant on external non-water company actions and policy/regulation changes. Companies have had to include these potential external contributors within their WRMP and PR24 plans, contributing to the long-term PCC target trajectory. Unfortunately, these external policy and regulation levers are unlikely to be contributing significant demand reduction in the 2025-30 period. These factors, which are not in water company control, need to be considered when assessing overall progress against projected PCC % reduction trajectories.

Changes made to the rdWRMP24

1.157 We have not made changes to the rdWRMP24 as a result of this comment, as our consideration is that we have provided sufficient explanation to demonstrate the ambition of our demand management programme.

Issue 2: Fully justify the selection of Teddington as best value, properly reflect current uncertainties around viability and progress development of Beckton water recycling scheme as a potential alternative should it be required.

2.1 Thames Water's revised draft plan does not reflect the environmental impacts of the Teddington option. The company has not fully addressed EA concerns, and mitigation measures need to be agreed. The company should review the viability of the Teddington option as it progresses its detailed investigations into mitigation and work on its priority actions through RAPID's gated process. The company should also address the priority actions for the Beckton water recycling scheme to ensure this option is available if the mitigation proposed for the Teddington option does not sufficiently protect the environment. The plan should be updated to show the risks and actions surrounding the Teddington option.

2.2 Thames Water should fully justify the selection of Teddington as best value. The scheme is substantially cheaper than the alternative of Beckton water recycling, but it is not clear if it is best value option in the long-term. The lack of flexibility of the scheme to be increased in the future may risk it becoming a stranded asset. The company should clearly demonstrate how it has used the best value metric scores in its decision making to select the best value plan and identify if this option would still be selected should the costs weighting be suspended.

Issue 2.1

Request

2.3 Thames Water's revised draft plan does not reflect the environmental impacts of the Teddington option. The company has not fully addressed EA concerns, and mitigation measures need to be agreed. The company should review the viability of the Teddington option as it progresses its detailed investigations into mitigation and work on its priority actions through RAPID's gated process. The plan should be updated to show the risks and actions surrounding the Teddington option.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue 2

2.4 Thames Water should ensure it updates the plan to reflect that the environmental impacts are not fully addressed through mitigation yet for its Teddington option. It needs to change the narrative for the final WRMP24 to reflect this.

2.5 Thames Water should continue working on priority actions with the EA to ensure the environment is protected.

2.6 Thames Water should review the viability of the Teddington option as it progresses the detailed investigations into mitigation and work on its priority actions through RAPID's gated process.

2.7 Thames Water should ensure work on Beckton as an alternative option is progressed at pace through the priority actions of the Gated process to bring it to the same level of understanding as the preferred option.

2.8 Thames Water should update the plan to show the risks and actions surrounding the Teddington option.

Further clarification

2.9 It has been clarified that Thames Water should acknowledge that environmental concerns raised by the Environment Agency have not been fully addressed and that environmental issues may present a risk to the consenting process.

2.10 It has been clarified that Thames Water does not need to confirm and agree mitigation measures with the Environment Agency in order for the WRMP to be approved but should acknowledge in its plan that mitigation measures need to be approved in the future.

Our consideration of the points raised

2.11 We acknowledge that conversations regarding the environmental feasibility of the Teddington scheme are still ongoing and that mitigation measures will need to be agreed as the scheme moves into the DCO process.

Changes made to the rdWRMP24

2.12 The following text will be included in WRMP Section 11, within the "Risk: Obtaining Planning Consent" section, after the current rdWRMP24 paragraph 11.332:

2.13 The Environment Agency has raised concerns regarding certain aspects of the environmental feasibility of the Teddington DRA scheme, particularly in relation to potential fisheries impacts from temperature and velocity changes. While our consideration is that these concerns will be able to be overcome, they have not yet been fully addressed, and as such present some risk within the consenting process. It will be for the Planning Inspectorate and Secretary of State to examine the evidence in our application and make a decision on whether to grant or refuse development consent. Further environmental feasibility issues may be identified as the scheme progresses into the DCO process and as such, as with any consenting application, there is a risk that the scheme may not be able to proceed. In relation to mitigation measures, while environmental assessments which have been undertaken have concluded that, with best practice mitigation measures, environmental concerns should be surmountable, as is normal for a scheme at this stage in development, detailed mitigation measures have not yet been agreed. While this is usual for the strategic planning stage of the WRMP, this nonetheless presents a risk which must be acknowledged. We will continue to review the viability of the Teddington option as we progress more detailed investigations into mitigation measures and will continue to work on actions raised through RAPID's gated process.

Issue 2.2

Request

2.14 The company should also address the priority actions for the Beckton water recycling scheme to ensure this option is available if the mitigation proposed for the Teddington option does not sufficiently protect the environment.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue 2

2.15 Thames Water should ensure work on Beckton as an alternative option is progressed at pace through the priority actions of the Gated process to bring it to the same level of understanding as the preferred option.

Our consideration of the points raised

2.16 We are progressing the Teddington DRA, and water recycling schemes at Beckton and Mogden as part of the Strategic Regional Options process overseen by RAPID. This gated assessment process will ensure that all options remain available and developed at a suitable pace should an alternative for the current preferred option (Teddington DRA) be required.

Changes made to the rdWRMP24

2.17 We will add the following text to Section 11 of our WRMP. This will be in the paragraph 11.358 of the rdWRMP24:

2.18 We will continue to progress the development of the Beckton and Mogden Water Recycling Schemes as part of the Strategic Resource Options process overseen by RAPID. This gated assessment process will ensure that all options remain available and are developed at a suitable pace should an alternative for the current preferred option (Teddington DRA) be required.

Issue 2.3

Request

2.19 Thames Water should fully justify the selection of Teddington as best value. The scheme is substantially cheaper than the alternative of Beckton water recycling, but it is not clear if it is best value option in the long-term. The lack of flexibility of the scheme to be increased in the future may risk it becoming a stranded asset.

2.20 The company should clearly demonstrate how it has used the best value metric scores in its decision making to select the best value plan and identify if this option [Teddington DRA] would still be selected should the costs weighting be suspended.

Further elaboration of request given in annex, or clarification given subsequently

2.21 The Environment Agency have given further clarification relating to the suspension of cost weighting. It was clarified that more detail should be provided on the sensitivity of the decision making to the cost aspect of best value planning, rather than identifying whether the Teddington DRA would be selected if the consideration of costs were disregarded entirely.

Our consideration of the points raised

2.22 We recognise the need to justify the selection of the Teddington DRA scheme as Best Value.

2.23 Best value plans are those that take account of a wider range of factors over the longer-term other than just cost (Section 10, paragraph 10.35). In Stage 2 of our Best Value Planning approach (Section 10, paragraphs 10.65-10.78) we set out that we will consider potential programmes against a set of objectives and criteria represented by cost, environmental and social and resilience metrics. We consider each of these in our assessment and do not support suspending any of them as it would be against the principles of best value planning and contrary to the Water Resources Planning Guideline e.g. "*A best value plan is one that considers factors alongside economic cost*". However, following the clarification on that we should consider the sensitivity of our decision-making to cost, we return later to the question of cost sensitivity and weighting after this summary.

Existing Programme Appraisal Narrative

2.24 We consider that the programme appraisal modelling, as presented within Section 10 of the revised draft WRMP does allow for assessment of the relative position of Teddington against its alternatives from a cost and a wider best value perspective. Cost and best value metrics are published alongside each run in Section 10 and in full across all pathways in Appendix X.

2.25 Section 10, Figure 10-15 provides a summary position. This shows the cost vs BVP aggregate metric plot for the key model runs discussed in pages before it, including the least cost and overall best value plans and a range of specific sensitivity tests including a) removing Teddington DRA and b) replacing it with Beckton Recycling at different sizes. It indicates that both against cost and against aggregated BVP metrics, removal of Teddington DRA would result in a lower performing programme.

2.26 Further information on the aggregation of BVP metrics is provided as part of our response to Issue 8.

Teddington DRA as a Best Value Solution

2.27 From a modelling perspective there is a very strong signal that Teddington DRA is part of the best value solution, with the scheme chosen in greater than 90% of the model runs. As a direct river abstraction, it performs well against alternatives such as Beckton and Mogden Recycling because it requires a less intensive treatment process, reducing capital and operating costs and carbon emissions.

2.28 It would require a significant change in option scope for another water recycling scheme to become the preferred option over Teddington DRA. This change could be driven by substantial improvement in environmental performance of the wastewater recycling alternatives, a step change in the forecast demand for water or supply capability, or a change in drought resilience policy.

2.29 We do not agree that scheme flexibility is linked to the chances of an option becoming a stranded asset. With a complex supply demand problem, programme-level flexibility is more important than option-level flexibility and it is equally possible to provide programme flexibility by using fixed output schemes as it is from developing modular assets. Both types of option may be selected by the Investment Model.

Comparing Teddington DRA to Alternatives

2.30 Our consideration is that programme-level comparisons are most instructive in identifying the Best Value Plan, with complexities such as option utilisation and scheduling meaning that an "Option A vs Option B" comparison is not often meaningful. However, in the case of the Teddington DRA scheme, the costs and impacts of the alternative schemes of Mogden Recycling and Beckton Recycling can easily be compared with the Teddington DRA scheme as the options would all provide water only to the London WRZ and can all be delivered on a similar timeline. Table 11 provides a comparison of the costs, carbon emissions, and other best value metrics for the Teddington DRA and alternative schemes.

Table 11 – Costs, carbon emissions and Best Value metrics for London Water Recycling options

Factor	Teddington DRA	Beckton 50	Beckton 100	Mogden 50	Mogden 100
DO Benefit (Ml/d)	67	46	89	46	89
Capex (£m)	237	798	913	510	624
Fixed Opex (£m/yr)	0.59	2.89	3.65	2.6	3.81
Variable Opex (£/Ml)	166	527	508	578	530
AIC (Max flow, p/m3)	51	226	144	133	97
AIC (Min flow, p/m3)	63	190	142	184	158
Carbon emissions (whole life, tCO2e)	242,000	588,000	688.000	560,000	1,028,000
SEA benefit	18	19	19	10	18
SEA disbenefit	-15	-26	-26	-26	-26
Natural Capital (£2022/yr)	485,268	40,833	40,833	1,082,155	1,082,155
Biodiversity Net Gain (Units post-mitigation)	2.37	7.92	7.92	14.9	14.9
Customer Pref.	1.12	1.15	1.15	1,15	1.15
Reliability	10.71	9.57	9.57	8.71	8.71
Adaptability	2	1	1	1	1
Evolvability	6	7	7	6	6

Sources: LWR SRO Gate 2 Report Table 6-1, 8-1 and 8-2 (Costs), WRMP supplementary info: Options metrics overview

2.31 The above confirms that DRA is preferable to alternatives on the ground of cost and carbon which can be traced back to the treatment type and the lengths of the conveyance elements which form each option's scope. The differences in the other BVP metrics are not substantial. Given the minimal differences between the BVP metrics for the Teddington DRA and its alternatives, the difference in cost and carbon emissions becomes the deciding factor in the option selection decision.

Solution sensitivity to cost and weighting

2.32 In the investment model, there is no weighting system applied to the metrics. The model is always running to find a solution that meets the constraints at the least cost. The difference in the BVP runs is that there are additional constraints applied to ensure that differing levels of BVP metric uplift are achieved.

2.33 Since the publication of the rdWRMP we have carried out further sensitivity analysis to explore the tipping point between programmes that choose Teddington DRA and alternatives. This supplements the existing sensitivity tests carried out removing Teddington from the options list and forcing in alternative options to the programme.

2.34 We have incrementally increased the cost of the DRA scheme by increasing the Optimism Bias by 10, 20, 50, 100 and 200% (Table 12).

Table 12 – Teddington DRA sensitivity run outputs

OB uplift (%)	£m uplift	Outcome
0	-	Teddington DRA
10	+7	Teddington DRA
20	+14	Teddington DRA
50	+34	Teddington DRA
100	+68	Teddington DRA
200	+136	Multiple GW options and transfers from SES (as per the No DRA sensitivity test)

2.35 This suggests the cost tipping point for the DRA scheme is between £68m-136m. As set out in Section 10, Stage 5, we consider that the alternative of multiple GW schemes and transfers from SES is high risk, because the transfers are predicated on water being available following their demand management programmes. As such, we have undertaken further sensitivity runs in which some options are excluded until 2040, in order to derive a plan with a strategic alternative to Teddington (Table 13).

Table 13 – Teddington DRA further sensitivity run outputs

OB uplift (%)	£m uplift	Outcome (2030s option for 1 in 200-year resilience)
0	-	Teddington DRA
200	136	Teddington DRA
300	204	Teddington DRA
400	272	Teddington DRA
500	340	Teddington DRA
600	408	Teddington DRA
700	476	Beckton Recycling 50 Ml/d

2.36 This suggests that the cost tipping point from the DRA scheme to a different water recycling scheme is an uplift of £408-476m.

Changes made to the rdWRMP24

2.37 Additional text will be added to Section 10 Stage 5: Sensitivity testing (under the 'Other options Teddington DRA, GUC and Beckton Recycling' subheading) to emphasize the Best Value as well as cost position of Teddington vs alternatives, including the Tables above. The results of these model runs will be included in WRMP24 Appendix X.

2.38 Further information on the aggregation of BVP aggregate metric is provided in answer to Issue 8.

Issue 3: Ensure transfers of water are aligned

3.1 The company should ensure accurate alignment of the transfers with its neighbours and New Appointments and Variations (NAVs). Thames Water's water resources management plan tables are missing the Cockfosters (5Ml/d) and Perivale (10Ml/d) exports from its London resource zone to Affinity Water. There is also a discrepancy in a transfer between Thames Water and Essex and Suffolk Water in the tables.

3.2 The company also does not represent the bulk transfers to its New Appointments and Variations (NAVs) accurately. If it did it would potentially lead to a deficit in the London water resource zone for several years in the 2030s and beyond 2049. The company must ensure it is aligned with its NAVs and describe each transfer to a NAV in its plan and the contractual volumes should be set out in the planning tables. Thames Water should also ensure properties and populations served by NAVS are not included within the forecasts in the company plan going forward. This is to prevent double counting of demand components and also overstating supply. The company should work with the NAV companies to ensure alignment of assumptions e.g. number of sites, population, property and contractual volumes.

3.3 We do not expect incumbents to forecast beyond the appointed sites set out in the NAV WRMPs i.e. new sites will be awarded but the incumbent will not know when and to which NAV. The company should use the WRMP cycle to update the figures and adjust forecasts accordingly.

Issue 3.1

Request

3.4 Thames Water's water resources management plan tables are missing the Cockfosters (5Ml/d) and Perivale (10Ml/d) exports from its London resource zone to Affinity Water. There is also a discrepancy in a transfer between Thames Water and Essex and Suffolk Water in the tables.

Further elaboration of request given in annex, or clarification given subsequently

3.5 We have obtained copies of the WRMP Tables for Affinity Water and Essex & Suffolk Water, and have jointly authored notes on the representation of transfers in our rdWRMP24s.

Our consideration of the points raised

3.6 We acknowledge that there was misalignment in the way that transfers were presented in WRMP Table 1. There was, however, alignment in the representation within WRMP Table 3 (supply-demand balance).

3.7 As a result of this request, we have jointly drafted notes regarding the representation of transfers between Thames Water and Essex & Suffolk Water (Annex A: Thames Water to Essex & Suffolk Water – Joint Note on Representation in WRMP Tables), and Thames Water and Affinity Water (Annex B: Thames Water to Affinity Water – Joint Note on Representation in WRMP Tables).

Changes made to the rdWRMP24

3.8 In the joint notes referenced above, we have highlighted changes made to our WRMP Table 1 (licences and transfers). We will publish these notes in an Annex at the end of Section 4 of our WRMP.

Issue 3.2

Request

3.9 The company also does not represent the bulk transfers to its New Appointments and Variations (NAVS) accurately. If it did it would potentially lead to a deficit in the London water resource zone for several years in the 2030s and beyond 2049. The company must ensure it is aligned with its NAVs and describe each transfer to a NAV in its plan and the contractual volumes should be set out in the planning tables. Thames Water should also ensure properties and populations served by NAVs are not included within the forecasts in the company plan going forward.

3.10 The company should work with the NAV companies to ensure alignment of assumptions e.g. number of sites, population, property and contractual volumes.

Further elaboration of request given in annex, or clarification given subsequently

3.11 We have discussed this issue with WRSE, the Environment Agency and the NAV suppliers who import water from us.

3.12 The Environment Agency has confirmed that the use of contractual volumes as the export from suppliers is the default position. Where contractual volumes may not be required due to insufficient NAV growth, particularly early in the plan, the EA are willing for incumbents to work with the NAVs to agree a realistic profile in place of the contractual amount. Should companies wish to pursue this approach they should agree a revised export with their NAVs that will form the WAFU within the NAV tables and ensure that population / properties are accounted for within the NAV plan, not the incumbent's. Alignment between the tables must be ensured. We are looking to review and update the guidance around the inclusion of NAVs for WRMP29.

3.13 Actions the EA are requesting Thames Water to undertake to resolve this issue within the fWRMP24 tables are as follows:

- Amend Table 1g as follows:
    - Include separate export lines to each supplier from each WRZ
    - Amend DYAA, DYCP and Annual Limit fields to the contractual value (or other export value as agreed with the NAVs.
- Amend Table 3 as follows:
    - Remove population and properties associated with NAVs
    - Amend row 5BL (Potable Water exported) to include the contractual export (or other export value as agreed with the NAV).
    - Ensure that water is removed from the WRZ demand forecast to account for the forecast growth in DI in NAV areas to ensure double counting is avoided.

Our consideration of the points raised

3.14 We accept that there is inconsistency in how demand for water from NAVs is reported.

3.15 The inconsistency is due to the NAVs reporting their full contractual volumes as an import, whereas we had included delivered volumes in the base year as the import and then allowed for NAV growth (volumetric and demographic) within our demand forecast (with the demand forecast covering the wholesale supply area, rather than the retail supply area).

3.16 However, the impact of this inconsistency is not material to the plan or any decision making required upon it as the change can be covered by predicted surpluses and headroom allowances.

3.17 We are grateful to the Environment Agency for responding to our request for clarification and their input to the discussions that followed.

3.18 We will change our WRMP Tables (Table 1g) to reflect the contractual volumes to NAVs and add explanatory notes.

3.19 We consider that stating contractual volumes as the potable export value for NAVs is unrealistic, as the NAVs (unlike the incumbent water companies who export the treated water) are unable to use their full contracted amounts immediately. The NAV areas are in development and 'built out' over time, so demand grows gradually. Indeed, none of the NAVs are forecasting that demand reaches their full contracted availability.

3.20 Nevertheless, given the low materiality to the plan in this planning round and the limited time in which to formally agree a more realistic position with our NAVs we will follow the default position for WRMP24 and contribute to guideline improvements for WRMP29,

3.21 As such we have agreed to reflect the export to NAVs in Table 3 as being equal to their contracted volumes. The increase in export will be netted off through with removing NAV growth from our demand components (volumetric and demographic) and reductions to target headroom.

Changes made to the rdWRMP24

3.22 Updates to WRMP Tables: Table 1 to include contractually agreed maximum and include explanatory notes. Table 3 to be updated to reflect contractual volumes as the bulk export, with the NAV growth removed from our forecast demand components and Target Headroom edited.

3.23 Updates to WRMP Main Report Section 3 (Demand Forecast), 4 (Supply) and 6 (Uncertainty and Baseline Supply-Demand Balance) to reflect the aligned position.

Issue 4: Account for likely constraints on groundwater options

4.1 Thames Water has two small groundwater options; Moulsford (delivering 2 Ml/d in 2032/33 and Woods Farm (delivering 2.4 Ml/d in 2073/74). There could be a risk of deterioration from these schemes and therefore they are unlikely to provide as much water as the company is assuming. While these options are small, Moulsford provides water in the early part of the plan and therefore makes a contribution to the supply-demand balance. The company should make the relevant assessments and consider whether any further action is needed to maintain the supply-demand balance and avoid the risk of deterioration.

4.2 Thames Water should also complete the Level 2 Water Framework Directive assessment for the Confined Chalk North London scheme by including the assessment for the Mid Chilterns Chalk water body. The latest abstraction policies for the confined London Basin Chalk Aquifer are detailed in the Environment Agency's 2022 London Basin Chalk Aquifer Management report.

Issue 4.1

Request

4.3 Thames Water has two small groundwater options; Moulsford (delivering 2 Ml/d in 2032/33 and Woods Farm (delivering 2.4 Ml/d in 2073/74). There could be a risk of deterioration from these schemes and therefore they are unlikely to provide as much water as the company is assuming. While these options are small, Moulsford provides water in the early part of the plan and therefore makes a contribution to the supply-demand balance. The company should make the relevant assessments and consider whether any further action is needed to maintain the supply-demand balance and avoid the risk of deterioration.

Further elaboration of request given in annex, or clarification given subsequently

4.4 The two sites of concern are Moulsford and Woods Farm. Both are considered at risk of causing water body deterioration. They will also both be subject to EA Thames Area's licensing strategy if there is continuity with surface water, or if they are to abstract from a failing or at risk groundwater body. This means that the sources may need Hand off Flow conditions, and thus reduced yield over certain periods of the year. The hand off flow conditions have not been discussed in the WRMP. Thames Water will additionally need to consider the risk of deterioration posed by the Moulsford licence as a new option in combination with existing abstractions in the same water body. Thames Water should propose and agree investigations on no deterioration and hands off flow conditions with EA Thames Area Office for the above sources.

4.5 Additional notes for Woods Farm: This is a source at risk of causing deterioration. It was originally intended to be included in the grouped AMP7 investigation considering risk of deterioration on the Thames. The source was not investigated as part of this investigation, as water returned upstream was considered to mitigate the abstraction impact. However, network constraints meant that this was not feasible, and therefore any source growth may continue to pose a deterioration risk. Appropriate assessments are required for Woods Farm to ascertain any risk of deterioration from source uplift or growth.

4.6 Thames Water should confirm what no deterioration investigation is planned for Woods Farm in AMP8, as there was a question about double-counting of funding for the investigation, between

AMP8 deterioration investigation and WRMP/source development funding. The information in your fWRMP24 and PR24 Business Plan should be fully aligned.

Our consideration of the points raised

4.7 We have initiated the necessary modelling work to investigate the potential risks of water body deterioration from the Moulsford and Woods Farm schemes. Due to the locations of these schemes and the water bodies which may be impacted, this work will involve use of the Middle Thames Regional Groundwater Model. Due to the complexity of this model and availability of specialist modelling resources, the finalised results are not currently available. Findings from this work will be incorporated into WRMP24 alongside updated WFD assessments for Moulsford and Woods Farm. We will communicate results from this modelling to colleagues at the Environment Agency as soon as they are available.

4.8 While this modelling work is clearly important in providing a quantitative assessment of the impacts of these schemes, here we provide a qualitative view of the scheme impacts, which demonstrates that the schemes are unlikely to pose a risk of deterioration and are expected to yield the projected amount of water.

4.9 An AMP8 WINEP no deterioration investigation is planned for the Woods Farm source. We recognise that there is some overlap in the scope of the WINEP investigation and the work which would be undertaken in ensuring that the proposed scheme is feasible. Following the conclusion of investigations to confirm the feasibility of the Woods Farm WRMP scheme, we will confirm with the Environment Agency the remaining scope of an AMP8 WINEP investigation. Our expectation is that such an investigation would involve significantly more detail. Our WRMP does not set out the funding requirements for our WINEP programme.

Moulsford

4.10 The Moulsford groundwater scheme would involve the construction of new boreholes. This water would be abstracted, transferred to the Cleeve WTW, where it would be treated, and put into supply.

4.11 The WFD assessment has identified further work as being required to fully assess the impact of this scheme on the following waterbodies: “The Thames Wallingford to Caversham” (surface water body) and “Berkshire Downs Chalk” (groundwater body). The concern raised in the WFD assessment is that new abstraction at Moulsford would reduce flow in the Thames, and would negatively impact the water balance of the groundwater body (reducing outflows into dependent surface water bodies).

4.12 Regarding deterioration of the surface water body, our consideration is that the inclusion of an “upstream Use” condition on the licence for the Moulsford source (see Figure 4-1) would ensure that no risk of deterioration would be posed for the River Thames. A similar licence condition exists for the Gatehampton groundwater source. The licence condition would require that water abstracted from Moulsford would be transferred into the GATOX water transfer main. Transfer via this main would mean that water abstracted at Moulsford would be used in locations where water would be returned to the River Thames and its tributaries (via sewage treatment works) upstream of the abstraction location, making the abstraction effectively non-consumptive. Given the net-neutral impact on flows at Moulsford, we would therefore anticipate no deterioration of the quantity of water in the River Thames.

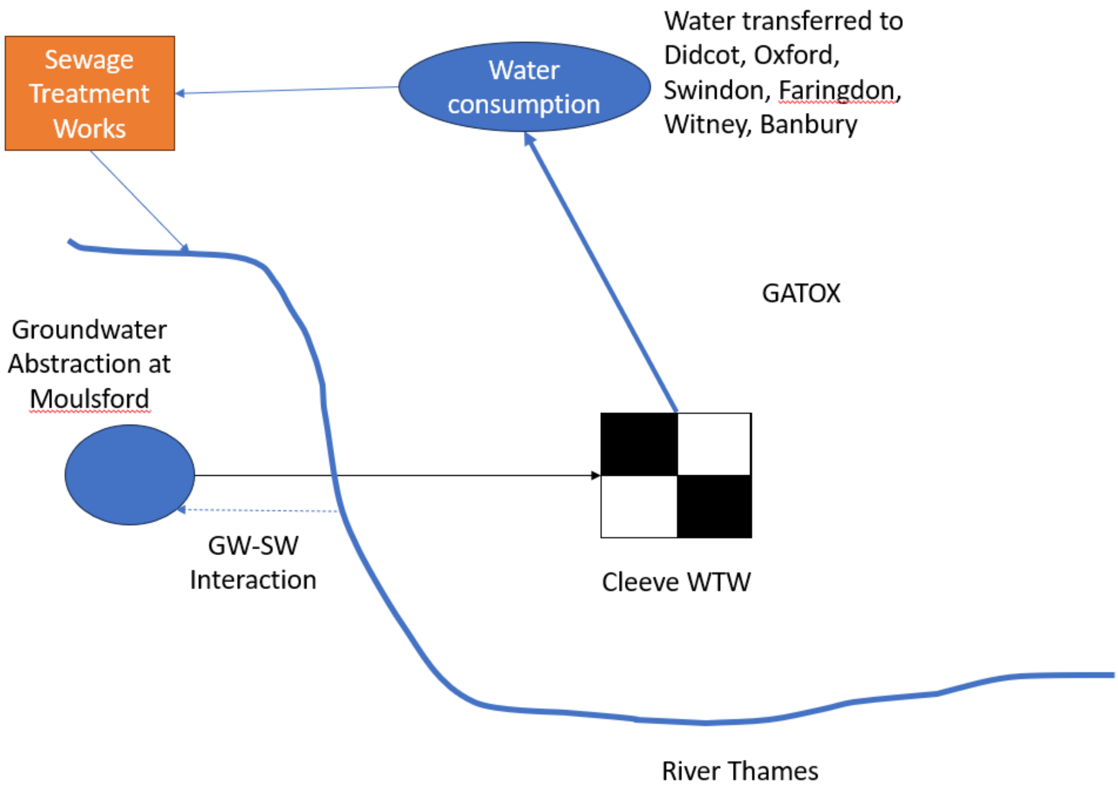

Figure 4-1: Schematic View of Moulsford groundwater source

4.13 Regarding deterioration of the groundwater body, the Berkshire Downs Chalk Groundwater Body is very large, stretching from west of Marlborough to Reading and covering an area of nearly 1000 km^2. An abstraction of 2 Ml/d from such a large water body would cause only a negligible change in the overall water balance. Our expectation is that the use of the Middle Thames Groundwater Model will demonstrate negligible change in outflows from the water body. Furthermore, we note that the planned licence reductions at Bradfield (1.64 Ml/d, 2030), Pangbourne (5 Ml/d, 2035), Marlborough (2.48 Ml/d, 2040), Clatford (1.24 Ml/d, 2040) will all improve the water balance in this water body.

4.14 While modelling is needed to provide a quantitative assessment, our qualitative assessment is that, as described, deterioration would not result from the new abstraction at Moulsford, and so our expectation is that the full intended Deployable Output from the source can be achieved.

Woods Farm

4.15 The Woods Farm option involves the drilling of a new borehole at the existing Woods Farm source site. One of the existing boreholes at this source suffers from water quality issues, limiting the quantity of water which can be abstracted to a volume lower than the licence, and the drilling of a new borehole would allow for abstraction up to the licensed quantity.

4.16 Modelling of the Woods Farm option will focus on impacts of the scheme on the Berkshire Downs Chalk groundwater body. The scheme is not expected to impede reaching Good Ecological Potential (GEP) or compromise water body objectives for the Thames Wallingford to Caversham River water body. The Berkshire Downs Chalk Groundwater Body is very large, stretching from west of Marlborough to Reading and covering an area of nearly 1000 km^2. An additional abstraction of 2.4 Ml/d from such a large water body would cause only a negligible change in the overall water balance. Our expectation is that the use of the Middle Thames Groundwater Model will demonstrate negligible change in outflows from the water body. Furthermore, we note that the planned licence reductions at Bradfield (1.64 Ml/d, 2030), Pangbourne (5 Ml/d, 2035), Marlborough (2.48 Ml/d, 2040), Clatford (1.24 Ml/d, 2040) will all improve the water balance in this water body.

4.17 The addition of connection to the GATOX main will, similarly to Moulsford, ensure that water which is not used locally is transferred upstream. Upstream use would enable the return of water to the watercourse from the upstream sewage treatment works, effectively making the abstraction non-consumptive. This approach removes the potential for deterioration of the surface water body. As such, our consideration is that no "upstream use" licence condition is required for Woods Farm, as, due to network constraints, additional abstraction above recent actual can only be used locally or discharged into the GATOX main. Furthermore, even if local growth occurs such that increased use of Woods Farm occurs which is not upstream, the area served by the source is limited to an area from which sewage treatment works discharge either to the Thames (upstream of Caversham) or Pang catchments, and so there would be no deterioration at the assessment point (Caversham).

4.18 While modelling is needed to provide a quantitative assessment, our qualitative assessment is that, as described, deterioration would not result from increased abstraction at Woods Farm, and so our expectation is that the full intended Deployable Output from the source can be achieved.

4.19 Results of the modelling investigation of Woods Farm will indicate whether there is a risk of deterioration and will also help identification of further mitigation measures required, such as a hands off flow conditions. However, as described above, the scheme is considered unlikely to lead to a risk of deterioration.

<u>Future modelling and tests to assess the impact of Moulsford and Wood Farm.</u>

4.20 The initiated groundwater modelling aims to assess the impact of Moulsford and Woods Farm on the water balance in the Berkshire Downs Chalk. This includes examining their effects on surface water bodies at the following locations (which are the conceivable dependent surface water bodies which could be impacted by these changes in abstraction from the chalk):

- The River Thames, adjacent to the Moulsford source (new source)
- The River Thames, adjacent to the Woods Farm source (existing source with proposed increased abstraction)
- The River Thames at Caversham (downstream of both sources)
- The River Pang, near its confluence with the River Thames

4.21 The objectives are to understand how increased abstraction may affect river flow and the overall water balance. Additionally, the study aims to review the network to document water usage for upstream purposes as part of the AMP8 WINEP investigation.

4.22 There are the seven scenarios to be run in the Middle Thames Groundwater Model to assess the impacts of these abstractions on WFD waterbodies:

1. Recent actual abstraction rates
2. As per scenario 1. plus an increase at the existing Woods Farm source.

3. As per scenario 1. plus the inclusion of a new source, Moulsford
4. As per scenario 1. plus increases from the existing and new sources described in scenarios 2. and 3.
5. As per scenario 2. plus planned sustainability reductions
6. As per scenario 3. plus planned sustainability reductions
7. As per scenario 4. plus planned sustainability reductions

4.23 While this modelling has not yet been carried out, our expectation is that it will confirm the conclusions of qualitative assessment, and so our consideration is that the quantitative exercise not having been completed should not impede the finalisation of our WRMP24.

Changes made to the rdWRMP24

4.24 The following text will be added to WRMP24 Appendix D (Water Framework Directive Assessment), in a new Annex (Annex C), entitled "Further Work Undertaken to Support WFD Assessment":

4.25 A qualitative assessment of the deterioration risks associated with the Moulsford and Woods Farm groundwater options has been undertaken, supplemented by quantitative outputs from a modelling study[9].

4.26 The WFD Assessments for the Moulsford and Woods Farm options indicated that there may be a risk of deterioration of the following water bodies as a result of delivery of these options:

- *River Thames, Wallingford to Caversham (surface water body)*
- *Berkshire Downs Chalk (groundwater body)*

4.27 Regarding deterioration of the surface water body, the concern raised in the WFD assessment is that new/increased abstraction would reduce flow in the Thames via groundwater-surface water interaction. Our consideration is that ensuring consumption is either local to the source, or upstream of the source, will ensure that the risk of deterioration is avoided. Use locally or upstream will ensure that water which is abstracted is returned to the Thames, via effluent returns from sewage treatment works. As such, mitigation will be included for the Moulsford option in the form of an "upstream use" licence condition, similar to that currently included for the Gatehampton source. This will involve discharge of water from Moulsford into the Gatox transfer main (with this water transferred to Didcot, Oxford, Swindon, etc.), which is illustrated schematically for the Moulsford option below. No such licence condition is required for Woods Farm, as, due to network constraints, additional abstraction above recent actual could only be used locally (within the Pang or Thames catchments) or discharged into the GATOX main. Given the net-neutral impact on flows, we would therefore anticipate no deterioration of the quantity of water in the River Thames from either option.

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[9] This text is written as though the modelling study has been completed. This is due to the expectation that it will be completed by the time of fWRMP24 publication. The results of the modelling study will be added to this text.

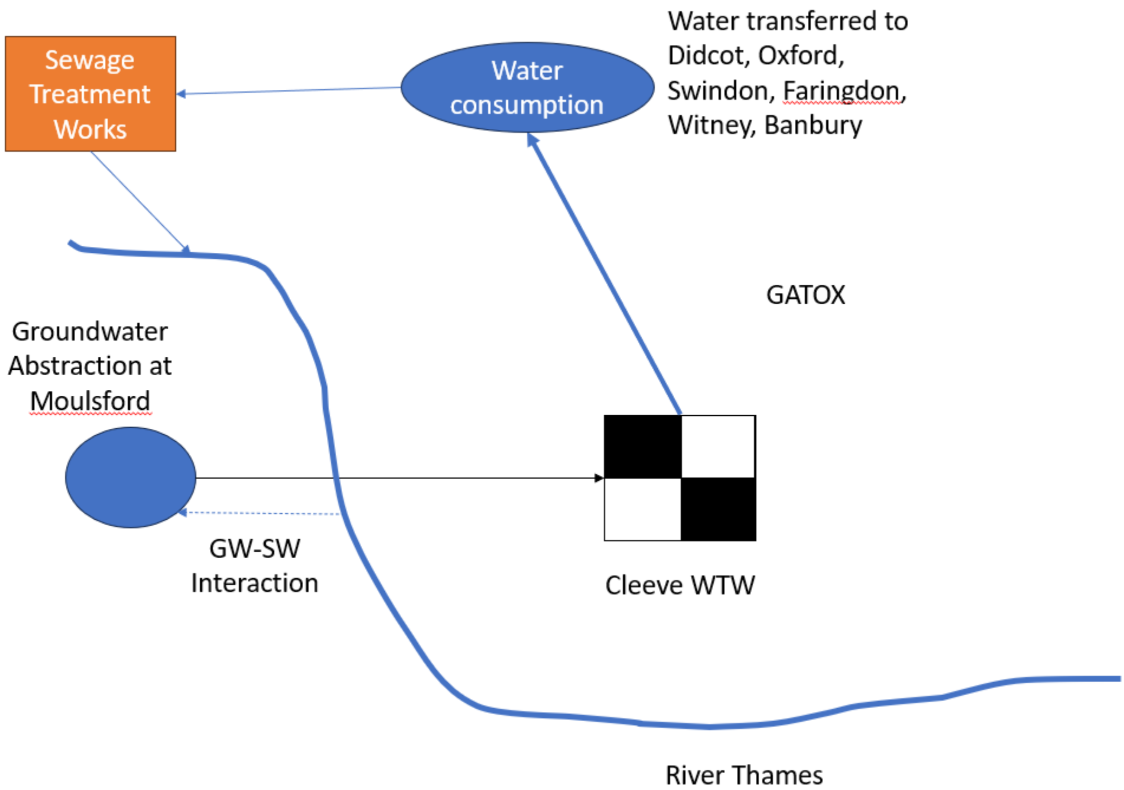


Figure X - Schematic View of Moulsford groundwater source

4.28 *Regarding deterioration of the groundwater body, the Berkshire Downs Chalk Groundwater Body is very large, stretching from west of Marlborough to Reading and covering an area of nearly 1000 km^2. Qualitatively, an abstraction of 4.4 Ml/d (2 Ml/d from Moulsford and 2.4 Ml/d from Woods Farm) from such a large water body would cause only a negligible change in the overall water balance. Our expectation prior to the modelling study was that the use of the Middle Thames Groundwater Model would demonstrate negligible change in outflows from the water body, and as such a small change in the groundwater body's water balance would not cause deterioration in dependent surface water bodies. Furthermore, we note that the planned licence reductions at Bradfield (1.64 Ml/d, 2030), Pangbourne (5 Ml/d, 2035), Marlborough (2.48 Ml/d, 2040), and Clatford (1.24 Ml/d, 2040) will all improve the water balance in this water body.*

4.29 Further to this text, the quantitative assessment undertaken through the modelling work will be incorporated into Appendix D of the WRMP.

Issue 4.2

Request

4.30 Thames Water should also complete the Level 2 Water Framework Directive assessment for the Confined Chalk North London scheme by including the assessment for the Mid-Chilterns Chalk water body. The latest abstraction policies for the confined London Basin Chalk Aquifer are detailed in the Environment Agency's 2022 London Basin Chalk Aquifer Management report.

Further elaboration of request given in annex, or clarification given subsequently

4.31 No further elaboration.

Our consideration of the points raised

4.32 The assessment for the Mid-Chilterns Chalk water body was noted and actioned but was accidentally omitted from the revised draft WRMP24. The overlooked statement will be included in Appendix D, section 3.1.22 Groundwater Development - Confined Chalk North London.

Changes made to the rdWRMP24

4.33 Include the following text in Appendix D, section 3.1.22 Groundwater Development - Confined Chalk North London.

4.34 The Level 2 WFD assessment identified negligible effects (impact score 0) on this groundwater body. The abstraction is located within the confined chalk, approximately 15km from the Chalk outcrop and this small abstraction is not anticipated to lead to any deterioration of any of the groundwater tests at the outcrop. The groundwater abstracted is likely to be at the expense of groundwater flow into the deep confined aquifer beneath London and ultimately groundwater flows into the tidal Thames.

4.35 Alongside the inclusion of this text, a revised WFD assessment sheet for this option has been submitted to our regulators and is available on request.

Issue 5: Monitoring plan

5.1 The company has stated that there are no triggers or metrics that will initiate specific actions in its adaptive plan. It is especially important for the company to report on its metrics, particularly around demand management, given the reliance in the early years of the plan on the savings from demand management to ensure security of supply. Stakeholders and regulators need to be able to see how key risks are being managed within the planning cycle and what alternative action could be taken and when. The company's plan is not clear on how it will report and make decisions if its metrics show that action needs to be taken. We expect the company to report its metrics in the annual review and any changes to pathways are explained and justified in the annual review.

5.2 The company should also report its metrics on a six-monthly basis. The company should report its distribution input to Government and regulators for all its resource zones on a monthly basis. The company has quarterly updates with RAPID to discuss the progress of its strategic resource options. It should explain how it will use the outcomes of these meetings to inform its decision-making. For example, how the company would report and manage its decision-making process if the RAPID process identified that that there is an infeasibility with one of its options.

5.3 Thames Water should also explain the feedback mechanism from the company level monitoring into the regional plan. We recommend that the company works with WRSE so that there is consistency between the regional and company level monitoring plans.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue 5

5.4 In parallel to the actions set out in the Defra letter the company should ensure it follows the Environment Agency's supplementary guidance on adaptive planning.

5.5 Update the monitoring plan to include a clearly defined sequence of decision points leading up to the first adaptive branching point. This should include when the company would need to consider switching to alternative options, and what triggers/ thresholds will influence this decision, including for instance the outcomes of ongoing investigations detailed in stage 1 of the monitoring plan, and the delivery of the demand management programme.

5.6 Clearly present the sequence of decision points and associated triggers and thresholds in relation to milestones in the early part of WRMP24. It may be useful to illustrate this using a timeline diagram.

Our consideration of the points raised

5.7 We recognise that our monitoring plan did not include specific triggers or metrics on which decisions would be taken regarding individual factors. This was intentional, as is described in our rdWRMP24 monitoring plan, reflecting the fact that decisions should be taken reflecting risks in the round, rather than in response to individual outcomes (e.g., if PCC goes up and leakage goes down and there is no net supply-demand balance impact, we question whether additional action would be needed to ensure the security of supply).

5.8 We have made amendments to our monitoring plan such that it now sets out metrics, thresholds and decisions and our updated monitoring plan is provided in Annex C: Monitoring Plan.

5.9 Our revised monitoring plan confirms our commitment to report progress against our monitoring plan as part of our Annual Review, our commitment to provide an update on our metrics on a six-monthly basis and our commitment to report distribution input to the Environment Agency for all resource zones monthly.

5.10 We will continue to engage with RAPID for the quarterly updates to discuss the progress of the strategic resource options. Our monitoring plan explains how we will use the outcomes of these meetings to inform decision-making. For example, how we will report and manage the decision-making process if the RAPID process identified that that there is an infeasibility with one of our SRO options.

5.11 The monitoring plan also explains the feedback mechanism from the company level monitoring into the regional plan. We confirm that we are working with WRSE to achieve consistency between the regional and company level monitoring plans.

Changes made to the rdWRMP24

5.12 We have deleted our existing monitoring plan section within rdWRMP24 Section 11 and have replaced it with the information set out in Annex C: Monitoring Plan, which confirms our commitment to monitoring and evaluating progress with delivering our plan.

Issue 6: Provide further detail around the company's water resources modelling

6.1 Both the Group Against Reservoir Development (GARD) and ourselves [the Environment Agency] raised concerns around the company's water resources modelling in response to the draft plan. The company has made some changes to its plan, but there are a number of topics where the company should provide further information including the:

- calibration of the rainfall run off model
- stochastic data set and its reflection of long duration droughts
- relationship between the deployable output benefit of a strategic resource option and the deployable output benefit it brings to the London supply system.

Issue 6.1

Request

6.2 Thames Water should provide further information on the calibration of the rainfall-runoff model

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue 6

6.3 We identified issues with calibration and validation of the rainfall run-off model, and its impact on the Pywr model in our advice for Improvement 2.1 in our draft plan review. Thames Water should ensure that it highlights calibration data for the 1933-34 and 1943-44 droughts after the required work is carried out. Please refer to improvement 2.1 for further details.

Annex Improvement 2.1

6.4 The company should review the new rainfall runoff model's ability to consistently replicate winter flow recovery, particularly after severe or long-duration droughts. This should focus on the parts of the hydrograph critical at key locations, e.g. at thresholds controlling abstractions. The company should discuss consequences from uncertainties resulting from adoption of the rainfall runoff model, and investigate the impact on deployable output accordingly. The company should:

- investigate rainfall run-off model calibration fits in isolation from the DO model where possible, to provide confidence in the outputs of the rainfall runoff model
- ensure it presents comparisons of historic and modelled time series and flow duration curves for key locations
- provide explanations for any significant discrepancy, and consider amended inflow hydrographs if there are significant differences in flow magnitude, especially if such differences impact the drawdown of reservoir stocks as presented in the rdWRMP Appendix I
- consider alternative representations of the rainfall runoff model to investigate improved model fits where there is significant differences, particularly over multiple years, or over severe or long duration droughts.
- Use any improved fits from the alternative representations to reassess deployable output in the water resources model, for comparison with the current range of deployable output uncertainty within headroom.

6.5 The company should complete the review of rainfall run-off model calibration and present any update to the modelled DO before the final plan.

Our consideration of the points raised

6.6 We agree with the need to better document the calibration of the rainfall-runoff models which were used in WRMP24.

Background

6.7 Prior to detailing the calibration performance of the rainfall-runoff models used in our WRMP24 hydrological and water resources modelling, it is useful to reflect on the hydrological and water resources modelling which has been undertaken in recent WRMP iterations, and how this has influenced the approach which has been taken in WRMP24.

WRMP19

6.8 In WRMP19, two hydrological/water resources modelling exercises were undertaken, and two water resources models were used:

- The Water Resources Management Simulator 2 (WARMS2), a model bespoke to Thames Water which is built using Aquator Modelling Software. This model incorporates both the hydrological modelling of the Thames catchment and water resources modelling.
- A simplified model built using the IRAS modelling software. This model included a very simplified representation of the London supply system (no other WRZs were included). Lumped parameter hydrological models were used to provide river flow inputs to the model, and these hydrological models were run prior to (and outside) the water resources model.

6.9 In terms of these respective water resources models, a summary of the advantages and disadvantages is included in Table 14.

Table 14: WARMS2 and IRAS/Catchmod comparison

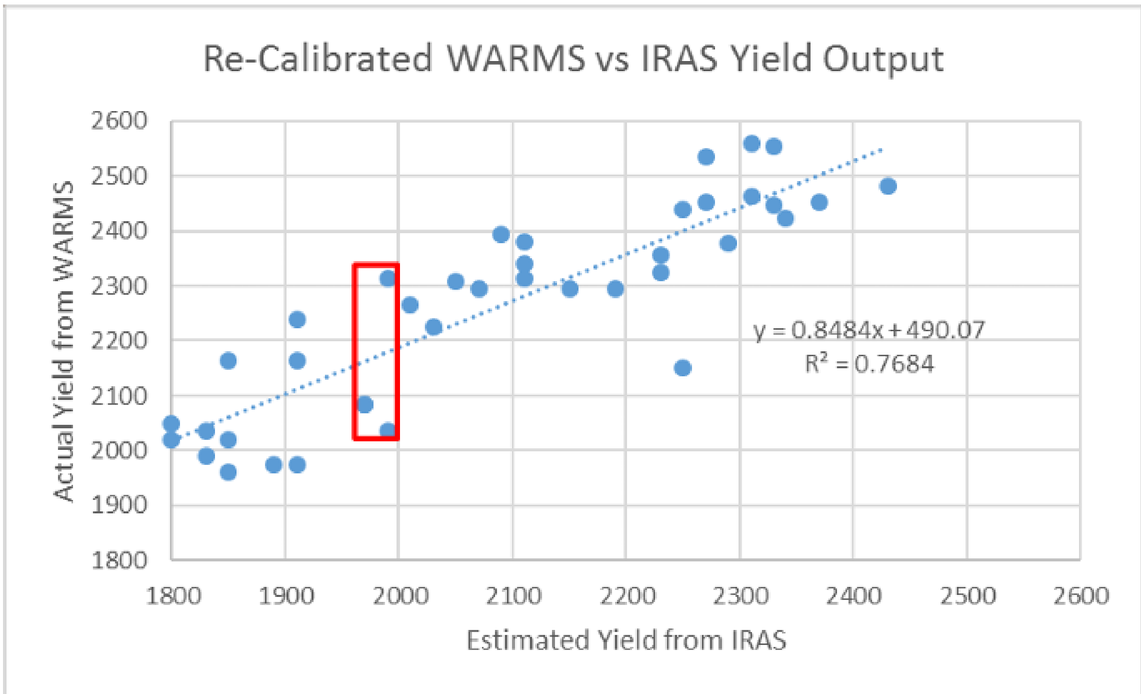
	WARMS2	IRAS/Catchmod
Advantages	Well calibrated, with the semi-distributed modelling approach meaning that complexities of hydrological response around the catchment can be captured, and calibration of different locations within the Thames ensures good overall calibration. The hydrological models being within the water resources model allows for denaturalising influences to be considered dynamically.	Very fast, meaning that the model is suitable for Deployable Output modelling using long, stochastically generated weather datasets.

Disadvantages	Relatively slow to run, as the model is detailed and includes hydrological models within a water resources model. Too slow to run full stochastic weather sequences through the model. Flows are required as an input (at Days Weir and Teddington Weir), meaning that the model cannot be run for non-historical sequences without input flows being provided.	Use of single, lumped parameter rainfall-runoff model rainfall run-off models meant that the model calibration was relatively poor.

6.10 In WRMP19, the importance of considering weather datasets other than the historical timeseries was recognised and the UK water industry began using “stochastic” weather datasets. These datasets represent different versions of weather that “could” have occurred, given the underlying climate. In order to consider a wide range of possible conditions, long (thousands of years) weather timeseries were produced. WARMS2 was too slow to be used for Deployable Output runs using stochastic weather datasets, and so the IRAS model was developed and used.

6.11 When developing IRAS, checks were undertaken in which a comparison was made between Deployable Output for given replicate as calculated by IRAS, compared to the Deployable Output as calculated by WARMS2. This comparison was presented in Figure I-17 in WRMP19, reproduced below. Note that the red box on this Figure is referred to in WRMP19, but is not of relevance in this discussion.

Figure I-17: Comparison of IRAS and WARMS2 yields



Source: Figure 5-2 Atkins' 2016 Stage 2&3 Report (July 2018).

Figure 6-1: WARMS vs IRAS Yield Output from WRMP19

6.12 As is shown on this graph there was a significant difference between Deployable Outputs calculated using IRAS and WARMS2. This difference was attributed primarily to the hydrological modelling differences. As such, a translation equation was used to take a DO from catchmod/IRAS and convert it into a result which would be found in WARMS2. This equation is included on Figure I-19. As an example, a Deployable Output figure of 2000 Ml/d as calculated in IRAS would result in a WARMS2-equivalent Deployable Output of 2187 Ml/d.

WRMP24 - Approach

6.13 Stochastic water resources modelling is now expected to be the basis of our Deployable Output assessments, given the requirement to calculate a 1 in 500-year Deployable Output. However, we wanted to improve upon the hydrological modelling undertaken for WRMP19 in order that we would not need to rely on corrections such as the regression used in WRMP19. Additionally, in order to ensure a coherent plan for the South East, the WRSE Regional Group developed a regional-scale water resources model meaning that hydrological modelling for WRZs other than London would be necessary. As such, aims for our hydrological modelling in WRMP24 were:

- The hydrological models used should be semi-distributed, in order to provide flows across the Thames catchment and in order to ensure good calibration.
- Hydrological modelling should be done outside the water resources model, in order to ensure speed within the water resources model.
- The hydrological models themselves should be sufficiently fast so as to allow them to be run for stochastic sequences in a reasonable amount of time.

- Given the significant denaturalising influences within the Thames catchment, as many of the denaturalisation processes as possible should be represented dynamically within pywr.

6.14 Based on these aims, the following approach was taken to hydrological modelling in our WRMP24:

- WARMS2 was used as the hydrological model for WRMP24. This is because it is acknowledged as a well-calibrated model (see Annex F: Calibration of WARMS2) which takes a semi-distributed approach, and ensures consistency between our WRMPs.
- Due to the requirement for hydrological modelling to be undertaken outside the water resources model, WARMS2 was to be run for a single scenario, reflective of a naturalised catchment.
- Denaturalising influences were to be considered within the water resources model where possible, as is discussed in rdWRMP24 Appendix I, paragraphs I.101-I.102.
- Recognising that WARMS2 itself requires flow inputs (Thames at Teddington and Thames at Days Weir) in order to produce flow outputs, the calibration of models for the Thames at Teddington and Thames at Days Weir was undertaken.

6.15 The resulting process is demonstrated in the schematic below. Ovals below represent models, while rectangles represent datasets. The existing WARMS2 model is shown in blue, while new models/datasets are shown in green. The result of this process is that we have taken the WARMS2 model, which has been shown to be well calibrated and which has been used as our hydrological model for several iterations of water resources planning, and have calibrated models to provide the inputs that WARMS2 needs in order to run for scenarios other than the historical time series. We have then used flows produced by WARMS2 as the inputs to the pywr model. This process ensures that we are able to use the robust and well-calibrated WARMS2 model for hydrological modelling, but are able to ensure the speed required for water resources modelling using stochastic datasets.

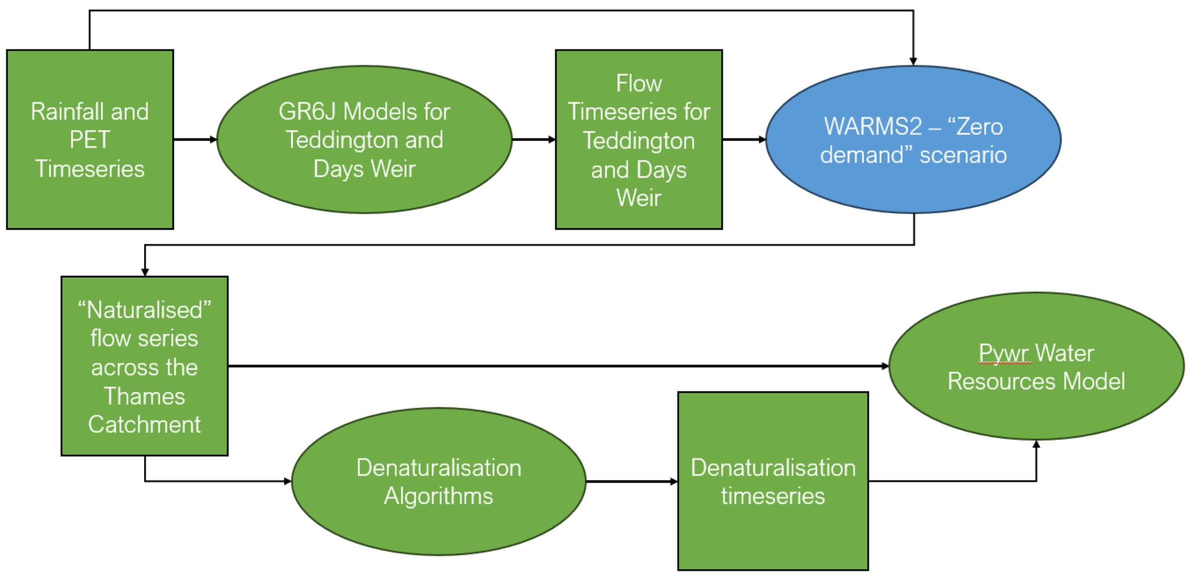


Figure 6-2: Hydrological Modelling Process for WRMP24

Hydrological Model Calibration

6.16 As noted above, the hydrological model calibration/validation exercise involves the calibration of new rainfall-runoff models for the Thames at Days Weir and Teddington, followed by the use of flows produced by these models within a single run of the WARMS2 model, in order to generate flows to then be used in the water resources (pywr) model. As such, we have first detailed the calibration of the models produced for Teddington and Days Weir, and then the validation of the flows produced by WARMS2 using these new flow inputs as compared to flows produced when WARMS2 is run using historical measured flows.

Calibration of Lumped Parameter Rainfall-Runoff Models for the Thames at Teddington and Thames at Days Weir

6.17 Daily lumped GR6J and Catchmod models were calibrated at both Day's Weir and Teddington Weir to observed naturalised flows. Model performance was compared over calibration and validation periods, 1920 to 1966 and 1967 to 2013 respectively, as well as during key historical drought events. The GR6J models fit better to the observed flows in the calibration period and outperformed Catchmod in all error and correlation model fit statistics (as shown in Figure 6-3 and Figure 6-4). Comparison with historical drought years shows that during low flow periods, baseflow is better represented by the GR6J models, whilst the Catchmod models show a flashier response than the observed record (as shown in Figure 6-5 and Figure 6-6). As a result of this hydrological model comparison work, the GR6J hydrological models were used to provide the inflows required for WARMS2 (zero demand scenario), which was then used to produce flows used in the water resources model.

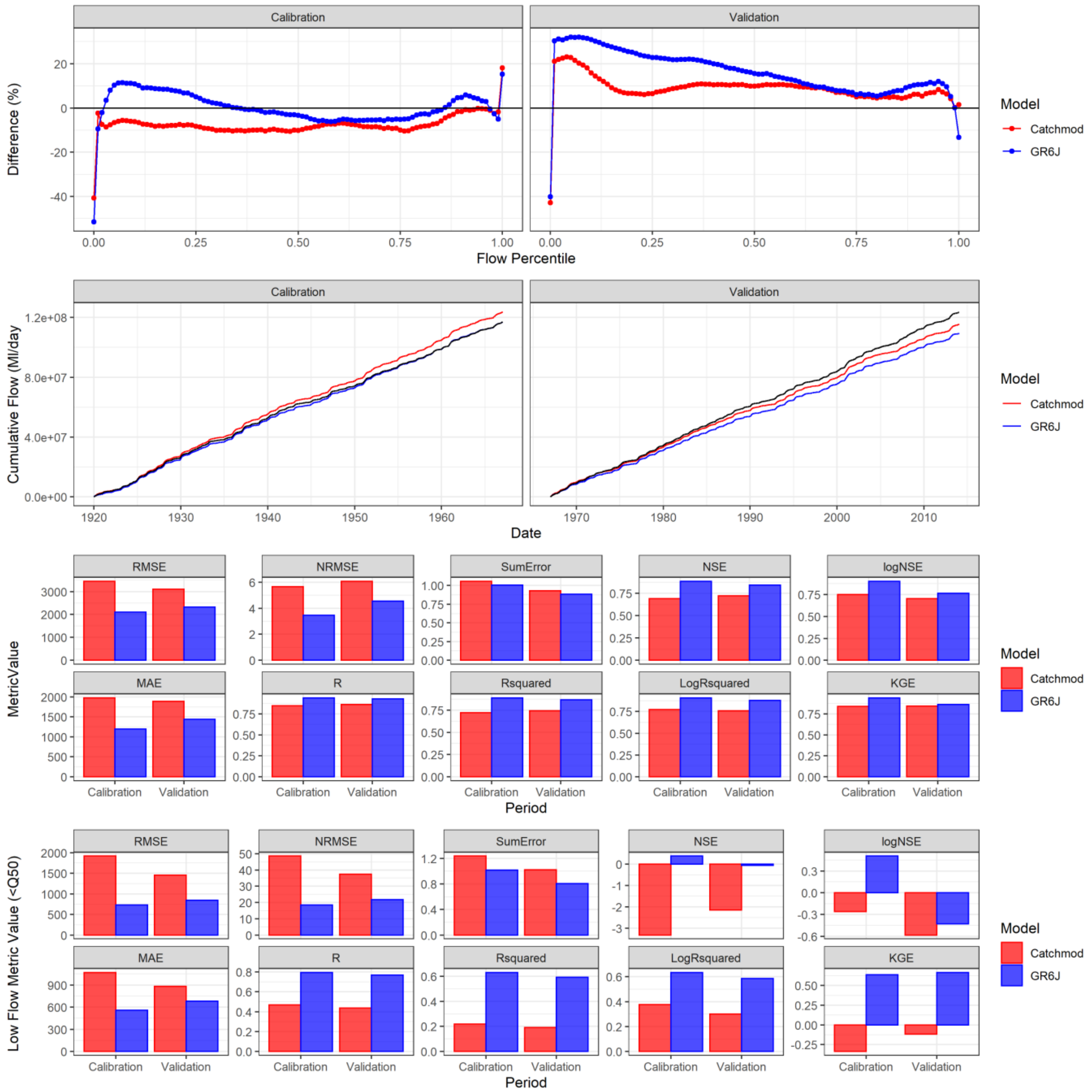


Figure 6-3: Teddington Weir comparison of hydrological model fit statistics for calibration and validation periods

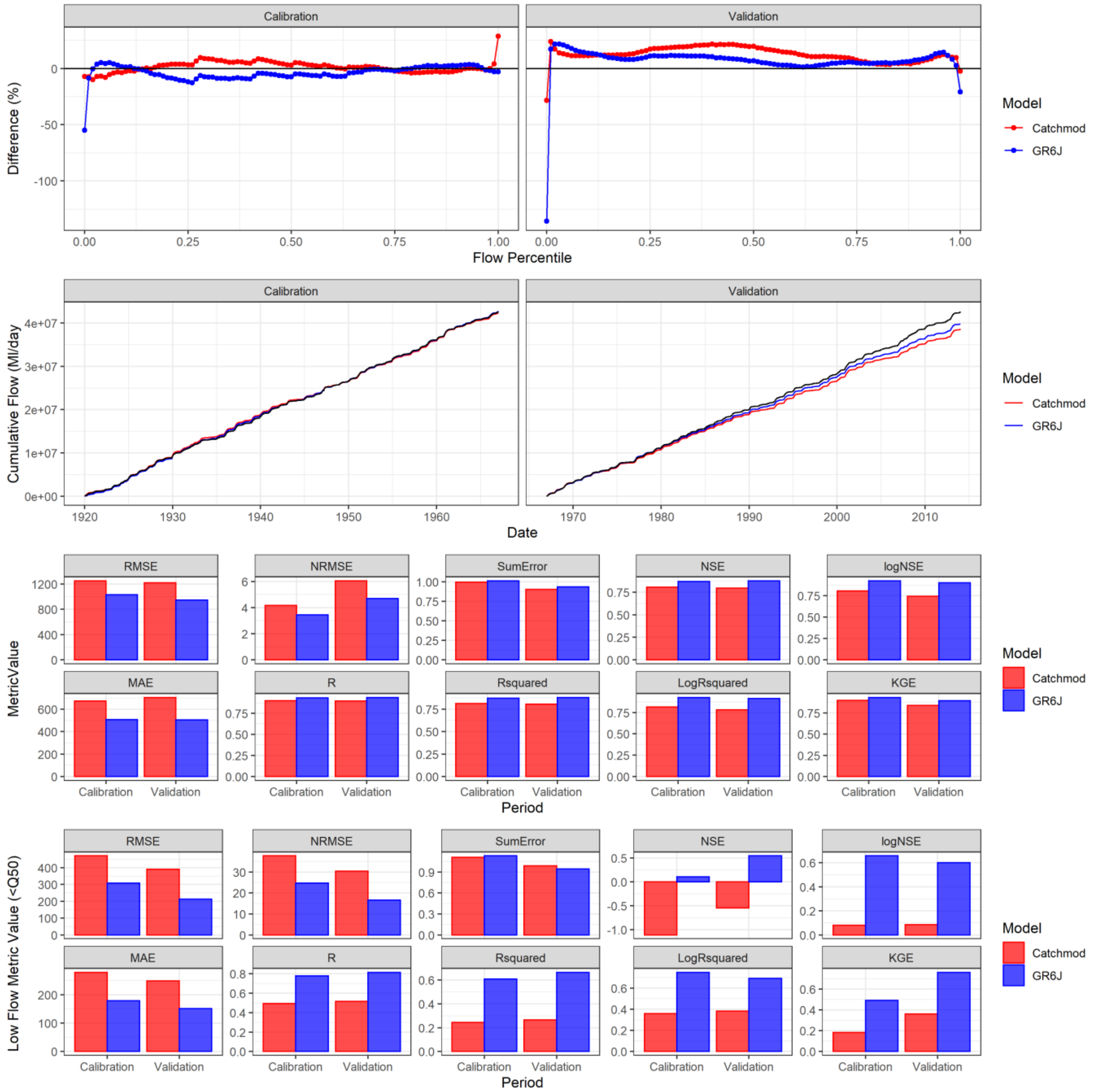


Figure 6-4 Days Weir comparison of hydrological model fit statics for calibration and validation periods

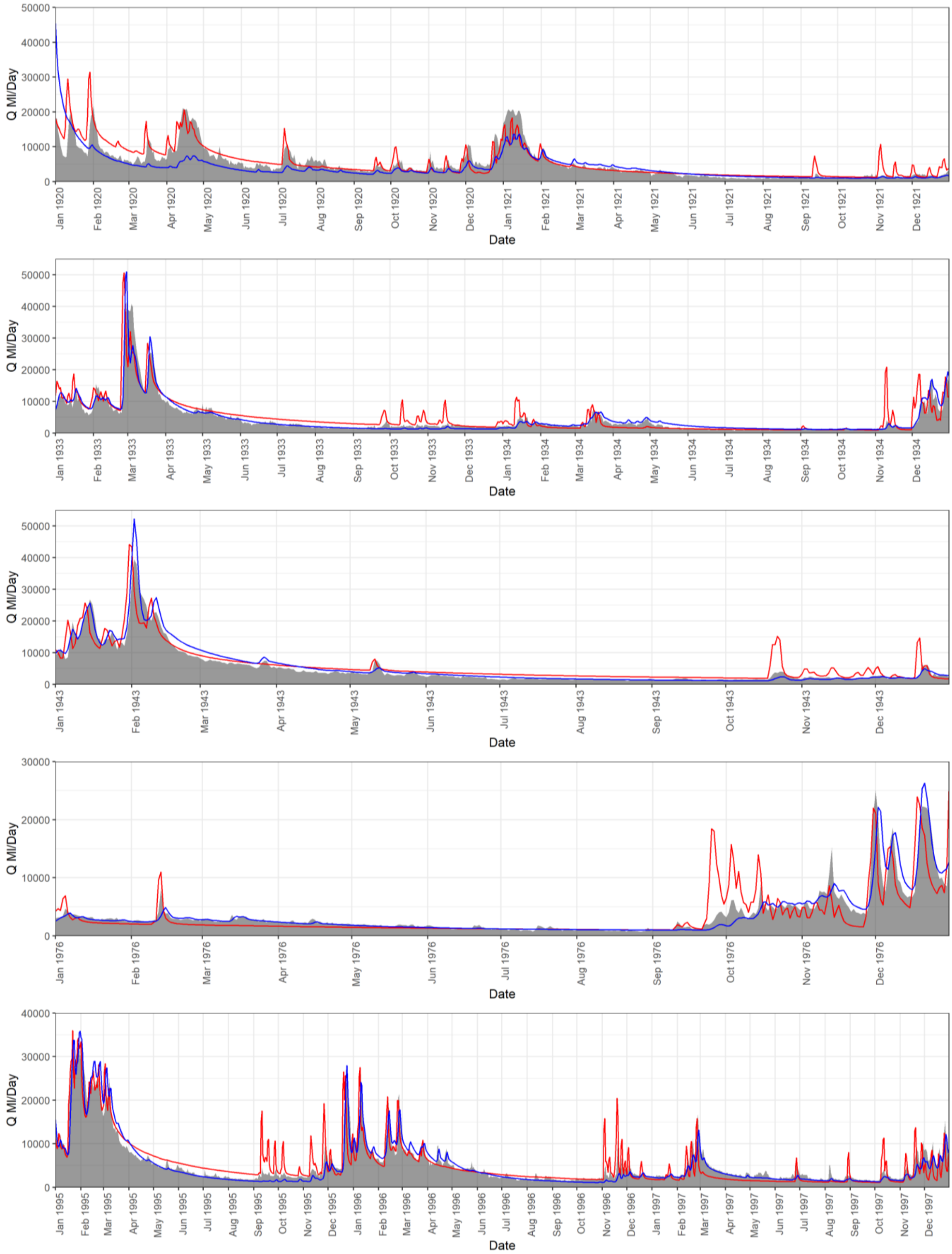


Figure 6-5: Teddington Weir historical drought year hydrographs (Observed flow in grey, GR6J in blue, Catchmod in red)

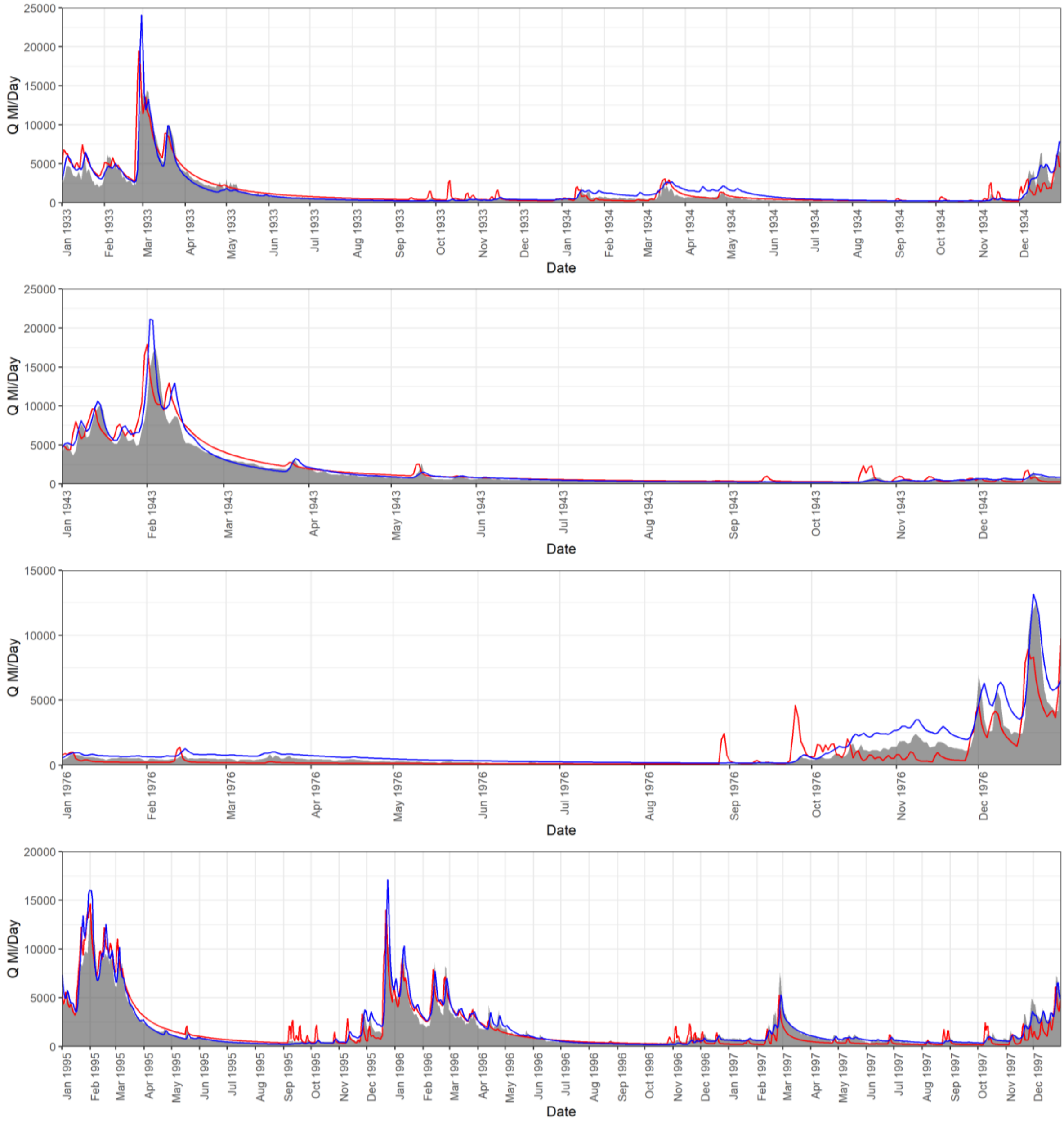


Figure 6-6: Days Weir historical drought year hydrographs (Observed flow in grey, GR6J in blue, Catchmod in red)

6.18 Calibration statistics for the calibrated models are shown in Table 15. The key values of Nash-Sutcliffe Efficiency (logNSE) being around 0.9 for both models, logNSE (a metric which is particularly important when considering low flow calibration) also being around 0.9 for both models, and Kling-Gupta Efficiency (KGE) being >0.9 for both models indicate strong model calibration performance.

Table 15: Calibration Statistics for Hydrological Models

	Thames at Teddington	Thames at Days Weir
RMSE	2074.89	992.9135
NRMSE	3.3985	3.3002
SumError	0.9385	0.9643
NSE	0.8818	0.8693
logNSE	0.8833	0.9046
KGE	0.9149	0.9201
MAE	1183.863	512.413
R	0.9428	0.9337
Rsquared	0.8888	0.8719
LogRsquared	0.9036	0.9123

Validating flows used in pywr against flows from WARMS2

6.19 Naturalised flows simulated by using GR6J models for Days Weir and Teddington Weir were processed to produce the "baseflow" and "surface flow" components required as inputs to Aquator (WARMS2). The Aquator model (WARMS2) was then run with demands set to very low levels using these inflows and compared to the flows produced from an Aquator model run using the same demand levels, but in which observed flows were used as an input (observed flow inputs have historically been the inputs used in WARMS2).

6.20 Statistics of a comparison between Aquator modelled flows for key locations relative to the WRMP19 methodology (observed flow inputs) are provided in Table 16. The statistics show a very good level of correlation between the two sets of flows, indicating that the method applied to generate the flows was robust. Comparisons of flow duration curves and hydrographs for key historical years are shown in Figure 6-7 to Figure 6-11.

Table 16 Summary "zero demand" flow statistics for key locations generated by Aquator using the GR6J simulated flows relative to the WRMP19 method

	Thames at Teddington	Lee at Feildes Weir	Kennet at Theale	Wey at Guildford	Thames at Farmoor
NSE	0.912	0.977	0.985	0.960	0.954
logNSE	0.938	0.999	1.000	0.999	0.999
r^2	0.914	0.939	0.952	0.875	0.913
Mean Absolute Error (Ml/d)	1028.963	37.941	43.946	36.327	46.664
Volume Error	0.981	0.976	0.996	0.973	0.997

RMSE (Ml/d)	1924.046	104.318	131.381	113.452	428.247
RMSE for flows below Q50 (Ml/d)	582.740	39.964	57.057	41.686	123.289

6.21 As with all forms of modelling there is uncertainty, whether from the gauged data or the modelling methodology applied. The purpose of using calibration metrics which prioritise periods of low flow is to reduce as far possible the uncertainty associated with DO calculation further down the modelling chain.

6.22 Recognising that the Deployable Output of water resources systems with reservoir storage requires water resources modelling and should involve comparisons of reservoir storage drawdown and Deployable Output as well as comparison of flows, Appendix I of WRMP24 documents a staged validation process in which the water resources model is first validated using flows taken directly from the WRMP19 model. This comparison is shown in Figure I-6 in rdWRMP24 and resulted in a London WRZ Deployable Output of 2314 Ml/d, compared to a reference value of 2302 Ml/d using the WRMP19 model. When the WRMP19 flows were replaced with flows calculated using the modelling process described here (results shown in rdWRMP24 Figure I-7) the Deployable Output changes to 2296 Ml/d. This demonstrates that the combination of water resources modelling and hydrological modelling changes resulted in a baseline Deployable Output change of less than 1% of the London WRZ Deployable Output.

6.23 In summary, the hydrological modelling methodology has been updated to address computational challenges simulating stochastic and climate change perturbed outputs with the WRMP19 method. The validity of the resultant simulated flows was assessed using a suite of metrics, with a particular focus on low flow periods. The cascaded impact on the assessment of DO of less than 1% was deemed to be immaterial.

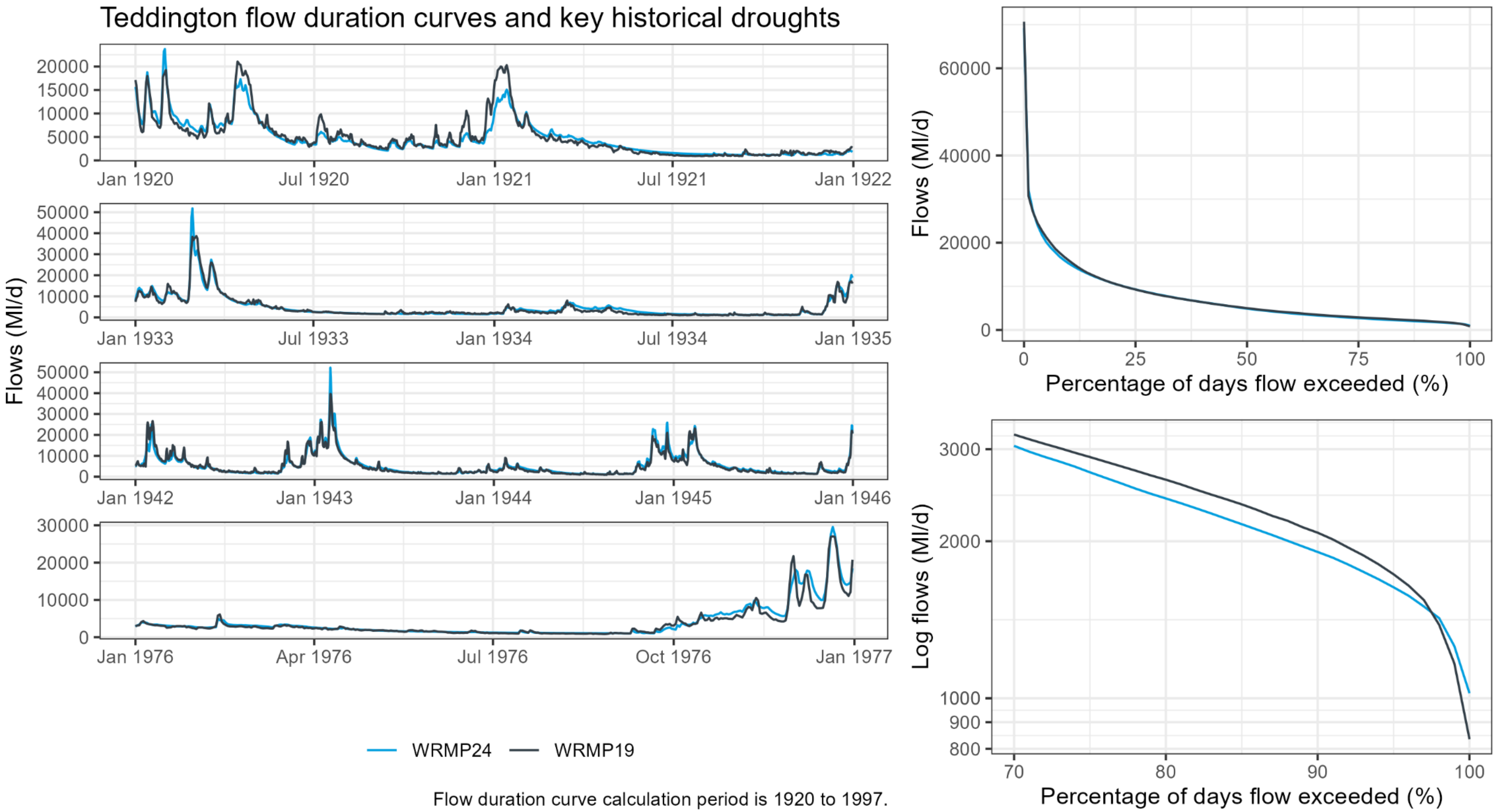


Figure 6-7: Thames at Teddington flow duration curves and key historical droughts for WRMP24 and WRMP19 zero-demand flows

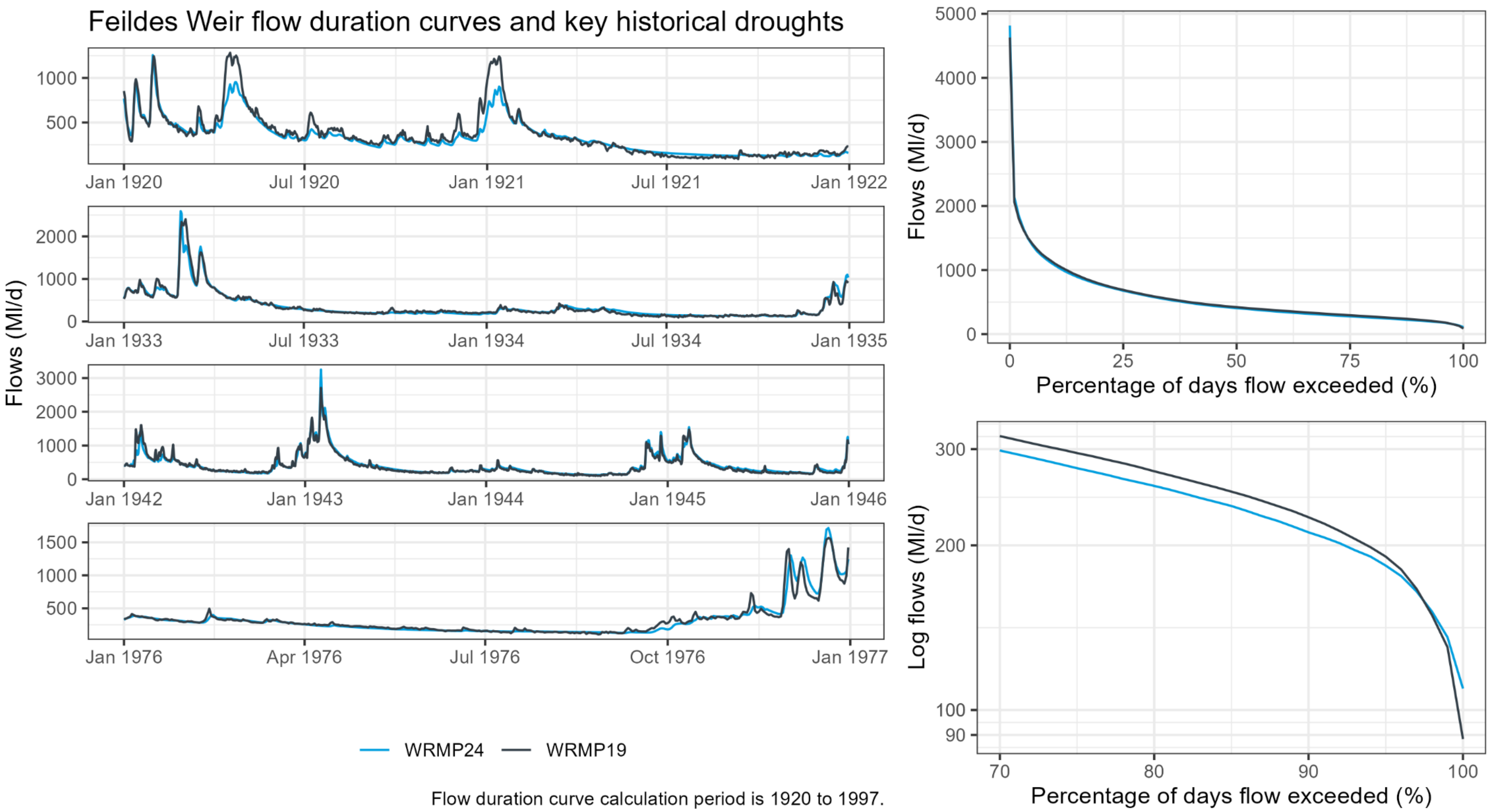


Figure 6-8: Lee at Feildes Weir flow duration curves and key historical droughts for WRMP24 and WRMP19 zero-demand flows

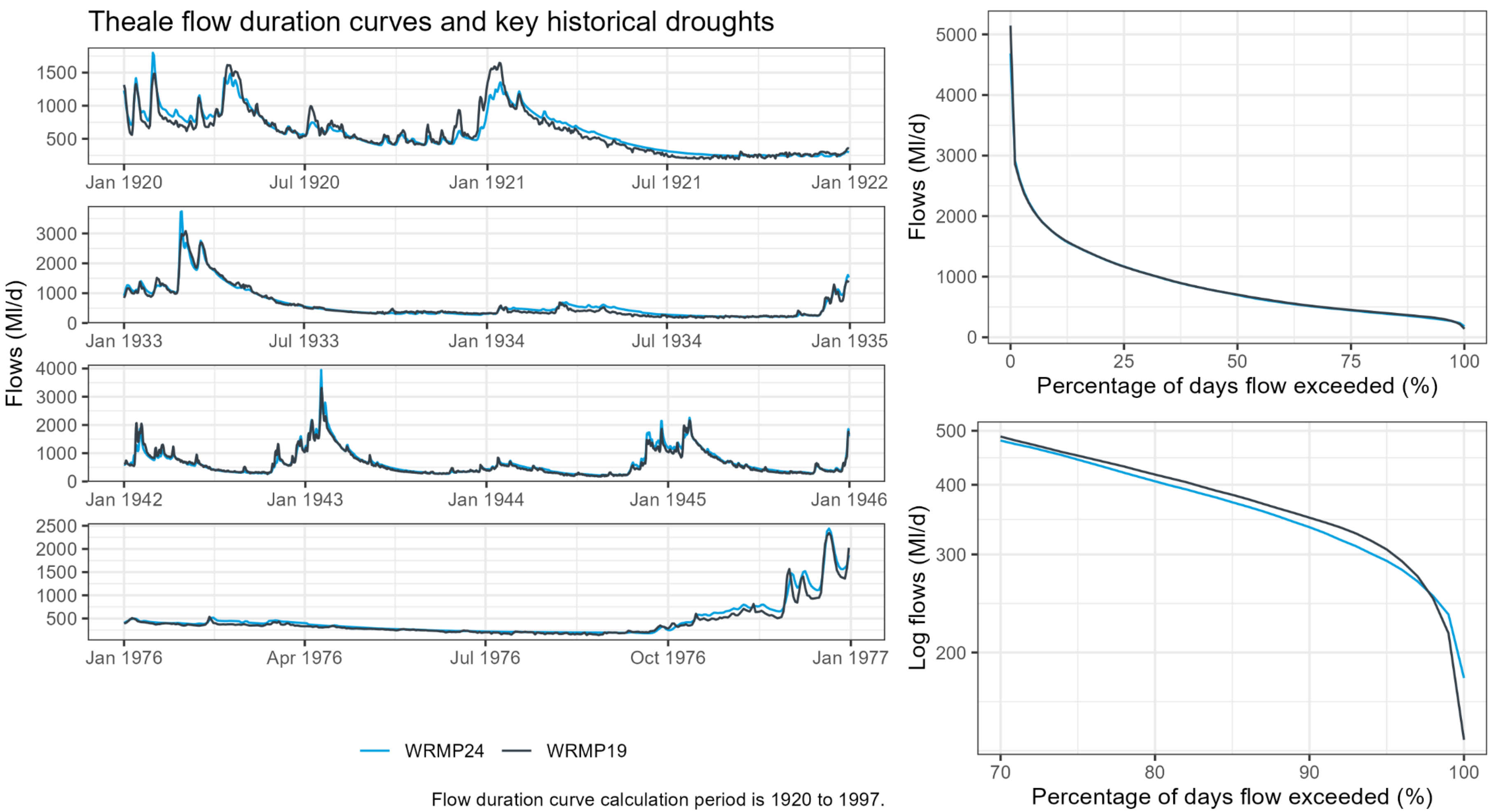


Figure 6-9: Kennet at Theale flow duration curves and key historical droughts for WRMP24 and WRMP19 zero-demand flows

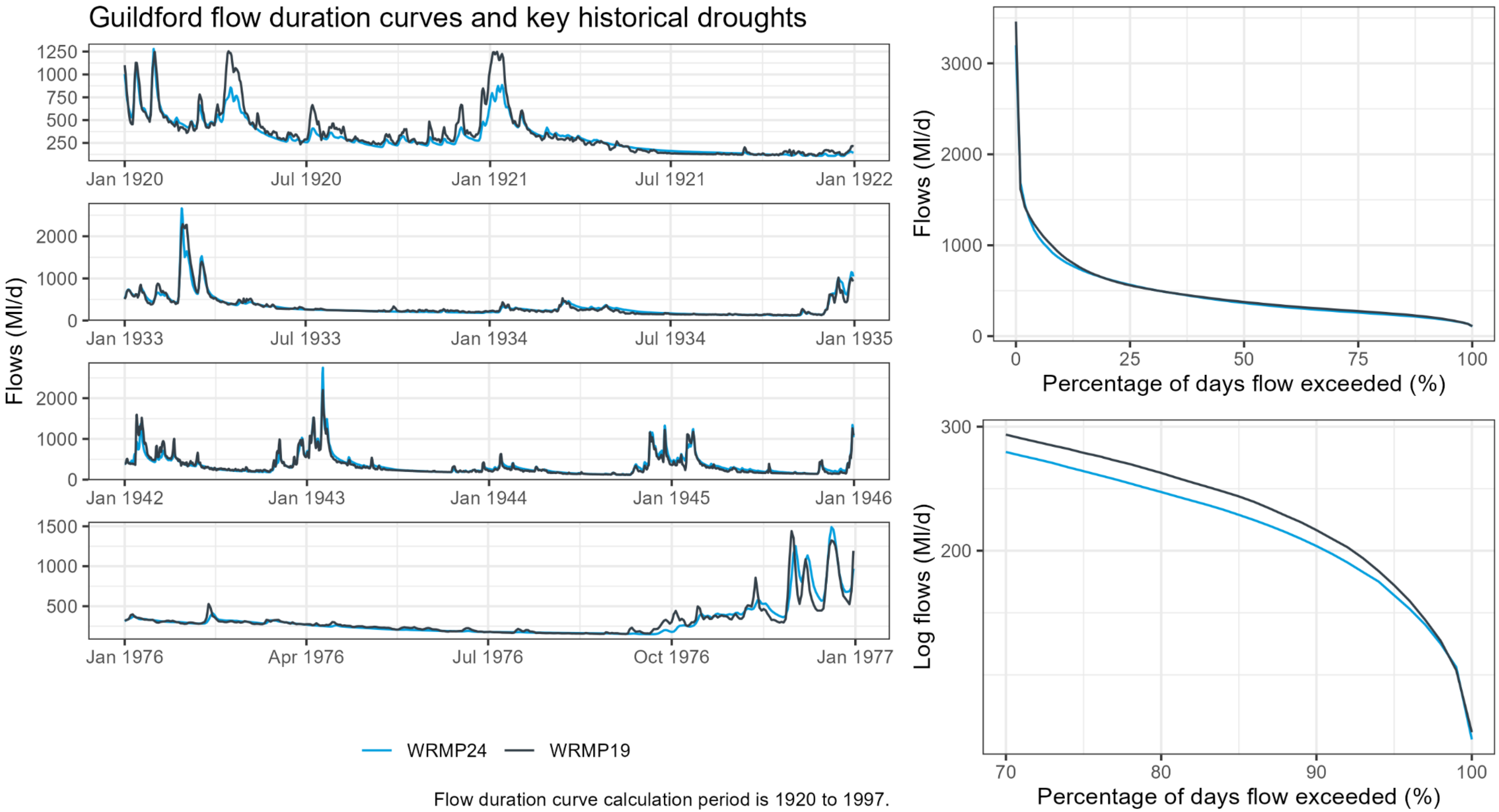


Figure 6-10: Wey at Guildford flow duration curves and key historical droughts for WRMP24 and WRMP19 zero-demand flows

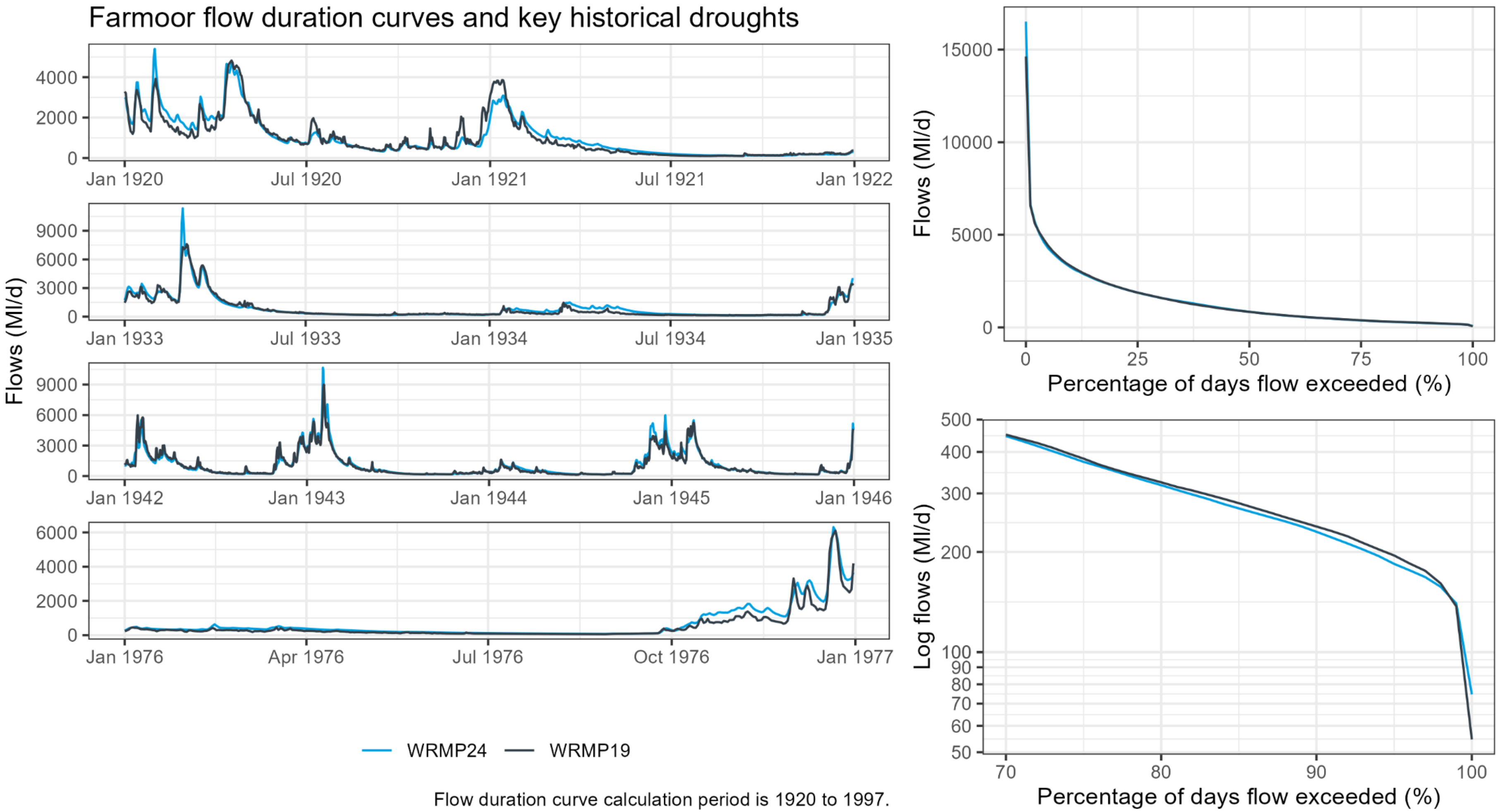


Figure 6-11: Thames at Farmoor flow duration curves and key historical droughts for WRMP24 and WRMP19 zero-demand flows

Changes made to the rdWRMP24

6.24 We will include additional information on the calibration of hydrological models in Appendix I of rdWRMP24. The following will be added after the current paragraph I.99 in rdWRMP24 Appendix I.

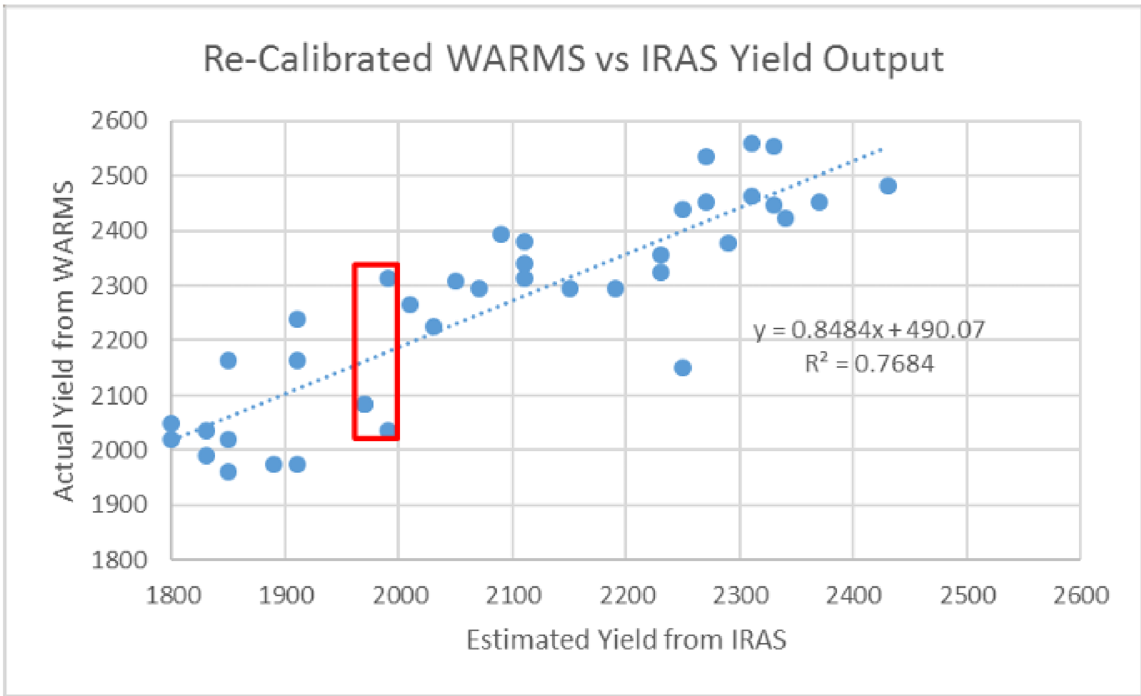
6.25 In terms of these respective water resources models, a summary of the advantages and disadvantages is included in Table X.

	WARMS2	*IRAS/Catchmod*
Advantages	*Well calibrated, with the semi-distributed modelling approach meaning that complexities of hydrological response around the catchment can be captured, and calibration of different locations within the Thames ensures good overall calibration.* *The hydrological models being within the water resources model allows for denaturalising influences to be considered dynamically.*	*Very fast, meaning that the model is suitable for Deployable Output modelling using long, stochastically generated weather datasets.*
Disadvantages	*Relatively slow to run, as the model is detailed and includes hydrological models within a water resources model. Too slow to run full stochastic weather sequences through the model.* *Flows are required as an input (at Days Weir and Teddington Weir), meaning that the model cannot be run for non-historical sequences without input flows being provided.*	*Use of single, lumped parameter rainfall-runoff model rainfall run-off models meant that the model calibration was relatively poor.*

Table X

6.26 When developing IRAS, checks were undertaken in which a comparison was made between Deployable Output for given replicate as calculated by IRAS, compared to the Deployable Output as calculated by WARMS2. This comparison was presented in Figure I-17 in WRMP19, *reproduced below. Note that the red box on this Figure is referred to in WRMP19, but is not of relevance in this discussion.*

Figure I-17: Comparison of IRAS and WARMS2 yields



Source: Figure 5-2 Atkins' 2016 Stage 2&3 Report (July 2018).

Figure X - WARMS vs IRAS Yield Output from WRMP19

6.27 *As is shown on this graph there was a significant difference between Deployable Outputs calculated using IRAS and WARMS2. This difference was attributed primarily to the hydrological modelling differences. As such, a translation equation was used to take a DO from catchmod/IRAS and convert it into a result which would be found in WARMS2. This equation is included on Figure I-19. As an example, a Deployable Output figure of 2000 Ml/d as calculated in IRAS would result in a WARMS2-equivalent Deployable Output of 2187 Ml/d.*

6.28 The following text will be inserted after the bulleted list following paragraph I.103. Current paragraphs I.104 to I.108 will be deleted.

6.29 *In WRMP24, stochastic water resources modelling is now expected to be the basis of our Deployable Output assessments, given the requirement to calculate a 1 in 500-year Deployable Output. However, we want to improve upon the hydrological modelling undertaken for WRMP19 in order that we do not need to rely on corrections such as the regression used in WRMP19. Additionally, in order to ensure a coherent plan for the South East, the WRSE Regional Group developed a regional-scale water resources model meaning that hydrological modelling for WRZs other than London would be necessary. As such, aims for our hydrological modelling in WRMP24 were:*

- *The hydrological models used should be semi-distributed, in order to provide flows across the Thames catchment and in order to ensure good calibration.*

- *Hydrological modelling should be done outside the water resources model, in order to ensure speed within the water resources model.*
- *Given the significant denaturalising influences within the Thames catchment, as many of the denaturalisation processes as possible should be represented dynamically within the water resources model.*

6.30 Based on these aims, the following approach was taken to hydrological modelling in our WRMP24:

- *WARMS2 was used as the hydrological model for WRMP24. This is because it is acknowledged as a well-calibrated model (see Annex – calibration of WARMS2) which takes a semi-distributed approach, and ensures consistency between our WRMPs.*
- *Due to the requirement for hydrological modelling to be undertaken outside the water resources model, WARMS2 was to be run for a single scenario, reflective of a naturalised catchment.*
- *Denaturalising influences were to be considered within the water resources model where possible, as is discussed in rdWRMP24 Appendix I, paragraphs I.101-I.102.*
- *Recognising that WARMS2 itself requires flow inputs (Thames at Teddington and Thames at Days Weir) in order to produce flow outputs, the calibration of models for the Thames at Teddington and Thames at Days Weir was undertaken.*

6.31 The resulting process is demonstrated in the schematic below. Ovals below represent models, while rectangles represent datasets. The existing WARMS2 model is shown in blue, while new models/datasets are shown in green. The result of this process is that we have taken the WARMS2 model, which has been shown to be well calibrated and which has been used as our hydrological model for several iterations of water resources planning, and have calibrated models to provide the inputs that WARMS2 needs in order to run for scenarios other than the historical time series. We have then used flows produced by WARMS2 as the inputs to the pywr model. This process ensures that we are able to utilise the robust and well-calibrated WARMS2 model for hydrological modelling, but are able to ensure the speed required for water resources modelling using stochastic datasets.

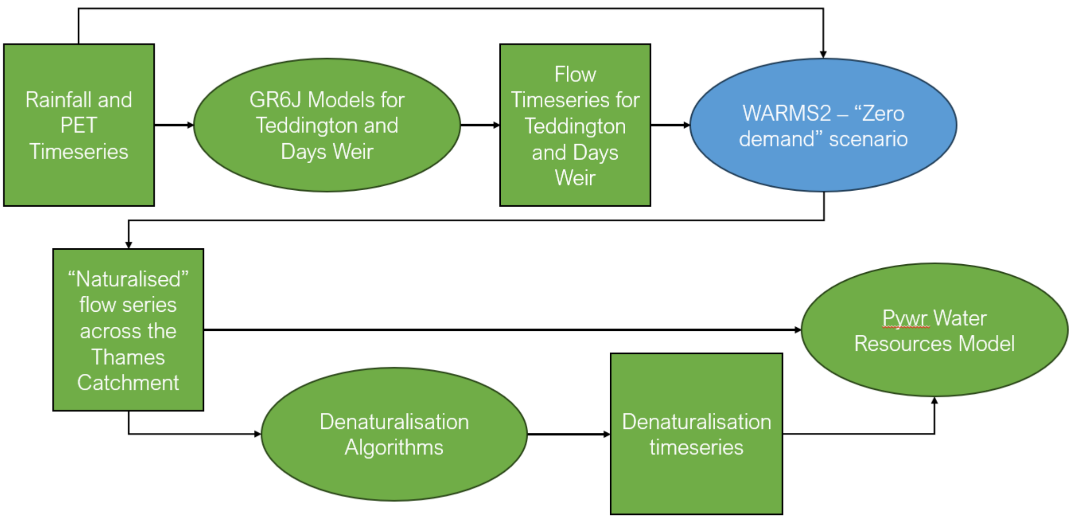


Figure X - Hydrological Modelling Process for WRMP24

6.32 The following text will be included after paragraph I.111:

6.33 In this section, we have first detailed the calibration of the models produced for Teddington and Days Weir, and then the validation of the flows produced by WARMS2 using these new flow inputs as compared to flows produced when WARMS2 is run using historical measures flows.

Calibration of Lumped Parameter Rainfall-Runoff Models for the Thames at Teddington and Thames at Days Weir

6.34 Daily lumped GR6J and Catchmod models were calibrated at both Day's Weir and Teddington Weir to observed naturalised flows. Model performance was compared over calibration and validation periods, 1920 to 1966 and 1967 to 2013 respectively, as well as during key historical drought events. The GR6J models fit better to the observed flows in the calibration period and outperformed Catchmod in all error and correlation model fit statistics (as shown in Figure X and Figure Y). Comparison with historical drought years shows that during low flow periods, baseflow is better represented by the GR6J models, whilst the Catchmod models show a flashier response than the observed record (as shown in Figure X and Figure Y). As a result of this hydrological model comparison work, the GR6J hydrological models were used to provide the inflows required for WARMS2 (zero demand scenario), which was then subsequently used to produce flows used in the water resources model.

[the same Figures as referenced above will be included]

6.35 Calibration statistics for the calibrated models are shown in Table X. The key values of Nash-Sutcliffe Efficiency (logNSE) being around 0.9 for both models, logNSE (a metric which is particularly important when considering low flow calibration) also being around 0.9 for both models, and Kling-Gupta Efficiency (KGE) being >0.9 for both models indicate strong model calibration performance.

	Thames at Teddington	Thames at Days Weir
RMSE	2074.89	992.9135
NRMSE	3.3985	3.3002
SumError	0.9385	0.9643
NSE	0.8818	0.8693
logNSE	0.8833	0.9046
KGE	0.9149	0.9201
MAE	1183.863	512.413
R	0.9428	0.9337
Rsquared	0.8888	0.8719
LogRsquared	0.9036	0.9123

Table X – Calibration Statistics for Hydrological Models

Validating flows used in pywr against flows from WARMS2

6.36 Naturalised flows simulated by using GR6J models for Days Weir and Teddington Weir were processed to produce the "baseflow" and "surface flow" components required as inputs to Aquator (WARMS2). The Aquator model (WARMS2) was then run with demands set to very low levels using these inflows and compared to the flows produced from an Aquator model run using *the same demand levels, but in which observed flows were used as an input (observed flow inputs have historically been the inputs used in WARMS2).*

6.37 *Statistics of a comparison between Aquator modelled flows for key locations relative to the WRMP19 methodology (observed flow inputs) are provided in Table X. The statistics show a very good level of correlation between the two sets of flows indicating that the method applied to generate the flows was robust. Comparisons of flow duration curves and hydrographs for key historical years are shown in Figures I-X to I-Y.*

	Thames at Teddington	*Lee at Feildes Weir*	*Kennet at Theale*	*Wey at Guildford*	*Thames at Farmoor*
NSE	*0.912*	*0.977*	*0.985*	*0.960*	*0.954*
logNSE	*0.938*	*0.999*	*1.000*	*0.999*	*0.999*
r^2	*0.914*	*0.939*	*0.952*	*0.875*	*0.913*
Mean Absolute Error (Ml/d)	*1028.963*	*37.941*	*43.946*	*36.327*	*46.664*
Volume Error	*0.981*	*0.976*	*0.996*	*0.973*	*0.997*
RMSE (Ml/d)	*1924.046*	*104.318*	*131.381*	*113.452*	*428.247*
RMSE for flows below Q50 (Ml/d)	*582.740*	*39.964*	*57.057*	*41.686*	*123.289*

Table X - Summary "zero demand" flow statistics for key locations generated by Aquator using the GR6J simulated flows relative to the WRMP19 method

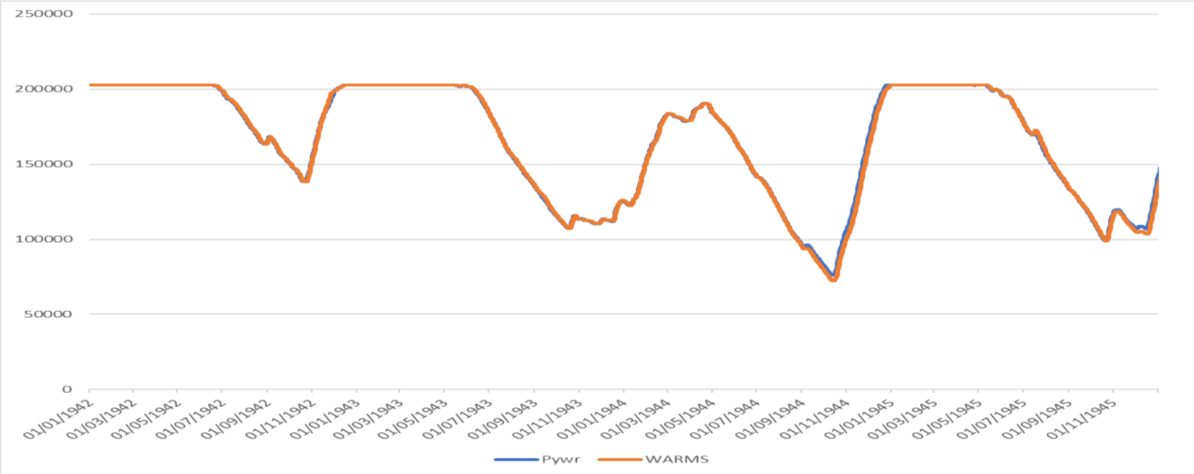
[The Figures referenced above will be included]

6.38 As with all forms of modelling there is uncertainty, whether from the gauged data or the modelling methodology applied. The purpose of using calibration metrics which prioritise periods of low flow is to reduce as far possible the uncertainty associated with DO calculation further down the modelling chain.

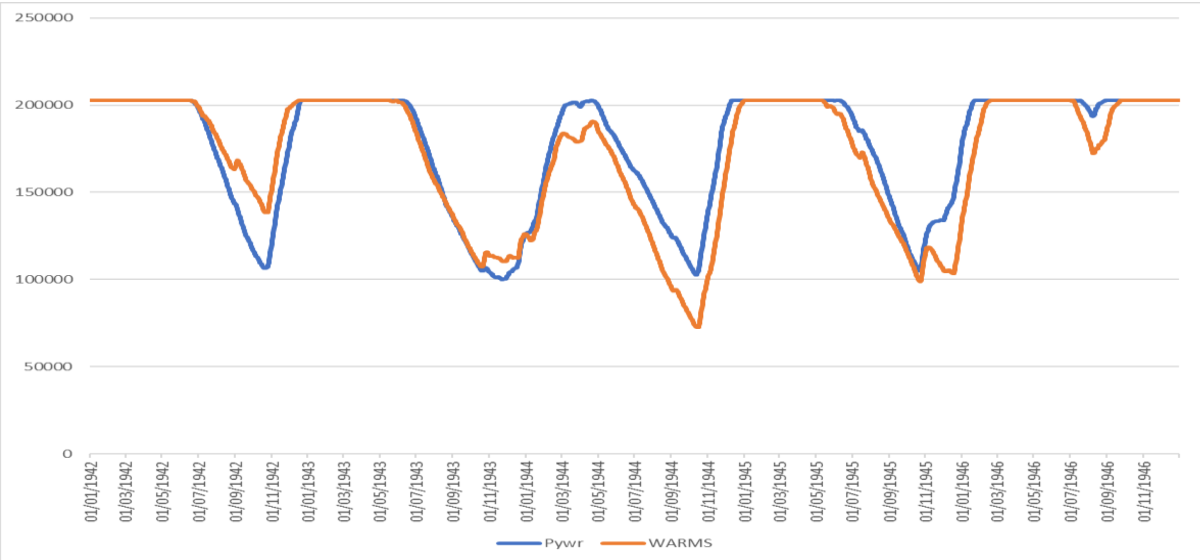
6.39 Recognising that the Deployable Output of water resources systems with reservoir storage requires water resources modelling and should involve comparisons of reservoir storage drawdown and Deployable Output as well as comparison of flows, the "Model Validation" section of this Appendix documents a staged validation process in which the water resources model is first validated using flows taken directly from the WRMP19 model, and is then validated using these newly produced flows. As is described later in this Appendix, the cascaded impact on the assessment of DO was found to be less than 1%, and was as such deemed to be immaterial.

6.40 [We will include the following storage comparison charts within the existing Figure I-6 and I-7, in order to comply with the request that the 1943-44 drought is included within validation charts]

Included within Figure I-6



Included within Figure I-7



Issue 6.2

Request

6.41 Thames Water should provide further information on the stochastic data set and its reflection of long duration droughts

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue 6

6.42 Thames Water has not provided sufficient assurance that the stochastic dataset used adequately reflects long duration droughts. Thames Water should critically assess how well the stochastic dataset represents the range of durations of critical historic droughts. Thames Water should consider investigating the model's performance during long duration droughts, including those which may occur outside of the variants generated within stochastic replicates, and investigate the impact of such droughts on the deployable output of key supply schemes.

Our consideration of the points raised

6.43 We have considered the issue raised from three perspectives:

1. Statistical analysis of the WRMP24 stochastic dataset, the WRMP19 stochastic dataset, and historical datasets
2. The sensitivity of different options' Deployable Output benefit to different datasets
3. The sensitivity of our decision-making to different options' Deployable Output benefit

6.44 The aim in doing this is to identify the overall sensitivity of our decision-making process to the uncertainties inherent in ascertaining our supply capability during extreme drought conditions. The aim of each of the three steps is to:

1. Investigate how well fitted the stochastic datasets are to the historical, and inspect differences between the WRMP19 and WRMP24 stochastic datasets.
2. Identify whether, if there are differences in the different datasets used in Deployable Output modelling, this translates into a significant difference in the Deployable Output benefit that different schemes bring.
3. Identify the degree to which changes in Deployable Output benefit would change decisions made in our WRMP24.

Validity of Stochastic Rainfall Datasets

6.45 We have analysed the stochastic rainfall dataset which has been used in our WRMP24 Deployable Output modelling. In this analysis we compare the WRMP24 stochastic dataset with historical rainfall datasets and the WRMP19 stochastic dataset. The analysis focusses on a comparison of extreme event rainfall accumulations over different accumulation periods.

6.46 In this comparison, we have used a Thames catchment areal average for each dataset (calculated by averaging rainfall for the Chilterns East, Cotswolds West, Berkshire Downs and Wey Greensand hydrometric areas). The datasets used are:

- HadUK historical rainfall dataset (considering both 1920-2020 and 1891-2020 assessment periods) – this dataset is included as the HadUK rainfall dataset was used in the training of the WRMP24 stochastic dataset

- A rainfall dataset labelled as "EQUIS" which is an internal corporate database. This rainfall dataset is provided by the Environment Agency. It is this rainfall dataset which has historically been used for our "worst historical" Deployable Output assessments, and was the dataset used in training the WRMP19 stochastics
- The WRMP19 stochastic dataset
- The WRMP24 stochastic dataset

6.47 For each dataset analysed, we first calculate the monthly rainfall. For a given accumulation period of N months, we have then identified the minimum rainfall accumulation over the N months ending August, September, October, November or December (recognising the drought events which impact our supply system). We have then ranked these annual accumulation values and derived a return period for each rainfall accumulation volume according to the length of the dataset. For example, in the 1920-2020 HadUK dataset, for a 1-year accumulation period we have calculated 101 rainfall accumulation values, and the lowest rainfall accumulation is said to have a return period of 101 years. We have then plotted rainfall accumulation as a proportion of the long-term average against the return period. We have undertaken this analysis for values of N of 12 months, 18 months, 24 months, 36 months, and 48 months. Figure 6-12 to Figure 6-16 are the result of this analysis.

6.48 The key points of interpretation from this analysis are:

- Both the WRMP19 and WRMP24 stochastic datasets perform well when compared to the different historical datasets, when considering all accumulation periods.
- The different historical datasets give slightly different results, highlighting that uncertainty exists even in measuring rainfall volumes (e.g., 12-month accumulation for 1934 is 63.9% in the HadUK dataset and 61.4% in the EQUIS dataset).
- The most significant differences between the WRMP24 stochastic dataset and other datasets exist in events with 1 to 10-year return periods, which are not material events when calculating supply capability.
- When looking at all rainfall accumulation durations, for drought events with return periods of c.20 years and more, the WRMP19 and WRMP24 datasets give very similar results.
- When looking at long-duration rainfall accumulation, both the WRMP19 and WRMP24 stochastic datasets appear to possibly over-represent long-duration droughts. As an example, the most severe 3-year accumulation on the historical record is c.80% of the LTA, whereas a 1 in 100-year 3-year event in both the stochastic datasets would indicate an accumulation of 72-73% of LTA. As the accumulation period considered increases, the WRMP24 stochastic dataset appears to over-represent long droughts more than the WRMP19 stochastic dataset.

6.49 While the relative performance of the WRMP19 and WRMP24 stochastic datasets is not materially different (i.e., the question may be raised as to why new datasets were produced given that the results are similar), it is important to bear in mind the significant improvements that were made in the production of the WRMP24 datasets, in particular:

- A nationally coherent method was applied, using the same base dataset. In WRMP19, different companies used different rainfall datasets as the training set, meaning that national coherence was compromised. In WRMP24, the HadUK dataset was used.

- Reduced bias correction. In WRMP19, the stochastic datasets were criticised for the bias correction required. Less bias correction is needed in the WRMP24 datasets, and a more sophisticated approach was taken.

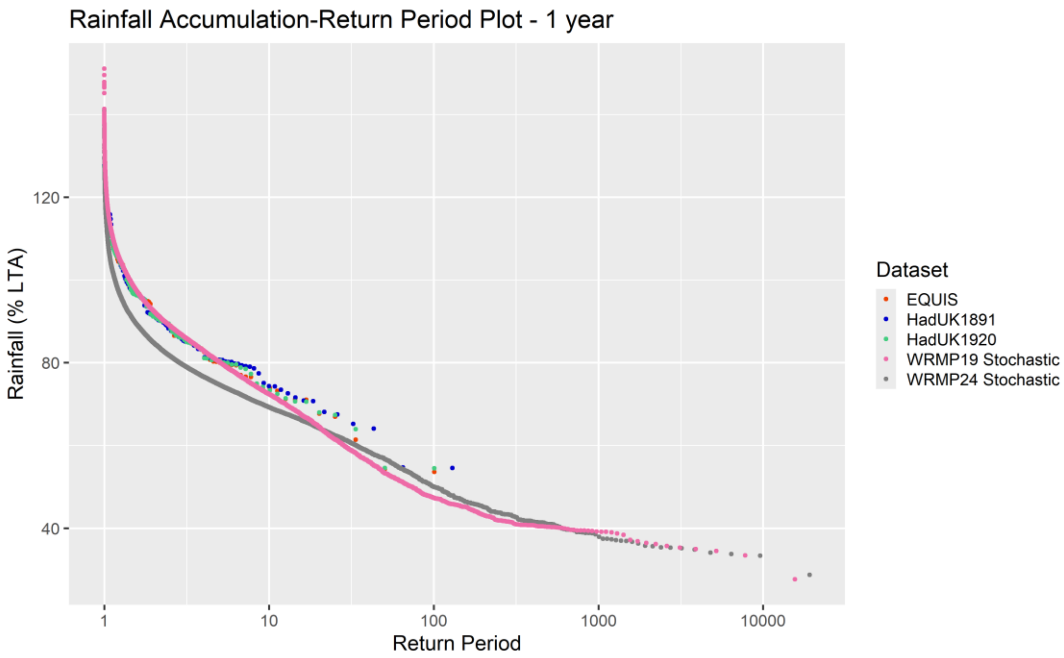


Figure 6-12: Rainfall Accumulation-Return Period Plot – 1 year

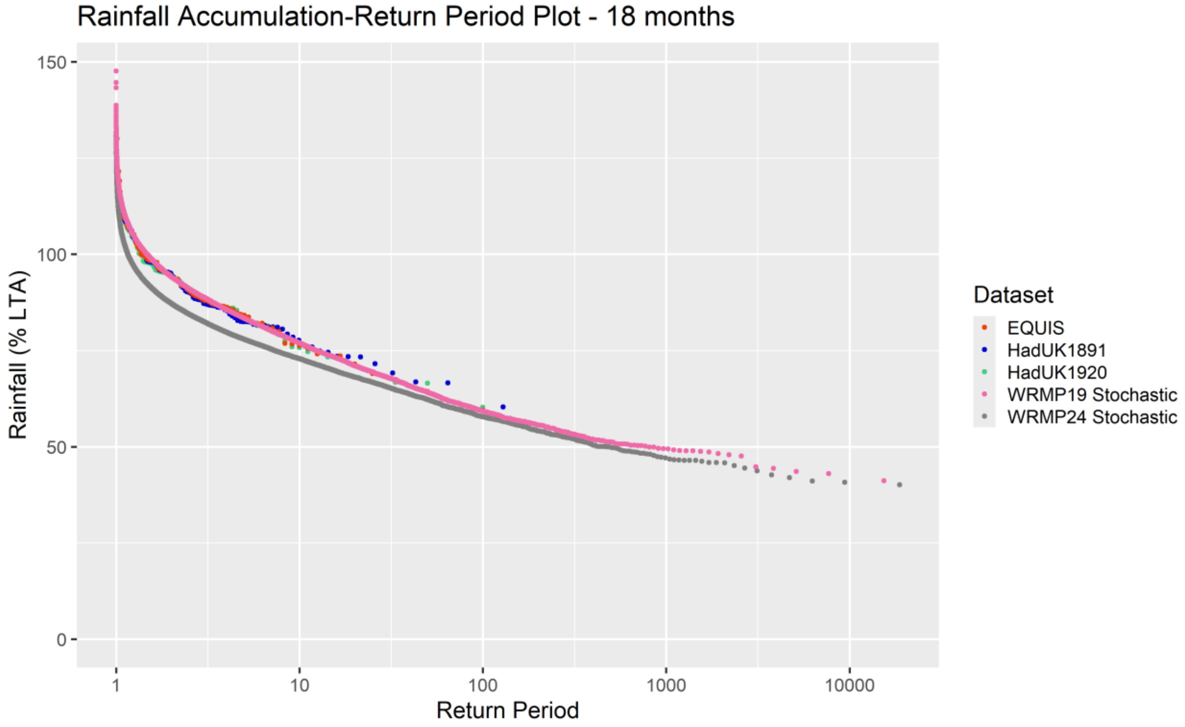


Figure 6-13: Rainfall Accumulation-Return Period Plot – 18 months

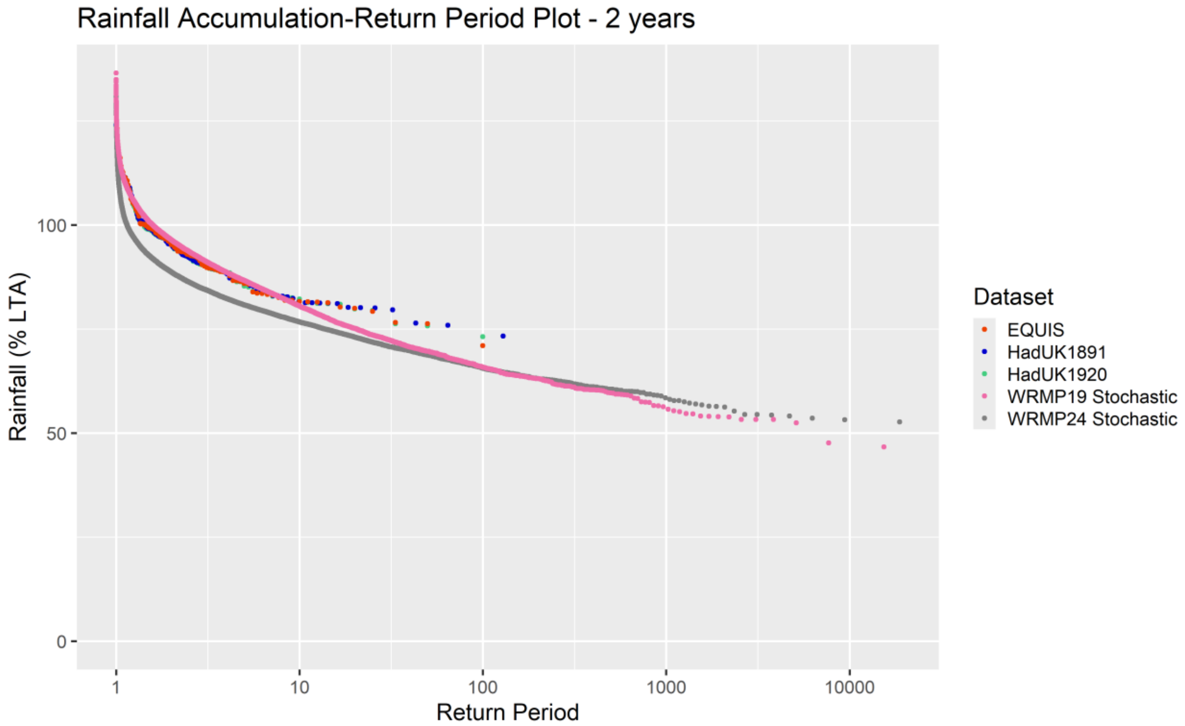


Figure 6-14: Rainfall Accumulation-Return Period Plot – 2 years

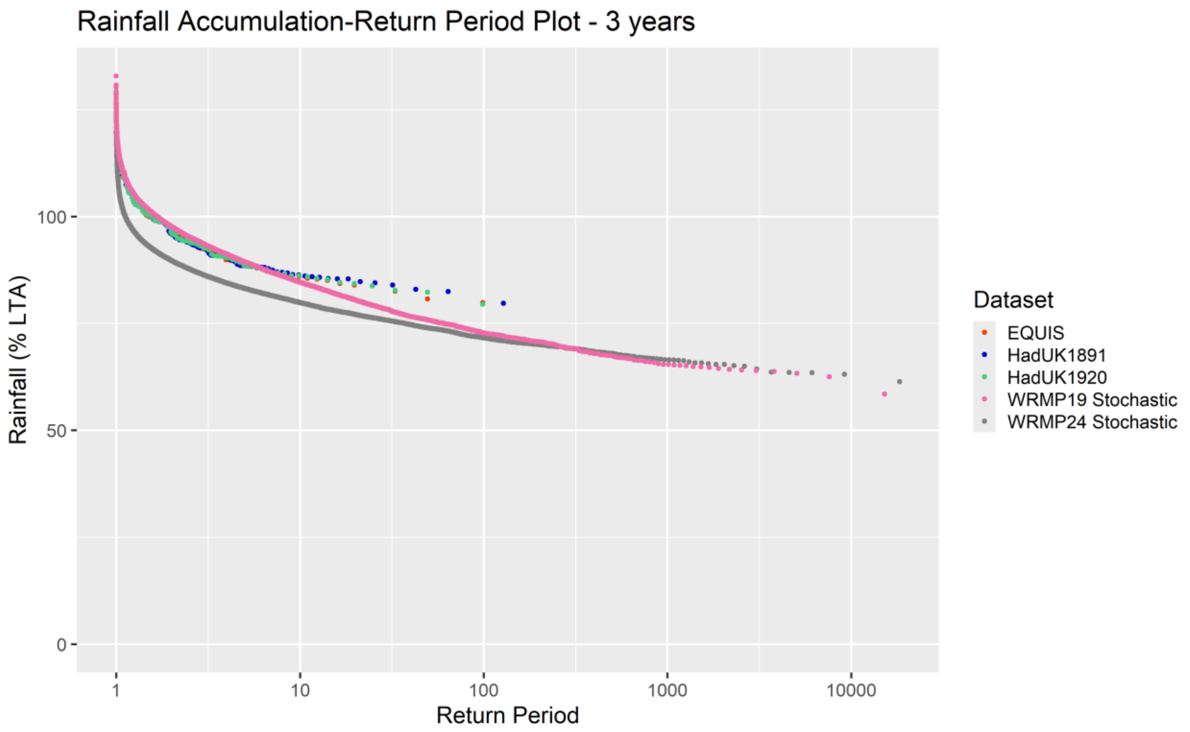


Figure 6-15: Rainfall Accumulation-Return Period Plot – 3 years

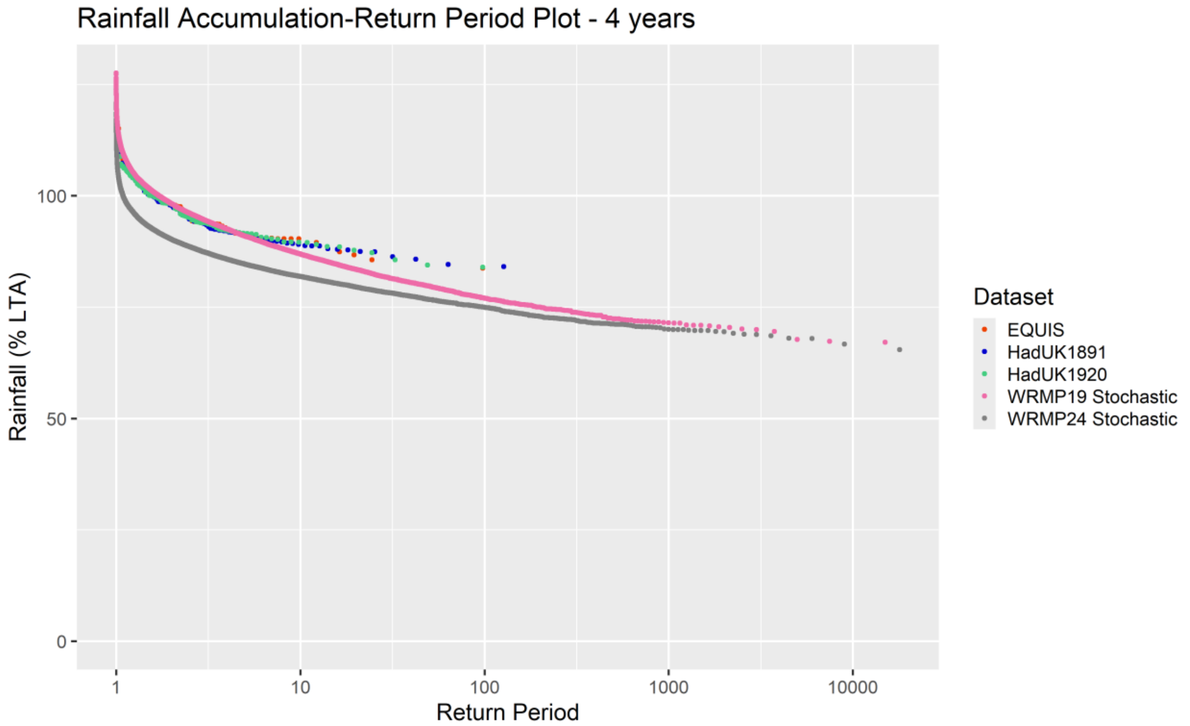


Figure 6-16 - Rainfall Accumulation-Return Period Plot – 4 years

Conclusion

6.50 This analysis demonstrates that the stochastic datasets used do not under-estimate the likelihood of long-duration droughts. If anything, the datasets appear to include more severe long-duration droughts than would be likely when considering the historical weather datasets. As such, we do not consider that modelling of additional long-duration droughts is required.

Deployable Output Benefit of Options when Considering Different Datasets

6.51 In this section, we focus on the Deployable Output benefit of the Severn Thames Transfer (STT) and SESRO options, as these are large options which have yields which are significantly impacted by hydrology. The other large options (e.g., Teddington DRA, Beckton Water Recycling, Mogden Water Recycling) are supported by sewage treatment works effluent, and so their deployable output is not significantly impacted by hydrological conditions. We reflect on the Deployable Output modelling which has been undertaken for these options in recent WRMP iterations.

6.52 Our aim in this section is to demonstrate that, despite using different models and different datasets, the Deployable Output benefit of the SESRO and STT schemes have remained fairly constant from assessment to assessment. While by no means conclusive, a consistent finding for Deployable Output lends confidence and indicates that differences between different underlying datasets do not necessarily translate into changes in the Deployable Output benefit of options. This links to the discussion in response to Issue 6.3, in which we discuss the Deployable Output of an option and the Deployable Output benefit to a Water Resource Zone.

SESRO

6.53 In Table 17, we have collated the Deployable Output benefit calculated during the WRMP19 and WRMP24 assessments for the 150 Mm^3 SESRO option. As can be seen, the Deployable Output calculated in these different assessments was very similar.

6.54 It is notable also that climate change impacts on the Deployable Output benefit of the reservoir (c.5% DO reduction) are relatively small. This consistency in the results obtained lends confidence and may suggest that the Deployable Output benefit that the SESRO option brings may be more linked to the underlying vulnerabilities of the London WRZ (to c.18-month drought events) rather than the specific events contained within an underlying series.

Table 17: Deployable Output values for SESRO Using Different Datasets

Assessment	Deployable Output Benefit to London WRZ of 150 Mm^3 SESRO scheme (Ml/d), without Climate Change
WRMP19 – “Worst Historical”	283
WRMP19 – Stochastic	282
WRMP24	285
WRMP24 Models, using WRMP19 Stochastics	300

STT

6.55 Tracing the changes between our WRMP19 and WRMP24 assessments for the STT is slightly more complicated than for SESRO, as between WRMP19 and WRMP24 two major underlying assumptions in the modelling of the STT DO benefit have changed. These are:

- HOF Conditions which would restrict abstraction from the River Severn. In WRMP19 assessments, the Environment Agency suggested that a HOF of 1800 Ml/d would apply to unsupported abstraction. Between WRMP19 and WRMP24, the Environment Agency advised that this value would change to 2568 Ml/d.
- Whether abstraction during spate would be allowed. In WRMP19 it was assumed that abstraction would need to be ceased if high river flows occurred in the River Severn, due to concerns over water quality. The STT SRO team have designed a treatment works which would allow for transfer to be made during all water quality conditions. As such, no abstraction stops during high-flow periods are included in our DO modelling in WRMP19.

6.56 In Table 18, we have collated key model outputs from Severn Thames Transfer Deployable Output runs for a 300 Ml/d unsupported transfer.

Table 18: Deployable Output values for STT Using Different Datasets and Assumptions

Assessment	HOF Conditions	Abstraction during spate allowed?	Deployable Output Benefit to London WRZ of unsupported 300 Ml/d pipeline, without Climate Change (Ml/d)
WRMP19 – “Worst Historical”	Old	No	142
WRMP19 – “Worst Historical” with new HOF	New	No	94
WRMP19 – Stochastic	Old	No	120
WRMP24 (1 in 500-year DO benefit)	New	Yes	101
WRMP24 (1 in 100-year DO benefit)	New	Yes	92
WRMP24 with Old HOF	Old	Yes	151
WRMP24 with no spate abstraction	New	No	76
WRMP24 with Old HOF and no Spate	Old	No	124
WRMP24 Models, using WRMP19 Stochastics	New	Yes	79
WRMP24 Models, using WRMP19 Stochastics (old HoF)	Old	Yes	130

6.57 These results demonstrate that the Deployable Output impacts for the two major changes are:

- HOF change – DO reduction of c.33-40%
- Abstraction during spate allowed – DO increase of 22-33%

6.58 Taking the mid-points of these values, we may anticipate that these changes would have resulted in a decrease in the Deployable Output between WRMP19 and WRMP24 of around 19%, but could be between and 11% and 27%. Applying a 19% reduction to the calculated WRMP19 stochastic Deployable Output results in a value of 97 Ml/d. Applying the same reduction to the WRMP19 “worst historical” DO results in a figure of 115 Ml/d. As such, the calculated WRMP24 stochastic DO of 101 Ml/d is well within the range of what might have been expected.

6.59 Again, the consistency of outcomes regarding Deployable Output assessments using different models and datasets gives us confidence in the result which is obtained.

6.60 With regards to the STT, an additional note to add is that “unsupported” STT scheme Deployable Output is the aspect of the scheme which is most sensitive to hydrological conditions. A “supported” STT scheme Deployable Output would be less sensitive to hydrological conditions. a 300 Ml/d STT scheme with 300 Ml/d of available support would deliver a DO benefit of approximately 300 Ml/d, as under these conditions the STT would be able to transfer 300 Ml/d throughout the duration of a drought. The deployable output benefit of a STT scheme with a given pipeline capacity and support flow available could be approximately calculated as:

6.61 Supported scheme DO = Unsupported DO + (Pipeline capacity – Unsupported DO) * (Support / Pipeline capacity)

6.62 As examples, if we take a 300 Ml/d pipeline and 100 Ml/d available support, if the unsupported DO of the scheme is 100 Ml/d then the scheme DO would be expected to be around 167 Ml/d. If the unsupported DO were instead 150 Ml/d the scheme DO would be around 200 Ml/d (i.e., there may be a 50% increase in the unsupported scheme DO, but only a 20% increase in a supported scheme DO).

<u>Conclusion</u>

6.63 As demonstrated above, the Deployable Outputs calculated for the SESRO and STT options have been found to be very similar, even when using different datasets. The continuity in the DO benefit values calculated gives us confidence and indicates (as discussed further in response to Issue 6.3) that the underlying vulnerabilities of a given WRZ need to be considered when thinking about the Deployable Output benefit that a scheme brings.

Decision-making Sensitivity to Deployable Output Benefit of Different Options

6.64 The final step in our consideration of the impact that uncertainty around different schemes’ Deployable Output has on our plan is considering the sensitivity of our programme appraisal decision to the Deployable Output benefit of different schemes.

6.65 As noted previously, the key decision in our plan which could be impacted by hydrological uncertainty is between SESRO and STT, with both schemes’ Deployable Output being linked to hydrological conditions. As also noted, the Deployable Output impact of the STT scheme is complex and involves both pipeline capacity and support, with the Deployable Output of an unsupported scheme influencing the benefit that support can bring. As such, we have investigated the programme appraisal impacts of reducing the SESRO scheme’s DO benefit, in order to ascertain whether, should SESRO's DO be reduced, it would impact our programme appraisal decision.

6.66 WRSE sensitivity runs have been carried out and have confirmed that the least cost plan would include a SESRO option in 2040, even if the DO of the SESRO scheme were to be reduced by 30%. The size of the SESRO scheme included varies according to the DO reduction applied.

Conclusion

Overall Conclusion

6.67 As described in this section, we have demonstrated that:

- The stochastic datasets used in WRMP24 are well calibrated and include long-duration drought events. Long-duration drought events are possibly over-represented within the dataset.
- The Deployable Output benefit of the STT and SESRO options has remained relatively constant when using different models and datasets. This gives confidence and may imply that the underlying vulnerability of a WRZ plays a significant role in determining the Deployable Output benefit of different options.
- Even if the Deployable Output benefit of the SESRO option were to be reduced by a moderate amount, it would still be selected in the preferred programme.

Changes made to the rdWRMP24

6.68 We have included the following text in Appendix I of our WRMP24. This text will appear at the end of the sub-section entitled "Stochastic Weather Datasets".

Validity of Stochastic Rainfall Datasets

6.69 We have analysed the stochastic rainfall dataset which has been used in our WRMP24 Deployable Output modelling. In this analysis we compare the WRMP24 stochastic dataset with historical rainfall datasets and the WRMP19 stochastic dataset. The analysis focusses on a comparison of extreme event rainfall accumulations over different accumulation periods.

6.70 In this comparison, we have used a Thames catchment areal average for each dataset (calculated by averaging rainfall for the Chilterns East, Cotswolds West, Berkshire Downs and Wey Greensand hydrometric areas). The datasets used are:

- *HadUK historical rainfall dataset (considering both 1920-2020 and 1891-2020 assessment periods) – this dataset is included as the HadUK rainfall dataset was used in the training of the WRMP24 stochastic dataset.*
- *A rainfall dataset labelled as "EQUIS" which is an internal corporate database. This rainfall dataset is provided by the Environment Agency. It is this rainfall dataset which has historically been used for our "worst historical" Deployable Output assessments, and was the dataset used in training the WRMP19 stochastics.*
- *The WRMP19 stochastic dataset*
- *The WRMP24 stochastic dataset*

6.71 For each dataset analysed, we first calculate the monthly rainfall. For a given accumulation period of N months, we have then identified the minimum rainfall accumulation over the N months ending August, September, October, November or December (recognising the drought events which *impact our supply system). We have then ranked these annual accumulation values and derived a return period for each rainfall accumulation volume according to the length of the dataset. For example, in the 1920-2020 HadUK dataset, for a 1-year accumulation period we have calculated 101 rainfall accumulation values, and the lowest rainfall accumulation is said to have a return period of 101 years. We have then plotted rainfall accumulation as a proportion of the long-term average against the return period. We have undertaken this analysis for values of N of 12 months, 18 months, 24 months, 36 months, and 48 months. The Figures below are the result of this analysis.*

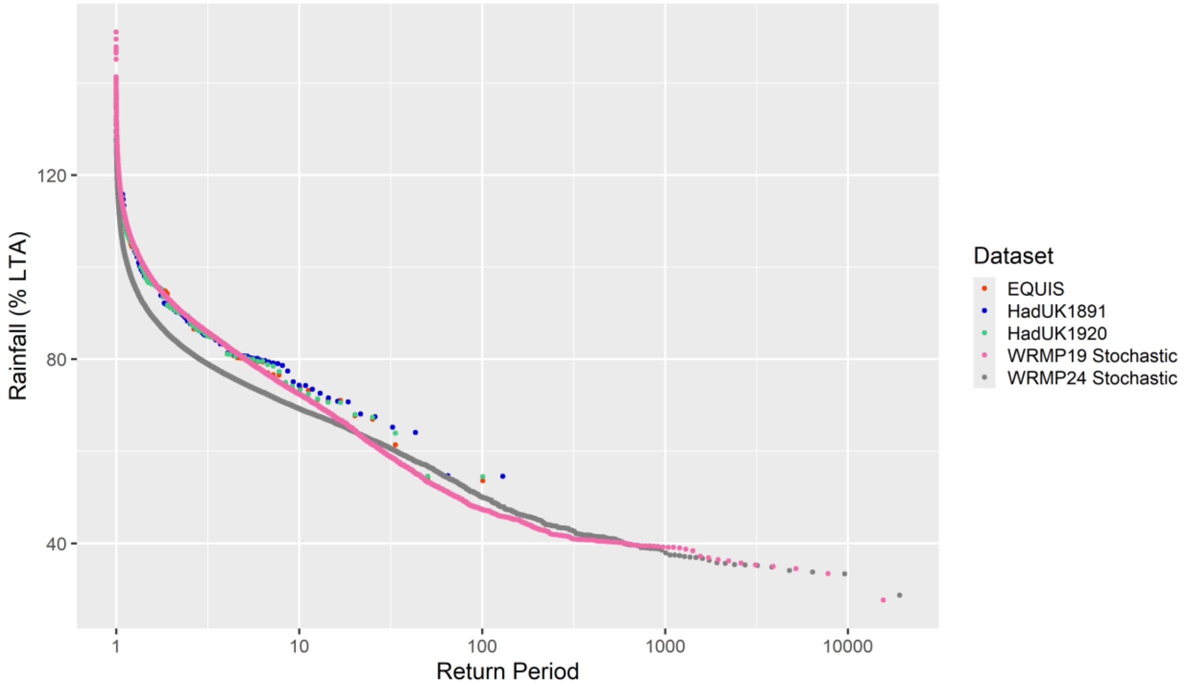
6.72 *The key points of interpretation from this analysis are:*

- *Both the WRMP19 and WRMP24 stochastic datasets perform well when compared to the different historical datasets, when considering all accumulation periods.*
- *The different historical datasets give slightly different results, highlighting that uncertainty exists even in measuring rainfall volumes (e.g., 12-month accumulation for 1934 is 63.9% in the HadUK dataset and 61.4% in the EQUIS dataset).*
- *The most significant differences between the WRMP24 stochastic dataset and other datasets exist in events with 1 to 10-year return periods, which are not material events when calculating supply capability.*
- *When looking at all rainfall accumulation durations, for drought events with return periods of c.20 years and more, the WRMP19 and WRMP24 datasets give very similar results.*
- *When looking at long-duration rainfall accumulation, both the WRMP19 and WRMP24 stochastic datasets appear to possibly over-represent long-duration droughts. As an example, the most severe 3-year accumulation on the historical record is c.80% of the LTA, whereas a 1 in 100-year 3-year event in both the stochastic datasets would indicate an accumulation of 72-73% of LTA. As the accumulation period considered increases, the WRMP24 stochastic dataset appears to over-represent long droughts more than the WRMP19 stochastic dataset.*

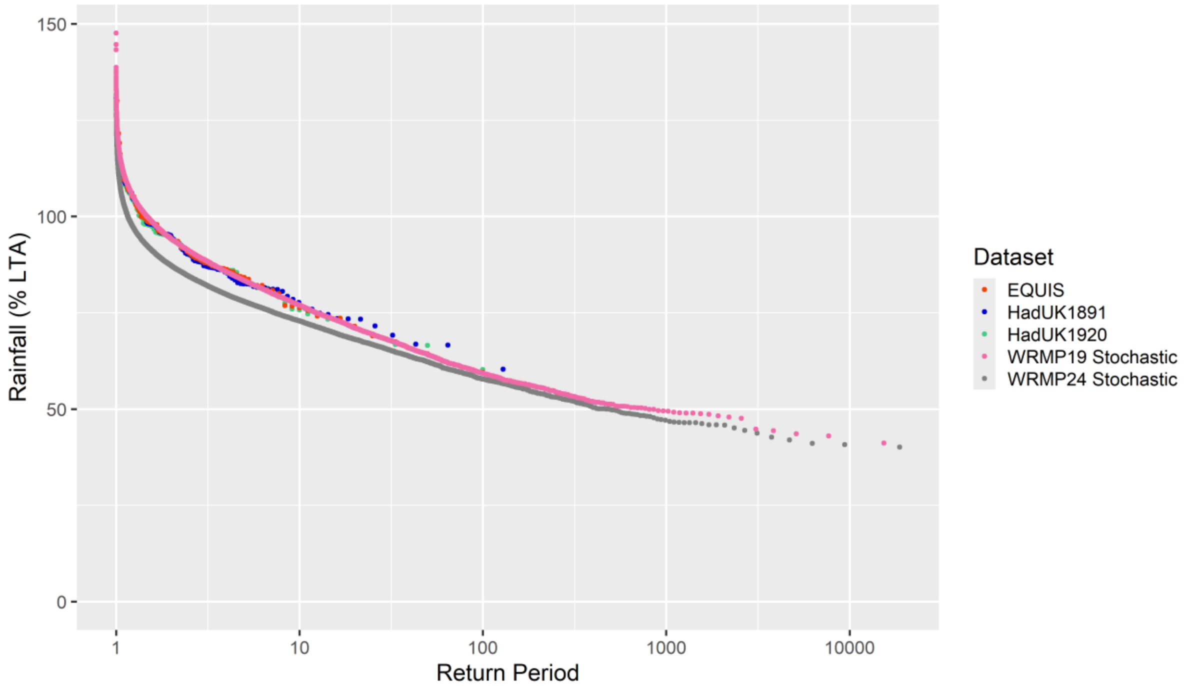
6.73 *While the relative performance of the WRMP19 and WRMP24 stochastic datasets is not materially different (i.e., the question may be raised as to why new datasets were produced given that the results are similar), it is important to bear in mind the significant improvements that were made in the production of the WRMP24 datasets, in particular:*

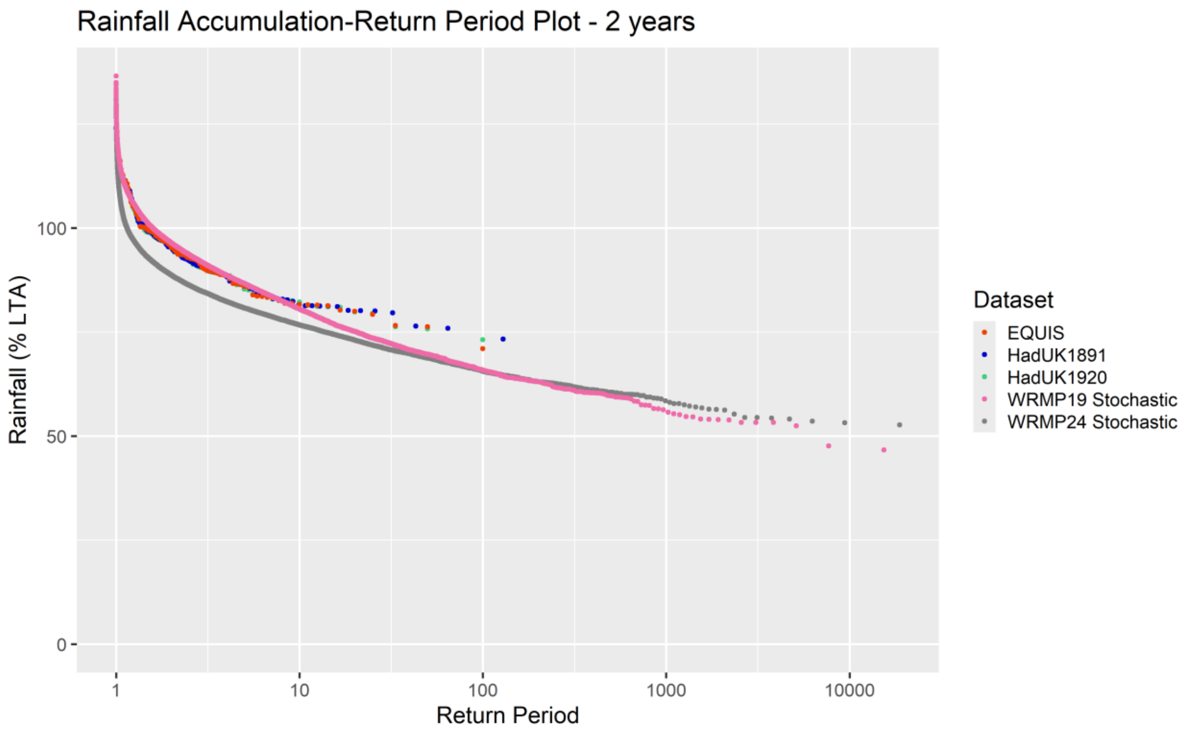
- *A nationally coherent method was applied, using the same base dataset. In WRMP19, different companies used different rainfall datasets as the training set, meaning that national coherence was compromised. In WRMP24, the HadUK dataset was used.*
- *Reduced bias correction. In WRMP19, the stochastic datasets were criticised for the bias correction required. Less bias correction is needed in the WRMP24 datasets, and a more sophisticated approach was taken.*

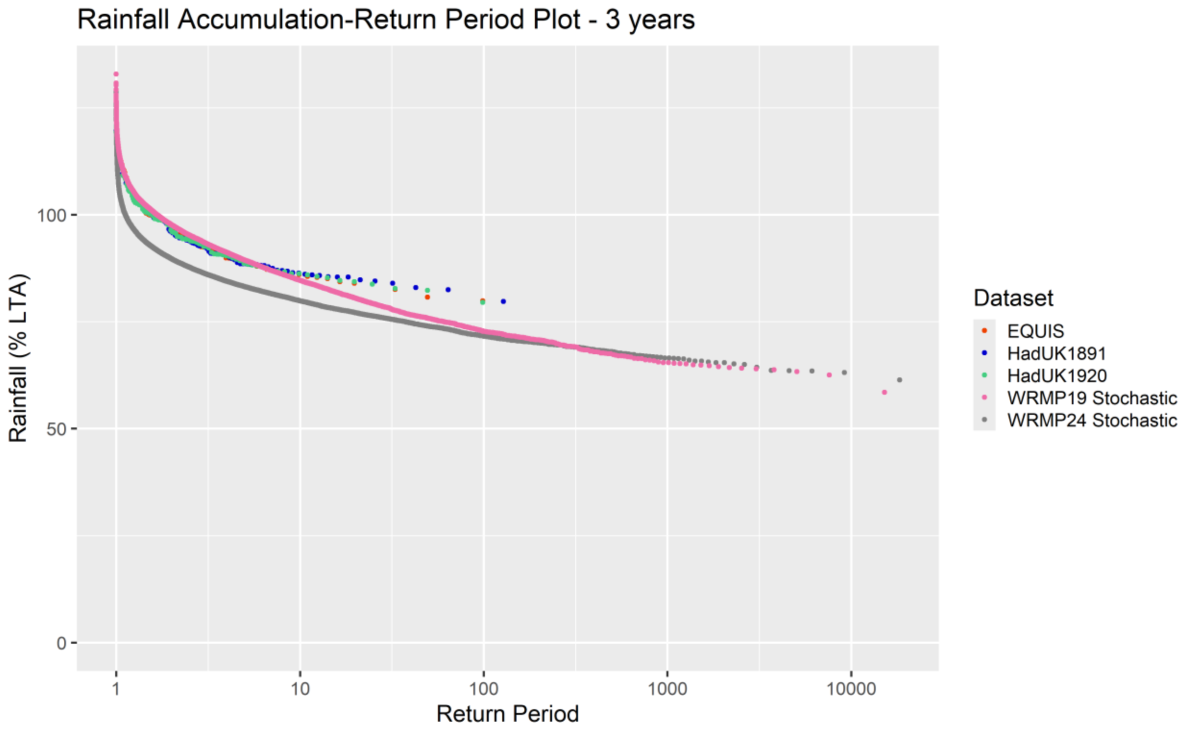
Rainfall Accumulation-Return Period Plot - 1 year

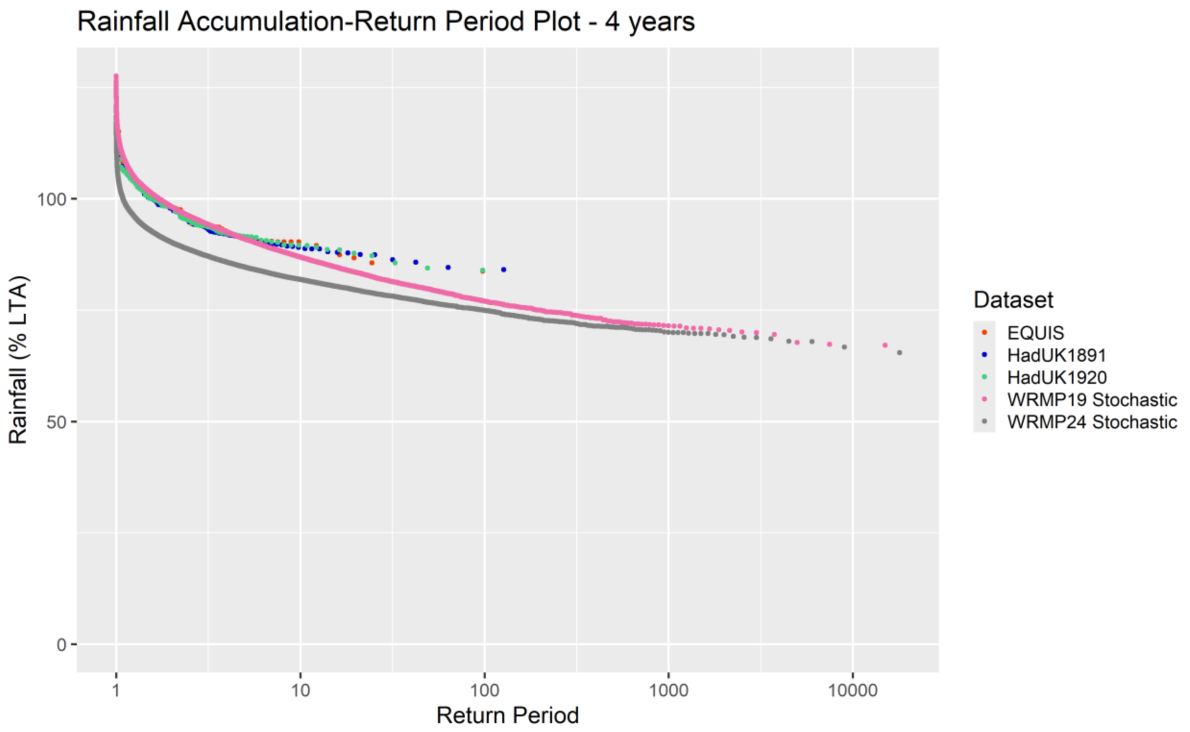


Rainfall Accumulation-Return Period Plot - 18 months




Rainfall Accumulation-Return Period Plot - 2 years
Rainfall (% LTA)
100
50
0
1
10
100
1000
10000
Return Period
Dataset
EQUIS
HadUK1891
HadUK1920
WRMP19 Stochastic
WRMP24 Stochastic


Rainfall Accumulation-Return Period Plot - 3 years
Rainfall (% LTA)
100
50
0
1
10
100
1000
10000
Return Period
Dataset
EQUIS
HadUK1891
HadUK1920
WRMP19 Stochastic
WRMP24 Stochastic



<u>Conclusion</u>

6.74 *This analysis demonstrates that the stochastic datasets are well calibrated. During the development of our plan, concerns were raised that the datasets could, due to the training dataset used, under-represent long-duration droughts. This analysis demonstrates that the datasets used do not under-estimate the likelihood of long-duration droughts. If anything, the datasets appear to include more severe long-duration droughts than would be likely when considering the historical weather datasets. As such, we do not consider that modelling of additional long-duration droughts is required.*

Issue 6.3

Request

6.75 Thames Water should provide further information on the relationship between the deployable output benefit of a strategic resource option and the deployable output benefit it brings to the London supply system.

Further elaboration of request given in annex, or clarification given subsequently

<u>Annex Issue 6</u>

6.76 Thames Water should provide further clarity in its final WRMP24 for how the stated "deployable output benefit of a given intervention" and "the deployable output benefit that the intervention brings to a given supply system" influences the company's supply resilience, when applied to the South East Strategic Resource Option (SESRO) and the London supply system. The company should quantitatively discuss the difference in resilience and vulnerability SESRO brings to the London system, particularly during extreme and multi-year droughts. Where applicable, this should be made with reference to transfers that SESRO provides to other SE companies as planned in WRMP24.

Our consideration of the points raised

6.77 As raised in response to Issue 6.2, the issue of how a new option would interact within a WRZ with an underlying vulnerability profile is an important one to consider, and is something we are happy to expand on in our plan. As such, we have added the text below to our plan.

Changes made to the rdWRMP24

6.78 We have added the following text to Section 7 of our WRMP, at the end of the section entitled “Option DO Assessment”.

6.79 When considering Option DO Benefit assessments, it is important to note that the value of importance is the DO benefit that an option brings to a given Water Resource Zone (WRZ), rather than the DO benefit that an option itself would be assessed to have in isolation. New water resources options would become part of wider systems, and so how any new solution would work within the context of the system is clearly very important.

6.80 An analogy which is useful in this context is that of a football team. If a team has a particularly poor goalkeeper, then signing a new striker is unlikely to be the most effective way to improve the team’s overall performance. In the same way, if an existing water resources system is known to be particularly vulnerable to short, sharp droughts then designing a solution which is designed to be most effective in long-duration droughts is unlikely to be the best overall solution.

6.81 *For the reasons highlighted above, for our larger solutions we undertake all Deployable Output modelling using a staged process. In this process (see Figure X), we first calculate a “baseline DO” for the water resources system; we then introduce a new intervention and calculate what the water resources system DO would be with the intervention in place, the “new DO”; the DO benefit of the scheme is then calculated as the difference between the “new DO” and the “baseline DO”.*

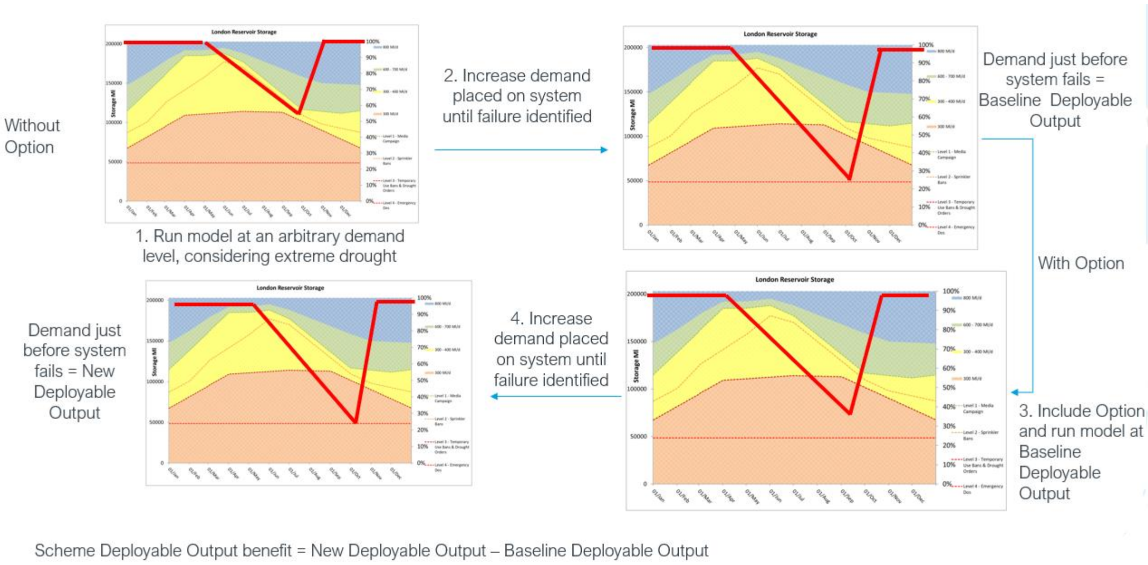


Figure X – Deployable Output Calculation Process

6.82 *In general, water resources system vulnerability involves a confluence of:*

- *Storage (whether surface water or groundwater)*
- *Drought intensity (how little it rains over a certain period, as a % of the long-term average)*
- *Drought duration (how long a drought lasts for)*
- *The interaction between intensity and duration, with intensity and duration having an inverse relationship (i.e., a very intense drought is statistically unlikely to last long)*

6.83 *The complexities of the interactions between these issues for existing systems and for new resources mean that modelling is necessary.*

6.84 *Given stakeholder interest in this issue, we have given further detail on how these issues influence the Deployable Output benefit of SESRO to our London Water Resource Zone in an Annex at the end of this chapter. We have also then expanded on how inter-company transfers within the South East Region are likely to bring efficiency.*

SESRO, London WRZ, and Intra-regional Transfers

London WRZ

6.85 *As set out in Appendix A, Appendix I and Section 4 of our WRMP, the London WRZ includes a significant volume of raw water storage and large abstractions from the River Lee and River Thames. The London WRZ includes a little over 200,000 Ml of storage (of which c.50,000 Ml is deemed "emergency storage"), a current demand of around 2,000 Ml/d, and around 300-400 Ml/d of direct supplies from groundwater supplies and desalination. At least a little abstraction is feasible at all times from the River Thames, but during periods of drought, our total reservoir storage can decline by more than 1000 Ml/d. Due to the existing reservoir storage and the significant baseflow contribution to flows in the River Thames, the WRZ does not tend to be vulnerable to 12-month drought events as these events would need to be so severe over the winter as to cause extremely low groundwater levels by the spring, diminishing flows in the River Thames to the extent that reservoir storage would quickly decline over a typical summer/autumn period (April/May onwards). Instead, the London WRZ is most vulnerable to events in which either:*

- *There has been a dry summer, leaving a high soil moisture deficit in the catchment and low groundwater levels. There is then a dry winter in which groundwater levels recover only a little, and a following dry summer in which river flows remain low and reservoir storage declines quickly.*
- *There is a dry winter and then a dry summer, depleting reservoir storage; there is then a further dry winter (reservoir storage is likely to partially or fully recover during this period due to low evapotranspiration levels meaning that at least some groundwater recharge is likely which will cause river flows to increase) where groundwater levels are left low in the spring and a further dry summer in which a combination of low groundwater levels, low flows and potentially already low reservoir stocks are further depleted.*

6.86 *Clearly, the London WRZ would also be severely impacted by long and intense droughts, in which sequences of dry winters and dry summers are strung together, but such events are, as the duration increases, increasingly unlikely to occur. As per the information set out in Appendix I of our WRMP, there is a clear inverse link between the intensity of a drought event and the duration it is conceivable it will last (e.g., in Appendix I the Figures indicate that an 18-month drought event with a 1 in 100-year return period would result 60% of the long-term average rainfall, while a 3-*

year drought event with a 1 in 100-year return period would result in more than 70% of the long-term average).

6.87 *Alongside drought duration sits drought intensity. London reservoir storage volumes are typically only impacted when river flows in the River Thames recess below levels around 3000 Ml/d, a relatively low flow which is exceeded around 80% of the time. During periods when river flows are above this level, reservoir storage can quickly refill. Similarly, groundwater levels recess quickly when levels are high (via increased river flows) and recess slowly when levels are low. The stabilising effects of baseflow and the relatively low river flow threshold above which reservoir storage can be filled quickly means that there is a threshold level of severity which must be reached before a system-level impact is felt in London. We have run our water resources model at a current level of demand over a 10-year period, considering different rainfall scenarios. The results (Figure X below) demonstrate that there is a threshold rainfall level above which there is sufficient rainfall to ensure that groundwater levels return to a healthy enough level in the spring to ensure that reservoir storage and baseflow are available to mitigate severe system-level impacts. In the run below, system level impacts are not experienced unless rainfall falls below 70% of the long-term average. Rainfall patterns are very complex, and we do not typically see endless months of the same percentage of long-term average rainfall, but over the long term, a drought's intensity must exceed a threshold level for it to result in sufficiently low river flows for reservoir levels to decline for a long enough duration for there to be a system-level impact. Droughts of a greater intensity than this threshold level will cause faster deterioration of the situation.*

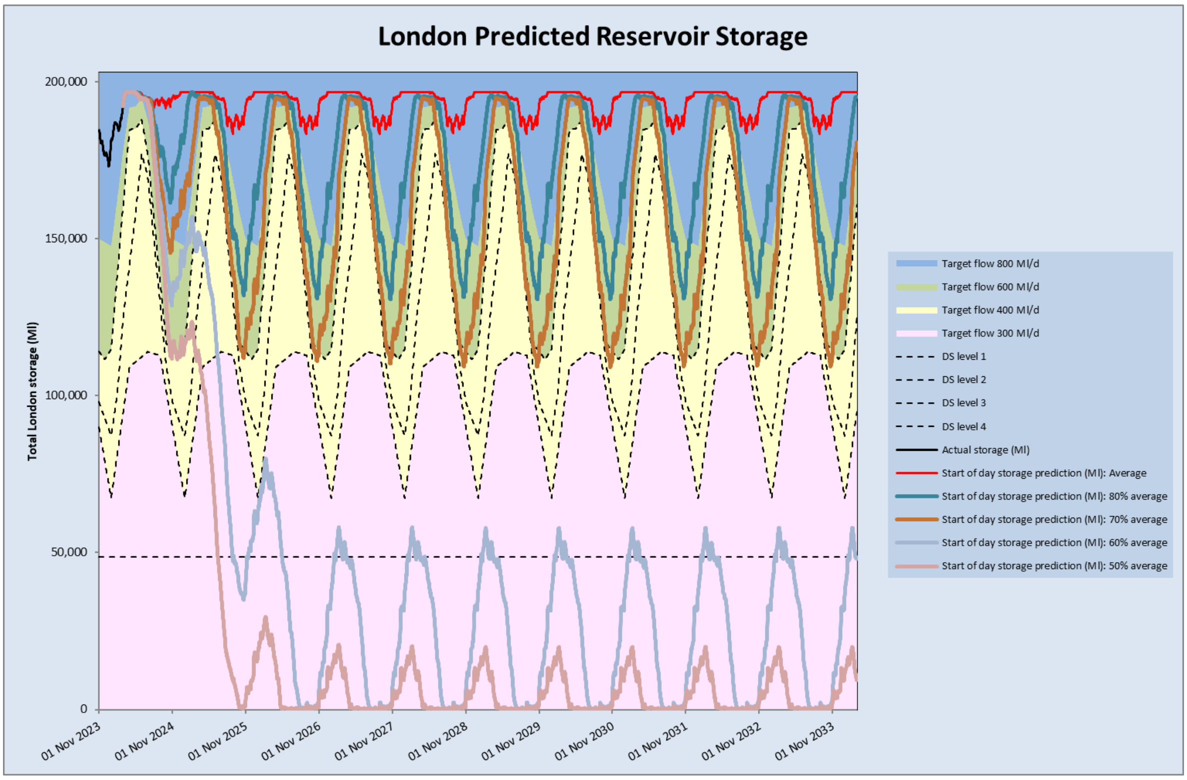


Figure X - London Drawdown from a Model Run in which fixed % LTA Rainfall Scenarios were used

6.88 *As per the above, the drought events which will typically impact London most are of an 18-month to 24-month duration, with a high intensity, and concluding in a final dry summer. While intense droughts continuing into a third year would impact the London WRZ, they are unlikely to be sufficiently intense to cause severe system-level issues in the London WRZ.*

<u>SESRO</u>

6.89 *Recognising the vulnerabilities of the London WRZ, the SESRO scheme, initially designed to provide water to London, was designed to have release levels which would deplete the reservoir across an 18-month drawdown period accounting for a winter interlude in releases. The release volume used in modelling (where the reservoir is used only for London – this would be reduced if transfer to Southern Water were needed) is 321 Ml/d for a 150 Mm^3 reservoir, and it is no coincidence that 321*15*30 = 144,450, which is close to the usable volume of the reservoir.*

6.90 *In hypothetical longer events in which refill of SESRO would not be possible, the Deployable Output contribution it could make would be reduced (e.g., a 141,000 Ml volume spread across 27 months of releases would equate to a DO benefit of 174 Ml/d, as opposed to the 285 Ml/d Deployable Output figure without climate change from WRMP24).*

6.91 *However, as noted above, in longer events with a plausible intensity, the existing London water resources system has a higher yield, as a longer drought with the same return period would be of a lower intensity. Table X below includes three drought events from a hypothetical "worst historical" Deployable Output run. The critical metric at all times is the overall system yield, and so the overall Deployable Output benefit of the reservoir in this case would be the smallest overall* *system yield with SESRO in place minus the system yield without SESRO in place. This is 2300 – 2000 = 300. In the table is included an event in which SESRO itself has a lower yield, but in that event the London system has a higher yield itself, and the system yield inclusive of SESRO is not as low as the critical event. These example situations are reflective of the Deployable Output modelling undertaken.*

	London system yield	*System yield with SESRO*	*SESRO Yield Benefit*
Short event	*2300*	*2700*	*400*
Long event	*2400*	*2500*	*100*
Critical event	*2000*	*2300*	*300*

Table X: System Yield and Yield Output Benefit Example

6.92 As demonstrated above, the important factor when assessing the Deployable Output of a water resources option is the Deployable Output benefit that option brings to a given WRZ, rather than an isolated assessment of the option's DO benefit. As such, water resources options which are designed to bring particular benefit in events which a WRZ is particularly vulnerable to are likely to be of most benefit. Given the complexities involved in hydrological and water resources modelling, using and interpreting modelled Deployable Output benefit values is the preferred method of appraising options' DO benefit.

<u>Transfers to other companies in the South East Region</u>

6.93 Alongside considering Deployable Output benefit which new options can bring to a water resources system, it is also important to consider that different water resources systems, when connected together via transfers, can bring a resilience benefit. Where different water resources systems have very different vulnerabilities, they can be connected to derive an efficient overall efficiency.

6.94 The Thames to Affinity Transfer is a good example of this, as:

- *The Affinity Water Central area is groundwater dominated, with groundwater yields which are vulnerable to long-duration drought events which deplete groundwater storage over time.*
- *As described above, the London WRZ is most vulnerable to 18-24 month drought events which deplete reservoir storage over a relatively long period.*
- *Given the lack of raw water storage, restrictions in the Affinity Water Central Area would be put in place reactively to ensure sufficiency of supply.*
- *Given the presence of significant raw water storage, restrictions in the London WRZ would be put in place to proactively mitigate the risk of emptying reservoirs.*

6.95 Given these different characteristics, a transfer from Thames Water to Affinity Water presents an efficient solution in two ways:

- *During long-duration drought events in which Affinity Water's resources are stretched, London's resources may be in a healthier position. Conversely, when London's reservoir storage is depleted, Affinity Water's groundwater yields may not yet be impacted and relatively small transfer volumes may be required.*

- *Affinity Water would require significant volumes of transfer only when its resources are impacted by declining yields. This would only occur when groundwater levels are at their lowest, during the late summer and autumn period during a drought.*

6.96 Given these factors, a transfer from Thames Water to Affinity Water may generate X Ml/d of DO benefit for Affinity Water but result in a disbenefit of less than X Ml/d of DO for London.

6.97 Of course, hypothetical description is not sufficient to rely on in water resources planning, but as is described in the T2AT Gated process documentation, the modelled outcome is that there is not a 1:1 relationship between DO gain for Affinity Water and DO disbenefit for Thames Water associated with the T2AT.

6.98 Reflecting on this, options which increase the region's storage are particularly efficient, as storage volumes can be used to provide resilience to the different companies across the South East according to their particular resilience needs.

Issue 7: Increase leakage reduction in Swindon and Oxfordshire resource zone

7.1 Thames Water's leakage programme is concentrated in London as this resource zone has the biggest deficit. It plans an approximate 55% reduction in London and an approximate 30% reduction in Swindon and Oxfordshire (SWOX) resource zone. SWOX is a zone with a significant baseline deficit, relatively high leakage and was shown to be vulnerable in the drought in 2022. The company should increase its leakage ambition in this resource zone.

Our consideration of the points raised

7.2 Our leakage programme is to more than halve the leakage levels by 2050 (compared to the 2017/18 position). This is a company-level target and there is variability in the percentage reductions forecast by WRZ. The largest leakage reduction volumes (55%) are in the London WRZ because this is the most cost efficient strategy to meet the target, but significant reductions are forecast in all WRZs.

7.3 Operational flexibility for when and where leakage reductions are made is important to us. In delivery we would tailor the reductions to where they are needed based on risk. In AMP7 we have seen challenges that have resulted in the supply demand balance in SWOX being tighter than forecast and we have taken steps to manage that risk (as discussed in Issue 1). It does not automatically follow that current in-AMP challenges demonstrate that future forecasts are incorrect. Nevertheless, we have worked with our operational teams to identify the maximum possible leakage reduction which could be achieved in the SWOX WRZ. Further reductions (beyond the 30% in the rdWRMP) could be achieved by increasing the amount of 'advanced DMA intervention' undertaken (see Table 19). These are reductions delivered by pressure management and calm systems approaches, specifically a combination of pressure optimisation of existing assets, new pressure management schemes, restriction removal and subsequent pressure stabilisation, system reconfigurations and pump replacements. Delivering additional leakage reduction in SWOX provides additional resilience to the supply-demand balance.

Table 19 – Advanced DMA intervention leakage reduction per AMP, SWOX WRZ

Ml/d	AMP8	AMP9	AMP10	AMP11	AMP12
rdWRMP24	1 Ml/d	0 Ml/d	0 Ml/d	0 Ml/d	0 Ml/d
Amended	2.80 Ml/d	2.60 Ml/d	2.40 Ml/d	2.20 Ml/d	2.00 Ml/d

7.4 This change would increase the leakage reduction forecast in SWOX to 48% by 2050.

7.5 To ensure best value for our customers, and to ensure that our leakage programme is deliverable, we would reduce planned leakage delivery in London to offset the volumetric increase in delivery in SWOX.

7.6 Leakage reduction in London would remain above 50% by 2050 and our leakage reduction at company level also would continue to achieve the 50% reduction target in the EIP and WRPG.

7.7 We have carried out a WRSE IVM sensitivity run to assess the impact of this change in demand reduction on options selection and no significant changes were triggered.

7.8 As described in response to Issue 1.6, we have considered adaptive solutions which we could implement in the SWOX WRZ should risks emerge in the short-term.

7.9 Given the ongoing risks to our supply-demand balance in the SWOX WRZ, we agree that delivering additional leakage reduction in the SWOX WRZ would be part of our Best Value Plan.

Changes made to the rdWRMP24

7.10 We will update our WRMP24 data tables for final plan submission to reflect the changes in leakage reduction in SWOX and London WRZs.

7.11 We will update the relevant numbers and graphs included in Sections 8 and 11 of the WRMP to ensure alignment with our WRMP24 tables.

7.12 As there is no change to total leakage reduction at company level there are no changes to our PR24 submission required.

Issue 8: Present the best value metric scores for its programmes, including those testing different sizes of the South East Strategic Resource Option (SESRO)

8.1 Thames Water has presented a comparison between the options selected for the Least cost plan, Best Value Plan and Best Environmental and Social Plan. It has not presented the best value metric scores for individual options or the aggregated metric scores for the above programmes, including those testing different sizes of SESRO. The scores provide important evidence for the selection of the candidate best value plan and should therefore be clearly presented. The company should also explain how Ofwat's public value principles have been used to inform best value decision making, and how the plan aligns with each principle.

Issue 8.1

Request

8.2 Thames Water has presented a comparison between the options selected for the Least cost plan, Best Value Plan and Best Environmental and Social Plan. It has not presented the best value metric scores for individual options or the aggregated metric scores for the above programmes, including those testing different sizes of SESRO. The scores provide important evidence for the selection of the candidate best value plan and should therefore be clearly presented.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue 8

8.3 The company should present the best value metric scores for individual options in the least cost, best environment and social, and best value plans. The company should present the aggregated best value metric scores for the following programmes: Least cost plan; No SESRO; BVP General Uplift; as well as the combination of optimisation of BVP aggregates (environment and society, resilience, and all BVP metric uplift) with different SESRO sizes (150, 125, 100 and 75 Mm^3). The scores should be presented both averaged across all adaptive pathways, and for pathway 4 (the preferred plan) specifically. Thames Water should also clearly identify which programme from the list above is selected as the candidate best value plan.

Our consideration of the points raised

8.4 We consider that the rdWRMP already presents much of this information:

- Option-level best value metric information is provided in rdWRMP24 supporting information
- Programme-level best value metric scores are provided throughout Section 10, across all pathways and on average for the Least Cost, Best Environmental and Social, Best Resilience, General BVP Uplift and the Overall Best Value plans.
- For sensitivity runs we provide the best value metric scores in Section 10 for pathway 4, with all pathways available in the run dossiers in Appendix X.
- Aggregated best value metric values are presented across all pathways and separately for pathway 4 in graphical format in Section 10 Figures 10-13 to 10-16.

8.5 We accept that the aggregated best value metrics need to be read off from the graphs rather than presented in a tabular format, but we chose to show these outputs graphically as it is easier to identify the patterns in the data that way, to aid clarity in the explanation of our decisions.

Changes made to the rdWRMP24

8.6 We will make the following changes ahead of the final plan submission:

- Include in Section 10, references to the additional information added to Appendix X.
- In Appendix X add a sub-section on aggregate metrics:

- Additional information on the calculation of aggregate metrics (as shown below)
- A table (as shown below) to provide the aggregate metric values across the runs shown in Figures 10-13 to 10-16 and the other aggregations requested.
- Amend the run dossiers to include the average metric scores across all pathways

<u>Aggregate Metrics</u>

8.7 There are eight Best Value Plan (BVP) metrics, not including cost and carbon, used to develop the regional plan and our WRMP. These are:

- Environmental:

- Strategic Environmental Assessment (SEA) benefit
- SEA disbenefit
- Natural Capital
- Biodiversity Net Gain

- Resilience:
    - Reliability
    - Evolvability
    - Adaptability
- Social
    - Customer option preferences

8.8 When the WRSE investment model is run, the programme-level best value metric scores for each pathway are calculated by summing up each individual option's BVP metric score, considering the number of years the scheme is selected for.

8.9 Given that many of the metrics are in different units and their assessed values have different orders of magnitude, we normalise the raw scores to allow summations and averages to be calculated. This ensures that the scale of one metric does not dominate the decision-making process for the entire plan as some metric scores are in the thousands and others are in single units. Additionally, some metrics may be monetised whereas others cannot be.

8.10 Runs are grouped together according to the input dataset used in the investment modelling. This means that the pathways and data used to generate the investment plan are consistent and comparable with each other.

8.11 The process for normalising each metric converts each raw score into a normalised score between 0 and 100. For all the runs in a selected group, the minimum raw score for a specific metric and pathway is set as zero and the maximum score for a specific metric and pathway is set to one hundred. The raw value of the metric is then used to derive a score between 0 and 100.

$$Normalised\ value = \frac{(Metric\ value - Minimum\ metric\ value)}{(Maximum\ metric\ value - Minimum\ metric\ value)}$$

8.12 This calculation is undertaken for each metric in each pathway of the plan.

8.13 In Table 20 below we show for each run, the normalised metric scores (average of pathways 1-9) for each of the individual BVP metrics. Also, the aggregated metric scores for each run calculated as follows:

$$Env\ and\ Social\ BVP\ Aggregate = \frac{(N\ Nat\ Cap + N\ BING + N\ SEA{+}'ve + N\ SEA{-}'ve + N\ Cust\ Pref)}{5}$$

$$Resilience\ BVP\ Aggregate = \frac{(N\ Evol + N\ Rel + N\ Adapt)}{3}$$

$$Overall\ BVP\ Aggregate = \frac{(N\ Nat\ Cap + N\ BING + N\ SEA{+}'ve + N\ SEA{-}'ve + N\ Cust\ Pref + N\ Evol + N\ Rel + N\ Adapt)}{8}$$

8.14 Better performing plans will have higher average scores than poorer performing plans.

Table 20: Best Value Metrics from Runs Included in rdWRMP24 Appendix X

IVM Model Run name	Simple run name	COST (£m)		INDIVIDUAL BVP METRICS (Normalised, Pathway 1-9 Average)								BVP AGGREGATE (Score)		
		Pathway 1-9 Average	Pathway 4	SEA +	SEA -	NATC	BING	Cust. Pref	Relia.	Adapt.	Evol.	E&S	Resil.	Overall BVP
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-2075	Least Cost (LCP)	17666	19052	74	71	88	67	4	65	74	84	61	75	66
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-2075-envsoc-07_50-v2	Best E&S	17769	19383	85	72	92	88	20	56	63	85	71	68	70
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-2075-resilience-07_50-v2	Best RESIL	17635	19377	84	62	91	87	5	58	69	88	66	72	68
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-2075-bvp-07_50-v2	General BVP uplift	17812	19491	84	81	92	91	20	59	72	89	74	73	73
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-sesro150-2075-bvp-07_50-v2	Overall BVP	17963	19255	86	80	90	62	19	76	83	89	67	83	73
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro75-only-t2a50-2075-envsoc-07_50-v3	BVP - E&S SESRO 75	17808	19419	84	80	92	89	19	55	63	84	73	67	71
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro100-only-t2a50-2075-envsoc-07_50-v3	BVP - E&S SESRO 100	17853	19420	85	79	92	81	19	60	68	86	71	71	71
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro125-only-t2a50-2075-envsoc-07_50-v3	BVP - E&S SESRO 125	17957	19357	85	79	91	69	19	68	75	86	69	76	72
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro150-only-t2a50-2075-envsoc-07_50-v3	BVP - E&S SESRO 150	18010	19341	84	81	91	64	19	75	81	87	68	81	73
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro75-only-t2a50-2075-resilience-07_50-v3	BVP - RESIL SESRO 75	17804	19486	82	71	92	87	5	59	69	89	67	72	69
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro100-only-t2a50-2075-resilience-07_50-v3	BVP - RESIL SESRO 100	17851	19428	81	75	91	79	4	62	72	88	66	74	69
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro125-only-t2a50-2075-resilience-07_50-v3	BVP - RESIL SESRO 125	17934	19339	81	76	89	69	4	70	77	88	64	78	69
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro150-only-t2a50-2075-resilience-07_50-v3	BVP - RESIL SESRO150	17978	19317	82	77	87	62	4	76	83	89	62	83	70
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro75-only-t2a50-2075-bvp-07_50-v3	BVP - ALL SESRO 75	17829	19515	85	81	92	91	19	60	71	90	74	74	74
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro100-only-t2a50-2075-bvp-07_50-v3	BVP - ALL SESRO 100	17877	19450	85	79	92	81	19	63	72	89	71	75	73
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro125-only-t2a50-2075-bvp-07_50-v3	BVP - ALL SESRO 125	17959	19362	86	78	91	70	19	69	78	87	69	78	72
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-only-sesro150-only-t2a50-2075-bvp-07_50-v3	BVP - ALL SESRO 150	17999	19350	85	80	90	64	19	77	82	89	68	83	73

st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-excl-ted-dra-2075	No DRA	17919	19264	75	58	82	65	4	63	60	87	57	70	62
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-excl-sesro-2075	No SESRO	17771	19682	62	84	2	27	4	45	41	86	36	57	44
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-sesro75-2075	LCP SESRO 75	17766	19365	72	81	92	88	3	55	62	85	67	68	67
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-sesro100-2075	LCP SESRO 100	17803	19274	72	82	90	80	3	61	68	87	65	72	68
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-sesro125-2075	LCP SESRO 125	17903	19198	71	85	89	71	3	68	75	86	64	76	69
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-sesro150-2075	LCP SESRO 150	17759	19052	75	72	87	61	4	72	82	85	60	80	67
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-lon-1in200-2035-2075	1:200 in 2035	17721	19180	71	82	82	68	3	63	66	85	61	72	65
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-force-beckton-reuse50-2033-2075	Force Beckton50	18212	19704	75	56	84	77	4	51	52	82	59	62	60
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-force-beckton-reuse100-2033-2075	Force Beckton100	18296	19942	74	65	85	85	3	50	47	85	62	61	62
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-force-beckton-reuse150-2033-2075	Force Beckton150	18609	20022	74	68	83	72	3	63	56	88	60	69	63
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-adj-existing-beckton-do-01-2075	Gateway 50	17690	19424	79	60	91	85	5	53	63	83	64	66	65
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybrida-2075	GOV A	19355	22388	91	25	92	31	9	82	69	73	50	75	59
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridb-2075	GOV B	19355	22388	91	25	92	31	9	82	69	73	50	75	59
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridd-2075	GOV D	19046	21577	86	43	95	50	8	81	66	76	56	74	63
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybride-2075	GOV E	18642	20552	81	59	91	53	6	97	83	86	58	89	69
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridf-2075	GOV F	19294	21574	91	11	93	32	10	87	75	77	47	80	60
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridg-2075	GOV G	18951	20706	88	24	90	43	8	95	85	84	51	88	65
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridg-only-sesro75-2075	GOV G 75	19077	21043	88	24	97	69	9	82	66	88	57	79	65
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridg-only-sesro100-2075	GOV G 100	18833	21231	87	23	93	60	9	82	73	84	54	79	64
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridg-only-sesro125-2075	GOV G 125	18897	20824	87	23	92	50	9	88	79	82	52	83	64
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridg-only-sesro150-2075	GOV G 150	18945	20706	88	23	92	40	9	95	83	83	50	87	64
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridh-large-sws-prt-transfer-v4-only-sesro75-2075	GOV H 75	18957	21970	88	34	90	65	9	70	72	76	57	73	63
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridh-large-sws-prt-transfer-v4-only-sesro100-2075	GOV H 100	18920	21831	87	39	88	56	9	73	76	77	56	75	63
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridh-large-sws-prt-transfer-v4-only-sesro125-2075	GOV H 125	18991	21716	88	38	90	45	9	81	82	75	54	79	63

st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridh-large-sws-prt-transfer-v4-only-sesro150-2075	GOV H 150	18937	21648	87	44	85	40	9	85	87	75	53	82	64
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridh-large-sws-prt-transfer-v4-delay5-sesro-2075	GOV H DEL5	19207	22067	81	33	45	29	8	68	64	76	39	69	50
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridh-large-sws-prt-transfer-v4-excl-sesro-2075	GOV H No SESRO	19339	22659	78	36	1	13	9	61	59	75	27	65	41
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-delay5-sesro-2075	LCP DEL5	17656	19626	65	76	17	29	4	44	49	84	38	59	46
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-only-guc100-2075	LCP GUC100	17825	19206	71	84	83	73	3	62	67	84	63	71	66
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-ltrisks-rts-v2-2075	LTRRTS (No Tunnel)	20128	21828	88	35	82	60	8	81	55	95	55	77	63
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-ltrisks-rts-v4-2075	LTRRTS 4 (Inc. Tunnel)	18114	19562	71	81	90	74	4	40	24	64	64	43	56
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-excl-wbgws-2040-2075	No WBGWS 2040	18044	19662	78	74	83	66	4	69	72	88	61	77	67
st-hybrid-dy-w1-tree16.05-options-v61-gov-led-hybridcp2-excl-wbgws-2050-2075	No WBGWS 2050	17910	19539	73	84	82	68	3	66	70	86	62	74	66

Issue 8.2

Request

8.15 The company should also explain how Ofwat's public value principles (PVP) have been used to inform best value decision making, and how the plan aligns with each principle.

Further elaboration of request given in annex, or clarification given subsequently

8.16 No further elaboration

Our consideration of the points raised

8.17 We mention alignment of our Best Value Planning process with Ofwat's PVP in Section 11 of the rdWRMP, however we can expand this to include further references and a tabulated summary by principle.

Changes made to the rdWRMP24

8.18 We will include the following text and tabulated summary of alignment with Ofwat's PVP in Section 10 of our WRMP, within the Section entitled "Best Value Plan Process". This will be in a new sub-section entitled "Alignment with Ofwat's Public Value Principles".

8.19 Throughout the development of our plan and the regional plan on which it is based, we have considered Ofwat's public value principles. They are implicit throughout, from company and regional policy and objectives, through options assessment and design to programme appraisal.

8.20 The regional best-value planning methodology has built public value principles into the methodology by:

- *ensuring that social and environmental value is built into the assessment metrics,*
- *by measuring social and environmental benefits across both individual options and selected programmes,*
- *by applying customer research to ensure that the delivery of social and environmental value outcomes is supported by customers and*
- *by collaborating with others in the development of the regional plan to optimise solutions and maximise benefits, seeking to align stakeholder interests.*

8.21 A summary by principle is provided in Table X:

Table X: How Ofwat's Public Value Principles Have Informed Our Approach

	Ofwat's Public Value Principles	How these have informed our approach
1	*Companies should seek to create further social and environmental value in the course of delivering their core services, beyond the minimum required to meet statutory obligations.* *Social and environmental value may be created both in direct service provision and through the supply chain.*	*Best Value metrics, developed by the WRSE Regional Group, have been used in our programme appraisal. These metrics measure options' impacts on the society and the environment. This allows us to ensure the delivery of social and environmental value while also delivering the statutory requirement of ensuring supply-demand balance.*
2	*Social and environmental benefits should be measurable, lasting and important to customers and communities.* *Mechanisms used to guide activity and drive decision-making should support this, for example through setting and using company purpose, wide external engagement and explicit consideration of non-financial benefits.*	*The creation of metrics ensures that social and environmental benefits are measurable. The WRSE Regional Group have consulted on the framework used, ensuring that the use of these metrics is important to customers and ensuring wide engagement.* *As described in this section, these metrics are built into the decision-making framework which has been adopted.*
3	*Companies should be open with information and insights on operational performance and impacts (both good and bad). This will support stakeholder engagement, facilitate collaboration and help identify opportunities for delivering additional social and environmental value.*	*Our existing and proposed Annual Review (inc. 6-month update) process ensures that we are open and transparent with our operational performance and the impacts our performance has.* *In the production of our WRMP we have responded to numerous queries and Environmental Information Requests.*
4	*Delivery of social and environmental value outcomes should not come at greater cost to customers without customer support.*	*Our Best Value Plan process begins with the identification of a least-cost plan. Changes from this least cost plan and the reasons for them are clearly described in line with the Best Value framework.*
5	*Companies should consider where and how they can collaborate with others to optimise solutions and maximise benefits, seeking to align stakeholder interests where possible, and leveraging a fair*	*Through the development of the shared strategic options, SESRO and the STT (alongside the T2AT and T2ST), we have ensured that optimal and collaborative solutions are included in our plan.*

	share of third-party contributions where needed. Companies' public value activities should not displace other organisations who are better placed to act.	
6	*Companies should take account of their capability, performance and circumstances in considering the scope for delivering greater social and environmental value.*	*We have taken account of the deliverability of different supply and demand interventions when identifying our preferred plan. This includes identification of feasible delivery of meter installations and leakage reduction, as well as the concurrent development of different supply-side solutions.*

Issue 9: Consider using surplus in 2040s to benefit the environment

9.1 The company states that it has a surplus of 190 Ml/d in 2040 due to SESRO being delivered. The surplus reduces through the 2040s to 45 Ml/d by 2050. However, it has delayed low confidence environmental destination schemes until 2050 without due regard to the outcome of possible investigations. The company states that this water could provide some additional resilience if its demand management programme does not deliver. The company and the regional group should consider whether some of this surplus should be used to provide benefit to the environment earlier.

Issue 9.1

Request

9.2 The company and the regional group should consider whether some of this surplus [available in the 2040s] should be used to provide benefit to the environment earlier [through the implementation of licence reductions].

Further elaboration of request given in annex, or clarification given subsequently

<u>Annex Issue 9</u>

9.3 This issue links to EA's Recommendation 7. The expectation from Water Resources Planning Guideline is that where abstraction related issues are known to be currently affecting the environment, they should be dealt with as soon as is feasible, and not delayed. Thames Water's approach appears to delay the delivery of solutions to 2050, when resource availability and the investigation programme suggest it is feasible to deliver at least some of the licence reductions between 2040 and 2050, based on the certainty of needs from the outcome of investigations.

9.4 The company should:

- consider whether some of the surplus from 2040 should be used to provide benefit to the environment earlier.
- include a monitor and review strategy for the licence reductions currently scheduled for 2050. This should fully consider the surplus in resource and improving certainty of abstraction impact from investigations, and aim to implement solutions to mitigate environmental impacts as soon as feasible.
- if delivery of some of the licence reductions is not considered feasible until 2050, the company should provide clear justification in Chapter 5 of the WRMP.

Our consideration of the points raised

9.5 We have considered the points raised and have made amendments to the relevant sections of our WRMP.

Changes made to the rdWRMP24

9.6 In Section 5 we have added the following text. This text will be added at the end of the chapter in a new chapter entitled "Adaptive Planning".

9.7 In our baseline supply-demand balance, we have included all licence reductions required to meet Environmental Destination by 2050, the "backstop" date for delivery of licence reductions in the

National Framework for Water Resources and the WRMP guidelines. The delivery of the licence reductions has been phased between 2030 and 2050. The programme was phased as set out in this chapter to enable us to identify a coherent overall solution when considering new water resources and new infrastructure, rather than applying a fractured approach where reductions are accelerated in certain locations. The process of investigation, design and solution implementation is important and will take time when considering the scale of infrastructure (both new water resources and new network infrastructure) which is necessary. However, when sites have been included in the programme for reduction in 2050, the intention was not that we would delay licence reductions where they are identified as beneficial and feasible (both in terms of water resource and network infrastructure) but that they would not be implemented until a comprehensive strategic solution could be implemented.

9.8 As such, as is described in Section 11 of our WRMP, we have considered an adaptive plan scenario in which licence reductions are confirmed and demand reduction (50% leakage reduction and 110 l/h/d PCC) is successful. In this adaptive plan scenario, we would see surplus available from the development of Strategic Resource Options and so we would look to accelerate licence reductions from 2050 to the 2040s where possible. Here we describe those licence reductions which could perhaps be accelerated, and give reasons as to why acceleration is unlikely to be feasible at other sources, noting that the implementation/acceleration of licence reductions would be dependent on both investigation outcomes and solution identification.

9.9 In the preferred plan, surplus is generated in the SWOX WRZ in the 2040s, which could be utilised in the London, SWOX or SWA WRZs (via direct pipelines in the case of SWOX and transfer from the River Thames in SWA and London). As such, we have considered only licence reductions in those WRZs in which surplus from the preferred plan could enable licence reductions.

9.10 We have separated the licence reductions which are currently planned for 2050 into sub-WRZ categories and have described the feasibility of accelerating reductions in each category.

London – Darent and Cray catchments

9.11 The 2050 licence reductions in this category are:

- *Sundridge*
- *Westerham*
- *Darenth*
- *Wilmington*
- *Dartford*
- *Orpington*
- *Crayford*
- *Wansunt*
- *Green St Green*

9.12 These licence reductions total 65 Ml/d of Deployable Output reduction, and all of the sources are groundwater sources in South East London. As is described in WRMP24 Appendix A (Water Resource Zone Integrity), while London is a single WRZ, the supply system in South East London is different to the rest of the WRZ. In South East London there are a number of groundwater sources, ranging in size from c.1 Ml/d to c. 30 Ml/d. Water from these sources is treated relatively near each source, at relatively small water treatment works (again c.1 Ml/d to c.30 Ml/d), before *it is transmitted to customers via a complex system of trunk mains and service reservoirs. In addition to water provided from these groundwater sources, there is also a large transfer into South East London from the west London reservoirs via the London Ring Main, at Honor Oak.*

9.13 *Westerham and Sundridge are very small sources (totalling < 2 Ml/d) in the upper reaches of the River Darent. Strategic solutions would not be required in order to enable these licence reductions.*

9.14 *The total current Deployable Output of the groundwater sources in South East London is approximately 230 Ml/d. As such, a Deployable Output reduction of 65 Ml/d would be very significant, recognising that this would be in addition to other licence reductions which are included before 2050 in the High scenario. While the Honor Oak transfer into South East London is significant, the existing transfer could not simply be increased to enable all of these licence reductions. Major strategic network solutions would be required across this part of the WRZ to ensure that customer supplies would be maintained if these licences were to be reduced. The most efficient network solution would be different according to the licence reductions which are identified as being part of the final solution.*

9.15 *In view of this need for a strategic solution, our consideration is that we should (by 2035, following investigations) confirm the licence reductions which are required and then (by 2040) design strategic network solutions to enable those licence reductions. Given that the construction of infrastructure would then take a significant amount of time, we do not think it would be possible to accelerate most of these licence reductions ahead of the "backstop" date of 2050.*

9.16 ***Conclusion: acceleration not feasible at most sources, unless it is concluded that minimal reductions are required. Acceleration would be feasible at Sundridge and Westerham as these are small sources in the upper reaches of the Darent catchment where strategic solutions would not be necessary.***

London – New Gauge and NNRWs

9.17 *The 2050 licence reductions in this category are:*

- *New Gauge (transition from "DO neutral" reduction into "DO negative" reduction, i.e., not taking deferred abstraction at Lower Lee abstraction points).*
- *Northern New River Wells (Amwell End, Amwell Hill, Amwell Marsh, Broadmead, Broxbourne, Hoddesdon, Middlefield Road, Rye Common).*

9.18 *These licence reductions would be made at sources where water is currently treated at our Hornsey WTW and Coppermills WTW, in North East London.*

9.19 *While these licence reductions would result in a significant loss of Deployable Output (c.120 Ml/d in aggregate), the configuration at Coppermills (which treats around 400 Ml/d, with water being provided from our Lee Valley reservoirs) means that a network infrastructure solution would not be required in addition to new water resources. Therefore, these licence reductions could be accelerated if surplus water resource is available and investigations confirm that they are necessary.*

9.20 *Conclusion: acceleration feasible if surplus water resource is available*

London – Lower Lee

9.21 *This licence reduction would involve reducing the abstraction licence at our Lower Lee abstractions, which abstract water into our Lee Valley reservoirs. Similarly to the New Gauge and NNRW abstractions, water from these abstractions is treated at Coppermills WTW.*

9.22 *This licence reduction is considered a lower priority than the New Gauge and NNRW licence reductions, as the New Gauge and NNRW source reductions would be for the benefit of the same river (the River Lee) but further upstream (and so would benefit a longer stretch of river). Furthermore, very significant modifications would need to be made to the morphology of the Lower Lee in order for there to be ecological benefit from a licence reduction at our Lower Lee sources, which we consider is unlikely to be delivered ahead of 2050.*

9.23 *Delivering additional licence reduction beyond the NNRW and New Gauge reductions may well require major new infrastructure in addition to new resource (either raw water network, e.g., Thames-Lee tunnel improvements/duplication, or treated water network, e.g., ring main changes). The most efficient network solution would be dependent on the total volume of licence reduction which is required.*

9.24 *In view of the above, our consideration is that we should investigate the River Lee to confirm the total volume of licence reduction which is required at our sources in aggregate (by 2035), make licence reductions at NNRW and New Gauge subject to surplus being available, and then design and implement infrastructure which is required to enable any additional licence reduction which is identified. Given that the infrastructure required to implement the final reductions may be significant and given that significant river morphology modifications would be needed in order for ecological benefit to be derived, we do not think that acceleration ahead of 2050 would be feasible.*

Conclusion: acceleration not feasible

SWOX – Cotswolds

9.25 *The 2050 licence reductions in this category include:*

- *Upper and Lower Swell*
- *Seven Springs*
- *Syreford*
- *Ashdown Park*

9.26 *These licence reductions would all be made at groundwater sources in remote parts of the SWOX WRZ. These are all small sources which currently provide water to local areas.*

9.27 *We included these licence reductions at the backstop date of 2050 because they are lower-confidence (in terms of ecological benefit) and are located in parts of the SWOX WRZ which are very remote (and as such long pipelines would be needed to ensure customers remain in supply).*

9.28 *However, if surplus is available in the SWOX WRZ and investigations indicate that licence reductions are required, it may be feasible to accelerate these licence reductions ahead of 2050 depending on the required network solution.*

9.29 *Conclusion: acceleration feasible*

SWA Sources

9.30 *The 2050 licence reductions in this category include:*

- *Bourne End*
- *Medmenham*
- *Datchet*
- *Pann Mill*

9.31 *These are licence reductions at large groundwater abstraction sources, most of which are near the Thames. Aside from Pann Mill, they are also lower confidence in terms of likely ecological benefit. The licence reductions total 43 Ml/d and would involve a total Deployable Output reduction of nearly 25% of the total current SWA WRZ DO.*

9.32 *Significant network modifications and new treatment facilities, alongside new resources, would be required to enable these licence reductions, and the most efficient network solution would be different according to the specific licence reductions which are confirmed as being required.*

9.33 *As such, our consideration is that we should (by 2035, following investigations) identify the licence reductions which are required and then (by 2040) design network solutions to enable those licence reductions. Given that the construction of infrastructure would then take a significant amount of time, we do not think it would be possible to accelerate most of these licence reductions ahead of the "backstop" date of 2050.*

9.34 *Conclusion: acceleration not feasible*

9.35 In Section 11 we have included an additional section to our Monitoring Plan, entitled "Adaptive Plan – Accelerated Licence Reductions". Please see Annex C: Monitoring Plan for full details.

Issue 10: Uncertainty of climate change impacts on source yield

10.1 Uncertainty of climate change impacts on source yield has been removed from target headroom profile for the final set of adaptive branches from 2039-40. These branches branch out based on the median, upper quartile and lower quartile climate change scenarios. This avoids double counting. However, this means that climate change uncertainty is not presented in the planning tables from 2040 onwards, and the sizes and profiles of climate change impact from 2040 other than for the reported pathway are not available for assessment for the company's water resource zones.

10.2 To provide further clarity on the climate change uncertainty, the company should:

- provide the climate change impact on source yield as time series profiles for each water resource zone, for all climate change scenarios used in the adaptive branches from 2040 onwards in the final WRMP24.
- work with us to improve data presentation and provision for climate change impact and uncertainty for WRMP29.

Issue 10.1

Request

10.3 Thames Water should provide the climate change impact on source yield as time series profiles for each water resource zone, for all climate change scenarios used in the adaptive branches from 2040 onwards in the final WRMP24.

Further elaboration of request given in annex, or clarification given subsequently

10.4 No further elaboration.

Our consideration of the points raised

10.5 We have presented a significant amount of information regarding climate change impacts in Appendix U of our rdWRMP24, and have presented charts which show the climate change impacts for the scenarios used in the adaptive plan (e.g., Figure U-21 for London). We have also included tables of values which show the total impact of climate change on the supply-demand balance through the planning period (e.g., Table U-10). However, to ensure that all information is provided we are able to present charts with climate change impacts for all 28 scenarios modelled as well as tabulated information for all scenarios.

Changes made to the rdWRMP24

10.6 We will include the tables below in Appendix U of the rdWMRP24. The values in bold are those included in the preferred programme scenario.

Climate Change DO Impacts (Ml/d) for all Modelled Scenarios, London WRZ								
Year	2025	2030	2035	2040	2045	2050	2060	2075
CC1	-87.91	-121.72	-151.95	-175.63	-193.19	-210.75	-245.88	-298.56
CC2	-88.98	-123.20	-156.91	-186.43	-205.07	-223.71	-261.00	-316.93
CC3	-96.25	-133.28	-161.82	-177.88	-195.66	-213.45	-249.03	-302.39

CC4	-44.01	-60.94	-68.89	-74.93	-82.43	-89.92	-104.91	-127.39
CC5	-55.25	-76.50	-90.31	-101.15	-111.26	-121.37	-141.60	-171.95
CC6	-66.38	-91.91	-103.75	-104.98	-115.48	-125.98	-146.98	-178.47
CC7	-19.43	-26.90	-24.41	-24.33	-26.76	-29.20	-34.06	-41.36
CC8	-45.46	-62.95	-67.47	-66.37	-73.01	-79.65	-92.92	-112.84
CC9	-48.56	-67.23	-68.76	-60.48	-66.53	-72.58	-84.68	-102.82
CC10	-65.89	-91.23	-107.76	-117.92	-129.71	-141.50	-165.09	-200.46
CC11	-58.24	-80.64	-93.94	-102.25	-112.47	-122.69	-143.14	-173.82
CC12	-31.19	-43.18	-40.35	-33.32	-36.66	-39.99	-46.65	-56.65
CC13	-71.01	-98.32	-113.64	-118.83	-130.71	-142.59	-166.36	-202.00
CC14	-60.79	-84.17	-96.88	-102.71	-112.98	-123.25	-143.79	-174.61
CC15	-11.55	-15.99	-2.00	15.12	16.63	18.14	21.17	25.70
CC16	2.23	3.08	-7.94	-30.17	-33.18	-36.20	-42.23	-51.28
CC17	-28.34	-39.23	-46.46	-59.58	-65.54	-71.50	-83.41	-101.29
CC18	-31.32	-43.36	-53.92	-71.59	-78.74	-85.90	-100.22	-121.70
CC19	-23.35	-32.33	-30.90	-30.70	-33.76	-36.83	-42.97	-52.18
CC20	-26.51	-36.71	-44.28	-59.00	-64.90	-70.81	-82.61	-100.31
CC21	-4.15	-5.74	-9.72	-29.79	-32.77	-35.75	-41.71	-50.65
CC22	3.10	4.29	6.96	-4.74	-5.22	-5.69	-6.64	-8.06
CC23	21.96	30.41	53.07	68.22	75.04	81.86	95.51	115.98
CC24	-51.51	-71.32	-89.75	-111.13	-122.25	-133.36	-155.59	-188.93
CC25	-28.87	-39.98	-48.65	-64.14	-70.55	-76.97	-89.80	-109.04
CC26	-63.88	-88.45	-111.71	-135.38	-148.92	-162.46	-189.53	-230.15
CC27	-30.59	-42.36	-56.70	-81.74	-89.91	-98.09	-114.44	-138.96
CC28	-27.94	-38.69	-27.26	-60.32	-66.35	-72.39	-84.45	-102.55
Low (CC7)	-19.43	-26.90	-24.41	-24.33	-26.76	-29.20	-34.06	-41.36
Median	**-37.66**	**-52.15**	**-62.08**	-68.98	-75.88	-82.78	-96.57	-117.27
High (CC6)	-66.38	-91.91	-103.75	**-104.98**	**-115.48**	**-125.98**	**-146.98**	**-178.47**

Climate Change DO Impacts for all Modelled Scenarios, SWOX WRZ DYAA								
	2025	2030	2035	2040	2045	2050	2060	2075
CC1	-5.17	-7.16	-9.23	-10.49	-11.54	-12.58	-14.68	-17.83
CC2	-4.68	-6.49	-8.72	-10.52	-11.57	-12.62	-14.72	-17.88
CC3	-6.31	-8.74	-10.67	-11.05	-12.15	-13.26	-15.47	-18.78
CC4	-3.02	-4.18	-5.32	-5.99	-6.59	-7.19	-8.39	-10.19
CC5	-3.47	-4.80	-6.34	-7.51	-8.26	-9.01	-10.51	-12.76
CC6	-4.88	-6.76	-8.13	-8.24	-9.06	-9.89	-11.53	-14.00
CC7	-1.65	-2.28	-2.91	-3.37	-3.71	-4.05	-4.72	-5.74
CC8	-3.41	-4.72	-5.74	-5.99	-6.59	-7.19	-8.38	-10.18
CC9	-3.68	-5.10	-6.04	-5.99	-6.59	-7.19	-8.39	-10.19

CC10	-4.62	-6.40	-7.98	-8.62	-9.48	-10.34	-12.06	-14.65
CC11	-3.91	-5.41	-6.85	-7.61	-8.37	-9.13	-10.66	-12.94
CC12	-2.02	-2.80	-3.69	-4.44	-4.89	-5.33	-6.22	-7.56
CC13	-5.45	-7.55	-9.13	-9.31	-10.24	-11.17	-13.03	-15.82
CC14	-3.94	-5.45	-6.65	-6.95	-7.65	-8.34	-9.73	-11.82
CC15	-1.92	-2.66	-2.80	-2.22	-2.45	-2.67	-3.11	-3.78
CC16	-0.21	-0.30	-3.66	-2.05	-2.26	-2.46	-2.87	-3.49
CC17	-2.35	-3.25	-3.85	-3.82	-4.20	-4.58	-5.35	-6.49
CC18	-2.19	-3.03	-4.10	-5.12	-5.63	-6.14	-7.16	-8.70
CC19	-1.67	-2.31	-3.05	-3.73	-4.10	-4.47	-5.22	-6.34
CC20	-1.54	-2.13	-2.87	-3.60	-3.96	-4.32	-5.04	-6.11
CC21	-0.47	-0.65	-0.57	-2.37	-2.61	-2.85	-3.32	-4.03
CC22	1.04	1.44	0.57	0.88	0.97	1.06	1.24	1.50
CC23	0.67	0.93	2.10	5.01	5.51	6.01	7.01	8.52
CC24	-3.48	-4.82	-4.42	-4.72	-5.19	-5.66	-6.60	-8.02
CC25	-1.85	-2.56	-2.50	-3.82	-4.20	-4.58	-5.35	-6.49
CC26	-3.46	-4.80	-6.39	-7.65	-8.42	-9.18	-10.71	-13.01
CC27	-1.97	-2.73	-3.28	-4.70	-5.17	-5.64	-6.58	-7.99
CC28	-2.10	-2.91	-4.42	-4.42	-4.87	-5.31	-6.19	-7.52
Low (CC7)	-1.65	-2.28	-2.91	-3.37	-3.71	-4.05	-4.72	-5.74
Median	**-2.68**	**-3.72**	**-4.42**	-4.92	-5.41	-5.90	-6.88	-8.36
High (CC6)	-4.88	-6.76	-8.13	**-8.24**	**-9.06**	**-9.89**	**-11.53**	**-14.00**

Climate Change DO Impacts for all Modelled Scenarios, SWOX WRZ, DYCP Scenario								
	2025	2030	2035	2040	2045	2050	2060	2075
CC1	-5.17	-7.16	-9.23	-10.49	-11.54	-12.58	-14.68	-17.83
CC2	-4.68	-6.49	-8.72	-10.52	-11.57	-12.62	-14.72	-17.88
CC3	-6.31	-8.74	-10.67	-11.05	-12.15	-13.26	-15.47	-18.78
CC4	-3.02	-4.18	-5.32	-5.99	-6.59	-7.19	-8.39	-10.19
CC5	-3.47	-4.80	-6.34	-7.51	-8.26	-9.01	-10.51	-12.76
CC6	-4.88	-6.76	-8.13	-8.24	-9.06	-9.89	-11.53	-14.00
CC7	-1.65	-2.28	-2.91	-3.37	-3.71	-4.05	-4.72	-5.74
CC8	-3.41	-4.72	-5.74	-5.99	-6.59	-7.19	-8.38	-10.18
CC9	-3.68	-5.10	-6.04	-5.99	-6.59	-7.19	-8.39	-10.19
CC10	-4.62	-6.40	-7.98	-8.62	-9.48	-10.34	-12.06	-14.65
CC11	-3.91	-5.41	-6.85	-7.61	-8.37	-9.13	-10.66	-12.94
CC12	-2.02	-2.80	-3.69	-4.44	-4.89	-5.33	-6.22	-7.56
CC13	-5.45	-7.55	-9.13	-9.31	-10.24	-11.17	-13.03	-15.82
CC14	-3.94	-5.45	-6.65	-6.95	-7.65	-8.34	-9.73	-11.82
CC15	-1.92	-2.66	-2.80	-2.22	-2.45	-2.67	-3.11	-3.78
CC16	-0.21	-0.30	-3.66	-2.05	-2.26	-2.46	-2.87	-3.49
CC17	-2.35	-3.25	-3.85	-3.82	-4.20	-4.58	-5.35	-6.49

CC18	-2.19	-3.03	-4.10	-5.12	-5.63	-6.14	-7.16	-8.70
CC19	-1.67	-2.31	-3.05	-3.73	-4.10	-4.47	-5.22	-6.34
CC20	-1.54	-2.13	-2.87	-3.60	-3.96	-4.32	-5.04	-6.11
CC21	-0.47	-0.65	-0.57	-2.37	-2.61	-2.85	-3.32	-4.03
CC22	1.04	1.44	0.57	0.88	0.97	1.06	1.24	1.50
CC23	0.67	0.93	2.10	5.01	5.51	6.01	7.01	8.52
CC24	-3.48	-4.82	-4.42	-4.72	-5.19	-5.66	-6.60	-8.02
CC25	-1.85	-2.56	-2.50	-3.82	-4.20	-4.58	-5.35	-6.49
CC26	-3.46	-4.80	-6.39	-7.65	-8.42	-9.18	-10.71	-13.01
CC27	-1.97	-2.73	-3.28	-4.70	-5.17	-5.64	-6.58	-7.99
CC28	-2.10	-2.91	-4.42	-4.42	-4.87	-5.31	-6.19	-7.52
Low (CC7)	-1.65	-2.28	-2.91	-3.37	-3.71	-4.05	-4.72	-5.74
Median	**-2.68**	**-3.72**	**-4.42**	-4.92	-5.41	-5.90	-6.88	-8.36
High (CC6)	-4.88	-6.76	-8.13	**-8.24**	**-9.06**	**-9.89**	**-11.53**	**-14.00**

Climate Change DO Impacts for all Modelled Scenarios, KV WRZ DYAA								
Year	2025	2030	2035	2040	2045	2050	2060	2075
CC1	-2.38	-3.29	-5.74	-4.16	-4.58	-4.99	-5.83	-7.08
CC2	-2.40	-3.32	-5.17	-3.55	-3.91	-4.26	-4.97	-6.04
CC3	-2.15	-2.98	-5.29	-3.61	-3.97	-4.33	-5.06	-6.14
CC4	-1.76	-2.43	-4.24	-2.32	-2.56	-2.79	-3.25	-3.95
CC5	-1.76	-2.44	-4.57	-2.73	-3.00	-3.27	-3.82	-4.63
CC6	-1.93	-2.67	-4.51	-2.91	-3.21	-3.50	-4.08	-4.95
CC7	0.58	0.80	1.84	-1.94	-2.14	-2.33	-2.72	-3.31
CC8	-1.02	-1.41	-1.73	-2.70	-2.97	-3.25	-3.79	-4.60
CC9	-1.56	-2.16	-1.21	-2.40	-2.63	-2.87	-3.35	-4.07
CC10	-1.97	-2.73	-4.39	-3.03	-3.34	-3.64	-4.25	-5.15
CC11	-1.81	-2.51	-4.19	-2.40	-2.65	-2.89	-3.37	-4.09
CC12	-0.84	-1.16	-0.16	-2.51	-2.76	-3.01	-3.51	-4.26
CC13	-1.88	-2.60	-4.34	-2.94	-3.24	-3.53	-4.12	-5.00
CC14	-1.80	-2.49	-4.46	-2.59	-2.85	-3.11	-3.63	-4.40
CC15	1.20	1.66	5.81	2.55	2.81	3.06	3.57	4.34
CC16	3.37	4.67	-1.07	1.41	1.55	1.69	1.97	2.39
CC17	0.58	0.81	0.23	-1.18	-1.30	-1.42	-1.66	-2.01
CC18	-0.07	-0.10	-1.73	-0.07	-0.08	-0.09	-0.10	-0.12
CC19	0.31	0.42	2.55	-1.38	-1.51	-1.65	-1.93	-2.34
CC20	0.27	0.37	-1.31	-1.93	-2.12	-2.31	-2.70	-3.27
CC21	0.82	1.13	-2.40	-1.53	-1.69	-1.84	-2.15	-2.61
CC22	2.36	3.27	-0.83	1.30	1.42	1.55	1.81	2.20
CC23	5.65	7.83	9.65	6.39	7.02	7.66	8.94	10.86
CC24	-1.77	-2.45	-4.04	-2.62	-2.89	-3.15	-3.67	-4.46
CC25	-0.36	-0.50	-1.85	-2.12	-2.33	-2.54	-2.97	-3.60

CC26	-2.10	-2.90	-4.98	-3.23	-3.56	-3.88	-4.53	-5.50
CC27	-1.67	-2.32	-4.13	-2.18	-2.40	-2.62	-3.06	-3.71
CC28	0.02	0.03	0.50	-1.78	-1.96	-2.14	-2.49	-3.03
Low (CC7)	0.58	0.80	1.84	-1.94	-2.14	-2.33	-2.72	-3.31
Median	**-1.29**	**-1.78**	**-2.12**	-2.36	-2.60	-2.83	-3.30	-4.01
High (CC6)	-1.93	-2.67	-4.51	**-2.91**	**-3.21**	**-3.50**	**-4.08**	**-4.95**

Climate Change DO Impacts for all Modelled Scenarios, KV WRZ DYCP								
	2025	2030	2035	2040	2045	2050	2060	2075
CC1	-8.34	-11.55	-11.72	-9.00	-9.90	-10.79	-12.59	-15.29
CC2	-7.83	-10.85	-10.77	-7.98	-8.78	-9.58	-11.17	-13.57
CC3	-7.92	-10.96	-9.73	-7.89	-8.68	-9.47	-11.05	-13.41
CC4	-4.20	-5.81	-6.64	-7.16	-7.87	-8.59	-10.02	-12.17
CC5	-4.72	-6.53	-7.24	-7.46	-8.21	-8.95	-10.44	-12.68
CC6	-5.80	-8.02	-8.27	-7.09	-7.80	-8.51	-9.93	-12.06
CC7	-0.30	-0.42	-0.12	-2.35	-2.58	-2.82	-3.29	-3.99
CC8	-1.77	-2.45	-4.30	-6.50	-7.15	-7.80	-9.10	-11.05
CC9	-2.85	-3.95	-3.69	-3.99	-4.39	-4.79	-5.59	-6.78
CC10	-6.45	-8.93	-9.53	-6.78	-7.46	-8.13	-9.49	-11.52
CC11	-3.73	-5.17	-5.74	-7.14	-7.85	-8.57	-9.99	-12.13
CC12	-2.83	-3.91	-3.78	-3.58	-3.93	-4.29	-5.01	-6.08
CC13	-5.68	-7.86	-7.70	-6.76	-7.43	-8.11	-9.46	-11.49
CC14	-3.40	-4.71	-6.02	-7.18	-7.89	-8.61	-10.05	-12.20
CC15	0.10	0.14	2.13	-2.63	-2.89	-3.16	-3.68	-4.47
CC16	-3.40	-4.71	-4.43	-5.55	-6.10	-6.66	-7.77	-9.43
CC17	-2.08	-2.88	-3.23	-3.57	-3.93	-4.28	-5.00	-6.07
CC18	-3.50	-4.85	-4.57	-4.14	-4.56	-4.97	-5.80	-7.04
CC19	-1.00	-1.38	-1.79	-2.05	-2.26	-2.47	-2.88	-3.49
CC20	-2.85	-3.94	-3.65	-5.04	-5.55	-6.05	-7.06	-8.57
CC21	-3.38	-4.68	-5.81	-5.96	-6.55	-7.15	-8.34	-10.13
CC22	-2.23	-3.09	-2.50	-4.61	-5.07	-5.53	-6.46	-7.84
CC23	0.39	0.54	5.45	5.90	6.49	7.08	8.26	10.03
CC24	-4.10	-5.67	-7.35	-7.18	-7.90	-8.62	-10.05	-12.21
CC25	-2.55	-3.53	-5.47	-5.52	-6.07	-6.62	-7.72	-9.38
CC26	-6.14	-8.50	-8.66	-7.91	-8.70	-9.49	-11.08	-13.45
CC27	-4.78	-6.62	-7.81	-7.26	-7.98	-8.71	-10.16	-12.34
CC28	-1.98	-2.74	-3.82	-3.09	-3.40	-3.71	-4.33	-5.26
Low (CC7)	-0.30	-0.42	-0.12	-2.35	-2.58	-2.82	-3.29	-3.99
Median	**-3.40**	**-4.71**	**-5.61**	-6.23	-6.85	-7.47	-8.72	-10.59
High (CC6)	-5.80	-8.02	-8.27	**-7.09**	**-7.80**	**-8.51**	**-9.93**	**-12.06**

Climate Change DO Impacts for all Modelled Scenarios, SWA WRZ DYAA								
Year	2025	2030	2035	2040	2045	2050	2060	2075
CC1	-0.10	-0.13	-0.17	-0.19	-0.21	-0.22	-0.26	-0.32
CC2	-0.10	-0.14	-0.19	-0.18	-0.19	-0.21	-0.25	-0.30
CC3	-0.12	-0.17	-0.22	-0.23	-0.26	-0.28	-0.32	-0.39
CC4	-0.07	-0.10	-0.12	-0.15	-0.16	-0.18	-0.20	-0.25
CC5	-0.08	-0.11	-0.13	-0.13	-0.14	-0.15	-0.18	-0.21
CC6	-0.12	-0.17	-0.22	-0.22	-0.24	-0.27	-0.31	-0.38
CC7	-0.02	-0.03	-0.06	-0.07	-0.08	-0.08	-0.10	-0.12
CC8	-0.08	-0.11	-0.13	-0.13	-0.14	-0.16	-0.18	-0.22
CC9	-0.08	-0.11	-0.14	-0.15	-0.16	-0.18	-0.20	-0.25
CC10	-0.11	-0.15	-0.20	-0.19	-0.21	-0.23	-0.27	-0.33
CC11	-0.10	-0.14	-0.17	-0.18	-0.19	-0.21	-0.25	-0.30
CC12	-0.06	-0.08	-0.09	-0.09	-0.10	-0.11	-0.13	-0.15
CC13	-0.12	-0.16	-0.21	-0.22	-0.24	-0.26	-0.30	-0.37
CC14	-0.07	-0.10	-0.13	-0.14	-0.15	-0.16	-0.19	-0.23
CC15	-0.02	-0.03	-0.04	-0.05	-0.05	-0.05	-0.06	-0.08
CC16	0.01	0.01	0.03	-0.02	-0.02	-0.02	-0.02	-0.03
CC17	-0.03	-0.04	-0.07	-0.09	-0.09	-0.10	-0.12	-0.15
CC18	-0.04	-0.06	-0.08	-0.10	-0.11	-0.12	-0.14	-0.17
CC19	-0.01	-0.01	-0.02	-0.04	-0.04	-0.04	-0.05	-0.06
CC20	-0.03	-0.04	-0.05	-0.05	-0.05	-0.05	-0.06	-0.08
CC21	0.02	0.03	0.03	0.00	0.00	0.00	0.00	0.00
CC22	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
CC23	0.03	0.04	0.06	0.07	0.08	0.08	0.10	0.12
CC24	-0.05	-0.07	-0.08	-0.10	-0.11	-0.12	-0.13	-0.16
CC25	-0.02	-0.03	-0.04	-0.05	-0.06	-0.06	-0.07	-0.09
CC26	-0.07	-0.09	-0.11	-0.12	-0.13	-0.15	-0.17	-0.21
CC27	-0.02	-0.03	-0.04	-0.08	-0.08	-0.09	-0.11	-0.13
CC28	-0.02	-0.03	-0.05	-0.07	-0.07	-0.08	-0.09	-0.11
Low (CC7)	-0.02	-0.03	-0.06	-0.07	-0.08	-0.08	-0.10	-0.12
Median	**-0.05**	**-0.07**	**-0.09**	-0.10	-0.11	-0.12	-0.14	-0.17
High (CC6)	-0.12	-0.17	-0.22	**-0.22**	**-0.24**	**-0.27**	**-0.31**	**-0.38**

Climate Change DO Impacts for all Modelled Scenarios, SWA WRZ DYCP								
	2025	2030	2035	2040	2045	2050	2060	2075
CC1	-0.09	-0.12	-0.13	-0.18	-0.20	-0.22	-0.25	-0.31
CC2	-0.10	-0.14	-0.14	-0.18	-0.20	-0.22	-0.25	-0.31
CC3	-0.13	-0.17	-0.19	-0.23	-0.25	-0.27	-0.32	-0.39
CC4	-0.07	-0.10	-0.09	-0.13	-0.14	-0.16	-0.18	-0.22
CC5	-0.07	-0.10	-0.12	-0.13	-0.14	-0.16	-0.18	-0.22
CC6	-0.12	-0.17	-0.18	-0.24	-0.26	-0.28	-0.33	-0.40

CC7	-0.01	-0.02	-0.03	-0.02	-0.02	-0.02	-0.03	-0.03
CC8	-0.07	-0.09	-0.08	-0.12	-0.13	-0.15	-0.17	-0.21
CC9	-0.07	-0.10	-0.09	-0.14	-0.15	-0.16	-0.19	-0.23
CC10	-0.10	-0.14	-0.15	-0.20	-0.22	-0.24	-0.28	-0.34
CC11	-0.10	-0.13	-0.14	-0.19	-0.21	-0.22	-0.26	-0.32
CC12	-0.03	-0.05	-0.07	-0.07	-0.08	-0.08	-0.10	-0.12
CC13	-0.11	-0.16	-0.17	-0.21	-0.23	-0.25	-0.30	-0.36
CC14	-0.07	-0.10	-0.09	-0.13	-0.14	-0.15	-0.18	-0.21
CC15	-0.02	-0.02	-0.05	-0.03	-0.03	-0.04	-0.04	-0.05
CC16	0.00	0.00	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03
CC17	-0.05	-0.06	-0.10	-0.08	-0.09	-0.10	-0.11	-0.14
CC18	-0.06	-0.08	-0.13	-0.11	-0.12	-0.13	-0.15	-0.18
CC19	0.00	0.00	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02
CC20	-0.03	-0.04	-0.07	-0.05	-0.06	-0.06	-0.07	-0.09
CC21	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05
CC22	0.00	0.01	-0.01	0.02	0.02	0.02	0.02	0.03
CC23	0.02	0.03	0.08	0.11	0.12	0.13	0.16	0.19
CC24	-0.04	-0.06	-0.08	-0.09	-0.09	-0.10	-0.12	-0.15
CC25	-0.02	-0.02	-0.05	-0.04	-0.04	-0.04	-0.05	-0.06
CC26	-0.07	-0.09	-0.14	-0.13	-0.14	-0.15	-0.18	-0.21
CC27	-0.03	-0.04	-0.07	-0.08	-0.08	-0.09	-0.11	-0.13
CC28	-0.02	-0.03	-0.06	-0.06	-0.06	-0.07	-0.08	-0.09
Low (CC7)	-0.01	-0.02	-0.03	-0.02	-0.02	-0.02	-0.03	-0.03
Median	**-0.05**	**-0.07**	**-0.09**	-0.10	-0.11	-0.12	-0.13	-0.16
High (CC6)	-0.12	-0.17	-0.18	**-0.24**	**-0.26**	**-0.28**	**-0.33**	**-0.40**

10.7 We will include the charts below in Appendix U of the rdWMRP24.

10.8 For each chart we will include text to state that the figure shows climate change impacts for all scenarios considered within the adaptive plan. We will also note that the grey lines are individual scenarios, the black line is the impact included in the preferred plan, and the coloured lines are the High, Median and Low scenarios.

10.9 For each chart, we will include a footnote to state that the values are 1 in 100-year DO impacts until 2032, 1 in 200-year DO impacts from 2033 until 2039, and 1 in 500-year DO impacts from 2040 onwards.

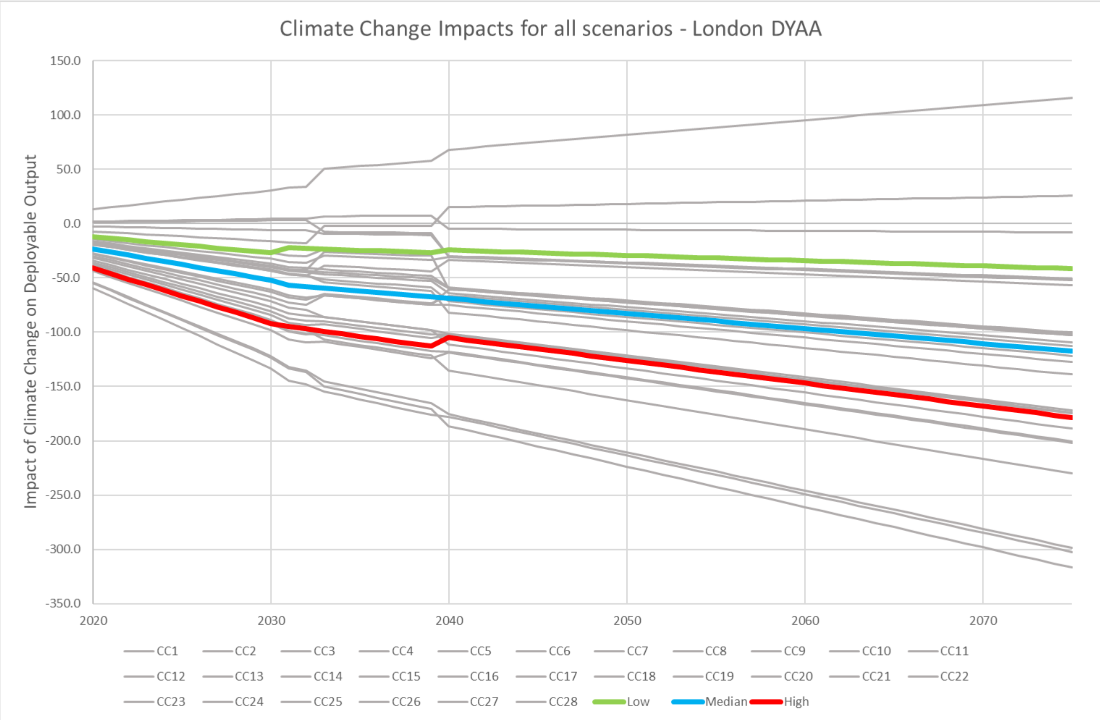


Figure 10-1: London DYAA Climate Change Impacts

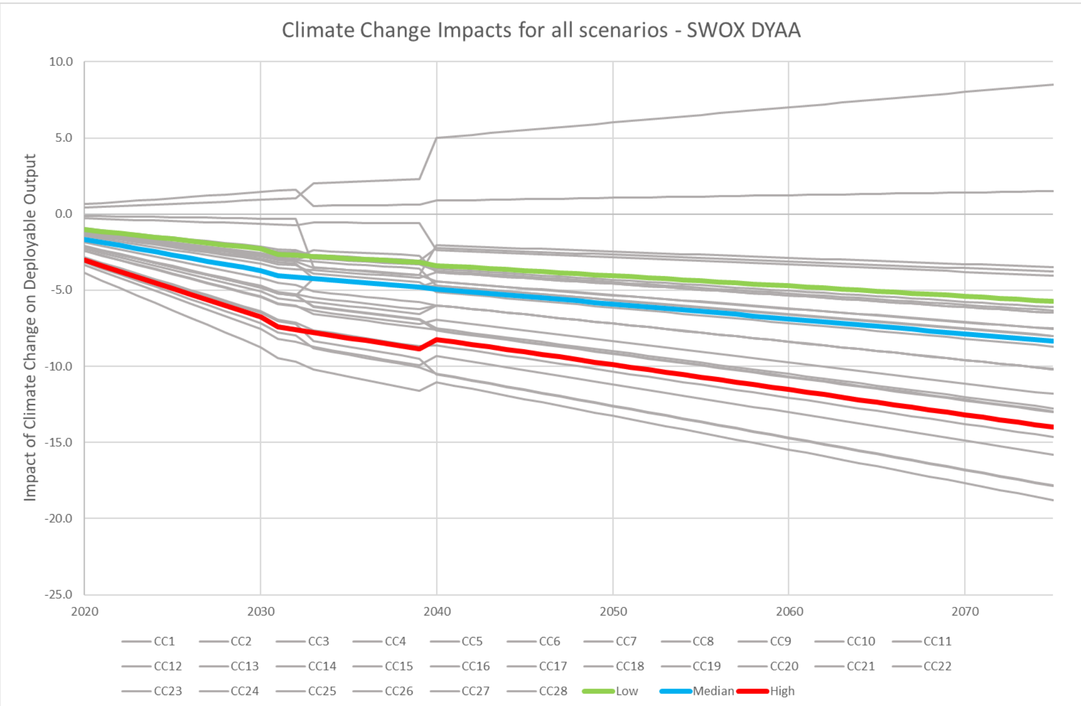


Figure 10-2: SWOX DYAA Climate Change Impacts

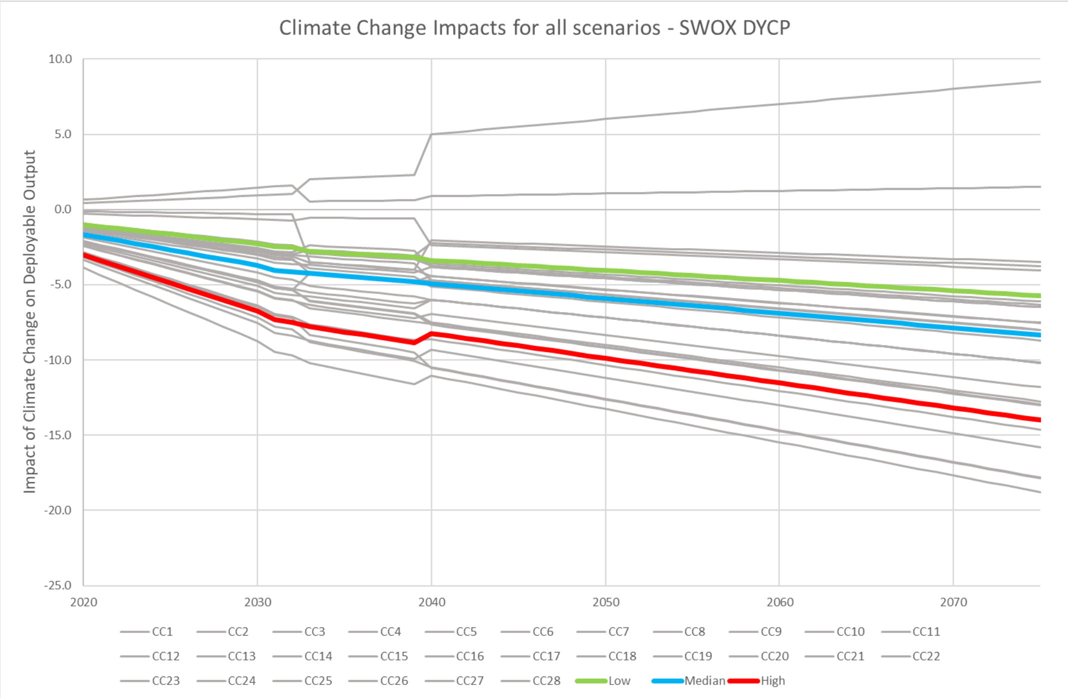


Figure 10-3: SWOX DYCP Climate Change Impacts

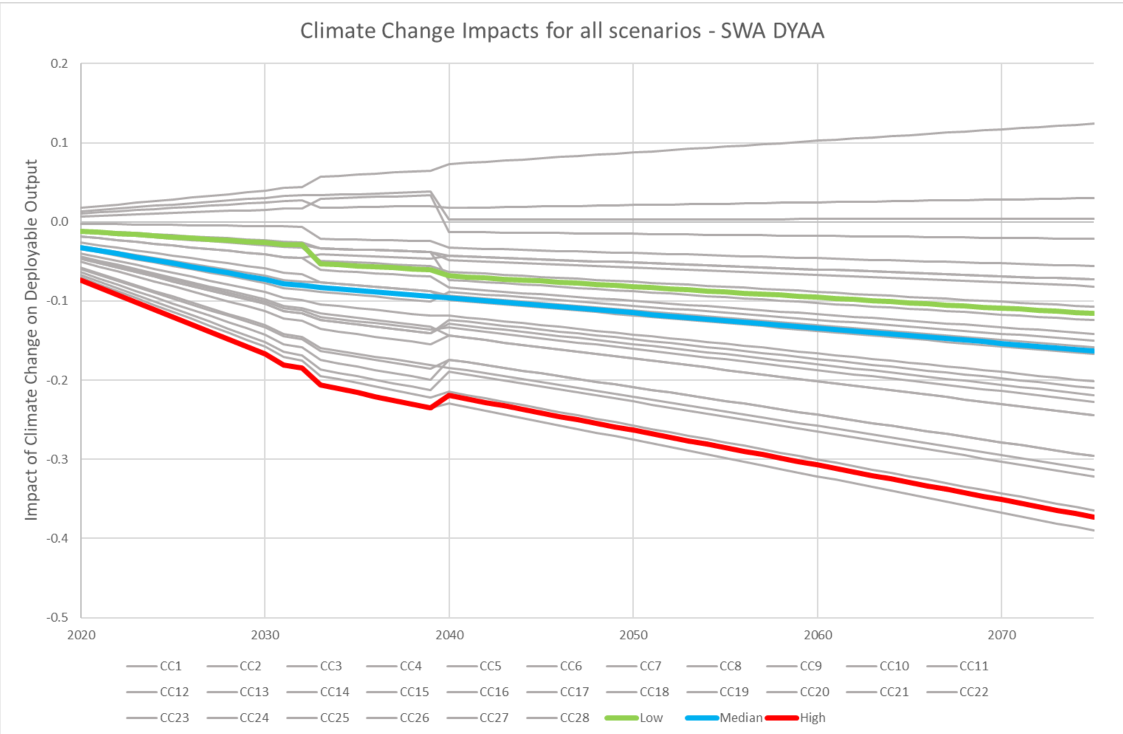


Figure 10-4: SWA DYAA Climate Change Impacts

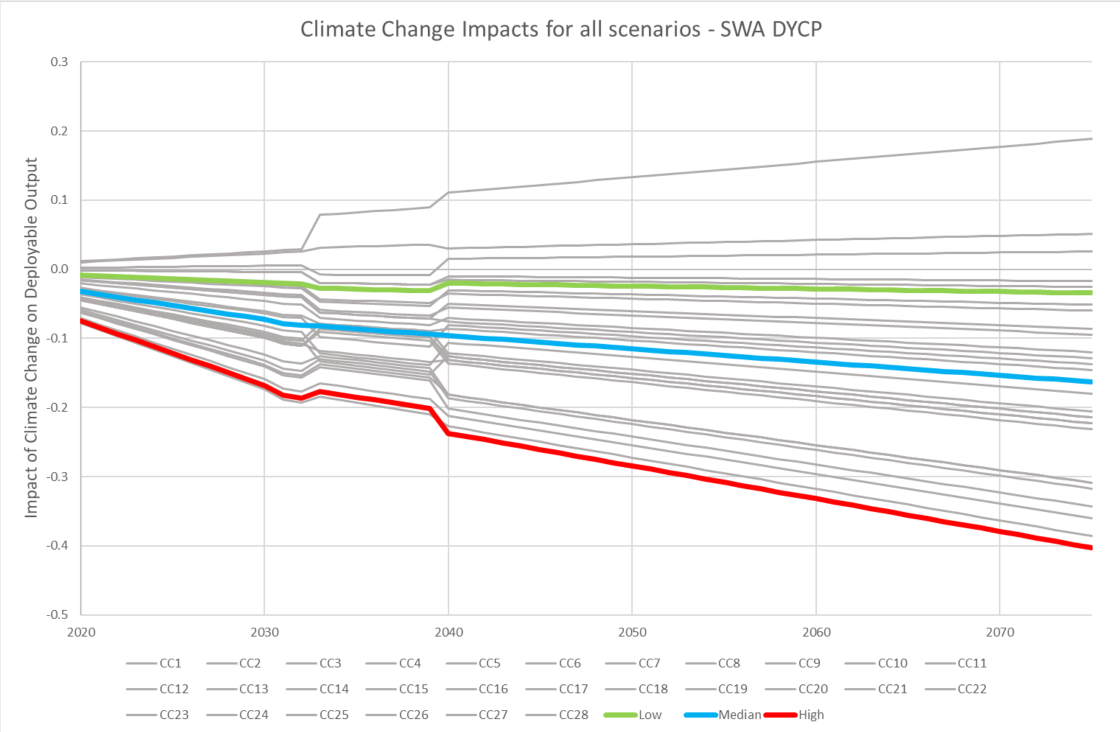


Figure 10-5: SWA DYCP Climate Change Impacts

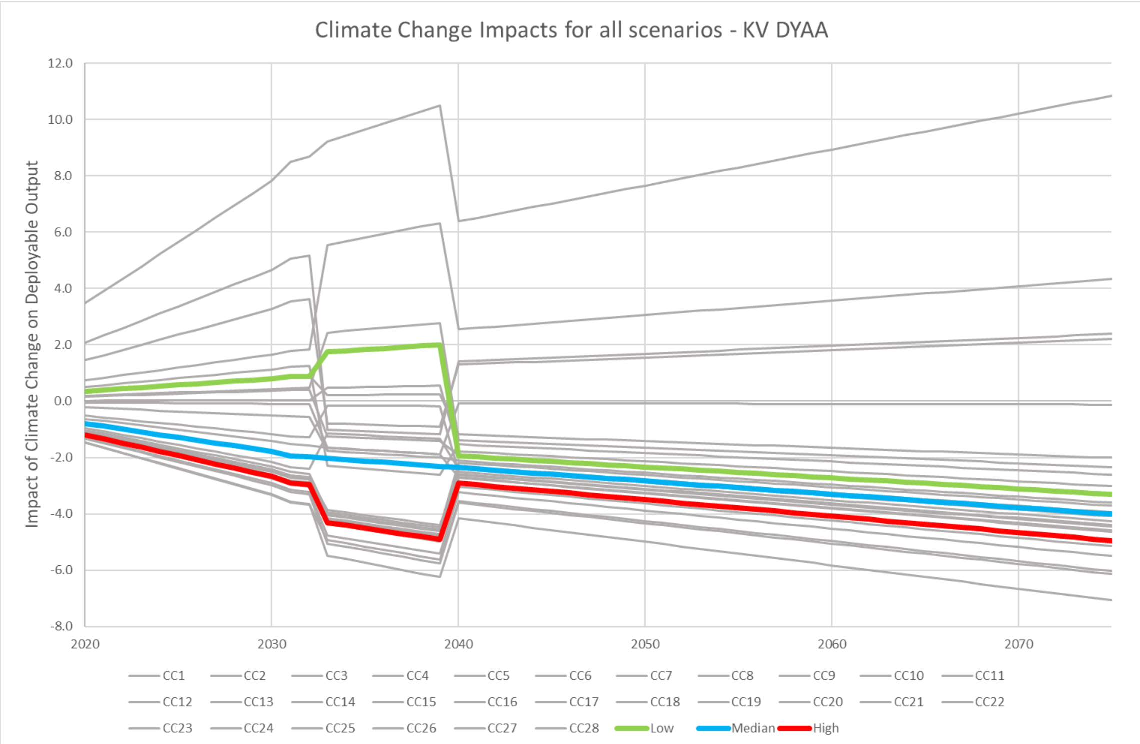


Figure 10-6: Kennet Valley DYAA Climate Change Impacts

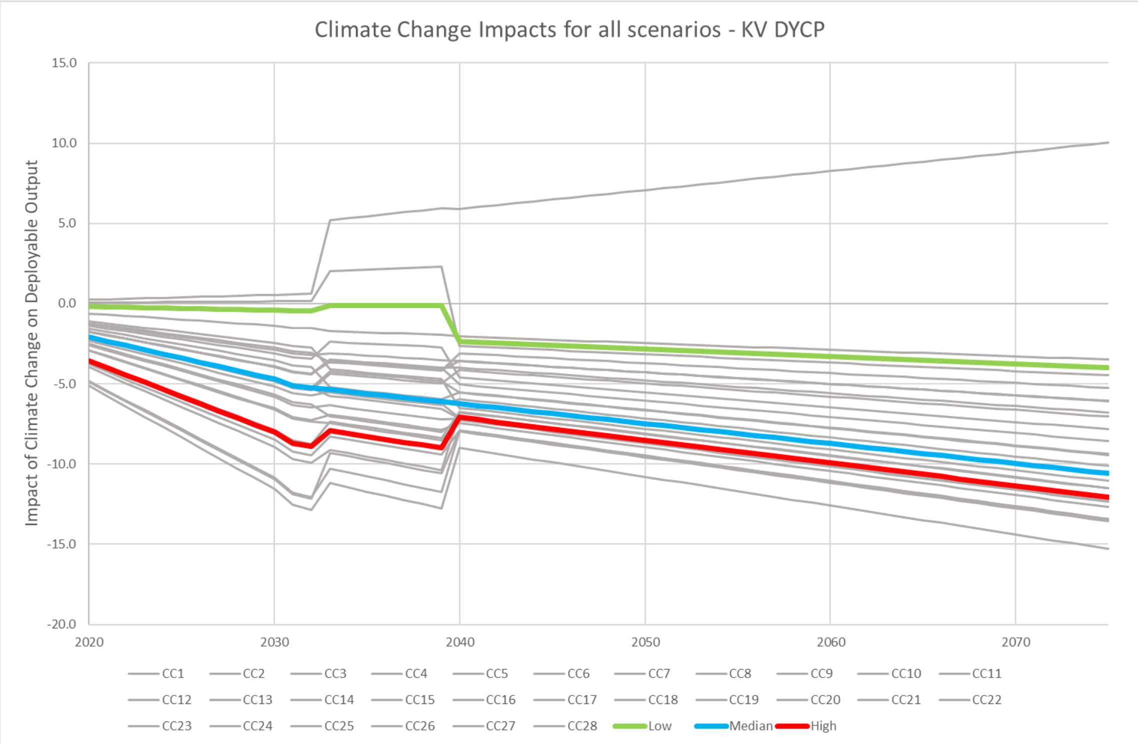


Figure 10-7: Kennet Valley DYCP Climate Change Impacts

Issue 10.2

Request

10.10 Thames Water should work with us to improve data presentation and provision for climate change impact and uncertainty for WRMP29.

Further elaboration of request given in annex, or clarification given subsequently

10.11 No further elaboration.

Our consideration of the points raised

10.12 We look forward to continuing to work with our regulators to ensure a clear representation of the impacts and uncertainty associated with climate change.

Changes made to the rdWRMP24

10.13 We will include the following text in Appendix U of WRMP24:

10.14 Climate change is a complex topic, and, as demonstrated in this chapter, significant uncertainty exists around climate change impacts on Deployable Output. We will continue to work with our regulators to improve the presentation and communication of climate change impacts and uncertainty.

Issue 11: Justify some elements of its option selection

11.1 Ofwat has identified a number of areas where the company should provide further justification for its decision-making. The company should:

- explain why it has chosen the Advanced District Meter Area Medium option when the low, medium and high options have the same Net Present Value and benefit.
- provide sufficient evidence as to why smart meter roll-out costs are best value in relation to benefits gained.
- provide detailed information on specific research undertaken with customers for acceptability in reducing levels of service for temporary use bans. The statement that this aligns with WRSE is not appropriate evidence for a reduction in resilience levels. The company must also explain the acceptability of the 1 in 200 year resilience not being achieved until 2032 as most options selected by the company do not deliver benefits until after AMP8.
- provide evidence in the final WRMP that accelerating the metering strategy is the optimal option. The company's strategy and justification in the final WRMP must align with final PR24 business plans.
- demonstrate in its business plans and final WRMP that where interconnectors are necessary to deliver new supplies to areas of demand, that the decision-making process has taken account of the combined cost of developing the new supplies and the interconnectors and does not double-count the benefits gained.
- demonstrate how the benefits for the metering programme are derived and evidence to support any assumptions made. The company should provide clear evidence of how the benefits of its metering programme have been included in per capita consumption forecasts.
- provide clear commentary, evidence and justification for the best value and regional benefit gained by the investment model selecting options that, in Average Incremental Cost terms, may not be the lowest cost. The company identifies why smaller options may be of lower unit cost (e.g. expanding current assets) but then doesn't explain why these option types are not explored more in feasible options and selected for the final plan. The concern about the selection of high unit cost schemes, including Strategic Resource Options, over alternatives has only been partially addressed.
- Waterwise asked that the company present the evidence that it tested different leakage reduction strategies with its customers, including the different costs.

Issue 11.1

Request

11.2 Thames Water should explain why it has chosen the Advanced District Meter Area Medium option when the low, medium and high options have the same Net Present Value and benefit.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue OF3

11.3 Ofwat states that DMA option selected in the rdWRMP is ‘high’, as described in Demand Option Section 8.374. It appears that it has been selected for all four demand management programmes as well as in all alternative programmes.

11.4 The tables in the rWRMP24 and report narrative do not distinguish the difference between DMA low, medium or high, as all have same NPV and benefit.

Our consideration of the points raised

11.5 The ‘Advanced DMA Intervention’ option is the same option, with the same costs and benefits, in each of the low/medium/high/high plus programmes due to it being a cost-efficient option that will be necessary and selected for delivery in all scenarios. The selection of the “Advanced DMA High” option is a reflection of the “High” programme having been selected (as described in Section 8 of the rdWRMP24), rather than a “High” variant of the “Advanced DMA intervention” option having been selected. This is described in more detail below.

11.6 As is described in Section 8 of the rdWRMP24, paragraphs 8.355-8.385, we have created four demand programmes to be considered within our WRMP24 programme appraisal. Each of these programmes aggregates individual interventions in order to achieve set aims in the most cost-effective way. The aims of each of the four programmes are detailed in the table below (Table 8-54 from rdWRMP24 Section 8).

Programme	Leakage	PCC*	Business/NHH Consumption
Low	Reduced to 50% of 2017/18 level by 2049/50	N/A	N/A
Medium	Reduced to 50% of 2017/18 level by 2049/50	Reduced to 110l/h/d PCC by 2049/50	N/A
High	Reduced to 50% of 2017/18 level by 2049/50	Reduced to 110l/h/d PCC by 2049/50	Reduced by 9% of 2019/20 level by 2049/50
High+	Reduced to 50% of 2017/18 level by 2037/38	Reduced to 110l/h/d PCC by 2049/50	Reduced by 9% of 2019/20 level by 2049/50

Table 8-54: Targets for programmes

11.7 The Advanced DMA intervention involves activities such as designing DMAs in order to pinpoint leakage, installing acoustic loggers, replacing service pipes, pressure management (calm systems) activities, and find and fix. The aim of the intervention is to optimise DMA design and operation, in order to efficiently identify and fix leaks.

11.8 Given that all four demand programmes include the aim of achieving 50% leakage reduction, which will be challenging and expensive to achieve (and will rely on a significant volume of leakage reduction to come from mains rehabilitation and innovative reduction methods), each programme concentrates initially on the most efficient leakage reduction activities. These are customer-side leakage reduction (enabled by smart meter installation) and Advanced DMA intervention. As is stated in paragraph 8.360, only two options are varied within the demand management programmes (leakage innovation and mains rehabilitation), as achieving 50% leakage reduction involves maximising delivery of all other interventions.

11.9 The bulleted list below rdWRMP24 paragraph 8.358 and Table 8-55 identifies Advanced DMA intervention as an "All-or-nothing" option, which is described as being an option which is cost-effective compared to other options in aiming for programme-level targets as specified in Table 8-54. This is intended to explain that, if a given programme aims to achieve a set target (e.g., 50% leakage reduction), then it should definitely contain that option as alternatives are less cost-effective.

11.10 As such, within each demand management programme we have included what we consider to be the deliverable volume of leakage reduction through the Advanced DMA intervention, as any programme aiming to deliver >50% leakage reduction should include this option. Delivery of less than the included volume would result in a programme which is not cost-efficient (relying on more mains rehabilitation), while relying on delivery of more than the included reduction volume may result in deliverability concerns.

11.11 Under the preferred plan, the chosen demand management programme is the "High" programme (see Section 8 report, Modelling section), as this achieves the policy aims regarding leakage reduction, PCC reduction and NHH demand reduction. Additional reduction on top of these aims (i.e., adoption of the High+ scenario) is shown to be cost inefficient in the rdWRMP24.

11.12 For consistency with the Water Resources South East regional group and due to the requirements of the WRSE investment model, we have included individual intervention-level information within our WRMP Tables for each option within each of the four programmes (e.g., as noted in this request for information, we have included options of "Advanced DMA Intervention Low", "Advanced DMA Intervention Medium", "Advanced DMA Intervention High" and "Advanced DMA Intervention High+"). As explained, the Advanced DMA Intervention option would be the same under each of the four programmes and so the interventions listed in the WRMP Tables are effectively duplicates.

11.13 In summary, the 'Advanced DMA Intervention', whether labelled as "Low", "Medium", "High", or "High plus" is the same option, with the same costs and benefits. Its selection in each programme is due to it being a cost efficient option that will be necessary and efficient for delivery in all scenarios. The selection of the "Advanced DMA High" option is a reflection of the "High" programme having been selected, rather than a "High" variant of the "Advanced DMA intervention" option having been selected.

Changes made to the rdWRMP24

11.14 We will add the following footnote within rdWRMP24, Section 8:

11.15 Please note that, in order to ensure consistency with the Water Resources South East regional group and due to the requirements of the WRSE investment model, we have included individual intervention-level information within our WRMP Tables for each option within each of the four programmes (e.g., we have included options of "Advanced DMA Intervention Low", "Advanced DMA Intervention Medium", "Advanced DMA Intervention High" and "Advanced DMA Intervention High+"). In the case of "All-or-nothing" options, this will mean that these options will *either have no associated cost and no associated benefit, or may appear as options with benefits and costs which are identical to one another.*

11.16 We will add the following information in the Data Tables Supplementary Note:

Table & Row	Clarification, or Deviation & Explanation
Table 4, Table 5, Table 5a, Table 5b	*Demand Options – clarification* *Demand options have been aggregated into four programmes (Low, Medium, High and High+), as described in the "Modelling" sub-section of WRMP24 Section 8. Each intervention within each programme has been included as a separate option within our WRMP Tables.* *However, as is described in the "Modelling" sub-section of WRMP24 Section 8, some options are not considered within some programmes (e.g. the Low programme excludes "innovation" options), while some other interventions are considered "all-or-nothing" options. These "all-or-nothing" interventions are either not included in a given programme (according to the aims of the programme – e.g., the "Low" programme does not aim to meet the 110 l/h/d PCC target and so excludes "Household Innovation and Tariffs") or they are included in full (as these options are cost-effective compared to alternatives, for example the Advanced DMA intervention is included in all programmes which aim to achieve 50% leakage reduction).* *As above, within the WRMP Tables we have included an option for each intervention within each programme. With some options being either "all or nothing" or excluded from some programmes, in some cases, demand management options with no benefit and no cost are included (e.g., "Household Innovation and Tariffs Low" has no benefit and no cost as the Household Innovation and Tariffs Option is not included in the Low demand programme), while in other cases the same option appears as part of different programmes (e.g., the Advanced DMA Intervention option is duplicated as Advanced DMA Intervention Low, Advanced DMA Intervention Medium, Advanced DMA Intervention High, and Advanced DMA Intervention High+).*

Issue 11.2

Request

11.17 Thames Water should provide sufficient evidence as to why smart meter roll-out costs are best value in relation to benefits gained.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue OF4

11.18 Ofwat queries the assumed savings from metering (especially smart metering) in order to estimate the savings expected from future activities. The company does not provide any further information on how this is efficient, and states that this will be provided in PR24 business plan.

Our consideration of the points raised

11.19 Demonstrating that our smart metering programme is best value in relation to the benefits gained requires consideration of four aspects:

- The benefits calculated to be derived from the installation of smart meters
- The costs of rolling out the smart metering programme
- Identifying the other demand reduction activities which are enabled by the installation of smart meters and calculating the benefits of these activities
- A comparison with alternatives

11.20 In summary:

- The calculations undertaken to identify benefits which will be derived from the installation of smart meters, and the underlying assumptions, are already documented in Section 8 of our rdWRMP24.
- Our PR24 business plan documents the detailed cost calculations which have been performed in order to determine the cost of delivering the smart meter programme, and describes why these costs are efficient.
- Several very efficient household and non-household demand reduction activities are enabled by the installation of smart meters. When determining whether smart metering presents best value for customers, it is important to recognise the activities which would not be possible if smart metering were not undertaken.
- When accounting for the enabled activities, our smart metering programme clearly presents best value to customers in comparison to alternatives. Additionally, when recognising that our demand management programme must be designed to hit the targets of 50% leakage reduction and 110 l/h/d PCC, it is important to recognise that smart metering and enabled activities will be necessary.

Calculating Benefits

11.21 From the information provided by Ofwat it is not possible to identify in what respect Ofwat query the assumed savings from smart metering.

11.22 Our smart metering programme has gone through a number of assessment processes, not limited to WRMP14, WRMP19, PR14 and PR19, all underpinned by Defra's approval for the Progressive Metering Programme (compulsory installations on unmeasured households). These previous assessment processes included evidence of programme costs and benefits, broken down into their component parts and installation types.

11.23 Section 8 *Appraisal of demand options* of our WRMP submission also documents the calculations which underpin the metering benefit. Broadly, based on analysis undertaken by Artesia consulting (see Issue 11.6), the installation of a water meter (whether smart or not) alone results in a consumption reduction of 13%; resulting Ml/d benefit values are determined by considering the housing stock and existing consumption levels. The additional benefit derived from a smart meter is associated with the enabled activities (see below), such as CSL reduction, Smarter Home Visits, Smarter Business Visits and digital tools.

Costs

11.24 Section 5 of our TMS28 Enhancement Case: WRMP Demand Reduction document[10], published as part of our PR24 submission, outlines in detail how our smart metering costs have been calculated, the assurance of these costs, and how the AMP8 costs compare to previous AMP investment periods.

11.25 Our PR24 programme will deliver a very different mix of smart meters compared to AMP7, enabling a more bespoke unit-rate to be developed for each meter type, incorporating programme efficiency improvements gained over the AMP6 and AMP7 periods. The use of a bottom-up approach with each meter and installation type to build a total smart meter programme cost has enabled significant unit-rate efficiency improvements compared to previous periods. Compared to PR19, our PR24 unit-rate efficiency cost reductions range from c.3% to c.62% in cost per meter installation, depending on meter type.

11.26 The content submitted in TMS28 Enhancement Case: WRMP Demand Reduction is broken down into all meter and installation types, so as to avoid inappropriate cost benchmarking processes, which have negatively impacted previous assessments of smart metering programmes.

Enabled Options

11.27 Our selection of, and progression with, smart metering underpins all our major demand reduction workstreams, including leakage reduction, household and non-household water efficiency, targeting of high usage and continuous flows, long-term regular customer engagement to drive behaviour change, and tariffs. Utilisation of the data provided through smart metring will be the critical enabler for the majority of future demand reduction activities, all playing vital roles for the national water target agenda.

11.28 In our household programme smart meters enable our;

- wastage/internal leak alerts and repairs
- Smarter Home Visits
- digital engagement
- tariffs
- customer side leak identification and repairs

11.29 In our non household programme smart meters enable us to deliver;

- Smarter Business Visits
- Continuous flow alert and wastage repairs
- Identification of discretionary water users who we can work with to promote alternative sources of water

[10] TMS28 Enhancement Case: WRMP Demand Reduction - https://www.thameswater.co.uk/media-library/home/about-us/regulation/our-five-year-plan/pr24-2023/wrmp-demand-reduction.pdf

11.30 Any assessment of best value of smart meter installations should include these enabled activities. Table 21 demonstrates this.

Table 21: Costs and benefits of smart metering and enabled activities

Activity	Cost (£m) 2025-2050, nearest £10m	Consumption Reduction Benefit (Ml/d) 2025-2050	Leakage Reduction Benefit (Ml/d) 2025-2050
Household New Meter Installations (PMP), inc. Metering Innovation	970	43	0.4
Household Smart Meter Upgrades (PSUP), inc. Metering Innovation	390	0	17
Bulk Meter Installation	30	0	21
Mini-Bulk Meter Installation	110	0	6
Non-Household Smart Meter Upgrades	50	3	4
Digital Engagement*	1	10	0
Household Innovation and Tariffs*	400	61	0
Smarter Home Visits*	30	11	0
Wastage fixes*	3	4	0
Green Redeem*	0.2	0.4	0
Smarter Business Visits*	10	56	0
Non-household innovation, retailer activity and tariffs*	6	37	0

*Would not be possible without the installation of smart meters

11.31 The information in this table demonstrates that the metering options themselves would deliver a total of 46 Ml/d of consumption reduction and 48 Ml/d of leakage reduction at a cost of c.£1.5bn, or £16m per Ml/d benefit, which is relatively expensive compared to our supply options but cheaper than mains rehabilitation. However, the installation of smart meters then enables the additional demand reduction activities, which deliver an additional 180 Ml/d consumption reduction at a cost of only c.£450m, or £2.5m per Ml/d benefit, which is much less than comparable supply options. This means that the programme as a whole delivers demand reduction at a cost of £7m per Ml/d, which is efficient when compared to our SRO supply options and very efficient when compared to mains rehabilitation.

Best Value

11.32 Each of the demand reduction options appraised was compared through both cost per megalitre saved and average incremental cost. These cost benefit values are not the only criteria for selection, but are assessed alongside other factors such as delivery feasibility, scale of water savings opportunity and relevance to our household and non-household customer base.

11.33 As described above:

- The benefits of our smart metering programme have been calculated using robust evidence.
- The costs of our smart metering programme are efficient, as evidenced in our PR24 business plan
- Smart metering enables additional demand reduction through activities such as Smarter Home Visits, digital tools, tariffs, and targeting customer-side leakage. These enabled activities are very cost-efficient, meaning that the programme as a whole is also cost-efficient.

11.34 In addition, in order to achieve the challenging targets of 50% leakage reduction and 110 l/h/d, it is important that we are able to maximise the benefits of activities which we undertake. Smart metering enables this maximisation, and without smart metering we do not think these targets could be achieved.

11.35 As such, our smart metering programme is clearly best value in relation to benefits gained.

Changes made to the rdWRMP24

11.36 After rdWRMP24 paragraph 8.46 we will include the following text:

11.37 Smart meters enable significant further demand reductions from our household and non-household water efficiency demand reduction and leakage programmes. In our household programme smart meters enable our: wastage/internal leak alerts and repairs; Smarter Home Visits; digital engagement; tariffs; and customer side leak identification and repairs. In our non household programme smart meters enable us to deliver: Smarter Business Visits; Continuous flow alert and wastage repairs; identification of discretionary water users who we can work with to promote alternative sources of water. When making an assessment of the value of smart meter installations, it is important to factor in these enabled activities.

11.38 After the text currently in rdWRMP24 paragraph 8.77, we will include the following text:

11.39 Our WRMP demand reduction enhancement case gives full details of how the costs of our metering programme have been developed, and why these costs are efficient. [Footnote reference to Enhancement Case document will be provided]

Issue 11.3

Request

11.40 Thames Water should provide detailed information on specific research undertaken with customers for acceptability in reducing levels of service for temporary use bans. The statement that this aligns with WRSE is not appropriate evidence for a reduction in resilience levels. The company must also explain the acceptability of the 1 in 200 year resilience not being achieved until 2032 as most options selected by the company do not deliver benefits until after AMP8.

Further elaboration of request given in annex, or clarification given subsequently

Annex – Issue OF6

11.41 Ofwat recognises Thames Water's response that the change to TUB frequency from 1 in 20 to 1 in 10 years was subject to public consultation. However, no detail was given and no change was made to the revised WRMP24 following the draft plan consultation. There is also insufficient evidence that customers were consulted on reductions in LoS. In addition, the move to 1:200 drought resilience does not occur until 2031, and scheme benefits are generally delivered later in the planning period after AMP8.

11.42 Adequate evidence for the consultation process and output for the changes to TUBs frequency provide the assurance stakeholders and regulators need for the company's decisions on this subject. This should be discussed alongside the timing of moving to 1:200 resilience.

11.43 Further clarification from Ofwat[11]:

We note the customer engagement justification set out in your WRMP. Our specific concerns around this were that some justification was used from WRMP19, rather than WRMP24 engagement, and the evidence cited from both WRMP19 and Drought Plan 2022 engagement does not revolve around a specific question being asked on whether customers agree to the reduction in TUBs level of service. The WMRP24 engagement also presents priority statements from customers to the contrary, such as taking action sooner rather than later to secure sustainable supply, despite bill impacts, and a willingness to safeguard service levels.

Our consideration of the points raised

Change to the Level of Service regarding Temporary Use Bans (TUBs)

11.44 In summary, our consideration of the point raised regarding demonstrating customer acceptability of the change in our Level of Service regarding TUBs is:

- Customer research undertaken for WRMP19 was the starting point for the development of the 2024 plan.
- We worked collaboratively with the other South East (SE) water companies, as part of WRSE, to undertake collective customer research to inform the draft SE regional plan and in turn TW's draft WRMP24. In respect of levels of service for water use restrictions, this research highlighted that customers are most concerned with protecting and improving Levels of Service regarding severe (Level 4) restrictions, rather than TUBs.

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[11] Email from RAPID Principal to Thames Water WRMP team, 27/03/24

- The proposed alignment of Levels of Service across the WRSE region was consulted upon by the WRSE regional group in 2020, and this received support amongst respondents[12].
- Proposed changes to our Levels of Service were made clear in our draft Drought Plan. The Drought Plan was subject to public consultation and no representations were made regarding this change. The Secretary of State approved our Drought Plan, and as such we considered this change to our Level of Service as finalised. Inclusion of these amended Levels of Service in our WRMP24 follows from the process set out in the WRPG.
- Due to the nature of our water resources system, implementing TUBs earlier during a drought decreases the chance that more severe restrictions will be needed later. As such, moving from implementing TUBs once every 20 years to once every 10 years improves customer Levels of Service regarding severe restrictions, and as such making this change is in line with customer priorities.
- The suggestion that bespoke research be undertaken on this topic for WRMP24 has been made very late in the planning process and we consider that we have developed our WRMP based on a good understanding of customers' preferences.
- Examination of WRMP Table 2f demonstrates that our modelled Level of Service for TUBs exceeds the minimum stated Level of Service throughout the planning period. The modelled Level of Service for Temporary Use Bans is near to a 1 in 20-year frequency from the beginning of the planning period, and improves from this point onwards.

Findings of Customer Research

11.45 For WRMP19 we undertook customer research[13] to understand customers' priorities and preferences to inform the development of the plan, the topics covered included Levels of Service. The research findings showed that severe water use restrictions are of most concern to customers, and customers supported planning for greater resilience to a severe drought but had lesser interest in relation to TUBs (and hosepipe bans) as they are not perceived to have significant impacts on customers' day-to-day activities.

11.46 For WRMP24 we worked in collaboration with the other SE water companies, who were part of WRSE, and commissioned customer research to inform the development of the draft SE regional plan. This research included a review of all the companies' relevant research from WRMP19 and PR19 to ensure we were drawing on this information and making best use of existing knowledge and insight[14] and new research[15] as part of which we explored levels of service, amongst other matters. Findings from the research in relation to levels of service, and specifically hosepipe bans, was that hosepipe bans and non-essential use bans were not seen as significant concerns and had limited impact for most customers. In contrast, severe drought restrictions were considered to be extremely serious by participants. This finding was largely consistent with the conclusions

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[12] Policies to shape the South East's multi-sector, regional resilience plan. Our response to feedback on our consultation, October 2020

[13] WRMP19 Appendix T

[14] Customer Preferences to Inform Long-term Water Resource Planning Part A Evidence Review Water Resources South East (WRSE) February 2021

[15] Eftec ICS Customer preferences to inform long-term water resource planning, WRSE Part B deliberative research, February 2021

of work completed for WRMP19 which showed that customers are more concerned about severe water use restrictions at Level 4, rather than the implementation of TUBs.

11.47 With the SE regional plan providing the foundation for all the SE water companies WRMP24s, including our WRMP24, in line with regulatory guidelines, we did not repeat foundation work including the customer research, and relied on the findings of the research undertaken for the SE region plan for our draft WRMP24.

11.48 It is noteworthy that similar findings were reported in relation to TUBs in research undertaken for Ofwat and CCW[16], which considered different service aspects by theme and grouped them by importance and in that research hosepipe bans were one of the least important service aspect for domestic customers.

11.49 A further relevant aspect to address the point raised by Ofwat is the work that WRSE did to develop regional policies. The regional policies are a set of planning assumptions used in the regional plan and cover a range of issues including the use of drought permits and orders, leakage reduction, per capita consumption targets and carbon emissions. We worked closely with our member companies to agree initial policy positions and then consulted on the policy matters. In respect of Levels of Service, WRSE water company members set out the proposed policy to work towards a common service level for all customers in the South East for TUBs and also potentially Non Essential Use Bans[17]. The main driver for this policy was to provide consistency and clarity of messages for customers. The response to this consultation[18] indicated that overall respondents supported this policy position particularly in relation to the clarity it would bring to communications around water use and improving consistency across the region as more cross company water transfers are developed.

11.50 In response to this feedback we took forward the change in the levels of service for hosepipe bans by changing the frequency for implementation of a full TUB from 1 in 20 years frequency to 1 in 10 years into our statutory Drought Plan in 2022. We undertook a public consultation on our draft Drought Plan with the revised levels of service. In the consultation material, this change was made very prominent[19]. No representations were received on our Drought Plan in response to this

[16] Ofwat CCW Preferences Research April 2022, https://www.ofwat.gov.uk/wp-content/uploads/2022/04/Yonder-Preferences-research.pdf, p.76

[17]Water Resources South East, 2022, Policies to shape the South East's Multi-sector regional resilience plan – Consultation document, p.13, https://www.wrse.org.uk/media/navh0vze/wrse-policies-consultation-document-04082020.pdf

[18]Water Resources South East, 2022, Policies to shape the South East's Multi-sector regional resilience plan – Our response to feedback on our consultation, p.17, https://www.wrse.org.uk/media/lnjnyemc/wrse-response-to-policies-consultation_051020.pdf

[19] The following information was included in the Draft Drought Plan, demonstrating the prominence of the change in LoS within the consultation:

On page 3 of the draft Drought Plan NTS, the plan stated "*We've updated our levels of service – the frequency that we expect to need to apply water use restrictions. Temporary Use Ban (TUB) restrictions (see page 8) will now be implemented at the same time as applied by the other water companies in the South East*."

change. The Secretary of State approved our Drought Plan, and as such as we have considered this change to be final.

11.51 The changed Levels of Service were then reflected in our draft WRMP24. The WRPG at Section 1.6 E states:

11.52 'Your WRMP is complemented by your water company drought plan. Your drought plan sets out the short term operational steps you will take if the area you cover faces a drought in the next 5 years. It describes how you would enhance available supplies, manage customer demand and minimise environmental impacts as the drought progresses.

11.53 You should clearly explain how your drought plan and WRMP link in a way that your customers, regulators, government and interested stakeholders can understand. Your emergency plan will set out the actions you will take in a civil emergency. Your WRMP should set out your current and future levels of service and your justification for the order of actions you will take in a drought.'

11.54 This is the process that we have followed, with our Drought Plan 2022 clearly setting out the short-term operational steps that we will take to manage drought, with these steps being informed by the findings of the customer research we undertook at WRMP19 and as part of WRSE. We consulted widely with regulators and stakeholders on our draft Drought Plan 2022. As stated earlier, no objections were received in representations from stakeholders including CCW. We note that Ofwat did not respond to the consultation on our 2022 Drought Plan. Our draft Drought Plan was subsequently approved by the Secretary of State.

11.55 Specifically in relation to the point referenced by Ofwat "*Action should be taken sooner rather than later to ensure a secure and sustainable water supply, despite the likely disruption and bill impact*" this is taken from the customer research[20] completed as part of the public consultation on the draft WRMP24 and this finding is in the context of discussion with customers on their attitudes to water resources in the Thames catchment overall rather than specifically levels of service. A headline message from this research was that it is important to invest for the future and take timely action to futureproof water supplies in the face of current challenges.

11.56 In Section 1 and Appendix T of our revised draft WRMP24 we clearly set out that we had revised our Levels of Service for TUBs (Paragraphs 1.20 and T.18)

11.57 In summary, we have set out the chronology of customer research and stakeholder engagement that has been undertaken on our levels of service for water supply, and the opportunities for regulators, stakeholders and customers to input to this work. We consider that this work and its chronology justify the change we have made to our levels of service for the implementation of a full TUB from 1 in 20 year frequency in our 2017 Drought Plan to 1 in 10 year frequency in our

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On Page 8 of the draft Drought Plan NTS, the plan stated "*Early stages of a drought Frequency: once every 10 years on average - Restrict the use of sprinklers and hosepipes in and around the home for uses including watering gardens, topping up ponds, filling paddling and swimming pools, cleaning cars – this is referred to as a Temporary Use Ban*."

In the Executive Summary of our Draft Drought Plan, the following text was included: "*We have updated our levels of service to align with the Environment Agency guidelines and with Water Resources in the South East (WRSE). Previously we included a staggered implementation of Temporary Use Ban (TUB) restrictions. We have now amended this so that a full TUB would be implemented at Level 2 of our levels of service. This is aligned with all water companies in the South East who all implement TUBs as a Level 2 drought measure with a level of service of 1:10 years*."

[20] 7120 Water Resource Management Plan – Thames Water, Verve, May 2023

2022 Drought Plan. We would be happy to undertake further customer research on this matter as part of the next planning round for our Drought Plan 2027 and WRMP29 if this is considered to be required by Ofwat.

Improvement of LoS Regarding Emergency Restrictions Resulting from TUB LoS Change

11.58 London's water supply system is reliant on a large volume of raw water storage. We abstract water from the River Thames and River Lee and store it in large storage reservoirs. During drought periods we are not able to abstract as much from the River Thames as is needed to fulfil customer demand, and so during these periods our reservoir storage declines. Demand restrictions are triggered according to reservoir control curves.

11.59 When we impose demand restrictions, demand falls. When this happens, we need to take less water from our reservoirs, and so the rate at which reservoir storage declines reduces. As such, implementing less severe demand restrictions (such as TUBs) earlier during a drought means that reservoir storage falls more slowly for a longer period. This then reduces the probability that reservoir storage hits the "Level 4" control curve, improving the Level of Service for this restriction level, which customers prioritise more highly. This proactive use of demand restrictions is different to some other companies' water resources systems, where restrictions are used as a reactive measure to ensure a more instantaneous supply-demand balance.

11.60 As was stated in our WRMP Annual Review 2022, the change made in implementing TUBs at Level 2 rather than Level 3 brings 18 Ml/d of Deployable Output benefit (London's Deployable Output being constrained by L4 restriction frequency). Examination of our Deployable Output analysis outputs indicates that this change results in a 10% improvement in the Level of Service for Level 4 (severe) restrictions.

11.61 A further implication is that, were we to revert to a 1 in 20-year LoS for TUBs, we would need to invest in more, or larger, supply solutions in order to ensure 1 in 200-year and 1 in 500-year Levels of Service for emergency restrictions.

WRMP Table 2f

11.62 WRMP Table 2f includes Levels of Service labelled as "Minimum" (stated) and "Modelled" (actual, according to the implementation of the plan).

11.63 Thames Water's Table 2f submission indicates that our modelled Level of Service for Temporary Use Bans exceeds the stated 1 in 10-year resilience level. At the beginning of the planning period, the expected return period of TUBs is 18 years; this increases to 23 years when our L4 resilience increases to a 1 in 200-year Level and nearly 100 years when our L4 resilience increases to a 1 in 500-year Level. This demonstrates that, while we may have changed our stated minimum Level of Service for Temporary Use Bans, our actual Level of Service is dependent on the supply-demand balance situation and is not materially different to that included in our WRMP19.

Conclusion

11.64 As our response demonstrates:

- Customers are more concerned with Levels of Service surrounding severe restrictions than they are with Levels of Service for TUBs. While initially identified in WRMP19 research, this has been confirmed by research undertaken by WRSE in the course of preparing the Regional Plan (which is the basis of our WRMP24).

- Implementing TUBs earlier decreases the likelihood that severe restrictions will be required. As such, implementing TUBs earlier is in line with customer priorities.
- The proposed alignment of Levels of Service across the WRSE Region was consulted upon by the WRSE regional group in 2020. Alignment of Levels of Service across the region was supported by respondents.
- Proposed changes to our Levels of Service were made clear in the public consultation on our draft Drought Plan and no representations were made on this subject. The Secretary of State approved our drought plan, and as such we considered this change to our Level of Service as finalised. Inclusion of these amended Levels of Service in our WRMP follows from the process set out in the WRPG.
- The Levels of Service set out in our WRMP24 have been taken directly from our approved Drought Plan. As such, further customer research has not been considered necessary.
- Examination of WRMP Table 2f demonstrates that our modelled Level of Service for TUBs exceeds the minimum stated Level of Service throughout the planning period. The modelled Level of Service for Temporary Use Bans is near to a 1 in 20-year frequency from the beginning of the planning period.

Acceptability of the 1 in 200 year resilience not being achieved until 2032

11.65 As per our Statement of Response Appendix A (Response to Environment Agency Representations), p.78, the change in the proposed date for achievement of 1 in 200-year resilience has been made due to the change in the identified feasible timescale for delivery of the London Water Recycling options. As such, our target date for the achievement of 1 in 200-year resilience is driven not by reason of customer acceptability, but by the feasible delivery timeframe for an option of sufficient size to deliver a 1 in 200-year level of resilience. Conducting customer research on this subject would be of no use, as even if customers supported delivery of 1 in 200-year resilience sooner it would not be possible.

11.66 Ofwat has stated that Thames Water must explain *'the acceptability of the 1 in 200 year resilience not being achieved until 2032 as most options selected by the company do not deliver benefits until after AMP8'* and that this timing should be discussed in the context of our levels of service for water supply. As stated above, our current service standard for L4 restrictions is 1 in 100 years on average and to achieve a Level 4 service standard of 1 in 200 years on average requires delivery of approximately 120 Ml/d improvement in the supply demand balance in London (in addition to approximately 180 Ml/d of supply-demand balance benefit needed to offset climate change impacts, sustainability reductions and growth). The bulk of this enhancement is planned to be delivered through an extremely ambitious programme of demand management reduction, which is being delivered in AMP8, contrary to Ofwat's assertion as stated above. The justification and timescale for the magnitude of the demand management plan has been extensively discussed in the responses to a number of other challenges raised in this document which we believe fully justify the ambitious programme that we have set out and why it would be very high risk to seek to deliver further reduction in the first 5 years of our plan.

11.67 Even after delivering our demand programme in AMP8 there is still a significant supply demand imbalance to secure 1 in 200-year resilience for Level 4 restrictions and as such a strategic resource option is also required to improve security of supply. The earliest and most cost beneficial option that can be delivered to achieve this is the Teddington DRA scheme in the early 2030s, as detailed in our preferred programme. As we have explained in our plan, other non-

SRO resource options would be very high risk, being dependent on other water companies achieving the demand reductions and resource development options detailed in their own revised draft plans and are therefore not directly within Thames Water's control. Given customer and regulator expectations for improving L4 resilience we consider that the Teddington DRA scheme represents best value for delivering improved L4 resilience, and that the next-best alternative would be a different water recycling scheme. The earliest feasible delivery date for either the Teddington DRA or an alternative recycling scheme is currently estimated to be 2032/33. It should be recognised that the level of L4 resilience will continually improve as we deliver our demand management reduction programme throughout AMP8 and we will be reporting on this in our Monitoring Plan and Annual Review. It is just that the final improvement to the 1 in 200 year standard will not be achieved until completion of one of the London reuse SROs and the estimated timescale for this being the early 2030s.

Changes made to the rdWRMP24

11.68 The following text will be added to Section 1 of our WRMP. This text will replace the current text in paragraph 1.20. We have included paragraphs 1.19 and 1.21 and a bulleted list for context here, but have not made changes to these paragraphs.

11.69 1.19 We have consulted household and non-household customers on levels of service for water use restrictions specifically seeking their feedback on whether the levels of service should deteriorate, be maintained, or improved. The main findings are summarised as:

- *Customers did not want deterioration in the levels of service particularly for the more severe restrictions such as rota cuts and drought permits*
- *The current expected frequency of sprinkler bans, hosepipe bans (TUBs) and NEUBs were not perceived to have significant impacts on customers' day-to-day activities and as such were not a significant concern*
- *Customers did show support for improved levels of service for the more severe restrictions. For rota-cuts (Level 4 restrictions), both household and non-household customers showed some support for an improvement in the level of service*

11.70 1.20 In 2021 we updated our Drought Plan in line with regulatory requirements. We worked with the other water companies across the South East as part of this work, and in accordance with the findings of our own customer research and WRSE's policy ambition statement we updated our Levels of Service for TUBs from 1 in 20 to 1 in 10 years on average to ensure consistent service levels across the South East region. WRSE consulted on this policy ambition statement and respondents were supportive of the alignment of Levels of Service for TUBs across the WRSE Region. We also consulted on our draft Drought Plan, making very clear the proposals regarding our updated Levels of Service, and no representations were made regarding this change. Implementing TUBs sooner means that severe restrictions will be less likely, and so this change is in line with our customers' priorities.

11.71 1.21 Our Drought Plan was approved by the Secretary of State for Environment, Food and Rural Affairs in August 2022. It sets out the actions we would take, and when we would take them, during and after periods of prolonged dry weather. Our levels of service to customers, as stated in our Drought Plan, and the foundation of our WRMP24 are shown in Table 1-1.

11.72 The following text will be added to both Section 4 (Supply forecast) and Section 11 (The Overall Best Value Plan) of our WRMP. The text will be inserted into the initial "blue box" summary of changes between the draft and revised draft WRMP24 (i.e., before the first numbered paragraph in the section).

Date for Achievement of 1 in 200-year Resilience

11.73 In our draft WRMP24, we included a move to a 1 in 200-year Level of Resilience for severe (Level 4) restrictions by 2030-31. The achievement of this level of resilience relies upon the delivery of approximately 120 Ml/d improvement in the supply demand balance in London (in addition to approximately 180 Ml/d of supply-demand balance benefit needed to offset climate change impacts, sustainability reductions and growth). The bulk of this enhancement is planned to be delivered through an ambitious programme of demand management reduction. Even after delivering our demand programme in AMP8 there is still a significant supply demand imbalance to secure 1 in 200-year resilience for Level 4 restrictions and as such a strategic resource option is also required to improve security of supply. Between the draft WRMP24 and revised draft WRMP24 we reassessed the feasible delivery schedule for the London Water Recycling options accounting for the likely planning route (Development Consent Order rather than under the Town and Country Planning Act) and concluded that the earliest date for the delivery of these options would be 2032-33. As such, we have moved the target date for achievement of 1 in 200-year resilience to 2032-33. We have not assessed customer acceptability or consulted on this change, as a large option is still needed to secure this level of resilience, and so the change is driven by what is feasible rather than being influenced by acceptability.

Issue 11.4

Request

11.74 Thames Water should provide evidence in the final WRMP that accelerating the metering strategy is the optimal option. The company's strategy and justification in the final WRMP must align with final PR24 business plans.

Further elaboration of request given in annex, or clarification given subsequently

Annex – Issue OF2

11.75 Ofwat states that Thames Water has justified its strategy for NHH demand reduction. However, the company has proposed an accelerated "PR24 plan" that does not align between WRMP24 and PR24 submission. New options for water efficiency include continuous flow targeting (piloted in AMP7 and estimated with expert judgement), tariffs (implementation in AMP10) and retailer activities. The company is proposing to accelerate the NHH strategy with delivery in AMP8. However, the table in section 8 show that there is a lower overall benefit for NHH PSUP consumption and CSL in the accelerated "PR24 alternative plan" (see 8.273 onwards). There is insufficient evidence given as to why this is the optimal approach.

Our consideration of the points raised

11.76 We have accelerated our NHH smart meter upgrades to comply with MOSL and the Strategic Panel's Interim National Metering Strategy for the Non-Household Market target guidance to 'ensure all medium and large meters are 'smart' or smart enabled [by the end of AMP8]'.

11.77 This guidance, coupled with our need to replace meters at the end of their life, guided us to bring forward all AMP9 installations into AMP8.

11.78 We will ensure the volumes, costs and benefits of our NHH smart meter upgrades in our final WRMP24 submission and business plan submission align.

11.79 Following smart meter installation, additional demand reduction benefit will be enabled by the hourly consumption data, through new enhanced water efficiency activity with NHH Retailers, NHH Innovative Continuous Flow Targeting and Smarter Business Visits (SBV). These additional demand reduction activities and benefits are only possible through the installation of smart NHH meters.

11.80 We consider that the metering programme outlined in our WRMP and PR24 submissions is the optimal option as it ensures the greatest feasible delivery of NHH demand reduction is included in AMP8 – using the best property survey and delivery feasibility information available at the time of submission development. As noted in paragraph 8.285 of our rdWRMP24 there is a discrepancy between metering totals caused by updates to NHH metering figures for PR24. This was due to updated property survey details for our PR24 submission. External factors such as supply chains, property survey details (internal installation feasibility, shared supply properties, communal hot water systems etc), customer access barriers and other unplanned factors (eg. pandemics, extreme weather impacting supply-demand balance etc), can still impact meter rollout programmes.

11.81 Our WRMP and PR24 plans also account for asset life and balancing total costs against other business investment priorities. These asset life and total costs factors are assessed in balance with the policy and regulatory drivers associated with the new Defra national water target agenda, which will be reliant on smart metering and utilisation of the consumption data captured.

Changes made to the rdWRMP24

11.82 We will revise the text in paragraphs 8.273-8.285, Tables 8-28 to 8-36 and numbers in our WRMP Data Tables to ensure alignment with our PR24 submission.

11.83 The text in paragraphs 8.273 to 8.285 in the rdWRMP24 currently outlines the programme included in the rdWRMP24 and then describes a misalignment between the rdWRMP24 and PR24 plans as a result of the NHH smart meter acceleration. This will be revised to simply set out the metering programme included in the final PR24 submission.

11.84 As agreed with the Environment Agency, WRMP table updates will be made at the time of fWRMP submission.

Issue 11.5

Request

11.85 Thames Water should demonstrate in its business plans and final WRMP that where interconnectors are necessary to deliver new supplies to areas of demand, that the decision-making process has taken account of the combined cost of developing the new supplies and the interconnectors and does not double-count the benefits gained.

Further elaboration of request given in annex, or clarification given subsequently

Annex – Issue OF9

11.86 Ofwat states that where interconnectors are necessary to deliver new supplies to areas of demand these should be evaluated by combining the costs of developing the new supply with the interconnector costs as a single option, to produce an optimised best value plan. The SoR details the reason for separating interconnectors/system reinforcements, but does not explain how the decision making process has been able to differentiate between the cost of supply options with required interconnectors, against interconnectors that produce no additional supply. Ofwat requires this information to ensure accurate presentation of the costs.

Our consideration of the points raised

11.87 We acknowledge that the investment modelling approach taken is complex and requires further explanation in this respect. In the content we have added to our plan, we have ensured that it is clear that the decision making process has taken account of the combined cost of developing the new supplies and that interconnector benefits are not double-counted. For further clarity, we have included additional content regarding other aspects of complexity which are considered in the WRSE Investment Model.

Changes made to the rdWRMP24

11.88 We will add the information below into WRMP24 Appendix W (Programme Appraisal Methods), as an annex. This information will be at the end of this chapter.

Annex title: Interconnectors and System Reinforcements

11.89 As described in the earlier section of this chapter entitled "The Investment Model (IVM)", the IVM uses complex methods to ensure supply-demand balance in all water resource zones (WRZs) across the WRSE region.

11.90 The IVM can consider complex scenarios, such as optimising programmes for multiple supply-demand balance scenarios simultaneously. As well as this form of complexity, the investment model can ensure optimal solutions when considering "system" complexity. Water resources solutions can involve several elements, including raw water sources, treatment, tunnels and pipelines. Different solutions require different combinations of these elements, and some solutions may be flexible and incorporate different elements when used in different ways. Ensuring that all necessary components of a solution are considered when deriving an investment plan, while also ensuring efficiency, can be a complex modelling task.

11.91 The simplest representation, which is adopted wherever possible, is that an option should encompass all the assets required to deliver water to consumers. For example, a new groundwater option for use in the London WRZ may incorporate the costs associated with new boreholes, a raw water interconnector to transport water to a treatment facility, a new treatment works to treat water, and a treated network interconnector to transport water into the supply network. In this way, all costs associated with obtaining and transporting water would be considered within a single "option" or "solution".

11.92 However, in many situations, complexities mean that this level of aggregation is not possible. In these circumstances, the WRSE investment model is able to ensure proper consideration of system complexity via the following means:

- *Dependencies*
- *Groups*
- *Phasing*
- *Differentiation between "raw" and "potable" water*
- *Differentiation between "resource", "interconnector" and "treatment" options*

11.93 *The inclusion of these factors ensures that the overall system benefit is considered. This means that our decision making process has taken account of the combined cost of developing new supplies, and ensures that interconnector benefits are not double-counted.*

11.94 *These complexities are best considered through examples. We have detailed six hypothetical examples below, which highlight how the investment model is able to use these features to deal with different aspects of complexity to identify the optimal plan overall.*

11.95 *When comparing interconnector solutions with other solutions in our plan, it is important to bear in mind that, aside from the Severn-Thames Transfer, no interconnectors included in our plan yield a WAFU benefit on their own. All either require a resource input, support in some form, or are "system reinforcement" option (see Section 7 for further details). As such, aside from the Severn-Thames Transfer, comparison should not be made between resource options (with benefits stated as WAFU benefit) and interconnectors (with benefits stated as capacity).*

[Please see Annex E - Further information to be included in WRMP Appendix X in response to Issue 11.5 – for examples which are used to describe how the WRSE IVM deals with these complexities]

Issue 11.6

Request

11.96 Thames Water should demonstrate how the benefits for the metering programme are derived and evidence to support any assumptions made. The company should provide clear evidence of how the benefits of its metering programme have been included in per capita consumption forecasts.

Further elaboration of request given in annex, or clarification given subsequently

11.97 No further elaboration.

Our consideration of the points raised

11.98 Benefits of metering have primarily been based on an Artesia study on smart metering benefits[21], as summarised within our Section 8 report in the section entitled *Metering Benefits*.

11.99 Within our WRMP, the benefits have been separated out by new (PMP) vs. upgraded (PSUP) meters and property type, to give a better resolution of assumptions. These were then applied to profiles for our metering options to generate associated savings.

11.100 These option savings directly show resultant leakage and PCC forecast changes.

[21] Artesia Consulting, May 2022, 'Smart Metering Benefits Template_2022-05-18'

11.101 The translation of benefits from our metering programme into a PCC reduction is clear from the calculations in the WRMP Tables. Our demand reduction programmes, the benefits of which are calculated using bottom-up estimates of no. installs, % consumption reduction or l/install/d reductions, result in Ml/d benefits. Reductions in Ml/d are applied between our baseline and final plan, and these Ml/d figures, when divided by the forecast population, result in the calculation of PCC.

Changes made to the rdWRMP24

11.102 For the final plan, we will include the following tables within the "Metering Benefits" section of rdWRMP24 Section 8, presenting the core breakdown at the property-type level at which the study was conducted.

11.103 The Table below will be included after paragraph 8.72, and will be referenced in that paragraph.

Progressive Meter Installations	*Variable Use + Wastage (litres)*			
Property Type	*Measured*	*Unmeasured*	*Savings*	*Savings (%)*
Detached	*378*	*439*	*61*	*13.8%*
Semi-detached	*349*	*400*	*51*	*12.6%*
Terrace	*357*	*409*	*52*	*12.7%*
Flat Dwelling (SBF)	*260*	*300*	*40*	*13.4%*
Flat Dwelling (LBF)	*261*	*302*	*41*	*13.4%*
Unknown	*383*	*469*	*85*	*18.2%*
Average	***345***	***396***	***51***	***13.0%***

Table X – Smart Metering Consumption Reduction

11.104 The table below will be included after paragraph 8.146, and will be referenced in that paragraph.

Smart Upgrades	*Customer Supply Pipe Leakage (litres)*			
Property Type	*Smart*	*Dumb*	*Savings*	*Savings (%)*
Detached	*12*	*24*	*12*	*49.7%*
Semi-detached	*18*	*34*	*16*	*47.4%*
Terrace	*19*	*35*	*17*	*47.0%*
Flat Dwelling (SBF)	*21*	*49*	*28*	*57.1%*
Flat Dwelling (LBF)	*24*	*51*	*27*	*52.5%*
Unknown	*17*	*17*	*0*	*-0.3%*
Average	***19***	***39***	***20***	***50.5%***

Table X – Smart Metering CSL Reduction

Issue 11.7

Request

11.105 Thames Water should provide clear commentary, evidence and justification for the best value and regional benefit gained by the investment model selecting options that, in Average Incremental Cost terms, may not be the lowest cost. The company identifies why smaller options may be of lower unit cost (e.g. expanding current assets) but then doesn't explain why these option types are not explored more in feasible options and selected for the final plan. The concern about the selection of high unit cost schemes, including Strategic Resource Options, over alternatives has only been partially addressed.

Further elaboration of request given in annex, or clarification given subsequently

Annex – Issue OF10

11.106 Ofwat queries why strategic and multi-period schemes have higher costs than smaller localised options, which is counter to the expectation that economies of scale efficiencies can be achieved through regional options.

11.107 Ofwat expects that the investment models will not pick only low AIC options. However, in order to justify the best value nature of the preferred plan over least cost plan or lower cost options, the final WRMP24 should evidence why options are chosen in respect to the additional value they bring. The statement that the WRSE model selects it as best value isn't justification enough – the programme should be able to be justified in a simple manner to prove an optimum and fair selection of options.

11.108 Ofwat requires this justification to ensure good quality and transparent options appraisal and decision-making.

Our consideration of the points raised

11.109 We recognise the need to fully justify our Best Value Plan. We have, as detailed below, included further information in our plan to address the concerns raised.

11.110 There are several aspects to this request. As such, we have broken down our response into:

- Explanation of the feasibility assessment undertaken in which options to expand use of existing sources (which are often low-cost options) are identified and screened
- Explanation of why low AIC options may not be selected in a least cost or best value plan
- Identification of specific low AIC options which are not selected in the Best Value Plan, and interpretation of WRSE model outputs to explain why they are not selected
    - Similarly, we have identified specific options with exceptionally high AICs, in order to explain why they are selected
- Explanation of the options which are selected in the Best Value Plan, compared to the Least Cost Plan

Feasibility of expanded use of existing sources

11.111 As part of the options development process for WRMP24, we undertook a review to establish whether additional Deployable Output could be delivered at any of our existing sources within existing licence limits. In this review, we identified sources which have Deployable Output constraints other than licence, hydrological/hydrogeological availability, or water quality (as enhanced Deployable Output at sources with these constraints would not be possible). Sources not constrained by these factors are usually constrained by either licence or pump capacity. Where potential for improvements at existing sources to increase the DO within licence limits exists, the required actions to enable Deployable Output increases up to licensed volumes were considered.

11.112 As the further explanation which follows demonstrates, we have appropriately considered expanded use of existing sources in our WRMP.

11.113 The following description focuses on the increased use of existing groundwater sources. This is because Thames Water's existing surface water sources are either hydrologically constrained (Lower Lee group, Lower Thames group, Fobney, Farmoor) or licence constrained (Shalford, New Gauge) and so there were no options identified to increase surface water source deployable outputs without new sources being developed.

11.114 The deployable output figures of most of our existing sources are limited by either licence or hydrological/hydrogeological availability, but this review did yield a number of unconstrained options to consider. Further to this options identification process, we screened options against a screening framework and identified some options as infeasible. This exercise is documented in the rdWRMP24 Groundwater Feasibility Report Addendum, with unconstrained options identified in rdWRMP24 Appendix P and rejection reasoning included in rdWRMP24 Appendix Q. The results (presented across the feasibility report and WRMP appendices) are summarised in the table below.

11.115 We recognise that the existence of this screening process may not be clear from our existing documentation, and so have included additional information in our WRMP, as detailed in the following section.

11.116 In Table 22, we refer to options as either "Preferred", "Feasible", or "Rejected". Those options which are defined as "Preferred" are included in our preferred plan. Those options which are defined as "Rejected" have been found to be infeasible according to the screening process described in Section 7 of our WRMP. Those options described as "Feasible" have not been found to be infeasible according to our screening process, but are not included in our preferred plan.

Table 22: Summary of options identified where increased capability could be generated at an existing sources within licensed limits

Source and WRZ	Status (Rejected, Feasible, or Preferred)	Rejection reasoning if rejected, and DYAA/DYCP DO benefit (Ml/d)[22]
Addington, London	Preferred	2.7
Epsom, London	Rejected	Licence reduction included for Epsom sources in dWRMP24 3.3
Nonsuch, London	Rejected	Duplicate of Epsom (aggregated licence) 1

[22] DYAA DO only for London WRZ

Source and WRZ	Status (Rejected, Feasible, or Preferred)	Rejection reasoning if rejected, and DYAA/DYCP DO benefit (Ml/d)[22]
New River Head, London	Initially found feasible. Currently subject to further ground investigation which is needed to confirm feasibility, and so rejected for inclusion in WRMP24.	Ground investigation works have been identified as being required to confirm option feasibility 3
Honor Oak, London	Feasible	3.1 (2 options)
Merton, London	Feasible	2
Shortlands, London	Rejected	Shortlands is rejected due to uncertainties regarding the impact of the abstraction on groundwater levels in the Chalk aquifer, flows in the River Ravensbourne, potential reduction in DO at nearby Thames Water abstractions and the stability of the Thanet Sands Formation. 4.2
Green St Green, London	Rejected	Scope of WRMP scheme delivered within AMP7 N/A
Britwell, SWOX	Rejected	Increased use of source above recent actual in conflict with WFD No Deterioration requirements 1.3/1.3
Woods Farm, SWOX	Preferred	2.4/2.9
Ashton Keynes, SWOX	Feasible	0/2.0
Witheridge Hill, SWOX	Rejected	This option involves lowering of the pumps in a single unconfined Chalk borehole. This option has been rejected due to high costs to complete the investigation compared with the potential DO benefit and low resilience of the source. This therefore failed due to resilience and cost

Source and WRZ	Status (Rejected, Feasible, or Preferred)	Rejection reasoning if rejected, and DYAA/DYCP DO benefit (Ml/d)[22]
		benefit to investigate potential yield. 0.6/0.6
Taplow, SWA	Feasible	0/5.7
Datchet, SWA	Preferred	1.6/6.2
Dorney, SWA	Feasible	0/4.3
Hampden, SWA	Rejected	It is not considered to be cost-effective to deliver the potential volume benefit without an increase in licence. However, the Environment Agency will not support an increase in licence at this location due to concerns about the impacts of the abstraction on headwater flows in the River Misbourne. This therefore rejected due to no realistic prospect of an abstraction licence. 0.8/0.8
Mortimer, Kennet Valley	Preferred	4.5/4.5
East Woodhay, Kennet Valley	Feasible	0/2.1
Mousehill and Rodborough, Guildford	Rejected	This option involves borehole rehab to support a licence increase. However, the Environment Agency will not support an increase in licence at this location due to concerns about the impacts of the abstraction on the River Ock. This therefore rejected due to no realistic prospect of an abstraction licence. 1.55/0.18

Source and WRZ	Status (Rejected, Feasible, or Preferred)	Rejection reasoning if rejected, and DYAA/DYCP DO benefit (Ml/d)[22]
Sturt Road, Guildford	Rejected	A lower than expected potential yield coupled with uncertain water quality and low resilience has resulted in rejection of this option. 0.25/0.28

11.117 This exercise was carried out near the beginning of the WRMP24 cycle. As a result of this information request, we have revisited the review which was undertaken to establish whether any further options should be considered within WRMP24, considering changes in source DO which may have been made in the interim and considering any works to reinstate sources' Deployable Output. The results of this revisited review have identified the following sources where Deployable Output[23] is constrained by either treatment capability or pump capacity, but which were not identified in the initial options identification process. We have screened these options according to the same framework. In this exercise we have considered only options where the delivery of >1 Ml/d of Deployable Output would be possible (Table 23). The identification of these options would not impact our programme selection.

11.118 As noted in the following section, the relevant WRMP documentation will be updated to reflect this revisited review exercise.

Table 23: Outcome of revisited screening exercise

Source and WRZ	Status (Rejected, Feasible, or Preferred) Reason for non-inclusion previously	Rejection reasoning if rejected, and DYAA/DYCP DO benefit (Ml/d)[24]
Barrow Hill, London	Rejected Deployable Output written down between AR21 and AR22	Minimal Deployable Output to be gained, but significant investigation would be required to ascertain scope of works required to restore Deployable Output. As such, screened out according to Stage 2 screening criterion "Cost/benefit of further investigation to validate yield"

[23] Note: for London we consider only DYAA DO in this exercise, as we do not undertake a DYCP supply-demand balance for London WRZ

[24] DYAA DO only for London WRZ

		Further, this source would discharge water into the Thames Lee Tunnel. The feasibility of this and likely yield are uncertain, and so option is also screened out on the basis of uncertainty around scheme capacity. 1.7
Chinnor, SWOX	Rejected	Licence reduction to be made at source at end of AMP8, due to WFD no deterioration requirement. Potential DO gain from reduced licence < 1Ml/d
Gatehampton, SWOX	Rejected Deployable Output written down after 2022 drought	Gatehampton's peak DO is planned to be restored prior to the WRMP24 planning period. 0/4.3
Sheeplands, Henley	Feasible Work planned during AMP7 to restore source output	Option to be reviewed in WRMP29. Lack of inclusion in WRMP24 not material as Henley WRZ not in deficit 4.1/4.1
Dancers End	Rejected Work planned during AMP7 to restore output	Work still planned during AMP7 to restore output, and as such the source's DO is due to be restored prior to the WRMP24 planning period. 1.5/1.6

Explanation of why low AIC options may not be selected in a least cost or best value plan

11.119 Water resources investment appraisal has moved on a great deal from simple ranking of schemes based on AIC. The WRSE investment model considers complexities such as the scale and timing of deficits in multiple water resource zones and in different adaptive plan scenarios, the prospect of shared resources, inter-WRZ transfers which may vary over time, and many other complexities.

11.120 The WRSE investment model, when run in its "Least cost" mode identifies the lowest cost plan for the whole WRSE region, subject to modelled constraints such as policy decisions. The WRSE investment model has been the subject of independent assurance which has confirmed that it achieves this objective. The assurance report (see Issue 14.1 for further details)[25] includes the quote, *"The design of the model accords with the requirements which is to objectively find an optimal solution to the planning problem posed"*. As such, while we recognise that the interpretation of model outputs is important, our consideration is that we should start from a position of trust in the model's ability to derive a least cost plan. It would be infeasible for us to manually consider the many millions of possible option combinations which could solve the WRSE Region's planning problem.

11.121 There are many examples when low AIC solutions may not be part of an overall lowest cost plan (i.e., non-selection of low AIC options is not necessarily a reflection of having disregarded them through "Best Value" consideration). Two hypothetical examples of this are highlighted here, which are of significant relevance to Thames Water's decision-making process.

Example 1 – large planning problem magnitude

11.122 The problems considered in WRMP24, in particular environmental destination and 1 in 500-year resilience, are exceptionally large. In many cases, the large planning problem means that a large option must be selected, and as such the selection of small options is not efficient. Furthermore, while large options can be expensive, in many cases delivering larger variants of large options is much more efficient than the delivery of smaller variants of large options, and as such the marginal cost of upsizing large options can be smaller than the marginal cost of delivering small options. SESRO is an excellent example of this: the 150 Mm3 SESRO option is only c.25% more expensive than the 75 Mm3 SESRO option, despite delivering c.100% more Deployable Output benefit.

11.123 A useful hypothetical example is explained here. In this example, a WRZ has a future deficit of 100 Ml/d, with options available as per Table 24. In this example, the smaller schemes have the lowest price per Ml/d benefit gained (£2m per Ml/d DO benefit as compared to £2.5m per Ml/d DO benefit for the larger SRO variant and £4m per Ml/d DO benefit for the smaller SRO variant) but would not be part of an overall least cost plan as can be seen in the examples.

11.124 The feasible programme solutions to this planning problem are:

- Smaller SRO variant + 5 small schemes. Cost = £300m
- Larger SRO variant. Cost = £250m

11.125 As such, in this example, the cheapest individual solutions do not feature in the cheapest overall solution.

Table 24: Programme level cost example 1

Option	DO benefit (Ml/d)	Cost (£m)
SRO – smaller variant	50	200
SRO - larger variant	100	250
Small scheme 1	10	20
Small scheme 2	10	20

25 WRSE Investment Model External Review, 2022, Liz Archibald (Independent Consultant), https://www.wrse.org.uk/media/gdwhjxsp/wrse-investment-model-external-review-august-2022.pdf

Small scheme 3	10	20
Small scheme 4	10	20
Small scheme 5	10	20

Example 2 – planning problem magnitude and shared resources

11.126 In the WRSE region, not only are the planning problems large, but they are spatially distributed across the region and can involve shared solutions. This can mean that the overall planning solution can be different to the optimum solution for a single WRZ.

11.127 In this example, WRZ1 has a deficit of 60 Ml/d while WRZ2 has a deficit of 20 Ml/d. As such, feasible combinations of solutions (tabulated below) are:

- SRO smaller variant + Interconnector 1 + small scheme 1 + small scheme 3 + small scheme 4. Cost = £320m
- SRO larger variant + Interconnector 1 + Interconnector 2. Cost = £270m

11.128 Clearly, when considering WRZ2 in isolation, the adoption of the SRO would not be the most cost efficient solution (small solution 3 and 4 together cost only £40m). However, a larger solution being required for WRZ1 means that the shared use of a larger solution is the most efficient solution overall.

Table 25: Programme-level cost example 2

Option	WRZ benefit/connection	DO benefit/capacity (Ml/d)	Cost (£m)
SRO – smaller variant	N/A (interconnector required)	50	200
SRO - larger variant	N/A (interconnector required)	100	250
Interconnector 1	SRO to WRZ1	100	10
Interconnector 2	SRO to WRZ2	100	10
Small scheme 1	WRZ1	10	20
Small scheme 2	WRZ1	10	20
Small scheme 3	WRZ2	10	20
Small scheme 4	WRZ2	10	20

11.129 While these examples are intended to be illustrative, they are useful when reflecting on the TW/WRSE programme appraisal problem and the options selected.

11.130 As is discussed in our rdWRMP24, the large options in our plan are cost efficient solutions to the planning problem because:

- Teddington DRA – the London WRZ has a significant deficit in the early 2030s, due to the need to deliver 1 in 200-year resilience for London WRZ.

  - The solution demonstrated in rdWRMP24 Table 10-22, in which the 1 in 200-year resilience objective is achieved with smaller options and transfers, is more costly at the programme level.
  - When it is established that the overall solution including Teddington DRA is more efficient than alternatives which exclude it, low AIC options are not needed in addition.
  - As such, while some solutions may have lower AICs than the Teddington DRA scheme, they do not necessarily form part of a lowest cost overall programme.

- SESRO 150 Mm^3 – a large solution (either SESRO or the STT) is required by 2040 in order to fulfil environmental destination requirements and to provide 1 in 500-year resilience for the west of the region.
  - Given that a large resource option is required in the west of the catchment, and given that the River Thames provides a cost-free conduit for resource to be transferred eastwards, utilisation of the resource in the east of the WRSE region is a cost-effective solution.
  - As is described in Sections 10 and 11 of our WRMP, programmes which include the STT are more expensive than those which include SESRO.
  - The low marginal cost and added resilience of moving from a smaller SESRO option to a larger SESRO option means that it is better value to adopt a larger SESRO option than it is to adopt a smaller SESRO option and construct additional resource schemes.

Identification of specific low AIC options which are not selected in the Best Value Plan

11.131 The complexity and magnitude of the WRSE regional planning problem and assurance of the WRSE Regional Investment Model mean that examination of the many millions of possible combinations of options which could solve the WRSE planning problem is neither feasible nor necessary.

11.132 However, we recognise that Ofwat has asked us to demonstrate why low AIC options may not be selected in a least cost or Best Value Plan.

11.133 As such, detailed Annex D: Further information in response to Issue 11.7, we have considered those options in our supply area with low AIC values individually, and have described why they are not included in our best value plan.

Differences between the Least Cost and Best Value plans

11.134 We have compared the options selected in Thames Water WRZs in the Least Cost and Best Value plans. These are summarised in Table 26 and Table 27, along with an interpretation of why the selection decision has been made. As this demonstrates, there are relatively few differences, as the Least Cost plan (and by extension the options selected within it) perform well compared to others from a Best Value perspective.

Table 26: Options selected in Least Cost Plan but not Best Value Plan (Pathway 4)

Option	Reason
Merton Groundwater Recomissioning	Larger GUC option selected by Affinity Water in Best Value Plan, meaning that more of SESRO is available for London’s use. Larger GUC option is selected due to the added supply-demand balance resilience that it brings.
Merton SLARS	
London Confined Chalk Groundwater	
Cheam to Merton Transfer	
Henley to SWOX 2.4 Ml/d transfer	5 Ml/d transfer variant selected instead, allowing for greater inter-connectivity

Table 27: Options selected in Best Value Plan but not Least Cost Plan (Pathway 4)

Option	Reason
23 No. Catchment options	Environmental benefits
Henley to SWOX 5 Ml/d transfer	See table above

Changes made to the rdWRMP24

Feasibility of expanded use of existing sources

11.135 As per the description in the section above, we have considered, and documented our consideration of, options to expand capacity at existing sources. However, we recognise that we have not detailed the comprehensiveness of the exercise undertaken. As such, we have added the following text to the Groundwater feasibility report addendum. This text will appear in the bulleted list below paragraph 18 in this report:

11.136 As part of the option identification exercise, a review has been undertaken in which we have considered the constraints on Deployable Output at all our existing sources. Where sources are not limited by hydrological/hydrogeological availability, available licence or water quality constraints (i.e., where a source’s output is constrained either by treatment capability or pumping capacity), an option to make full use of the existing licence has been considered within the unconstrained option list. These options have been screened alongside other options. Please note that this exercise has been documented in the groundwater feasibility report because our existing surface water Deployable Outputs are limited either by licence (New Gauge, Shalford) or hydrological availability (Farmoor, Fobney, Lower Thames, Lower Lee).

Explanation of why low AIC options may not be selected in a least cost or best value plan

11.137 The following text is added to Appendix W. The text will be included in the sub-section entitled “The Investment Model (IVM)”.

11.138 In previous WRMPs, Average Incremental Cost (AIC) ranking was used to identify the preferred programme. However, water resources investment appraisal has moved on a great deal from simple ranking of schemes based on AIC, recognising that the timing, scale and spatial distribution of need for new water resources, as well as the costs (capital and operational), lead time and emissions of different options, alongside other factors, can mean that simple cost-based ranking of solutions will often not yield either the overall least cost or best value solution. The WRSE investment model is able to consider complexities such as the scale and timing of deficits in multiple water resource zones and in different adaptive plan scenarios, the prospect of shared resources, inter-WRZ transfers which may vary over time, and many other complexities.

11.139 The WRSE investment model, when run in its "Least cost" mode identifies the lowest cost plan for the whole WRSE region, subject to modelled constraints such as policy decisions. The WRSE investment model has been the subject of independent assurance which has confirmed that it achieves this objective. The assurance report[26] includes the quote, "The design of the model accords with the requirements which is to objectively find an optimal solution to the planning problem posed". When considering the infeasibility of manually inspecting the programme-level cost of the many millions of possible option combinations which could solve the WRSE Region's planning problem, this assurance of the WRSE investment model is valuable.

11.140 The following text is also added to Appendix W. This text is added in a new sub-sub-section of the "Best Value Planning metrics", "Cost" sub-section. This sub-sub-section will be entitled "Programme-level costs".

11.141 According to the options selected and their utilisation, using the methods described, the IVM is able to calculate a programme-level cost for any programme of options. It is this regional-scale, programme-level cost which is used in our programme appraisal, as opposed to examination of individual option costs.

11.142 *When considering the scale and complexities in the WRSE regional planning problem, interpreting the investment model outputs can be challenging. For example, there are many examples when low AIC solutions may not be part of an overall lowest cost plan. Two hypothetical examples of this are highlighted here, which are of relevance to Thames Water's decision-making process.*

Example 1 – large planning problem magnitude

11.143 The problems considered in WRMP24, in particular environmental destination and 1 in 500-year resilience, are exceptionally large. In many cases, the large planning problem means that a large option must be selected, and as such the selection of small options is not efficient. Furthermore, while large options can be expensive, in many cases delivering larger variants of large options is much more efficient than the delivery of smaller variants of large options, and as such the marginal cost of upsizing large options can be smaller than the marginal cost of delivering small options. SESRO is an excellent example of this: the 150 Mm3 SESRO option is only c.25% more expensive than the 75 Mm3 SESRO option, despite delivering c.100% more Deployable Output benefit.

11.144 A useful hypothetical example is explained here. In this example, a WRZ has a future deficit of 100 Ml/d, with options available as per Table X. In this example, the smaller schemes have the

[26] WRSE Investment Model External Review, 2022, Liz Archibald (Independent Consultant), https://www.wrse.org.uk/media/gdwhjxsp/wrse-investment-model-external-review-august-2022.pdf

lowest price per Ml/d benefit gained (£2m per Ml/d DO benefit as compared to £2.5m per Ml/d DO benefit for the larger SRO variant and £4m per Ml/d DO benefit for the smaller SRO variant) but would not be part of an overall least cost plan.

11.145 The feasible programme solutions to this planning problem are:

- *Smaller SRO variant + 5 small schemes. Cost = £300m*
- *Larger SRO variant. Cost = £250m*

11.146 As such, in this example, the cheapest individual solutions do not feature in the cheapest overall solution.

Option	*DO benefit (Ml/d)*	*Cost (£m)*
SRO – smaller variant	*50*	*200*
SRO - larger variant	*100*	*250*
Small scheme 1	*10*	*20*
Small scheme 2	*10*	*20*
Small scheme 3	*10*	*20*
Small scheme 4	*10*	*20*
Small scheme 5	*10*	*20*

Table X – Programme-level cost example 1

Example 2 – planning problem magnitude and shared resources

11.147 In the WRSE region, not only are the planning problems large, but they are spatially distributed across the region and can involve shared solutions. This can mean that the overall planning solution can be different to the optimum solution for a single WRZ.

11.148 In this example, WRZ1 has a deficit of 60 Ml/d while WRZ2 has a deficit of 20 Ml/d. As such, feasible combinations of solutions (tabulated below) are:

- *SRO smaller variant + Interconnector 1 + small scheme 1 + small scheme 3 + small scheme 4. Cost = £320m*
- *SRO larger variant + Interconnector 1 + Interconnector 2. Cost = £270m*

11.149 Clearly, when considering WRZ2 in isolation, the adoption of the SRO would not be the most cost efficient solution (small solution 3 and 4 together cost only £40m). However, a larger solution being required for WRZ1 means that the shared use of a larger solution is the most efficient solution overall.

Option	*WRZ benefit/connection*	*DO benefit/capacity (Ml/d)*	*Cost (£m)*
SRO – smaller variant	*N/A (interconnector required)*	*50*	*200*
SRO - larger variant	*N/A (interconnector required)*	*100*	*250*

Interconnector 1	*SRO to WRZ1*	*100*	*10*
Interconnector 2	*SRO to WRZ2*	*100*	*10*
Small scheme 1	*WRZ1*	*10*	*20*
Small scheme 2	*WRZ1*	*10*	*20*
Small scheme 3	*WRZ2*	*10*	*20*
Small scheme 4	*WRZ2*	*10*	*20*

Table X - Programme-level cost example 2

11.150 While these examples are intended to be illustrative, they are useful when reflecting on the TW/WRSE programme appraisal problem and the options selected.

11.151 In order to ensure transparency, in Appendix X, we have interpreted model results to describe why low AIC options have not been selected. We have itemised low AIC options which have not been selected as part of the preferred plan, providing a description of the reason why the option has not been selected.

Identification of specific low AIC options which are not selected in the Best Value Plan

11.152 We have included the following text in WRMP24 Appendix W. This is included in a new section, entitled “Explanation for non-selection of low-cost options and selection of high-cost options”. As explained in this text, we do not propose to include the Table included in Annex D: Further information in response to Issue 11.7. However, we would be happy to include this in Appendix X of our rdWRMP24 if our regulators would consider this table useful.

11.153 Interpreting the outputs of the WRSE investment model can be challenging. There may be cases where options with low Average Incremental Costs (AICs) are not selected as part of a least cost/best value plan, and conversely there may be cases in which options with high AICs are selected. In order to ensure transparent decision making, in a response to a data request from Defra, we highlighted those feasible options with a low AIC which have not been selected in our preferred programme, and highlighted those options with a high AIC which have been selected in our preferred programme.

11.154 We identified the SESRO option as being the highest-AIC SRO which is selected. As such, we interpreted the reason for the non-selection of any option with an AIC less than SESRO (including those which bring WAFU/capacity benefit but are not selected). For completeness, we have then also interpreted the reason for the selection of any option with an AIC higher than SESRO (including those which do not bring WAFU/capacity benefit but are selected). The selection of SESRO over its alternatives has been discussed in detail throughout Sections 10 and 11 of the WRMP.

Issue 11.8

Request

11.155 Thames Water should present evidence that it tested different leakage reduction strategies with its customers, including the different costs.

Further elaboration of request given in annex, or clarification given subsequently

11.156 No further elaboration.

Our consideration of the points raised

11.157 Reducing leakage has been highlighted as being a priority for customers. Customers consider current levels of leakage unacceptable and think that we need to act to reduce the amount of leakage. Customers largely support the government target of 50% leakage reduction by 2050 noting some customers suggested we should aim to reduce leakage further and faster than proposed in our draft WRMP, while others recognise that disruption may be caused if we fix a large number of water pipes simultaneously, particularly in a heavily populated area such as London.

11.158 In Section 8 of our revised draft WRMP we describe in detail the actions we could take to reduce leakage and consumption of water, and how we have created different demand management programmes, including how we have prioritised different interventions within a given programme. Overall, our revised draft WRMP24 contains more demand reduction activity than is economically optimal (i.e. more than a true least-cost plan would require) and this is driven primarily by government policy expectations.

11.159 For our revised draft WRMP, we have revised our leakage forecast for AMP7 and early AMP8, leading to a further reduction in leakage by 2049/50 of 52.5% under our Low, Medium and High demand management profiles, this is in line with government and customer expectations.

11.160 Our WRMP24 consultation included a question on our leakage ambition. There was strong support for ambitious leakage reduction targets. Some considered this to be a pre-condition before delivering major new resource schemes while others felt the plan needed to remain deliverable.

11.161 We're committed to reducing the amount of water lost through leaks. We reviewed our leakage reduction options for the revised draft plan and have increased our ambition to more than halve leakage levels by 2050, with interim targets of a 20% reduction by 2027 and 30% reduction by 2032. These are challenging targets that rely on fresh thinking and innovative approaches.

11.162 In addition to our WRMP24 consultation, we tested consumer views on leakage reduction in our 'Vision 2050' research[27], asking customers' views on reducing leakage to below 10% (of distribution input) by 2050. Customers considered reducing leakage as a core responsibility for Thames Water.

[27] Vision 2050 May 2022 (thameswater.co.uk)

11.163 We also tested customers views on leakage reduction in our Long Term Delivery Strategy research[28] which found that leakage was a priority for customers but lead pipes and sewage spills were higher priority. This research found that customers were supportive of our long term strategy to halve leakage over the next 25 years.

Changes made to the rdWRMP24

11.164 We will add reference to the Vision 2050 research and Long Term Delivery Strategy research within Table T-2 of rdWRMP24 Appendix T.

[28] Long term delivery strategy research September 2023 (thameswater.co.uk)

Issue 12: Quantify and explain the baseline changes between draft plan and revised draft

12.1 The company has made some significant changes in its baseline between draft plan and revised draft plan with the baseline deficit increasing by 235 Ml/d in 2030 between draft and revised draft. We understand that this is because the company's baseline is now entirely based on 1:500 deployable output, following our representation and in line with the water resources planning guideline. Previously the company's level of service changed throughout the planning period leading to an inconsistent baseline.

12.2 While the company has now followed our guidance, it should make sure that this is clearly explained in its final plan so those who read the draft plan can understand the changes made.

Issue 12.1

Request

12.3 The company should clearly explain changes in the baseline supply-demand balance which occurred between the draft and revised draft plan.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue OF5

12.4 Ofwat states that a breakdown of the reasons for change in DO are given in the query response and in section 6 of WRMP. Thames Water accept that some changes in DO are due to the difficulty using the Gateway desalination plant and deferred delivery of small schemes. There are notable changes between the draft and revised draft WRMP24 (e.g. company level baseline SDB deficits are now 422 Ml/d by 2030, rather than 119 Ml/d.)

12.5 It is difficult to understand the reasons behind the worsening position between the draft and revised draft WRMP24 in the baseline SDB. It is not clear how much issues with the Gateway desalination has impacted this. Although the SoR states 1 in 500 year resilience is now incorporated from the start of WRMP24, neither section 6 nor the rdWRMP24 tables reflect this, so it is not possible to attribute this as the reasoning.

Our consideration of the points raised

12.6 We acknowledge the need to ensure that changes in our supply-demand balance are presented in a transparent way.

12.7 There has been no change in the WAFU contribution forecast for the Gateway desalination plant between the dWRMP24 and rdWRMP24.

12.8 The reason for the significant change in the baseline supply-demand balance in our WRMP Tables is the noted change which resulted from a representation made by the Environment Agency, i.e., the requirement to present a baseline supply-demand balance consistent with the provision of a 1 in 500-year level of resilience throughout the planning period (regardless of the actual level of service planned at a given point in the planning period). Other changes were also made between the dWRMP and rdWRMP (e.g., adjusting the demand forecast base year to 2022-23 and updating demand forecasts accordingly) as is described in the rdWRMP, however, by far the largest change was the inclusion of a 1 in 500-year resilience level throughout the planning period.

Changes made to the rdWRMP24

12.9 The following footnotes will be included in Section 6 of the rdWRMP.

12.10 As a footnote to Table 6-19 (Supply-demand balance component comparison between WRMP19 and WRMP24, London DYAA):

12.11 Please note that, between dWRMP24 and rdWRMP24 and because of a representation made by the Environment Agency, we amended our WRMP tables to ensure that we present a baseline supply-demand balance forecast consistent with the provision of a 1 in 500-year Level of Resilience throughout the planning period, as is required by the Water Resources Planning Guideline. Additionally, the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by guidance). As such, the value in the Table above is different to the baseline supply-demand balance value stated in our WRMP Tables. The difference is the sum of 242.25 Ml/d (which is the additional amount of water we would need to be able to supply to provide a 1 in 500-year resilience, rather than our current 1 in 100-year level of service) and 109.17 Ml/d (which is the amount of benefit forecast to be derived from demand restrictions during a drought in 2024-25). The baseline supply-demand balance in our WRMP Tables in 2024-25 is 59.74 - 242.25 - 109.17 = -291.67.

12.12 As a footnote to Table 6-21 (Supply-demand balance component comparison between WRMP19 and WRMP24, SWOX DYAA):

12.13 Please note that, between the dWRMP24 and rdWRMP24, and because of a representation made by the Environment Agency, we amended our WRMP tables to ensure that we present a baseline supply-demand balance forecast consistent with the provision of a 1 in 500-year Level of Resilience throughout the planning period, as is required by the Water Resources Planning Guideline. Additionally, the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by guidance). As such, the value in the Table above is different to the baseline supply-demand balance value stated in our WRMP Tables. The difference is the sum of 23.33 Ml/d (which is the additional amount of water we would need to be able to supply to provide a 1 in 500-year resilience, rather than our current 1 in 100-year level of service) and 25.88 Ml/d (which is the amount of benefit forecast to be derived from demand restrictions during a drought in 2024-25). The baseline supply-demand balance in our WRMP Tables in 2024-25 is 27.33 – 23.33 – 25.88 = -21.88.

12.14 As a footnote to Table 6-23 (Supply-demand balance component comparison between WRMP19 and WRMP24, SWOX DYCP):

12.15 Please note that, between the dWRMP24 and rdWRMP24, and because of a representation made by the Environment Agency, we amended our WRMP tables to ensure that we present a baseline supply-demand balance forecast consistent with the provision of a 1 in 500-year Level of Resilience throughout the planning period, as is required by the Water Resources Planning Guideline. Additionally, the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by *guidance). As such, the value in the Table above is different to the baseline supply-demand balance value stated in our WRMP Tables. The difference is the sum of 24.54 Ml/d (which is the additional amount of water we would need to be able to supply to provide a 1 in 500-year resilience, rather than our current 1 in 100-year level of service) and 60.43 Ml/d (which is the amount of benefit forecast to be derived from demand restrictions during a drought in 2024-25). The baseline supply-demand balance in our WRMP Tables in 2024-25 is 22.07 – 24.54 – 60.43 = -62.9.*

12.16 Note also that values in Table 6-23 will be amended to 22.1 (supply-demand balance, WRMP24) and 60.4 (benefit from demand savings, WRMP24) as these appear to be in error in Table 6-23 of our rdWRMP24.

12.17 As a footnote to Table 6-25: Supply-demand balance component comparison between WRMP19 and WRMP24, SWA DYAA:

12.18 Please note that the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by guidance). As such, the baseline supply-demand balance in our WRMP Tables in 2024-25 is 34.73 – 13.95 = 20.8.

12.19 Note also that values in Table 6-25 will be amended to 34.7 (supply-demand balance, WRMP24) and 14.0 (benefit from demand savings, WRMP24) as these appear to be in error in Table 6-25 of our rdWRMP24. This is due to the figures in Section 6 having omitted NEUB benefits.

12.20 As a footnote to Table 6-27: Supply-demand balance component comparison between WRMP19 and WRMP24, SWA DYCP:

12.21 Please note that the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by guidance). As such, the baseline supply-demand balance in our WRMP Tables in 2024-25 is 54.25 – 33.89 = 20.38.

12.22 Note also that values in Table 6-27 will be amended to 54.3 (supply-demand balance, WRMP24) and 33.9 (benefit from demand savings, WRMP24) as these appear to be in error in Table 6-27 of our rdWRMP24.

12.23 As a footnote to Table 6-29: Supply-demand balance component comparison between WRMP19 and WRMP24, Kennet Valley DYAA:

12.24 Please note that, between the dWRMP24 and rdWRMP24, and as a result of a representation made by the Environment Agency, we amended our WRMP tables to ensure that we present a baseline supply-demand balance forecast consistent with the provision of a 1 in 500-year Level of Resilience throughout the planning period, as is required by the Water Resources Planning Guideline. Additionally, the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by guidance). As such, the value in the Table above is different to the baseline supply-demand balance value stated in our WRMP Tables. The difference is the sum of 32.17 Ml/d (which is the additional amount of water we would need to be able to supply to provide a 1 in 500-year *resilience, rather than our current 1 in 100-year level of service) and 8.70 Ml/d (which is the amount of benefit forecast to be derived from demand restrictions during a drought in 2024-25). As such, the baseline supply-demand balance in our WRMP Tables in 2024-25 is 43.52 – 32.17 – 8.70 = -2.65.*

12.25 As a footnote to Table 6-31: Supply-demand balance component comparison between WRMP19 and WRMP24, Kennet Valley DYCP

12.26 Please note that, between the dWRMP24 and rdWRMP24, and as a result of a representation made by the Environment Agency, we amended our WRMP tables to ensure that we present a baseline supply-demand balance forecast consistent with the provision of a 1 in 500-year Level of Resilience throughout the planning period, as is required by the Water Resources Planning Guideline. Additionally, the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by guidance). As such, the value in the Table above is different to the baseline supply-demand balance value stated in our WRMP Tables. The difference is the sum of 19.4 Ml/d (which is the additional amount of water we would need to be able to supply to provide a 1 in 500-year resilience, rather than our current 1 in 100-year level of service) and 20.7 Ml/d (which is the amount of benefit forecast to be derived from demand restrictions during a drought in 2024-25). As such, the baseline supply-demand balance in our WRMP Tables in 2024-25 is 43.14 – 19.42 – 20.73 = 20.99.

12.27 Note also that values in Table 6-31 will be amended to 43.1 (supply-demand balance, WRMP24) and 20.7 (benefit from demand savings, WRMP24) as these appear to be in error in Table 6-31 of our rdWRMP24.

12.28 As a footnote to Table 6-33: Supply-demand balance component comparison between WRMP19 and WRMP24, Guildford DYAA

12.29 Please note that the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by guidance). Further, note that the WRMP tables indicate no transfer would be required from our Guildford WRZ to Affinity Water via the Ladymead export – the Table above includes an allowance for this transfer. As such, the baseline supply-demand balance in our WRMP Tables in 2024-25 is 18.2+2.3 – 4.0 = 16.5.

12.30 Note also that values in Table 6-33 will be amended to 18.2 (supply-demand balance, WRMP24) and 4.0 (benefit from demand savings, WRMP24) as these appear to be in error in Table 6-33 of our rdWRMP24.

12.31 As a footnote to Table 6-35: Supply-demand balance component comparison between WRMP19 and WRMP24, Guildford DYCP

12.32 Please note that the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by guidance). Further, note that the WRMP tables indicate no transfer would be required from our Guildford WRZ to Affinity Water via the Ladymead export – the Table above includes an allowance *for this transfer. As such, the baseline supply-demand balance in our WRMP Tables in 2024-25 is 14.7+2.3 – 10.6 = 6.4.*

12.33 Note also that values in Table 6-35 will be amended to 14.7 (supply-demand balance, WRMP24) and 10.6 (benefit from demand savings, WRMP24) as these appear to be in error in Table 6-35 of our rdWRMP24.

12.34 As a footnote to Table 6-37: Supply-demand balance component comparison between WRMP19 and WRMP24, Henley DYAA

12.35 Please note that the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by guidance). As such, the baseline supply-demand balance in our WRMP Tables in 2024-25 is 7.81 – 1.17 = 6.64.

12.36 Note also that values in Table 6-37 will be amended to 7.8 (supply-demand balance, WRMP24) and 1.2 (benefit from demand savings, WRMP24) as these appear to be in error in Table 6-37 of our rdWRMP24.

12.37 As a footnote to Table 6-39: Supply-demand balance component comparison between WRMP19 and WRMP24, Henley DYCP

12.38 Please note that the supply-demand balance value stated in the Table above is inclusive of the benefits which we forecast would be delivered as a result of demand savings interventions during a drought (which are excluded from the baseline in the WRMP24 Tables, as required by guidance). As such, the baseline supply-demand balance in our WRMP Tables in 2024-25 is 4.66 – 3.19 = 1.47.

12.39 Note also that values in Table 6-39 will be amended to 4.7 (supply-demand balance, WRMP24) and 3.2 (benefit from demand savings, WRMP24) as these appear to be in error in Table 6-39 of our rdWRMP24.

Issue 13: Headroom allowance

13.1 Ofwat has stated that the company has not justified its headroom allowance appropriately. The company should:

- provide justification that its headroom allowance is appropriate
- demonstrate that it has engaged with its customers regarding funding this level of risk appetite and assumed uncertainty

Issue 13.1

Request

13.2 Thames Water should provide justification that its headroom allowance is appropriate.

13.3 Thames Water should demonstrate that it has engaged with its customers regarding funding this level of risk appetite and assumed uncertainty.

Further elaboration of request given in annex, or clarification given subsequently

Annex – Issue OF7

13.4 Ofwat asked the company to present sufficient evidence that the headroom allowance is appropriate in both the short and long term, that it is not driving unnecessary and high regret investment, and that it has properly accounted for interactions with adaptive planning. No changes have been made to the revised WRMP, Ofwat's initial concern still stands. There is insufficient justification that the headroom allowance is appropriate and that customers have been consulted.

Further clarification from Ofwat:

13.5 "The remaining concern centres around whether relatively high headroom allowances are appropriate, whilst also moving to reduce level of services and not prioritise delivery of short-to-medium term options in your plan."

Our consideration of the points raised

13.6 It is understood from the additional Annex provided that this request for information follows a representation made by Ofwat on our dWRMP (see Appendix B to our Statement of Response, p.39), "The company's headroom allowance is high compared to most other companies, being an average of 9.4% of the company distribution input (demand) during 2025-30, rising to 10.1% during 2030-35. Therefore, this planning assumption contributes significantly to the company supply-demand balance and proposal for investment. In its final plan, the company should present sufficient and convincing evidence that the headroom allowance is appropriate in both the short and long term, is not driving unnecessary and high regret investment, and that it has properly accounted for interactions with adaptive planning."

13.7 In our Statement of Response, we provided direction to parts of our draft plan (reproduced in the revised draft plan) which we consider provide sufficient justification for our target headroom allowance. However, we have provided additional justification (as detailed below) to ensure that Ofwat's concerns are allayed.

13.8 The most important aspect of our consideration is that WRSE research undertaken for this round of water resources planning[29] concluded, "For customers, a resilient plan is one that reduces future uncertainty by building capacity into the water system to deal with future disruption. Insurance associated with overbuilding infrastructure is not a key concern, with a typical view that it is 'better to be safe than sorry'." This is a clear demonstration that customers want us to plan for uncertainty, that we should allow a significant buffer for this uncertainty, and that customers are not concerned about excess buffers, with many participants in this research feeling that "we will use the infrastructure eventually".

Benchmarking Target Headroom

13.9 The identification of a suitable target headroom allowance is not the result of a simple estimation process, and as such a simple benchmarking comparison across water companies is not appropriate. As is described in detail throughout Section 6, our Target Headroom allowances are the product of detailed and evidence-based calculations. Different WRZs will require different target headroom allowances according to the risks which those WRZs face and the ability to mitigate those risks with actions both within a company's supply area and from neighbouring companies. The different sources of uncertainty within our planning are considered in isolation and then brought together to provide an appropriate overall allowance for uncertainty. Pages 13 to 32 of Section 6 of our rdWRMP describe the approach taken in calculating the components of target headroom, and pages 33 to 36 describe our approach to bringing together the different uncertainties which are faced to derive a sensible buffer.

13.10 In summary, our approach to Target Headroom Calculation is:

- We Identify sources of uncertainty within the plan, and define appropriate distributions of target headroom contribution for those individual uncertainties. This is described on pages 17-32 of our rdWRMP24 Section 6.
- We bring those sources of uncertainty together in an appropriate way (i.e., through Monte Carlo analysis). This is described on pages 13-16 of our rdWRMP24 Section 6.
- We adopt an appropriate risk tolerance approach, accounting for adaptive planning – we have described this on pages 33-36 of our rdWRMP24.

13.11 As such, our consideration is that our headroom allowance is the product of factors which have all been explained and justified, and that our approach has followed the guidance set out in the UKWIR guidance on Risk Based Planning Methods[30] and Headroom calculation[31]. We recognise that Ofwat would like to see the outputs of our Target Headroom modelling justified and so will include additional content in Section 6 in this regard.

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[29] Efect/ICS, March 2021, Customer Preferences to Inform Longterm Water Resource Planning, https://ehq-production-europe.s3.eu-west-1.amazonaws.com/c221322f362c9380346c34bdda9fd294014df1c6/original/1620041787/71229bcac59bbceb6728b1900400f5df_WRSE_Customer_Preferences_Summary_Report_eftec___ICS_March_2021_FINAL.pdf?, pages v and 4

[30] UKWIR, 2016, WRMP19 Methods – Risk-based Planning

[31] UKWIR, 2002, An Improved Methodology for Assessing Headroom

Customer Views

13.12 Our customers are clear that they want to be protected from severe demand restrictions such as emergency drought orders and they expect us to undertake this planning on their behalf (see footnotes below with extracts from Appendix T of our rdWRMP24).

13.13 WRSE research[32] conducted in 2021 concluded that, "For customers, a resilient plan is one that reduces future uncertainty by building capacity into the water system to deal with future disruption. Insurance associated with overbuilding infrastructure is not a key concern, with a typical view that it is 'better to be safe than sorry'." This is a clear demonstration that customers want uncertainty to be planned for, and that they are not concerned about funding this level of risk appetite. In the same research, customers also said that they were willing to pay for investments now to safeguard water resources and the environment for future generations.

13.14 Further, when we asked our customers about risk allowances in WRMP19, they were clear with us that they expect us to be the experts in identifying and combatting the risks which we face. This is highlighted in paragraph T.40 of our WRMP19[33] (which referenced our consolidated "What customers want" research undertaken for WRMP19/PR19[34]).

13.15 As such, we do not consider further engagement with our customers to identify suitable levels of Target Headroom is warranted. Furthermore, no representations were made to our dWRMP24 which indicated that such research is necessary.

Adaptive Planning and Risk Tolerance

13.16 The approach we have taken to ensure that uncertainties are accounted for appropriately within an adaptive planning context is described in paragraphs 6.111-6.124. We note that the target headroom profiles set out in our WRMP Tables and Section 6 of the WRMP align with the risk tolerance approach set out in Section 6 (paragraph 6.126), which is:

13.17 The key features of the risk profile that we deemed appropriate were:

13.18 Initially, a relatively low risk tolerance should be taken. It would, however, be reasonable to take more risk than at WRMP19 due to the increased appreciation of supply-side risks that has been included.

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[32] https://ehq-production-europe.s3.eu-west-1.amazonaws.com/c221322f362c9380346c34bdda9fd294014df1c6/original/1620041787/71229bcac59bbceb6728b1900400f5df_WRSE_Customer_Preferences_Summary_Report_eftec___ICS_March_2021_FINAL.pdf

[33] Extract from WRMP19, "*Customers expect a 24/7 resilient and reliable service and expect us to plan to mitigate and recover from hazards including weather related events, terrorism and cyber-crime and provide a resilient service into the future. They trust in our expertise and expect Thames Water to be able to deal with such hazards – they are more concerned with impacts on their water and wastewater service rather than the cause of the problem",* as well as paragraph T.9 of our rdWRMP24 (which references our consolidated "What customers want" research undertaken for WRMP24/PR24[33]), *"Most customers are unaware of the challenges to ensuring future water supplies and that demand is projected to exceed supply. When they are informed, customers expect us to plan for a resilient water supply in the long-term*."

[34] CSD002-What customers want consolidated report, Thames Water August 2018

13.19 This low risk tolerance should be maintained until 1 in 200-year resilience is relatively secure.

13.20 It would be inappropriate to suggest significant investment be made on the basis of future uncertainties, and so a higher degree of risk tolerance is appropriate further into the future.

13.21 These factors align with the guidance set out in the WRPG: "You should consider the appropriate level of risk for your plan. If target headroom is too large it may drive unnecessary expenditure. If it is too small, you may not be able to meet your planned level of service. You should accept a higher level of risk further into the future. This is because as time progresses the uncertainties will reduce and you have time to adapt to any changes."

13.22 This approach to setting risk tolerance aligns with the requirements of the WRPG, ensures resilience in the short-term, and ensures that high-regret solution development is avoided. As such, this risk tolerance approach is aligned with our customers' views, which are:

- A resilient plan is one that reduces future uncertainty by building capacity into the water system to deal with future disruption.
- Customers support plans and investments that will safeguard service levels and the environment for future generations. They are not concerned about being overly prepared for future risks or overbuilding infrastructure and feel that it is "better to be safe than sorry". Many customers feel that "we will use the infrastructure eventually" if we are over-prepared.
- There is a strong expectation that the plan will deliver beyond the minimum statutory requirements.
- Overall customers support investment in new water supply schemes where they can be shown to deliver benefits for the future.

Changes made to the rdWRMP24

13.23 We have included the text below from WRMP19 which demonstrates that our customers expect us to be the experts in long-term planning and ensuring a resilient water supply for the future. This will be included in Appendix T of our WRMP24, within the section entitled "Overview of our customers' priorities and preferences".

13.24 "Customers expect a 24/7 resilient and reliable service and expect us to plan to mitigate and recover from hazards including weather related events, terrorism and cyber-crime and provide a resilient service into the future. They trust in our expertise and expect Thames Water to be able to deal with such hazards – they are more concerned with impacts on their water and wastewater service rather than the cause of the problem"

13.25 "Most customers are unaware of the challenges to ensuring future water supplies and that demand is projected to exceed supply. When they are informed, customers expect us to plan for a resilient water supply in the long-term."

13.26 The following text has been added to Section 6, after the current paragraph 6.125:

13.27 *WRSE research[35] conducted in 2021 concluded that, "For customers, a resilient plan is one that reduces future uncertainty by building capacity into the water system to deal with future disruption. Insurance associated with overbuilding infrastructure is not a key concern, with a typical view that it is 'better to be safe than sorry'." From this, we have taken that customers want us to plan for uncertainty, that we should allow a significant buffer for this uncertainty, and that customers are not concerned about excess buffers in the short-term, with the view among many participants being that "we will use the infrastructure eventually".*

13.28 The following text has been added to Section 6, after the current paragraph 6.127:

13.29 *This approach to setting risk tolerance aligns with the requirements of the WRPG, ensures resilience in the short-term, and ensures that high-regret solution development is avoided. As such, this risk tolerance approach is aligned with our customers' views, which are (as set out in Appendix T):*

- *A resilient plan is one that reduces future uncertainty by building capacity into the water system to deal with future disruption.*
- *Overbuilding water resources infrastructure is not seen as an issue, with many customers feeling that we will use infrastructure which is developed eventually.*
- *Customers support plans and investments that will safeguard service levels and the environment for future generations.*
- *There is a strong expectation that the plan will deliver beyond the minimum statutory requirements.*
- *Overall customers support investment in new water supply schemes where they can be shown to deliver benefits for the future.*

13.30 We have added the following justification for the Target Headroom allowance profiles which result from the analysis undertaken.

London DYAA – included before paragraph 6.134

13.31 *Table X below shows Target Headroom as a percentage of DI across the planning period. This table shows that the resultant Target Headroom profile for the London WRZ early in the planning horizon is 8-9% of DI and that this reduces over time, to c.5% of DI in the longer term.*

13.32 *The London WRZ's water resources are complex and reliant on hydrologically constrained abstractions from the River Thames and River Lee. We have seen in the 2022 drought event that there can be issues in abstracting from the River Thames caused by a number of different factors. These risks exist alongside other uncertainties and issues, for example risks around climate change's impacts on our supplies or customer demand. Furthermore, the current resilience level (1 in 100-year resilience to severe restrictions) in the London WRZ is a lower level than many other UK water companies (many of whom have 1 in 200-year level resilience), and so it is important to ensure that there is a prudent buffer to protect supplies. The risk profile for London is considered reasonable and aligns with the Water Resources Planning Guideline and priorities*

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[35] https://ehq-production-europe.s3.eu-west-1.amazonaws.com/c221322f362c9380346c34bdda9fd294014df1c6/original/1620041787/71229bcac59bbceb6728b1900400f5df_WRSE_Customer_Preferences_Summary_Report_eftec___ICS_March_2021_FINAL.pdf

of our customers because it ensures a reasonable buffer in the shorter term, during which time we have a limited ability to respond with new supply options (larger options having lead times of 8-15 years), and so this buffer safeguards service levels. Our AMP8 investment programme to improve resilience against Level 4 severe water use restrictions from 1 in 100 years on average to closer to 1 in 200 years is almost entirely based on demand management reductions, which in itself is a relatively high risk option. In the longer term, the reduced target headroom allowance means that we are not planning for large investments on the basis of a large uncertainty allowance; in the longer term our adaptive plan ensures that we will be able to respond to challenges and uncertainties as they arise.

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
London	8%	9%	9%	6%	4%	5%

Table X – London DYAA Target Headroom

SWOX DYAA – included before paragraph 6.137

13.33 *Table X below shows Target Headroom as a percentage of DI across the planning period. This table shows that the resultant Target Headroom profile for the SWOX WRZ early in the planning horizon is relatively high, at 8-9% of DI. This reduces over time, to less than 5% of DI in the longer term.*

13.34 *The SWOX WRZ's water resources are reliant on hydrologically constrained abstractions from the River Thames. Predicting river flows in the River Thames at Farmoor during extreme drought events involves a high degree of uncertainty, and we have also seen climate change impacts have significant impacts on demand recently. The risk profile for SWOX is considered reasonable and aligns with the Water Resources Planning Guideline and priorities of our customers because it ensures a reasonable buffer in the shorter term, during which time we have a limited ability to respond with new supply options, and so this buffer safeguards service levels. In the longer term, the reduced target headroom allowance means that we are not planning for large investments on the basis of a large uncertainty allowance; in the longer term our adaptive plan ensures that we will be able to respond to challenges and uncertainties as they arise.*

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
SWOX DYAA	9%	9%	8%	5%	3%	4%

Table X – SWOX DYAA Target Headroom

SWOX DYCP – included before paragraph 6.139

13.35 *Table X below shows Target Headroom as a percentage of DI across the planning period. This table shows that the resultant Target Headroom profile for the SWOX WRZ early in the planning horizon is 8-9% of DI and this reduces over time, to c.5% of DI in the longer term.*

13.36 *The SWOX WRZ's water resources are reliant on hydrologically constrained abstractions from the River Thames. Predicting river flows in the River Thames at Farmoor during extreme drought events involves a high degree of uncertainty, and we have also seen climate change impacts have significant impacts on demand recently. The risk profile for SWOX is considered reasonable and aligns with the Water Resources Planning Guideline and priorities of our customers because it* *ensures a reasonable buffer in the shorter term, during which time we have a limited ability to respond with new supply options, and so this buffer safeguards service levels. In the longer term, the reduced target headroom allowance means that we are not planning for large investments on the basis of a large uncertainty allowance; in the longer term our adaptive plan ensures that we will be able to respond to challenges and uncertainties as they arise.*

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
SWOX DYCP	9%	9%	8%	6%	5%	5%

Table X – SWOX DYCP Target Headroom

Kennet Valley DYAA – included before paragraph 6.145

13.37 *Table X below shows Target Headroom as a percentage of DI. This table shows that the resultant Target Headroom profile for the Kennet Valley DYAA scenario is set at, or close to, the de-minimis level of 3% across the planning horizon. This is because the analysis presented earlier in Section 6 indicates that there is a greater risk of having under-predicted the Fobney source's Deployable Output (which makes up around half of the WRZ's supplies) than having over-predicted it. Given the skewed risk in this scenario, allowing a smaller buffer across the planning period is reasonable and does not imply risk to customers' supplies.*

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
Kennet Valley DYAA	3%	3%	3%	3%	3%	3%

Table X – Kennet Valley DYAA Target Headroom

Kennet Valley DYCP – included before paragraph 6.147

13.38 *Table X shows Target Headroom as a percentage of DI. This Table shows that the Target Headroom profile for the Kennet Valley DYCP scenario begins at c.5-8% of DI, reducing to less than 5% of DI in the longer term. The increased headroom allowance in the shorter term ensures that levels of service are protected, while a reduced allowance in the longer term is reasonable as we will be able to adapt to different circumstances as they emerge.*

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
Kennet Valley DYCP	5%	7%	8%	3%	3%	3%

Table X – Kennet Valley DYCP Target Headroom

SWA DYAA – included before paragraph 6.141

13.39 *Table X shows Target Headroom as a percentage of DI. This table shows that the Target Headroom profile for the SWA DYAA scenario is set at, or close to, the de-minimis level of 3% of DI across the planning horizon. This is reasonable because the sources in this zone are primarily constrained by licence (resulting in lower levels of uncertainty).*

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
SWA DYAA	3%	3%	3%	3%	3%	3%

Table X – SWA DYAA Target Headroom

SWA DYCP – included before paragraph 6.143

13.40 *Table X shows Target Headroom as a percentage of DI. This shows that Target Headroom levels are at a reasonably low level, of 3-5% of DI across the planning period. Having a slightly higher headroom allowance earlier in the planning horizon is reasonable and aligns with the views of our customers and the Water Resources Planning Guideline because it ensures that service levels are safeguarded. Planning for a lower allowance in the longer term also aligns with the requirements of the Water Resources Planning Guideline as, in the longer term, we can adapt to circumstances which arise, according to our adaptive plan, and so do not need to plan longer-term investment now.*

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
SWA DYCP	4%	5%	5%	4%	3%	3%

Table X – SWA DYCP Target Headroom

Guildford DYAA – included before paragraph 6.149

13.41 *Table X shows Target Headroom as a percentage of DI. This table shows that the Target Headroom profile for the Guildford DYAA scenario is set at, or close to, the de-minimis level of 3% of DI across the planning horizon. This is reasonable because the sources in this zone are primarily constrained by licence (resulting in lower levels of uncertainty).*

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
Guildford DYAA	3%	4%	3%	3%	3%	3%

Table X – Guildford DYAA Target Headroom

Guildford DYCP – included before paragraph 6.151

13.42 *Table X shows Target Headroom as a percentage of DI. This shows that Target Headroom levels are at a reasonably low level, of 4-6% of DI across the planning period. Having a slightly higher headroom allowance earlier in the planning horizon is reasonable and aligns with the views of our customers and the Water Resources Planning Guideline because it ensures that service levels are safeguarded, for example ensuring resilience against increasing demands under increasingly frequent hot conditions. Planning for a lower allowance in the longer term also aligns with the requirements of the Water Resources Planning Guideline as, in the longer term, we can adapt to circumstances which arise, according to our adaptive plan, and so do not need to plan longer-term investment now.*

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
Guildford DYCP	5%	6%	6%	4%	4%	4%

Table X – Guildford DYCP Target Headroom

Henley DYAA – included before paragraph 6.153

13.43 *Table X shows Target Headroom as a percentage of DI. This table shows that the Target Headroom profile for the Henley DYAA scenario is set at, or close to, the de-minimis level of 3% of DI across the planning horizon. This is reasonable because the sources in this zone are primarily constrained by licence (resulting in lower levels of uncertainty).*

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
Henley DYAA	3%	3%	3%	3%	3%	3%

Table X – Henley DYAA Target Headroom

Henley DYCP – included before paragraph 6.155

13.44 *Table X shows Target Headroom as a percentage of DI. This shows that Target Headroom levels are at a reasonably low level, of 3-6% of DI across the planning period. Having a slightly higher headroom allowance earlier in the planning horizon is reasonable and aligns with the views of our customers and the Water Resources Planning Guideline because it ensures that service levels are safeguarded. Planning for a lower allowance in the longer term also aligns with the requirements of the Water Resources Planning Guideline as, in the longer term, we can adapt to circumstances which arise, according to our adaptive plan, and so do not need to plan longer-term investment now.*

	Target Headroom as a percentage of Distribution Input					
	AR22	AR25	AR30	AR40	AR50	AR75
Henley DYCP	5%	5%	6%	4%	3%	3%

Table X – Henley DYCP Target Headroom

Issue 14: Costs

14.1 A number of concerns around costs have not been adequately addressed, or addressed at all, by the company. The company should (in both its final plan and business plan where appropriate):

- provide transparency and assurance on option costs, including for SESRO. The company should provide full details and a breakdown of its costing approach. This is particularly important as the revised draft plan indicates that SESRO is selected on cost grounds.
- make clear whether partnership opportunities have been identified to enable co-funding and co-delivery
- ensure clear evidence is provided that the high unit costs for future leakage reduction are efficient. While lower than the leakage costs presented, the company has selected supply side options of significant cost. As such reductions in the cost of leakage or other demand management activities would have an impact on the optimal long-term delivery and timing of supply-side solutions
- provide details of how it proposes to investigate innovative options to make further leakage reductions at lower cost. It should re-evaluate its long-term leakage ambition regularly to account for innovations in leakage detection. The company should commit in its plan to investigate alternative novel options to mains replacement to ensure future leakage management is delivered efficiently.

Issue 14.1

Request

14.2 Thames Water should provide transparency and assurance on option costs, including for SESRO. The company should provide full details and a breakdown of its costing approach.

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue OF11

14.3 Ofwat notes that the selection of SESRO is based on current costs which have not changed in over five years, but may do so as the option development work progresses. Ofwat expects Thames Water to work with WRSE and Affinity Water, to further evidence the robustness and reliability of SESRO costs given their static nature is unusual for a project of this scale. Considering the additional customer funding provided at PR19 to support its development, we expect robust and up to date costs, presented transparently for all customers and stakeholders to engage with.

Further clarification

14.4 RAPID have clarified that this issue extends to the transparency and assurance of cost comparisons relevant to the decision-making process.

Our consideration of the points raised

14.5 We recognise the need to provide transparency, confidence and assurance of option costing and selection decisions. We have broken down our consideration of this request into sections. These are:

- A description of the process and assurance undertaken for costing of our options, with a focus on SESRO

- A description of the assurance of the WRSE investment model and its conclusions
- The result of cost sensitivity model runs undertaken to explore the sensitivity of the SESRO vs STT decision
- A transparent comparison of the costs of the SESRO and STT options, using data from our WRMP Tables and the WRSE IVM.

14.6 The aim of this is to provide:

- Assurance that the option costing process which has been undertaken is robust and has been assured, and as such confidence that the resultant option costings are accurate.
- Evidence to demonstrate that the WRSE investment model has been independently assured and can, as such, be trusted.
- An estimate of the degree to which option costs would need to change for our option selection decision to be impacted.
- Simplified comparisons of the costs of the SESRO and STT options.

Option Costing Approach and Assurance, SRO Focus

14.7 This request for information is similar in nature to representations made to RAPID on RAPID's draft assessment report on the SESRO Gate 2 submission[36]. As such, some of the information in this response is a duplication of the information given in response to our response to the Gate 2 representations.

14.8 The contents of this response help demonstrate that the SESRO costs have not been static and have instead been updated regularly to ensure that the base estimate, associated quantities, costed risk and optimism bias all reflect the scheme's developing design. The key aspects of this response are provided for clarity:

- Estimates, Costed Risk and Optimism Bias calculations all follow the guidance given in the ACWG Cost Consistency Methodology[37] (Linkhttps://www.thameswater.co.uk/media-library/home/about-us/regulation/regional-water-resources/south-east-strategic-reservoir/gate-2-reports/Representation-by-GARD-to-Gate-2-draft-assessment.pdf).
- The base-cost estimate for SESRO is an aggregation of approximately 300 separate cost elements, for which quantities and rates have been assessed. The relative maturity of the SESRO design gives confidence in the estimate.
- This estimate has been refined for both Gate 1 and Gate 2 submissions to reflect design development work undertaken in the respective RAPID gated periods.
- Similarly, Costed Risk registers and Optimism Bias calculations have been updated for these submissions to provide up to date contingency forecasts as the scheme develops.
- Examples of these changes are summarised in Gate 2, Supporting Document A-2 (Link)
- Between Gate 1 and Gate 2, an independent cost exercise benchmarked approximately 70% of the scheme. A variance of just over 5% was found between the SESRO base

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36 https://www.thameswater.co.uk/media-library/home/about-us/regulation/regional-water-resources/south-east-strategic-reservoir/gate-2-reports/Representation-by-GARD-to-Gate-2-draft-assessment.pdf

37 https://www.wrse.org.uk/media/u4gf5pye/acwg-cost-consistency-methodology.pdf

capex estimate and the benchmark position, demonstrating the robustness of the estimate.

14.9 As we continue the development of SESRO to a single option in RAPID Gate 3, greater definition will be added to the estimate to reflect the more detailed information available, quantities will be updated to reflect changes in design and additional cost intelligence will be sourced to ensure the continued robustness of the cost estimate and contingency forecasts.

Gate 1 cost estimation

14.10 At Gate 1, estimates of base Capex and Opex were derived following the guidance given in the ACWG cost consistency method. The capital cost estimates were primarily based on refinement of those developed for previous WRMP submissions. The WRMP09 cost estimate is referred to as a 'bottom-up' contractor's estimate because it is more detailed than the parametric estimated normally used at an early stage of project development. That cost estimate was reviewed and refined for Gate 1, meaning that the costs provided at Gate 1 (as per previous WRMP option costings) were based upon a relatively high degree of estimating detail. Additionally, the costed risk register was updated to reflect the Gate 1 design and environmental appraisal, to provide an updated estimate of the P50 risk. Optimism Bias was calculated alongside the costed risk analysis, as detailed in the ACWG Cost Consistency Methodology. In combination, therefore, due to this maturity of the scheme, the SESRO costs at Gate 1 already reflected a relatively high degree of engineering and risk definition when compared to other water resource options at a similar stage of development.

Gate 1 Benchmarking

14.11 At Gate 1, we undertook an independent cost benchmarking exercise on the capex costs. Jacobs were requested to prepare an independent Capex cost benchmark against the notional solutions for the South East Strategic Reservoir Option (SESRO) Strategic Resource Option (SRO) in support of the RAPID Gate 1 submission. The Capex benchmark was primarily undertaken by Bam who have reviewed the unit rates for the civils aspects of the project. Some of the larger M&E elements were benchmarked by ChandlerKBS using UK Water Company data, adjusted to the South East region. Over 70% of the principal items associated with the scheme were benchmarked. Overall, a variance of just over 5% was found between the SESRO base capex estimate and the benchmark position. The same approach to the bottom-up cost estimate has been used at Gate 1 and Gate 2, and therefore the benchmarking carried out at Gate 1 is still considered applicable to the Gate 2 cost estimate. Further review is planned to take place at the next stage of design development, to inform Gate 3.

Gate 2 Updates

14.12 At Gate 2, the engineering design and costs for the SESRO scheme were updated to align with the current option design. Quantities are consistent, rates have been updated and benchmarked, and allowances for uncertainty are included, in accordance with All Company Working Group and HM Treasury guidelines. That work has been completed and checked by professional quantity surveying firms and is set out in the Gate 2 Cost Report A-2 (Link). At Gate 3 we will produce an updated report.

14.13 The Gate 2 base-cost estimate is broken down into approximately 300 separate cost elements, for which quantities and rates have been assessed. Key rates have been benchmarked, including the rates for earthworks. The relative maturity of the SESRO design and the fact that the dominant cost element is the earthworks, gives added confidence in the estimate.

14.14 The base cost represents the known and measurable scope. Allowances for risk and uncertainty are added to the base cost. The allowance for risk is derived by analysing the probability and impact of identified risks, for example, unforeseen ground conditions. The allowance for risk totals £335m at a 50% confidence level. In line with good practice, a further allowance of £406m is added to account for the systemic tendency to underestimate uncertainty at an early stage of project development, known as Optimism Bias. In total, these allowances equate to £741m, or an uplift of 51% of the base cost. The nominal price and NPV are then calculated by adding allowances for inflation and applying discount rates set out in the WRMP appraisal process.

14.15 The design, schedule, risk analysis and resulting estimate will continue to be refined as the development process proceeds to RAPID Gate 3.

Conclusion

14.16 Therefore, the level of estimating detail, relative design maturity and significant allowances for uncertainty in the SESRO cost estimate give confidence that it is a reliable basis for comparison with other WRMP schemes.

Assurance of the WRSE Investment Model

14.17 Thames Water is part of the WRSE Regional group. The WRSE regional group have all adopted the same decision-support tool in their WRMP investment planning, the WRSE Investment Model (IVM), due to the interconnected plans within the WRSE region. The planning problem within the WRSE region is extremely complex, with inter-company transfers, shared options, option scheduling and adaptive pathways all bringing layers of complexity which must be considered when deriving the best value plan for the region. Due to the complexity of the planning problem, the WRSE IVM decision-support tool is also complex, and the inputs, processes and outputs can be complicated.

14.18 Recognising that the plans for all six WRSE companies are dependent on the outputs of this decision-support tool and acknowledging that confidence in the tool is important, expert independent assurance of the tool was undertaken[38]. The scope of the assurance review included:

- A review of the problem that is faced by WRSE, and a review of the broad approach taken
- A review of the platform and tools used in the model's development
- A review of the development history of the WRSE IVM and developments which have been made in this round of planning
- A review of the mathematical formulation of the model
- A review of the technical implementation of the model
- Validation and verification of the model

[38] WRSE Investment Model External Review, August 2022, Liz Archibald, https://www.wrse.org.uk/media/gdwhjxsp/wrse-investment-model-external-review-august-2022.pdf

14.19 Key comments from the independent expert review include:

14.20 "The size and complexity of the regional planning problem is such that a computer-based model is necessary to ensure that any proposed solution solves the problem."

14.21 "For complex problems, the established practice is to utilise specialist software known as "Solvers" and this is what has been done here. The Decision Lab developers of the WRSE IVM developed an algebraic formulation of the problem and encoded it in the Python language."

14.22 "All models are simplifications of reality, and the level of aggregation within a model is a key design choice. In the case of the WRSE IVM which is a strategic model, the spatial aggregation is to Water Resource Zone (WRZ) level. Forecasts of future supply and demand are associated with an entire WRZ. This represents a significant abstraction from reality as, for example, the model does not concern itself with the details of how water will move within a WRZ. This approach is entirely standard practice for WRMP's. In fact, in some strategic planning settings, further spatial aggregation is undertaken by combining WRZ's. In the case of the WRSE IVM, this was not done, and WRZ's were used as the spatial modelling unit. This was good to see."

14.23 "The WRSE IVM model has been platformed appropriately given the complexity of the planning problem and the regulatory requirements. The separation of model logic from model data supports the need for multiple models runs with different inputs and assumptions."

14.24 "The IVM has been developed to encompass elements of the previously adopted methodologies whilst incorporating more advanced methodologies appropriate to the depth of uncertainty in deficit projections over the planning period. Such advanced methodologies are inherently more complex which brings disadvantages in communication. However, the size of the projected regional deficit, and the uncertainty within the projections does indicate that previous more simplistic approaches may no longer suffice."

14.25 "The documentation of the mathematical formulation shows that the inherent design of the IVM is fit for purpose. It uses established methodologies, specifically those grounded in EBSD, which have been adapted to reflect current thinking around Best Value, and a range of regulatory requirements."

14.26 "The basis of the current methodology was found to consist of a combination of established, known to be reliable methods, combined with cutting edge approaches. This merging of well-established techniques used extensively over several WRMP cycles at both company and regional levels meant that certain parts of the model established high levels of confidence early on. The stochastic elements are well established in academic settings, but most definitely are innovative in this context. These were applied with reference to available guidance in the literature. The mix of old and new was concluded to be appropriate given the scale of the WRSE challenge."

14.27 "Verification of an optimisation model is challenging and "proof positive" is hard to pin down. The response from client/developer teams should be to develop a tight process which builds knowledge and confidence over time that model solutions are both feasible and optimal within the tolerances set. This was found to be the case in the WRSE IVM development, testing formed part of the process as different functionality was added and new versions of the model released for use."

14.28 "The design of the model accords with the requirements which is to objectively find an optimal solution to the planning problem posed, using a combination of the various options offered, whilst applying any over-riding constraints e.g., leakage targets."

14.29 "We saw nothing within the formal design of the model and the method of use which could lead to any bias in the results. The input data - SDB input, offered options, options costs and benefits, interdependencies – are separate and transparent, with good attention to detail as to what settings are in place for each model run."

14.30 "We were not able to access any formal testing records and this review therefore focused on separate discussions with members of the client and development teams. We are assured that a functional testing mechanism was in place throughout the development period which would ensure that the model was producing the results expected given the inputs and rules it was given."

14.31 "The combination of team members in both client and developer teams provided the appropriate skills, extensive experience, and expert knowledge to develop a high-quality model. The configuration parameters for the Solver, specifically the MIP-gap has been appropriately set after experimentation. The configuration parameters for the Progressive Hedging heuristic are mostly set to defaults and whilst this is the best place to start, there could be room for performance improvements."

14.32 These comments from an independent expert give confidence that the WRSE IVM is fit for purpose, both in its formulation and implementation. As such, we should be confident in the model's ability to derive a least-cost plan. The review recognises that using a complex tool brings challenges in communication but acknowledges that the complexity of the problem which has been posed to the WRSE regional group necessitates the use of such a complex tool. For these reasons, in our programme appraisal, documented in Sections 10 and 11 of the WRMP, we have accepted the outputs of the WRSE IVM as robust and have focussed on interpreting the outputs of the model.

SESRO cost sensitivity runs

14.33 In order to test the sensitivity of our decision-making, WRSE IVM model runs have been undertaken. Some stakeholders have raised concern that the cost of the SESRO option may have been under-estimated (although we reiterate that, as described above, the SESRO costs have been produced and assured using robust methods), and so we have tested the degree to which our decision-making is sensitive to increases in the cost of the SESRO option. While we have tested this aspect of our decision-making, it is important to acknowledge that alternative options such as the STT would also be subject to similar issues of cost uncertainty.

This sensitivity analysis supplements the existing sensitivity tests carried out removing SESRO from the options list. We have incrementally increased the cost of the SESRO scheme variants by increasing the Optimism Bias parameter for this scheme by 20, 30, 40, 50, and 60% (Table 28).

Table 28: SESRO Cost Sensitivity Runs

OB uplift (%)	£m uplift (150 Mm3 option)	Outcome (Pathway 4)
0	-	SESRO 150 Mm^3
20	268	SESRO 150 Mm^3
30	402	SESRO 150 Mm^3
40	535	SESRO 125 Mm^3
50	669	SESRO 150 Mm^3
60	803	STT 300 Ml/d

14.34 This suggests that the cost increase tipping point for the SESRO scheme is between £669m and £803m. This would be a significant cost increase, bearing in mind that this would be an increase relative to any cost increase which may also be experienced by the STT.

14.35 It should be highlighted that our preference for the SESRO scheme is not based solely on cost. As is described in Section 11 of our WRMP, paragraph 11.86, other factors such as the greater operational simplicity of SESRO, the greater flexibility of the scheme (it being more suitable for use as a source for the T2ST given the lack of raw water storage in the Southern Western Area), doubts raised by the EA around the viability of the STT scheme, the lower overall carbon emissions of the SESRO scheme (when considering construction and operation), and the risk that one or more of our existing reservoirs may need to be taken out of service also contribute to our preference for SESRO over the STT.

Cost Comparison

14.36 As is recognised in the expert independent assurance report of the WRSE investment model[39], the problem being solved by the WRSE investment model is very complex. The particular aspects of complexity which are highlighted are:

- The WRSE investment model is used to provide an investment solution for “37 water resource zones with complex interconnectivity“, simultaneously
- There are “thousands of option variants with complex interdependencies, e.g., mutual exclusivity or group dependencies”
- Consideration of “the intensity of utilisation” which “makes the model much more complex but is important because of the big differences in option types being considered. Some types of option have high capital costs but low operational costs and so might be cost effective at high utilisations but cost inefficient at low utilisations. The opposite is also true.

14.37 For these reasons, presenting a simplified cost comparison between the SESRO and STT options is challenging, as each option’s overall cost would depend on when and how the option is used.

[39] WRSE Investment Model External Review, August 2022, Liz Archibald, https://www.wrse.org.uk/media/gdwhjxsp/wrse-investment-model-external-review-august-2022.pdf

14.38 However, using information which is presented in our WRMP Tables (Tables 5a and 5b), a simplified comparison can be made. As is required by the guideline for the WRMP tables, information from WRMP Tables 5a and 5b includes an assumption of maximum option utilisation, and this comparison is static (i.e., there is no scheduling over the planning period). The comparison is presented in Table 29. We stress that this comparison cannot account for the complexities in option scheduling and utilisation, which are the reason that the WRSE IVM is used in decision support.

14.39 The key observations from the summary table are:

- STT has a significantly greater Net Present Cost (NPC) then SESRO.
- SESRO is a high capex (capital) scheme with low opex (operational costs).
- STT is a lower capex scheme but with high fixed and variable opex.
- Opex for STT is high because a) water has to be pumped longer distances and at substantially higher pressure to lift water over the Cotswolds (variable opex), and b) Severn Trent and United Utilities must invest in capital schemes of their own to free up water for transfer, which is charged back to the water companies that use the water as fixed opex. This also explains why a relatively high proportion of the STT opex costs are fixed.
- In order to provide a similar level of output, the STT requires a number of supporting elements, including from Netheridge sewage works in Gloucestershire, Minworth sewage works in Birmingham and Lake Vyrnwy in Wales.
- If you were to assume no STT usage (ie. assume zero variable opex) the sum of the financing cost and fixed opex of the supported STT (£6,537m) is higher than the full SESRO costs, including variable opex (£5,645m).

Table 29: Information from TW WRMP Tables, Comparing SESRO and STT Costs[40]

	SESRO 150Mm3	STT300 + Support	STT 300 + Netheridge	Vyrnwy 2	Vyrnwy 1	Vyrnwy 3	Vyrnwy 4	Vyrnwy 5	Minworth
Deployable Output increase (Ml/d)	271	264	104	13	16	19	19	19	74
Cost Summary (£m, 20/21 prices)									
Capex (intial)	2367	1283	1041	242	Opex Only				
Capex (repeat, during operation, over 80 years)	706	506	496	11	Opex Only				
Financing cost (ie. Total Capex including financing, over 80 years)	5334	3074	2587	487					
Opex (full utilisation)	311	6478	1938	369	277[41]	355	676	393	2470
Fixed	251	3463	958	191		145	485	188	1217
Variable	60	3015	980	177		210	191	205	1252
Net Present Cost (full utilisation)	1626	3012[42]	1359	291	91	114	213	125	860

[40] This table was first released in response to an EIR request. Small changes have been made to the table sent in response to the EIR following further checks.

[41] No fixed/variable opex breakdown is given for the "Vyrnwy 1" scheme element as it falls below the cost threshold to do so, as set within the WRMP Table Guidance.

[42] Please note: overall scheme NPC (3012) is lower than the sum of the scheme elements (3053) because costs for the elements are provided over slightly different time periods in Table 5a.

Cost Calculations in the WRSE IVM

14.40 Some representations made on the RAPID Gate 2 reports criticised the Net Present Cost methodology, which is sometimes used to provide a simplified comparison of cost between different options. In our response, we highlighted two key factors:

- Where we present Net Present Cost (NPC) values of individual options, they have been calculated using prescribed methodologies (there being different parameters which can be adopted in a NPC calculation, for example the time period over which the value is calculated, e.g. an 80-year NPC or a 200-year NPC).
- The WRSE IVM does not use these simplified NPC values, and instead uses scheduled annuitised capex, fixed opex and variable opex, alongside monetised carbon costs (indexed to account for both the treasury's guidance on valuation of carbon emissions now and in the future, and indexed to account for the forecast decarbonisation of the grid), which are discounted appropriately, in order that the cost on which investment decisions are based, and which is optimised in the WRSE IVM, is reflective of the cost to customers.

14.41 The process of capex annuitisation, and the overall calculation of cost used by the investment model is described in Appendix W of our rdWRMP24.

14.42 As discussed throughout this response, the need for the WRSE investment model to consider option scheduling and utilisation in adaptive scenarios means that a very simple, option-level, side-by-side cost comparison is not achievable (this being the reason that a programme-level cost comparison is presented in our programme appraisal). The WRSE IVM performs pre-processing calculations which determine the following parameters for each option:

- Annuitised capex (£m/yr)
- Fixed opex (£m/yr)
- Variable opex (£/Ml)
- Annuitised embodied carbon (tonnes/yr)
- Fixed operational carbon (tonnes/yr)
- Variable operational carbon (tonnes/Ml)
- Fixed electricity requirement (kWh/yr)
- Variable electricity requirement (kWh/Ml)

14.43 It is these values which the calculations in the IVM use to derive programme-level costs (and so compare between programmes including different options).

14.44 Using information used by the WRSE IVM, a simplified comparison can again be drawn between the cost of the SESRO option and the cost of STT options. In Table 30, the annuitised capex, fixed opex, the sum of these two values (the total annual fixed cost), and the Deployable Output benefit for the 150 Mm^3 SESRO option and STT options is shown. In this table we have also aggregated STT components with either Deployable Output or fixed costs similar to the SESRO 150 Mm^3 option.

14.45 The values in Table 30 demonstrate that the SESRO option is more cost efficient, on an annual basis, than comparable STT options, even when disregarding variable operational costs (which are much higher for the STT than SESRO). An STT option with a comparable Deployable Output benefit to the 150 Mm^3 SESRO option would cost around a third more in annual fixed costs, while an STT option with comparable annual fixed costs would deliver around a third less Deployable Output benefit.

14.46 The high fixed costs of the Severn-Thames Transfer exist because:

- The STT interconnector requires a relatively high capital expenditure. The 300 Ml/d pipeline would have an annualised capital cost equivalent to c.50% of the SESRO 150 Mm^3 annualised capital cost, while the equivalent values for the 500 Ml/d pipeline and 300 Ml/d canal options are around 70% and 75%.
- Each of the STT support options entails a high fixed operational cost. These high fixed costs are required because the means of providing support would require donors to construct either replacement sources and a River Vyrnwy bypass pipeline (in the case of Vyrnwy) or water recycling facilities (in the case of Minworth and Netheridge), and so fixed payments would be made to the donor to cover the costs associated with the development of these enabling works.

14.47 When considering that, in addition to higher fixed costs, the STT would also entail substantial variable operational costs and emissions associated with pumping water at a high head and over a long distance, the SESRO option is clearly more cost-effective.

Table 30: Cost and carbon information for SESRO and STT from WRSE Investment Model

Option	Annuitised Capex (£m/yr)	Fixed Opex (£m/yr)	Total Fixed Costs (£m/yr)	Deployable Output (Ml/d)
SESRO 150 Mm^3	58.00	3.86	61.86	271
STT 300 Ml/d pipe + Netheridge + Minworth 115 + Vyrnwy Phases 1-5	36.75	46.36	83.11	265
STT (by individual elements)				
STT 300 Ml/d pipe	30.54	2.89	33.43	80
STT 400 Ml/d pipe	37.69	3.55	41.24	107
STT 500 Ml/d pipe	42.34	4.06	46.41	134
STT 300 Ml/d canal	43.81	3.70	47.51	80
Netheridge	0.00	10.36	10.36	24
Minworth Phased option - Phase 1	0.00	12.26	12.26	37
Minworth Phased option - Phase 2	0.00	6.16	6.16	37
Minworth 115 Ml/d option	0.00	16.23	16.23	74
Vyrnwy 1	0.00	1.81	1.81	13
Vyrnwy 2	6.21	2.86	9.06	16

Option	Annuitised Capex (£m/yr)	Fixed Opex (£m/yr)	Total Fixed Costs (£m/yr)	Deployable Output (Ml/d)
Vyrnwy 3	0.00	2.17	2.17	19
Vyrnwy 4	0.00	7.24	7.24	19
Vyrnwy 5	0.00	2.80	2.80	19
Vyrnwy 6	0.00	8.89	8.89	13
Alternative STT combinations (ie. elements combined)				
STT 400 Ml/d + Netheridge + Minworth 115 + Vyrnwy Phases 1-4			88.12	272
STT 500 Ml/d + Netheridge + Minworth 115 + Vyrnwy 1-2			83.87	260
STT 500 Ml/d + Netheridge + Vyrnwy 1-6			88.74	257
STT 300 Ml/d + Netheridge + Minworth Ph1 + Vyrnwy 1			57.86	153.92
STT 300 Ml/d + Netheridge + Minworth 115			60.02	177.72
STT 300 Ml/d + Netheridge + Vyrnwy 1-3			64.07	152.12
STT 400 Ml/d + Netheridge + Minworth Ph1 + Vyrnwy 1			65.67	180.66
STT 400 Ml/d + Netheridge + Minworth 115			67.83	204.46
STT 400 Ml/d + Netheridge + Vyrnwy 1-2			62.47	159.56
STT 500 Ml/d + Netheridge + Minworth Ph1 + Vyrnwy 1			70.83	207.66
STT 500 Ml/d + Netheridge + Minworth 115			73.00	231.46

Option	Annuitised Capex (£m/yr)	Fixed Opex (£m/yr)	Total Fixed Costs (£m/yr)	Deployable Output (Ml/d)
STT 500 Ml/d + Netheridge + Vyrnwy 1-2			67.63	186.56

Conclusion

14.48 As has been demonstrated:

- The option costing process which has been undertaken is robust and has been assured, and as such we have confidence that the resultant option costings are accurate.
- The WRSE investment model has been independently assured and can, as such, be trusted. It is the right tool for the job, given the complexity of the planning problem faced by the WRSE region.
- The SESRO option would need to see a substantial (between £669m and £803m) cost increase for the STT to be selected instead of SESRO in a least cost plan. Given that SESRO is selected not only on the basis of cost, a further increase in cost above the "least cost tipping point" would be needed to change our decision to adopt SESRO in our preferred plan.
- While the planning problem being solved by the WRSE IVM is complex and demands the use of complex computational analysis, a simplified comparison of the costs of the SESRO and STT options, using information which was published in the rdWRMP24 Tables, demonstrates that the STT option is substantially more expensive than the SESRO option when considering options which deliver the same level of benefit. Similarly, a comparison of the annualised fixed costs of SESRO and the STT demonstrates that even when ignoring the high variable operational costs of the STT option, SESRO is more cost effective.

14.49 Our consideration is that this chain of evidence, assurance and sensitivity testing, alongside the presentation of simplified comparisons, gives the required transparency and confidence in the selection of the SESRO option.

Changes made to the rdWRMP24

14.50 We will make the following changes to our rdWRMP24:

14.51 As an annex to Section 10 of the WRMP, we will include the content under the "cost comparison" section of our consideration above.

14.52 Additional text will be added to WRMP24 Section 10, Stage 5: Sensitivity testing (under the "Upper Thames – SESRO and STT subheading) to detail the SESRO cost sensitivity runs, as described in the "SESRO cost sensitivity runs" section of our consideration above. The results of these model runs will also be included in WRMP24 Appendix X.

14.53 The text presented above in the "Assurance of the WRSE Investment Model" section of our consideration will be included in Appendix W of the WRMP24, within the sub-section entitled "The Investment Model (IVM)" under a new heading entitled "Assurance of the IVM".

Issue 14.2

Request

14.54 Thames Water should make clear whether partnership opportunities have been identified to enable co-funding and co-delivery

Further elaboration of request given in annex, or clarification given subsequently

Annex Issue OF12

14.55 Ofwat asked for clarity surrounding partnership opportunities where co-funding and co-delivery will occur. Thames Water acknowledged point but didn't make changes to plan. Ofwat requires further clarity surrounding partnership opportunities.

Our consideration of the points raised

Identifying third party options

14.56 Thames Water encourages third parties to submit bids for solutions covering water resources, demand management and leakage services that create value for customers. These solutions will help Thames Water meet its future water needs, as identified in our Water Resources Management Plan, and benefit our current and future customers. The solutions could also help the resource position in the wider South East, where Thames Water is working closely with other companies within the Water Resources South East group (WRSE) to develop a regional plan for WRMP24.

14.57 Thames Water welcomes the opportunity to develop and deliver innovative solutions that deliver best value for our customers and the environment. We consider that proposals will need to have sufficient technological maturity for consideration in our WRMP24.

14.58 We have sought to identify potential third party water resource options through three main approaches:

- Request for proposals for water resources through the Bid Assessment Framework[43] (BAF) and the UK Find a Tender Service, used to notify the market of our interest in being offered new water resources and demand management options.
- Bilateral discussions with other water companies.
- Active engagement with regional water resource planning groups including the Water Resources in the South East (WRSE), Water Resources West (WRW), Water Resources East Group (WRE) and the West Country Water Resources (WCWR).

14.59 In preparation for WRMP24, on 16 March 2020 we published a periodic indicative notice (PIN) via OJEU to invite third party organisations to register interest in providing water resources or demand management options. Water companies are required by Ofwat to have a Bid Assessment Framework (BAF), a public declaration outlining how third party offers of water resources, demand management or leakage solutions will be treated by us, ensuring that all offers are considered equally as compared with solutions that have been developed in-house.

[43] Thames Water Bid Assessment Framework https://www.thameswater.co.uk/media-library/home/about-us/regulation/water-resources/bid-assessment-framework-2021.pdf

14.60 Generic option types passed screening but no feasible options were received through the BAF. A summary of the responses received related to new water resource options is set out in Section 7, Table 7-6.

14.61 Further to options identified through the BAF process, we have also considered catchment options, as described in the section below.

WRSE

14.62 WRSE also encouraged the proposal of options from third parties. A summary of third party options submitted to WRSE is described in Section 7, Table 7-7.

14.63 Investment modelling has been carried out at the regional level, rather than the company level. As such, while option development has been carried out by Thames Water, information from this option development exercise has been fed into the WRSE 'Data Landing Platform' (DLP). The DLP is then used to provide inputs to the WRSE investment model and identification of best value options for the region.

Co-development

14.64 Perhaps the most prominent option being co-developed is SESRO which is being developed by, and will benefit three water companies – Thames Water, Affinity Water and Southern Water – and it would provide water to the customers of these water companies whilst increasing resilience across the wider South East region. This option is most likely to be delivered through the Specified Infrastructure Projects Regulations delivery mechanism, and so would be delivered by a third party to ensure protection and efficiency for customers.

Co-funding

14.65 If a proposal passes the first pre-qualification stage of the BAF evaluation process, Thames Water will offer the third party the opportunity to co-fund the development of their proposal to provide the information required for the second pre-qualification and detailed proposal evaluation stages.

14.66 Through the £300m Ofwat Innovation Fund we are currently leading on the delivery of five innovation projects valuing over £8m while supporting our partners with over £30m in collaborative projects. Of the five projects Thames is leading, two are water resources focussed.

- Community-centric rainwater management - A trial involving provision of water butts and rainfall management education in set areas to identify the benefit of working with communities to use water more efficiently and reduce demand.
- Digital Twins - A digital recreation of our network to enable more efficient management and reduce leakage and bursts.

14.67 A number of additional projects are awaiting a funding decision, one of which is water resources focussed.

- No Dig Leak Repair - assessing advanced technologies such as robotics and trenchless repair methods with an aim to implementing leak repair without digging up roads.

Co-delivery through government-led demand reduction

14.68 In order to achieve the challenging PCC target of 110 l/h/d we will need government to bring forward policies such as water labelling and changes to Building Regulations. These government-led demand reduction measures represent 29% of our total supply-demand balance need by 2050. This is a significant amount of water and whilst water labelling is planned for household goods from 2025[44], we do not yet have confirmation from the government regarding the measures that they intend to implement for building regulations, nor when such measures might be implemented.

Catchment Options

Co-funding though our catchment fund

14.69 We're currently offering up to £15,000 per farm business to help farmers in target areas protect water quality[45]. Eligible activities include infrastructure improvements, land management activities, education or equipment purchases. We also support innovative farming proposals for improving water quality. The fund is available in specific surface water and groundwater target areas, see Table 31 and associated Figure 14-1. The options mainly address pesticides in surface water and nitrate in groundwater with many in our water stressed SWOX WRZ. Funding of up to £40,000 is available for activities that will achieve significant, long term water quality improvements[46].

Table 31: Catchment fund target areas

Catchment	Catchment type	Water quality target (s)	Project partner
Sheafhouse (1) and Upper Swell (2)	Groundwater	Nitrate and pesticides	FWAG South West
Marlborough (3), Axford & Ogbourne (4), and Ashdown Park & Fognam Down (5)	Groundwater	Nitrate	FWAG South West
Hungerford (6), Leckhampstead (7) and Sheeplands (8)	Groundwater	Nitrate	Promar
Westerham (9), Wilmington (10), Green St Green & Lane End, and Southfleet (11)	Groundwater	Nitrate	Promar
Source of Thames (13), Ampney Brook (14), Marston Meysey Brook (15), Wiltshire Ray (16) Key and Thames to Coln (17), Cole (18) and Middle Windrush (19)	Surface water	Pesticides	FWAG South West

[44] https://www.gov.uk/government/news/household-goods-to-carry-water-efficiency-labels

[45] Smarter Water Catchments – our approach https://www.thameswater.co.uk/media-library/home/about-us/responsibility/smarter-water-catchments/smarter-water-catchments-our-approach.pdf

[46] Catchment Fund additional information https://www.thameswater.co.uk/media-library/home/about-us/responsibility/smarter-water-catchments/catchment-fund-additional-information.pdf

Lower Windrush (20), Great Brook and Thames to Farmoor (21)	Surface water	Pesticides	Promar
Upper Evenlode (22) and Lower Evenlode (23)	Surface water	Pesticides	Catchment Sensititve Farming
Upper Cherwell (including Ashby Brook) (24), Hanwell Brook and Middle Cherwell (25), Tadmarton Stream (26) and Lower Cherwell (27)	Surface water	Pesticides	Promar
Upper and Lower Oxon Ray (28 & 29)	Surface water	Pesticides	Promar
Ock (30) and Wantage (12)	Surface water (Ock) and groundwater (Wantage)	Pesticides (Ock) and nitrate (Wantage)	Promar
Thames to Thame and nearby tributaries (31), Upper Thame (32), Middle Thame (33) and Lower Thame (34)	Surface water	Pesticides	Promar
Enborne (35), Lower Kennet and Sulham Brook (36) and Foudry Brook (37)	Surface water	Pesticides	Promar
North Wey (38), Slea and Bucks Horn Stream (39), Cranleigh Waters and Compton Stream (40) and Tillingbourne (41)	Surface water	Pesticides	Promar
Beane (42), Rib (43), Ash (44), Upper Stort (45), Pincey Brook (46), Lower Stort (47), Cobbins Brook (48) and Lower Lee (49)	Surface water	Pesticides	FWAG South East

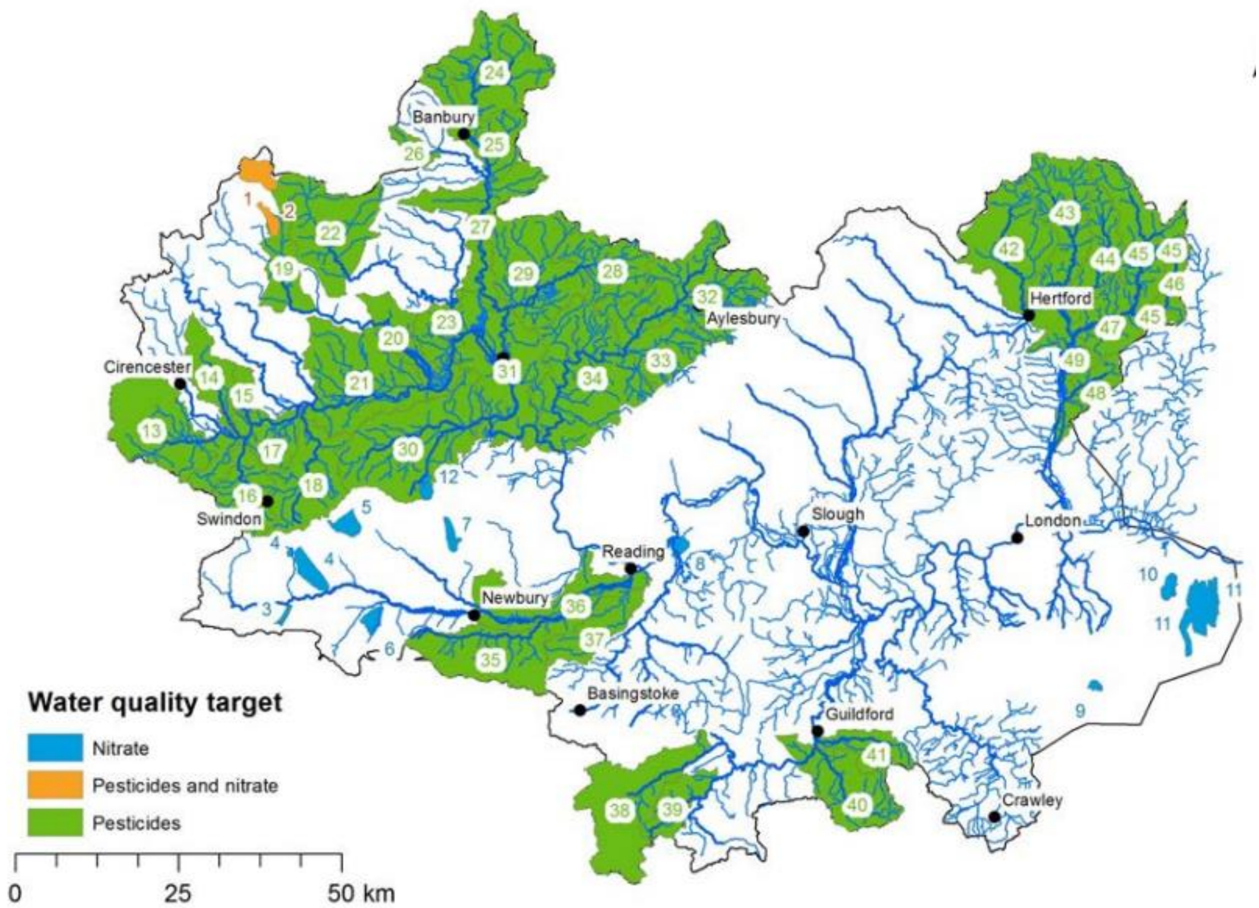


Figure 14-1: Catchment Fund Target Area Map

Catchment options through WRSE

14.70 Through WRSE, catchment option ideas for delivery in our supply area were identified through a number of means including:

- Liaison with water companies, and other stakeholders such as local rivers trusts and catchment partnerships, the Environment Agency and Local Councils. Our joint Water Resources Forum with WRSE has covered this specific initiative on a number of occasions.
- Collation of all catchment options included in WRMP19, Company Business Plans, Drinking Water Safety Plans and other plans and programmes.
- Catchment mapping to identify additional options outside of WRSE, including a number of workshops with key stakeholders.

14.71 As part of the regional planning process, we have engaged with multi-sector partners and environmental stakeholders across our catchments to identify novel solutions to improve the connectivity and resilience of the region. WRSE ran a series of workshops with stakeholders with an interest in catchments across the region to gather their ideas for nature-based solutions to benefit their local environment. A total of 161 options were identified (124 options proposed by stakeholders, we identified 37 options from our potential programmes for AMP8).

14.72 We identified three schemes in Section 7, Table 7-8 within our nature-based solutions programmes that may offer a deployable output benefit over the longer term. These schemes involve working with farmers to provide support and advice to implement environmental interventions, including measures to reduce the potential for nitrate to leach into groundwater. These schemes were included within our catchment options longlist to be screened and modelled by WRSE to develop the draft Regional Plan. As with the other catchment options on our longlist, the information for these options is less mature and the option type itself generates less certain water resources benefits. This means that a high degree of uncertainty remains around the deliverability of the estimated deployable output benefits from these options. Through our existing programmes to improve the environment and our WINEP and PR24 process we are working as a business to better understand the benefits of these options and support their implementation.

Changes made to the rdWRMP24

14.73 The following text will be added to Section 7, after paragraph 7.93.

Co-development of options

14.74 The most prominent option currently being co-developed is SESRO which is being developed by, and will benefit three water companies – Thames Water, Affinity Water and Southern Water – and it would provide water to the customers of these water companies whilst increasing resilience across the wider South East region. This option is most likely to be delivered through the Specified Infrastructure Projects Regulations delivery mechanism, and so would be delivered by a third party to ensure protection and efficiency for customers.

Co-funding of options

14.75 If a proposal passes the first pre-qualification stage of the BAF evaluation process, Thames Water will offer the third party the opportunity to co-fund the development of their proposal to provide the information required for the second pre-qualification and detailed proposal evaluation stages.

14.76 Through the £300m Ofwat Innovation Fund we are currently leading on the delivery of five innovation projects valuing over £8m while supporting our partners with over £30m in collaborative projects. Of the five projects Thames is leading, two are water resources focussed.

- *Community-centric rainwater management - A trial involving provision of water butts and rainfall management education in set areas to identify the benefit of working with communities to use water more efficiently and reduce demand.*
- *Digital Twins - A digital recreation of our network to enable more efficient management and reduce leakage and bursts.*

14.77 A number of additional projects are awaiting a funding decision by Ofwat, one of which is water resources focussed.

- *No Dig Leak Repair - assessing advanced technologies such as robotics and trenchless repair methods with an aim to implementing leak repair without digging up roads.*

Co-funding though our catchment fund

14.78 *We're currently offering up to £15,000 per farm business to help farmers in target areas protect water quality[47]. Eligible activities include infrastructure improvements, land management activities, education or equipment purchases. We'll also support innovative farming proposals for improving water quality. The fund is available in specific surface water and groundwater target areas, see Table X and associated Figure X. The options mainly address pesticides in surface water and nitrate in groundwater with many in our water stressed SWOX WRZ. Funding of up to £40,000 is available for activities that will achieve significant, long term water quality improvements[48].*

Table X: Catchment Fund Target Areas

Catchment	*Catchment type*	*Water quality target (s)*	*Project partner*
Sheafhouse (1) and Upper Swell (2)	*Groundwater*	*Nitrate and pesticides*	*FWAG South West*
Marlborough (3), Axford & Ogbourne (4), and Ashdown Park & Fognam Down (5)	*Groundwater*	*Nitrate*	*FWAG South West*
Hungerford (6), Leckhampstead (7) and Sheeplands (8)	*Groundwater*	*Nitrate*	*Promar*
Westerham (9), Wilmington (10), Green St Green & Lane End, and Southfleet (11)	*Groundwater*	*Nitrate*	*Promar*
Source of Thames (13), Ampney Brook (14), Marston Meysey Brook (15), Wiltshire Ray (16) Key and Thames to Coln (17), Cole (18) and Middle Windrush (19)	*Surface water*	*Pesticides*	*FWAG South West*
Lower Windrush (20), Great Brook and Thames to Farmoor (21)	*Surface water*	*Pesticides*	*Promar*
Upper Evenlode (22) and Lower Evenlode (23)	*Surface water*	*Pesticides*	*Catchment Sensititve Farming*
Upper Cherwell (including Ashby Brook) (24), Hanwell Brook and Middle Cherwell (25), Tadmarton Stream (26) and Lower Cherwell (27)	*Surface water*	*Pesticides*	*Promar*

[47] Smarter Water Catchments – our approach https://www.thameswater.co.uk/media-library/home/about-us/responsibility/smarter-water-catchments/smarter-water-catchments-our-approach.pdf

[48] Catchment Fund additional information https://www.thameswater.co.uk/media-library/home/about-us/responsibility/smarter-water-catchments/catchment-fund-additional-information.pdf

Upper and Lower Oxon Ray (28 & 29)	*Surface water*	*Pesticides*	*Promar*
Ock (30) and Wantage (12)	*Surface water (Ock) and groundwater (Wantage)*	*Pesticides (Ock) and nitrate (Wantage)*	*Promar*
Thames to Thame and nearby tributaries (31), Upper Thame (32), Middle Thame (33) and Lower Thame (34)	*Surface water*	*Pesticides*	*Promar*
Enborne (35), Lower Kennet and Sulham Brook (36) and Foudry Brook (37)	*Surface water*	*Pesticides*	*Promar*
North Wey (38), Slea and Bucks Horn Stream (39), Cranleigh Waters and Compton Stream (40) and Tillingbourne (41)	*Surface water*	*Pesticides*	*Promar*
Beane (42), Rib (43), Ash (44), Upper Stort (45), Pincey Brook (46), Lower Stort (47), Cobbins Brook (48) and Lower Lee (49)	*Surface water*	*Pesticides*	*FWAG South East*

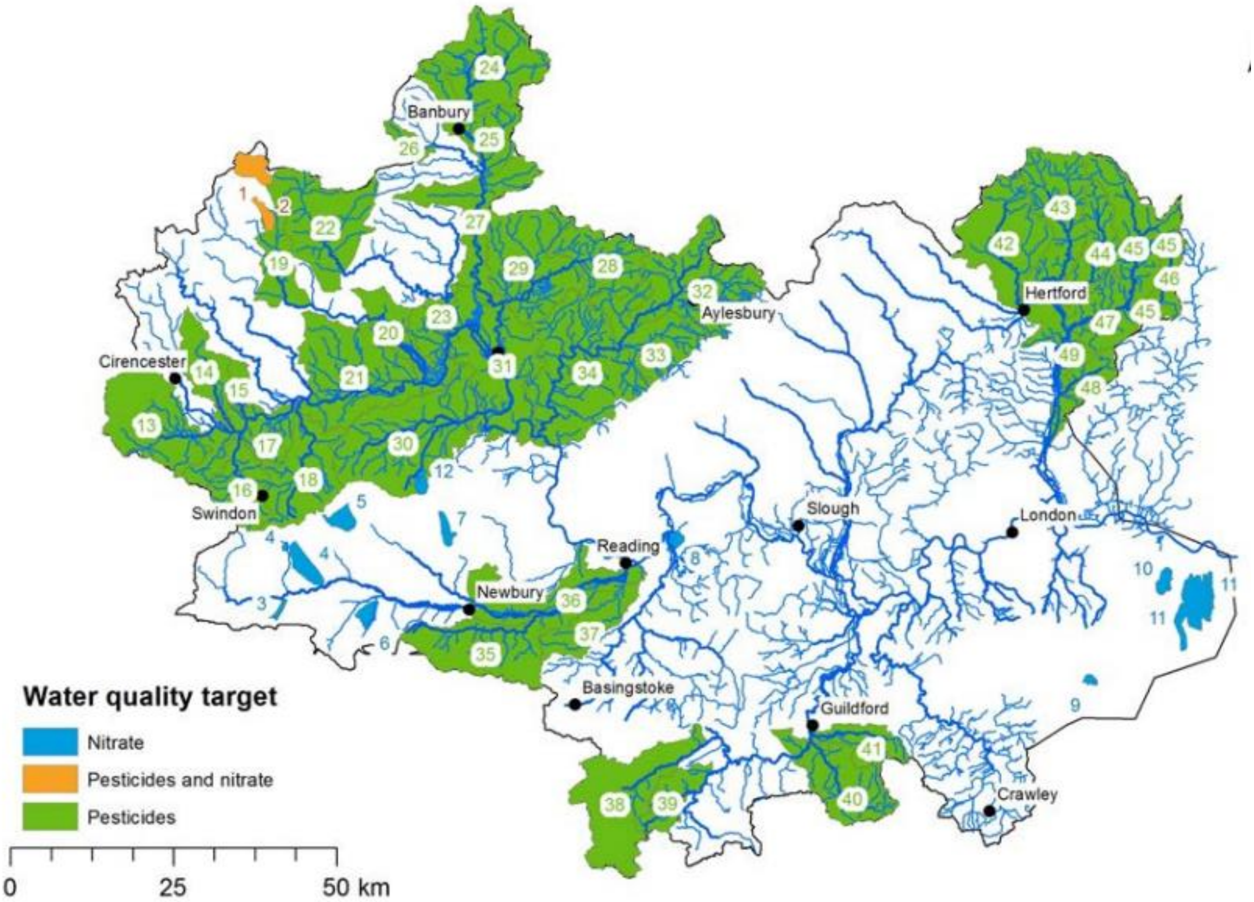


Figure X - Catchment Fund Target Area Map

Issue 14.3

Request

14.79 Thames Water should ensure clear evidence is provided that the high unit costs for future leakage reduction are efficient. While lower than the leakage costs presented, the company has selected supply side options of significant cost. As such reductions in the cost of leakage or other demand management activities would have an impact on the optimal long-term delivery and timing of supply-side solutions

Further elaboration of request given in annex, or clarification given subsequently

<u>Annex Issue OF14</u>

14.80 The company forecasts a significant increase in leakage reduction unit costs from 2030 onwards and a unit cost for 2025-30 that is higher than 2020-25. The company states that it will require innovative options from 2030 onwards.

Our consideration of the points raised

14.81 Mains rehabilitation continues to be our most expensive leakage reduction option. For this WRMP, we have considered savings from alternative options (Advanced DMA interventions, and Leakage Innovation), however in order to reach the 50% target for leakage reduction, large amounts of mains rehab will still be required.

14.82 For the analysis of mains rehab, we have considered mains which could be replaced at a sub-DMA-level, considering both the cost and the leakage savings from replacement. When constructing the potential options, sub-DMA replacement items were ordered in terms of most to least cost efficient in terms of savings/cost by our demand-side decision support tool, known as IDM. In this way, leakage reduction options required as part of our demand management programmes were given in the most cost-efficient way possible. Final costs were normalised across the company to a value of £1,261/m renewed, in line with current mains rehabilitation costs across Thames Water.

14.83 The total estimated savings possible from mains rehabilitation was around 160Ml/d, of which around 100Ml/d is targeted under either the WRMP reductions, or other capital maintenance activities. The remaining ~60Ml/d of reduction is possible but comes at significant cost as demonstrated in Figure 14-2, which plots the cost vs benefits of the mains rehabilitation option.

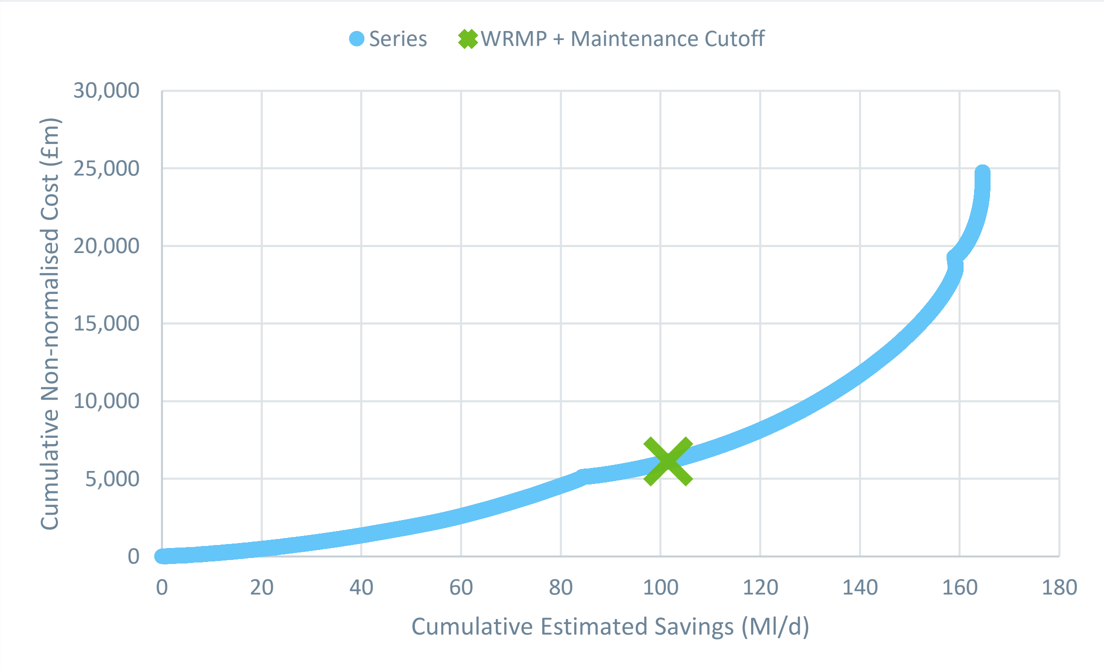


Figure 14-2: Cumulative Mains Rehabilitation Costs and Savings

14.84 When comparing mains rehabilitation activities to supply options to determine if more of the former could potentially replace the latter in the plan there are considerations to be made:

- Is there remaining potential for mains renewal, on top of what has already been planned? For some of the larger supply options (e.g. SESRO, with a total expected 149Ml/d added to DO for the 55% allocated to Thames Water), there is simply not the potential remaining from mains rehabilitation.

- Is the cost of further mains rehabilitation activities less than the cost of the supply option? For most (if not all) supply options, this is unlikely to be the case due to the high cost of mains rehabilitation. For example, the average incremental cost (noted in the data tables, Table 4) of the SESRO option is 101.51p/m^3, whereas the equivalent for the entire mains rehab programme is 675.50p/m^3, and the latter does not even consider that the cost to replace the supply option will be higher than the average (as per the figure above). Further, in AMP12 (2045-50), the mains rehabilitation option is forecast to deliver reduction at around £137m capex per Ml/d benefit and leakage innovation is forecast to deliver reduction at around £65m capex per Ml/d benefit; this is compared to less than £10m capex per Ml/d benefit from our SRO supply options. This demonstrates that there is such a significant gap between the cost of leakage reduction in the far future and new supply options that efficiency improvements in leakage reduction would not be sufficient to impact the optimum plan for the long term.
- Are there any other considerations that will make mains rehabilitation more valuable above and beyond a pure "cost" measure? Our consideration is that the most important measures of non-monetary value have been considered within the WRSE optimisation process, which includes for alternative metrics to compare between options to provide the best value approach.

14.85 We have considered a "high plus" demand management programme, which includes an increased mains renewal programme as one of its main differences from the high programme. Test runs were conducted for these programmes which concluded that the high-plus programme would not be chosen, for the reasons outlined above (i.e., that selection of the high-plus demand management programme is cost-prohibitive).

14.86 Wider discussions on benchmarking for leakage-related metrics are provided in our responses to Issues 1.3 and 1.4 above.

Changes made to the rdWRMP24

14.87 We have added the text above (our consideration of the Issue raised) at the end of rdWRMP24 Section 8, in a new section entitled "Would more leakage reduction be beneficial?"

Issue 14.4

Request

14.88 Thames Water should provide details of how it proposes to investigate innovative options to make further leakage reductions at lower cost. It should re-evaluate its long-term leakage ambition regularly to account for innovations in leakage detection. The company should commit in its plan to investigate alternative novel options to mains replacement to ensure future leakage management is delivered efficiently.

Further elaboration of request given in annex, or clarification given subsequently

14.89 No further elaboration.

Our consideration of the points raised

14.90 Our leakage innovation includes activities that we are currently aware of, those that are emerging and those that may be developed in the future. There is uncertainty around the costs and benefits of emerging and yet to be developed technologies. We plan to invest in trials in AMP8 to test and demonstrate cost effective innovative solutions and will incorporate the findings of these trials in our WRMP29. We will review our leakage costs and benefits at each WRMP cycle with updated insight into leakage innovations.

14.91 We strongly follow and actively engage with the UKWIR leakage roadmap – PALM (Prevent/Aware/ Locate/Mend) identifying projects/areas we wish to accelerate and drive forward in the business. We are currently most active in the Locate and Mend areas with recent projects such as Aquapea and Origin No dig being evaluated and implemented. We are also leading on a nationally engaged project called “No dig-leak repair” which is currently being proposed to the Ofwat Innovation fund and hopes to transform how we cost effectively locate and mend leaks. We are also part of an Ofwat Innovation funded project called “Designer liner” being led by Yorkshire Water which is specifying/developing lining technologies for the water industry of the future. Through the Smart Water programme we are digitally enhancing our data capability and visualisation which is making a step change in how we operate, for example our System Risk Visualisation is currently evaluating and testing the role of fibreoptics in leak detection.

14.92 We engage and support to steer both research and suppliers (including the oil and gas industry) to be aware of advances and new technologies both available and emerging. We directly implement or trial under controlled conditions depending on the development stage of the solution. We have our own pilot facilities to support this including a full scale Trunk Mains test facility at Kempton Park WTW.

Changes made to the rdWRMP24

14.93 We will add the text in our consideration of this Issue into the “Leakage Innovation” section within our WRMP24 Section 8.

Annex A: Thames Water to Essex & Suffolk Water – Joint Note on Representation in WRMP Tables

A.1. This note has been produced as a result of an issue raised in a letter sent from Defra to Thames Water requesting more information on the Thames Water rdWRMP24; and as a result of a recommendation for improvement from the Environment Agency to Essex & Suffolk Water on their rdWRMP24. This note has been jointly authored by Thames Water and Essex & Suffolk Water.

Background

A.2. Thames Water provides a transfer of raw water from its reservoirs in the Lee Valley (King George V and William Girling), which are in the London Water Resource Zone (WRZ), to Essex & Suffolk Water's Essex WRZ. This water is pumped by a pumping station which is operated by Essex & Suffolk Water (Lower Hall Pumping Station) before being treated by Essex & Suffolk Water at the Chigwell Water Treatment Works (WTW).

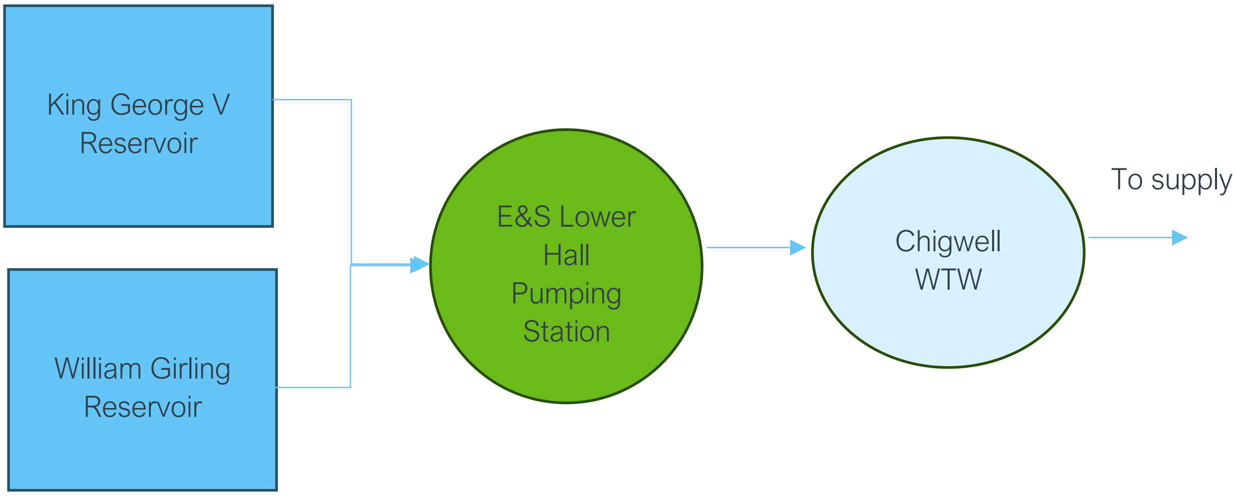


Figure A-1: Essex and Suffolk Transfer Schematic

A.3. This transfer has been operated since 1965 and began following an agreement made in 1963 between the Metropolitan Water Board (now Thames Water) and the South Essex Waterworks Company (now Essex & Suffolk Water). The origin of the transfer relates to the construction of the Wraysbury Reservoir in West London.

A.4. The agreement states that Thames Water should supply up to 20 million gallons per day (91 Ml/d) of raw water to Essex & Suffolk Water, and that the maximum daily quantity provided should not exceed 130% of the maximum average daily quantity permitted to be taken in a year, i.e., 26 million gallons (118 Ml/d). The agreement exists in perpetuity.

A.5. The agreement states that if Thames Water has a Temporary Use Ban in place in the London WRZ and Essex & Suffolk Water does not have a Temporary Use Ban in place in the Essex WRZ, the transfer may be reduced by 25%.

A.6. Subsequent to the agreement made in 1963, water trading agreements have been made between Thames Water and Essex & Suffolk Water. In these agreements, variations have been made to the 1963 agreement whereby Thames Water may reduce the volume of water exported, subject to the required notice being provided. The current water trading agreement in place allows Thames Water to reduce the average quarterly quantity of water supplied to the volumes listed in Table 32, and results in an average transfer of 71 Ml/d. This water trading agreement would only be enforced during periods of drought, as Thames Water have to pay Essex & Suffolk Water a supplement in order to enact the transfer reduction. The current agreement extends to 31st March 2035, and after this point the transfer shall revert to the 1963 agreement of 91 Ml/d on average.

Table 32: Thames Water to Essex & Suffolk Water, reduced (drought) transfer volumes according to water trading agreement.

	January-March	April-June	July-September	October-December
Export volume (Ml/d), quarterly average	60	75	75	75

Representation in Water Resources Management Plan 2024 Tables

Table 1

A.7. WRMP Table 1 shows licences and transfers included in the company's base year supply forecast.

A.8. The representation of the transfer in Thames Water and Essex & Suffolk Water's rdWRMP24 Table 1 is highlighted in Table 33. This table indicates that the understanding of the transfer volume is the same, which is that:

- The annual licence limit for the transfer is 91 Ml/d
- There is a water sharing agreement in place whereby the transfer may be reduced to 71 Ml/d, which extends until 2034/35

A.9. While the understanding is the same, clearly the values stated in the tables are different. Specifically:

- No value is stated for the DYCP Deployable Output impact of the export in the Thames Water tables. This is because the DYCP scenario is not assessed for the London WRZ.
- The DYAA Deployable Impact of the export is stated as 67 Ml/d by Thames Water and is stated as 91 Ml/d by Essex & Suffolk Water. The reasons for this are:
  - The value stated by Essex & Suffolk Water is reflective of the 1963 agreement, rather than the current variation. The value stated by Thames Water is reflective of the current variation.
  - The value stated by Thames Water is reflective of the "system" Deployable Output impact of the transfer on the London WRZ.

Table 33: Representation of London WRZ to Essex WRZ transfer in rdWRMP24 Table 1.

** Thames Water do not assess a DYCP Deployable Output for the London WRZ, and as such no DYCP Deployable Output impact is stated*

	DYAA Deployable Output (Ml/d)	DYCP Deployable Output (Ml/d)	Annual Limit (Ml/d)	Changes to agreement during drought	Additional notes (if desired)
Thames Water	67	N/A*	91	Current variation allows TW to ask E&S to reduce the import during drought periods, reflected in DO impact. In addition, original agreement states that E&S should impose hosepipe bans at the same time as Thames Water, or TW may reduce the transfer by 25%	Original bulk supply (1963) allows for a transfer of 91 Ml/d on average. A variation was in place in AR21 whereby TW could request that E&S reduce the transfer to 66.25 Ml/d on average (DO impact 62 Ml/d) during drought periods. A similar variation is in place for the period AR22-AR35 whereby we can request E&S to reduce the import to 71.25 Ml/d on average (DO impact 67 Ml/d - this is the value stated in this row). From AR36 onwards, the transfer will return to the 91 Ml/d on average.
Essex & Suffolk Water	91	118	91	Reduction to 71 Mld when TWU implement a L2 TUB, under water sharing agreement which expires in 2034/35	

Changes made since rdWRMP24

A.10. Table 34 shows the updated representation of the transfer in each company's WRMP Table 1. In this table, the Thames Water value for the DYAA Deployable Output impact of the export has been changed to 90 Ml/d. This ensures that both Essex & Suffolk Water and Thames Water both state values aligned with the original 1963 agreement and note that a reduction to 71 Ml/d (DO impact of 67 Ml/d for London WRZ) in additional notes. The misalignment which remains is reflective of the Deployable Output impact of the transfer on the London WRZ.

Table 34: Representation of London WRZ to Essex WRZ transfer in updated rdWRMP24 Table 1.

	DYAA Deployable Output (Ml/d)	DYCP Deployable Output (Ml/d)	Annual Limit (Ml/d)	Changes to agreement during drought	Additional notes (if desired)
Thames Water	**90**	N/A*	91	Current variation allows TW to ask E&S to reduce the import during drought periods, reflected in DO impact. In addition, original agreement states that ESW should impose hosepipe bans at the same time as Thames Water, or TW may reduce the transfer by 25%	Original bulk supply (1963) allows for a transfer of 91 Ml/d on average. A variation was in place in AR21 whereby TW could request that ESW reduce the transfer to 66.25 Ml/d on average (DO impact 62 Ml/d) during drought periods. A similar variation is in place for the period AR22-AR35 whereby we can request E&S to reduce the import to 71.25 Ml/d on average (DO impact 67 Ml/d - this is the value stated in this row). From AR36 onwards, the transfer will return to the 91 Ml/d on average.
Essex & Suffolk Water	91	118	91	Reduction to 71 Mld when TWU implement a L2 TUB, under water sharing agreement which expires in 2034/35	

Table 3a-3c

A.11. WRMP Tables 3a to 3c show the supply-demand balance position under the Dry Year Annual Average scenario.

A.12. Both the London WRZ and Essex WRZ are complex systems, involving multiple reservoirs, inter-WRZ transfers and groundwater systems. As such, the supply capability, known as Deployable output, for each WRZ is calculated using complex hydrological and water resources models.

A.13. In these complex systems, the Deployable Output impact of a given transfer may not be a simple “1 for 1” relationship, i.e., a 10 Ml/d import/export may not yield a 10 Ml/d Deployable Output increase/decrease. Similarly, the Deployable Output impact of a given transfer may be different for the donor and recipient, according to the supply systems of the donor and recipient. In the case of this transfer, the DYAA Deployable Output impact of the 1963 agreement is -90 Ml/d on the London WRZ and +88 Ml/d for the Essex WRZ.

A.14. Given the magnitude of the transfer, both companies incorporate it within their Deployable Output modelling. As a change in WRMP24, Thames Water have established the Deployable Output impact of the transfer on its London WRZ and have stated a Baseline Deployable Output value exclusive of all transfers and then stated the export volume.

A.15. Table 35 shows how the transfer is represented in each company’s rdWRMP24 DYAA supply-demand balance. This representation again demonstrates an aligned consideration of the transfer, insofar as there is a change to the exported volume stated by each company in the 2035/36. The two differences in the representation are:

- Thames Water state exports of 67 Ml/d and 90 Ml/d. These are different to the annual volume limits of 71 Ml/d (during the contract variation period) and 91 Ml/d (after the contract variation period). This is because Thames Water has modelled the impact of the transfer on its Deployable Output of its London WRZ.
- Essex & Suffolk Water state an export of 20 Ml/d until 2034/35, and 0 Ml/d after this point. This reflects the amendment to the 1963 agreement during the period until 2034/35. As such, Essex & Suffolk Water have included the 1963 agreement in baseline deployable output, and amendments to that agreement are reflected in the stated export volumes.

Table 35: Representation of the London WRZ to Essex WRZ Raw Water Transfer in rdWRMP24 Table 3a-3c

	2021-22 to 2034-35	2035-36 onwards
Thames Water (line 4BL, raw water export), Ml/d	-67	-90
Essex & Suffolk Water (line 4BL, raw water export), Ml/d	-20	0

A.16. While the numbers in these tables are clearly different, they also indicate that the export is considered correctly within each company’s supply demand balance. The only difference in the representation is whether the transfer is accounted for directly within Deployable Output (as

Essex & Suffolk have done) or as a transfer (as Thames Water have done). From a WAFU perspective, the transfer's representation is aligned in both WRMPs.

Table 3d-3f

A.17. WRMP Tables 3d to 3f show the supply-demand balance position under the Dry Year Critical Period scenario.

A.18. Table 36 shows how the transfer is represented in each company's rdWRMP24 DYCP supply-demand balance. Thames Water does not assess a DYCP scenario for the London WRZ, as there is a large volume of potable water storage in the Thames Water Ring Main. As such, the transfer is not represented in Thames Water's rdWRMP24 Tables 3d-3f.

A.19. The representation of the export in Essex & Suffolk Water's WRMP tables is aligned with the representation in Tables 3a-3c, i.e., the 1963 agreement is reflected in baseline deployable output, and amendments to that agreement are reflected in the stated export volumes.

Table 36: Representation of the London WRZ to Essex WRZ Raw Water Transfer in rdWRMP24 Table 3d-3f

	2021-22 to 2034-35	2035-36 onwards
Thames Water (line 4BL, raw water export), Ml/d	N/A	N/A
Essex & Suffolk Water (line 4BL, raw water export), Ml/d	-20	0

Conclusions

A.20. In this document, it has been demonstrated that Thames Water and Essex & Suffolk Water presented an aligned view of the transfer between them in their rdWRMP24s. Changes to improve transparency and alignment within WRMP24 Table 1 have been identified and actioned.

Annex B: Thames Water to Affinity Water – Joint Note on Representation in WRMP Tables

Purpose of this document

B.1. Transfers between water companies can be an efficient solution to ensuring drought resilience. In the Water Resources Management Plan 2019 (WRMP19) tables, there was a requirement for each transfer to be stated individually within baseline and final plan supply-demand balance tables. In WRMP24, the tables have been simplified such that, for each water resource zone, a single profile of values is stated for each of: potable imports; potable exports; raw imports; and raw exports. While this ensures more condensed data presentation, it can inhibit transparency. For this reason, and as a result of a request from Defra that water companies ensure and demonstrate alignment between WRMPs, Thames Water and Affinity Water have co-authored an appendix to demonstrate how transfers between the companies are aligned.

B.2. In this document we briefly introduce each of the transfers which feature in both Thames Water and Affinity Water's WRMP, and document how they have been represented in Table 1, Table 3 and, where relevant, Table 5 in the WRMP24 Tables. We also document changes made in the representation of these transfers made after rdWRMP24.

Background

B.3. Thames Water currently provides several transfers of water to Affinity Water. These are summarised in Table 37.

Table 37 - Current transfers between Thames Water and Affinity Water

Transfer Name	Donor Company and WRZ	Recipient Company and WRZ	Transfer Type
Fortis Green	Thames Water, London	Affinity Water, Pinn	Potable, in perpetuity
Cockfosters	Thames Water, London	Affinity Water, Pinn	Potable, temporary
Perivale	Thames Water, London	Affinity Water, Pinn	Potable, temporary
Hampstead Lane	Thames Water, London	Affinity Water, Pinn	Potable, in perpetuity
Sunnymeads	Thames Water, London	Affinity Water, Pinn	Raw, in perpetuity
Ladymead	Thames Water, Guildford	Affinity Water, Wey	Potable, in perpetuity

B.4. Further to these transfers, a number of new transfers have been considered as options within the WRMP24 process (Table 38).

Table 38 - Transfers considered as options within WRMP24

Transfer Name	Donor Company and WRZ	Recipient Company and WRZ	Transfer Type
Thames to Affinity Transfer (T2AT) West SRO	Thames Water, N/A (new SRO)	Affinity Water, Pinn	Raw
Thames to Affinity Transfer (T2AT) East SRO	Thames Water, N/A (new SRO)	Affinity Water, Stort	Raw
Egham Licence Trade	Affinity Water, Wey	Thames Water, London	Licence trade

B.5. A brief description of each transfer is given below.

Fortis Green and Hampstead Lane

B.6. The agreement for both of these bulk supplies originates from an agreement signed in 1927, between the Metropolitan Water Board (now Thames Water) and the Barnet District Gas and Water Company (now Affinity Water). The agreement exists in perpetuity. In this agreement, it is stated that a transfer of up to 6 million gallons per day (27.27 Ml/d, 12 Ml/d of this is Deployable Output) of water would be made. As per , water is treated at Kempton Park and Ashford Common (both Thames Water's Water Treatment Works, WTWs) and is transferred to Fortis Green Service Reservoir (Thames Water), before being transferred to Affinity Water at Winnington Road.

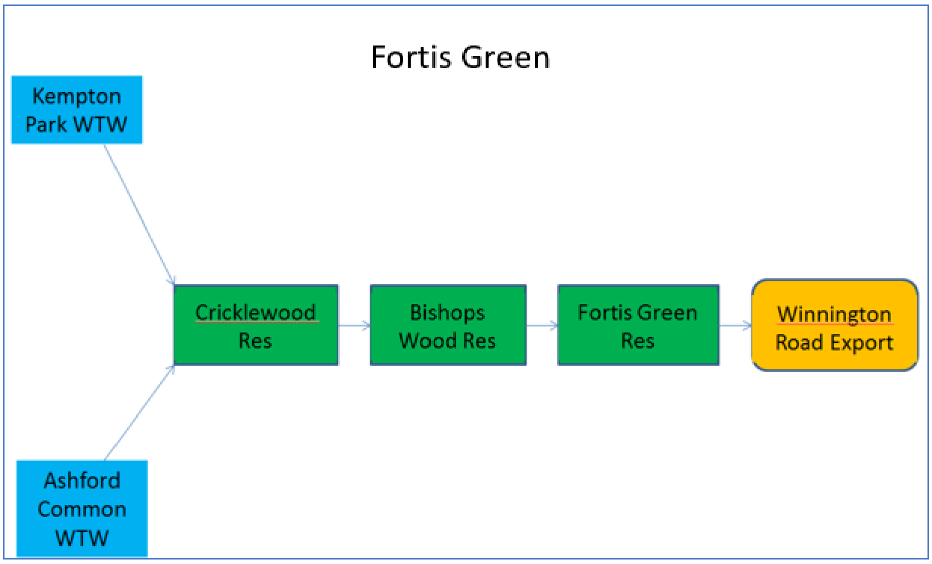


Figure B-1 Fortis Green Transfer Schematic

B.7. The Hampstead Lane bulk supply is provided directly from Kempton Park WTW.

Ladymead

B.8. This bulk supply originates from the Guildford Corporation Act 1926 and its provisions continue in perpetuity. In this act, ownership of the Dapdune Well is transferred from the Woking Water and Gas Company (now Affinity Water) to the Guildford Corporation (now Thames Water) and the requirement for a transfer back from Guildford Corporation to Woking Water and Gas Company is set out. It allows for a transfer of five hundred thousand gallons per day (2.27 Ml/d). As per Figure B-2, water is transferred from the Ladymead WTW or Pewley Service Reservoir to Affinity Water.

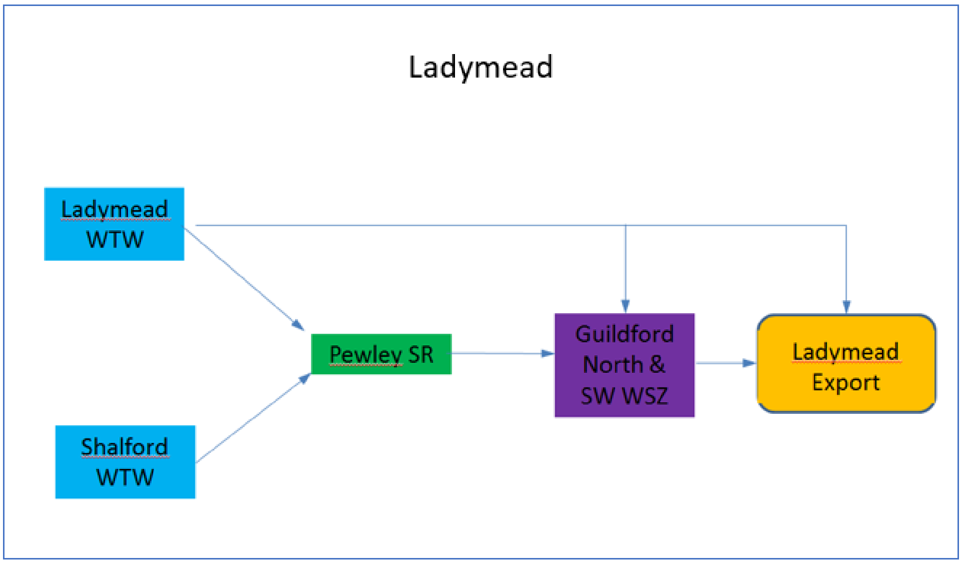


Figure B-2: Ladymead Transfer Schematic

Sunnymeads

B.9. The agreement for this bulk supply was made in 1981, updated in 2013. In this agreement, a supply of 2 Ml/d is required from Thames Water to Affinity Water. Water is transferred from either the Queen Mother or Wraysbury raw water reservoir (Thames Water) to Affinity Water's Iver WTW. The focus of this agreement is the provision of a larger emergency supply of raw water (up to the total treatment capability of the Iver WTW if necessary), but a constant flow of 2Ml/d (to maintain a sweetening flow in the tunnel) is included, which would be maintained during drought conditions. The raw water supply joins the Sunnymeads to Iver tunnel prior to the shaft at Iver, so this transfer can only be utilised at its full output when Affinity Water's river abstraction has ceased (resilience only).

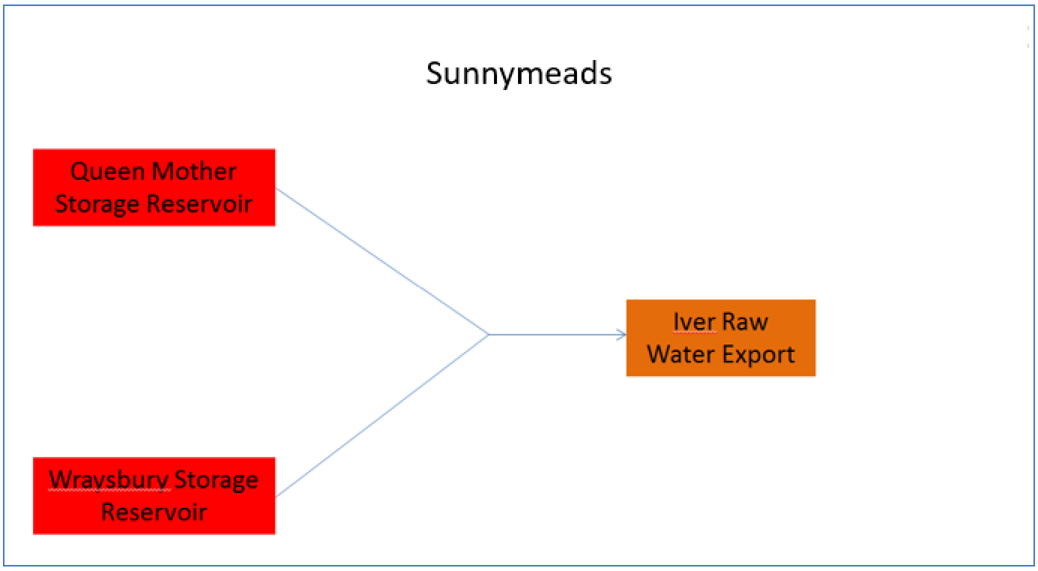


Figure B-3: Sunnymeads Transfer Schematic

Cockfosters and Perivale

B.10. These Bulk Supply Agreements (BSA) are in the process of being signed. The Perivale agreement was signed in March 2024 and the Cockfosters agreement is likely to be signed before the beginning of the WRMP24 planning period. Both are associated with the construction of High Speed Two (HS2) and provide for the supply of potable water.

B.11. The Cockfosters BSA would require Thames Water to provide 5 Ml/d to Affinity Water in average and peak conditions. The Perivale BSA would require Thames Water to provide 10 Ml/d to Affinity Water in average and peak conditions.

B.12. Under the negotiated terms of the current Perivale BSA, Thames Water would not be obliged to provide Affinity Water with water if a non-essential use ban is in place.

B.13. Both the Perivale and Cockfosters agreements are currently designed to meet the needs of the HS2 mitigation strategy, and new arrangements will need to be negotiated to determine the BSA arrangements when their purpose moves over to a WRMP driven need.

T2AT West and East

B.14. Neither T2AT option currently exists, and both are considered as options within the WRMP process. The Thames to Affinity Transfer (T2AT) West would involve greater use of the existing transfer tunnel from Thames Water's West London Reservoirs and would involve the construction of a new WTW by Affinity Water. The Thames to Affinity East would involve the transfer of water from the Beckton Water Recycling plant (a Thames Water SRO option) to a new WTW to be constructed by Affinity Water. The T2AT West option, making use of existing infrastructure, is included in both companies' preferred plan.

B.15. In order for either scheme to be considered feasible, new resources would be required. In the case of the T2AT West this would either be a new reservoir in the Thames catchment, or a supported Severn Thames Transfer. In the case of the T2AT East this would be the Beckton Water Recycling scheme.

B.16. More information on the T2AT can be found in SRO documentation:

B.17. https://affinitywater.uk.engagementhq.com/strategic-resource-options

Egham Licence Trade

B.18. This licence trade option does not currently exist and so is considered as an option in the WRMP. No infrastructure would be required to enable this licence trade, and it would instead be a contractual agreement. However, in order for this scheme to be considered feasible, Affinity Water would need to have constructed the Grand Union Canal SRO scheme.

B.19. Affinity Water's surface water (river) abstractions in the Lower Thames are not restricted by Hands-Off-Flow (HOF) conditions, i.e., abstraction is allowed regardless of flow conditions in the river. Thames Water's river abstractions in the Lower Thames are governed by the Lower Thames Operating Agreement which includes HOF conditions. In this agreement, a condition is included whereby a prescribed minimum flow must be maintained on the River Thames over Teddington Weir.

B.20. This licence agreement would involve Affinity Water agreeing to limit their abstraction volumes to levels below their licensed volumes. This would allow Thames Water to abstract more water while maintaining the same prescribed flow over Teddington Weir.

Representation in Water Resources Management Plan 2024 Tables

WRMP Table 1

B.21. WRMP Table 1 shows licences and transfers included in the company's base year supply forecast.

B.22. The representation of the transfers currently included in Thames Water and Affinity Water's rdWRMP24 Table 1 is summarised in Table 39.

B.23. As this table demonstrates, both companies' understanding of the transfers is aligned, aside from the following discrepancies:

- Thames Water does not include a DYCP forecast for the London WRZ, and so had not populated the DYCP fields for any transfers.
- Thames Water had not included either the Cockfosters or Perivale transfers in Table 1. This is because no contractual agreement had yet been reached regarding these transfers at the time of rdWRMP24 publication. The Perivale agreement has since been signed in March 2024. These transfers are currently in operation.
- Affinity Water had mistakenly included the Sunnymeads transfer in Table 1g rather than Table 1f. This has been rectified.
- Thames Water had mistakenly stated a 10 Ml/d annual limit for the Sunnymeads transfer, when a 2 Ml/d annual limit should apply. This has been rectified.
- Thames Water had mistakenly stated that the Hampstead Lane transfer is not bound by a contractual agreement, when it is associated with the Fortis Green transfer.

Table 39: Representation of Thames to Affinity transfers in rdWRMP24 Table 1.

Transfer	Company	DYAA Deployable Output (Ml/d)	DYCP Deployable Output (Ml/d)	Annual Limit (Ml/d)	Changes to Agreement During Drought	Additional Notes
Fortis Green	Thames Water	12.61	N/A*	27.30	Transfer may be terminated due to unusual drought	This transfer was included in our WRMP19 baseline supply forecast. For WRMP24, however, the WRSE investment model is able to optimise transfers within the WRSE region and so this transfer is posed as an option, rather than part of the baseline. The WRSE model is able to vary transfers year-on-year. The DYAA value stated here is that assumed in our WRMP19 baseline.
	Affinity Water	12	24	12	The 24Ml/d peak requires some drought operation activity to achieve	In Perpetuity
Hampstead Lane	Thames Water	0.2	N/A*	-	No contract, so could be terminated	This transfer was included in our WRMP19 baseline supply forecast. For WRMP24, however, the WRSE investment model is able to optimise transfers within the WRSE region and so this transfer is posed as an option, rather than part of the baseline. The WRSE model is able to vary transfers year-on-year. The DYAA value stated here is that assumed in our WRMP19 baseline.
	Affinity Water	0.2	0.2	0.2	-	In Perpetuity
Ladymead	Thames Water	2.27	2.27	2.27		This transfer was included in our WRMP19 baseline supply forecast. For WRMP24, however, the WRSE investment model is able to

Transfer	Company	DYAA Deployable Output (Ml/d)	DYCP Deployable Output (Ml/d)	Annual Limit (Ml/d)	Changes to Agreement During Drought	Additional Notes
						optimise transfers within the WRSE region and so this transfer is posed as an option, rather than part of the baseline. The WRSE model is able to vary transfers year-on-year. The DYAA value stated here is that assumed in our WRMP19 baseline.
	Affinity Water	2.2	2.2	2.2	-	In Perpetuity
Cockfosters**	Thames Water	-	-	-	-	-
	Affinity Water	5	5	5	Agreement in place by end of AMP7	-
Perivale**	Thames Water	-	-	-	-	-
	Affinity Water	10	10	10	Agreement in place by end of AMP7	-
Sunnymeads***	Thames Water	2	N/A*	10	-	This transfer was included in our WRMP19 baseline supply forecast. For WRMP24, however, the WRSE investment model is able to optimise transfers within the WRSE region and so this transfer is posed as an option, rather than part of the baseline. The DYAA value stated here is that assumed in our WRMP19 baseline. This transfer is used mainly as a transfer during times of water quality challenge. The capacity of the transfer is well in excess of

Transfer	Company	DYAA Deployable Output (Ml/d)	DYCP Deployable Output (Ml/d)	Annual Limit (Ml/d)	Changes to Agreement During Drought	Additional Notes
						the 2 Ml/d assumed yearly transfer for the DYAA scenario.
	Affinity Water	2	2	2	-	In Perpetuity

* Thames Water do not assess a DYCP Deployable Output for the London WRZ, and as such no DYCP Deployable Output impact is stated

** Reflects current arrangements that are designed to supply HS2 and mitigate water supply risks from the project.

*** Note: Included in Thames Water table 1f (raw water transfers) and Affinity Water table 1g (potable water transfers)

Changes made to the rdWRMP24 Table 1 in response to Defra's letter

B.24. In response to Defra's letter[49], Table 40 shows the updated representation of the transfers in each company's WRMP Table 1. Changes made are noted in bold.

Table 40: Representation of Thames to Affinity transfers in updated rdWRMP24 Table 1.

Transfer	Company	DYAA Deployable Output (Ml/d)	DYCP Deployable Output (Ml/d)	Annual Limit (Ml/d)	Changes to Agreement During Drought	Additional Notes
Fortis Green	Thames Water	**12**	N/A*	27.3	Transfer may be terminated due to unusual drought	This transfer was included in our WRMP19 baseline supply forecast. For WRMP24, however, the WRSE investment model is able to optimise

Transfer	Company	DYAA Deployable Output (Ml/d)	DYCP Deployable Output (Ml/d)	Annual Limit (Ml/d)	Changes to Agreement During Drought	Additional Notes
						transfers within the WRSE region and so this transfer is posed as an option, rather than part of the baseline. The WRSE model is able to vary transfers year-on-year. The DYAA value stated here is that assumed in our WRMP19 baseline.
	Affinity Water	12	24	**27.3**	The 24Ml/d peak requires some drought operation activity to achieve	In Perpetuity
Hampstead Lane	Thames Water	0.2	N/A*	**0.2**	-	This transfer was included in our WRMP19 baseline supply forecast. For WRMP24, however, the WRSE investment model is able to optimise transfers within the WRSE region and so this transfer is posed as an option, rather than part of the baseline. The WRSE model is able to vary transfers year-on-year. The DYAA value stated here is that assumed in our WRMP19 baseline.
	Affinity Water	0.2	0.2	0.2	-	In Perpetuity
Ladymead	Thames Water	2.27	2.27	2.27	-	This transfer was included in our WRMP19 baseline supply forecast. For

Transfer	Company	DYAA Deployable Output (Ml/d)	DYCP Deployable Output (Ml/d)	Annual Limit (Ml/d)	Changes to Agreement During Drought	Additional Notes
						WRMP24, however, the WRSE investment model is able to optimise transfers within the WRSE region and so this transfer is posed as an option, rather than part of the baseline. The WRSE model is able to vary transfers year-on-year. The DYAA value stated here is that assumed in our WRMP19 baseline.
	Affinity Water	2.27	2.27	2.27	-	In Perpetuity
Cockfosters	Thames Water	5	N/A	5	Pending the final agreement is in place, potential for No transfer when Thames Water NEUBs are in place.	No agreement currently in place. Agreement likely to be in place by end AMP7.
	Affinity Water	5	5	5	Agreement in place by end of AMP7. Pending the final agreement, potential for No transfer when Thames Water	-

Transfer	Company	DYAA Deployable Output (Ml/d)	DYCP Deployable Output (Ml/d)	Annual Limit (Ml/d)	Changes to Agreement During Drought	Additional Notes
					NEUBs are in place.	
Perivale	Thames Water	10	N/A	10	No transfer when Thames Water NEUBs are in place.	-
	Affinity Water	10	10	10	No transfer when Thames Water NEUBs are in place.	-
Sunnymeads**	Thames Water	2	N/A*	2	-	This transfer is used mainly as a transfer during times of water quality challenge. The capacity of the transfer is enough to replace the raw water input to Iver WTW in emergency conditions, with the 2 Ml/d being the sweetening flow in the DYAA scenario.
	Affinity Water	2	2	2	-	In Perpetuity

* Thames Water do not assess a DYCP Deployable Output for the London WRZ, and as such no DYCP Deployable Output impact is stated

** Note: Included in Thames Water table 1f (raw water transfers) and corrected to Affinity Water table 1f (potable water transfers)

Table 3a-3c

B.25. WRMP Tables 3a to 3c show the supply-demand balance position under the Dry Year Annual Average scenario. Table 3a shows the "baseline" supply-demand balance, Table 3b shows options selected in the preferred plan, and Table 3c shows the final supply-demand balance.

B.26. Affinity Water and Thames Water are both part of the WRSE Regional Group. The WRSE regional group has sought to identify the best value plan for the WRSE region. In identifying the best value plan for the region, it has been considered whether amendments to existing bulk supply agreements may be beneficial overall. As such, all transfers have been considered as an option, rather than as part of the baseline forecast, with the exception of transfers where it is infeasible to consider they could be ceased/amended. Therefore, only the Sunnymeads/Wraysbury transfer as a sweetening flow (2Ml/d) is considered in the baseline supply-demand balance, as this transfer is to ensure water quality is maintained and to ensure infrastructure to enable an emergency transfer is maintained.

B.27. *Table 41* below summarises the baseline transfer volume between Thames and Affinity Water included in Tables 3a of the rdWRMP24 Tables. The values stated in Table 41 are the Ml/d averages across the 5 year period shown.

Table 41: Inclusion of transfers in baseline supply-demand balance (Table 3a) rdWRMP24. Values stated are Ml/d averages across the period shown.

Transfer and Direction	2026-30	2031-35	2036-40	2041-50	2051-75
Wraysbury-Sunnymeads (TW to Aff)	2	2	2	2	2
Fortis Green and Hampstead Lane (TW to Aff)	0	0	0	0	0
Ladymead (TW to Aff)	0	0	0	0	0
Cockfosters and Perivale (TW to Aff)	0	0	0	0	0

B.28. Table 42 shows how transfers have been utilised as options in the WRSE preferred programme (i.e., the values behind WRMP Tables 3a and 5). It has been possible to verify using Thames Water and Affinity Water's WRMP Table 5 that both companies have included all transfers identically. The values stated in Table 6 are the Ml/d averages across the 5 year period shown.

Table 42: Utilisation of Affinity Water Transfers as options in preferred programme

Transfer and Direction	2026-30	2031-35	2036-40	2041-50	2051-75
Fortis Green and Hampstead Lane (TW to Aff)	9.12	0	0	0	0
Ladymead (TW to Aff)	0.08	1.36	1.36	1.08	0.68
Cockfosters and Perivale (TW to Aff)	11.00	0	0	0	0
T2AT West (TW to Aff)	0	0	0	25.84	69.68
T2AT East (TW to Aff)	0	0	0	0	0
Egham to (Aff to TW)	0	11.10	0	0	0

B.29. Table 43 shows how transfers have been utilised in total in the WRSE preferred programme (i.e., the values behind WRMP Table 5c). The implications of the transfer volumes shown (as well as the supply-demand balances in the relevant WRZs) are:

- The Wraysbury-Sunnymeads transfer from Thames to Affinity will be continued in perpetuity, in order to continue to ensure that water quality is maintained and the emergency bulk supply can be made when necessary.
- The Ladymead transfer from Thames to Affinity is likely to continue throughout the planning period.
- The Fortis Green, Hampstead Lane, Cockfosters and Perivale transfers from Thames to Affinity will be needed until Affinity Water constructs the Grand Union Canal SRO.
- When the Grand Union Canal SRO is developed, the Egham licence trade will come into effect.
- In the longer term, environmental destination reductions will mean that Thames Water will once again transfer water to Affinity Water, via the Thames to Affinity Transfer.

Table 43: Inclusion of transfers in final supply-demand balance (Table 3c) in the preferred programme rdWRMP24. Values stated are Ml/d averages across the period shown.

Transfer and Direction	2026-30	2031-35	2036-40	2041-50	2051-75
Wraysbury (TW to Aff)	2	2	2	2	2
Fortis Green and Hampstead Lane (TW to Aff)	9.12	0	0	0	0
Ladymead (TW to Aff)	0.08	1.36	1.36	1.08	0.68
Cockfosters and Perivale (TW to Aff)	11.00	0	0	0	0
T2AT West (TW to Aff)	0	0	0	25.84	69.68
T2AT East (TW to Aff)	0	0	0	0	0
Egham licence trade (Aff to TW)	0	11.10	0	0	0

Changes since rdWRMP24

B.30. Values in the WRMP tables may change slightly from rdWRMP (e.g., the utilisation of the Fortis Green, Cockfosters and Perivale transfers may be extended by a year to reflect the likely delivery date of the Grand Union Canal SRO), but no material change will be made.

Table 3d-3f

B.31. WRMP Tables 3d to 3f show the supply-demand balance position under the Dry Year Critical Period scenario. Thames Water does not assess a DYCP supply-demand balance for London WRZ, and so demonstration of alignment in this regard is not possible/necessary. We have, however, demonstrated alignment in the inclusion of the Ladymead transfer.

Table 44: Ladymead Transfer Table 5 Representation

Table	2026-30	2031-35	2036-40	2041-50	2051-75
5a (baseline SDB)	0	0	0	0	0
5b (options' utilisation in	0	0	0	0	0

preferred programme)					
5c (final SDB)	0	0	0	0	0

Conclusions

B.32. In this document, it has been demonstrated how Thames Water and Affinity Water have ensured alignment in the transfers between them in their WRMP24s. It has been demonstrated that inclusion of transfers in supply-demand balances was fully aligned in rdWRMP24, and changes to ensure alignment in WRMP Table 1 have been highlighted.

Annex C: Monitoring Plan

We will include the content set out in this Annex within our WRMP24, replacing the existing Monitoring Plan section within Section 11 of the rdWRMP24.

Monitoring Plan

C.1. Over the period building towards WRMP29 we will maintain a system of proactive monitoring and reporting to enable us to track progress, manage risk and adapt our plans where required. This system of monitoring and reporting is set out in this Monitoring Plan document which explains how we will:

- Monitor how our plan evolves over time using key water resource metrics.
- Evaluate how effectively our planned programme is being implemented and whether there are any gaps between planned and achieved results.
- Adapt our plan to manage risks to the supply demand balance.

C.2. We will use the existing WRMP Annual Review to review the progress with the Monitoring Plan. In addition, we will provide six-monthly reporting to government and regulators. We will provide distribution input data by water resource zone monthly to the Environment Agency. Provision of additional information regarding key water resources metrics will be provided at a granularity and frequency as agreed with the Environment Agency and will include monthly reporting of distribution input by water resource zone.

C.3. We will continue to report progress through our Water Resources Forum and associated stakeholder meetings. In addition, we will submit quarterly progress reports to the Regulators' Alliance for Progressing Infrastructure Development (RAPID) relating to the work programme associated with investigations of the SROs.

C.4. Our proactive work with WRSE, as well as RAPID, will ensure our work programme is aligned with neighbouring water companies as well as those further afield who are working with us to investigate and develop the SROs. We will report the outcomes of our monitoring plan into WRSE, to inform the regional monitoring plan.

Short term vs long term risks

C.5. This monitoring plan sets out how we will manage both the short-term and longer-term risks in our plan. Here, where we talk about the short-term, we refer to risks which materialise prior to the divergence of adaptive plan supply-demand balance pathways in 2035. This timescale is considered both due to the inclusion of adaptive supply-demand balance pathways in our plan from 2035, and because solution development for medium to large solutions takes approximately 5-10 years. There are risks which we are facing in the short-term (e.g., reducing leakage from 620 Ml/d in 2022-23 to 417 Ml/d in 2029-30, or by around a third), and those which are of more relevance for the long-term (e.g., reducing PCC to 110 l/h/d by 2050 and the resultant c.300 Ml/d supply-demand reduction which we are relying on the government to drive).

C.6. There being risks of relevance for the long-term and short-term is also aligned with the decisions we need to make, i.e., determining the supply option that should provide new supplies for the early 2030s (relatively short-term), the option we should develop to provide new supplies for 2040 (a decision which we must make now, considering long-term risks), and whether additional supplies are required in the future (a decision which we do not need to make now, but which factors into the decisions which we are making now). As such, some aspects of our monitoring plan are focussed more on the short-term decision we need to make, while other aspects are more focussed on long-term resilience.

C.7. In the short-term, the focus is on reacting to new information, updating our plan and ensuring that short-term risks are managed. In addition, in the short-term we need to track the consenting of the SRO options.

C.8. In the longer-term, we need to assess delivery, appraise new information and respond if required. The aim here is to identify whether additional investment beyond our preferred programme is required to ensure resilient supplies.

C.9. There is a clear link between our adaptive plan, in which we will develop different solutions according to different combinations of factors which influence our supply-demand balance, and our monitoring plan, in which we identify and set out the metrics which we will monitor and how we will use these metrics to inform decisions.

C.10. The use of the monitoring plan to both trigger actions to counter the emergence of risks and to assess the supply-demand balance pathway which is followed in relation to those considered within our adaptive plan is in line with the Supplementary Guidance on Adaptive Planning[50]. Consideration of this guidance has informed the development of our monitoring plan and our adaptive plan overall.

Water Resources Metrics

C.11. The metrics we propose to track as part of our on-going monitoring are summarised in Table X, including aspects which track past progress and aspects where we will track current delivery plans (labelled "forecast" below). In Table X, we have summarised how and when each metric is tracked and reported externally; we will of course be tracking and monitoring these metrics more frequently internally (for example, there is very frequent monitoring of leakage undertaken internally, and this monitoring is used to tailor delivery plans). In Table X we have highlighted that, for almost all of the metrics, there is an element of tracking past progress and an element of tracking current forecasts/delivery plans. Both performance and forecasts are important in monitoring and adapting.

Table X - Monitoring Plan Metrics

Assessment Area	Metric(s)	How and when metric is tracked and reported externally
Leakage	Past progress: - Outturn Leakage (Ml/d) - Dry year uplifted leakage (Ml/d)	Reported in the Annual Review and six-monthly review, with more frequent reporting potentially required.

[50] Environment Agency, 2020, Water resources planning guideline supplementary guidance – Adaptive planning

Assessment Area	Metric(s)	How and when metric is tracked and reported externally
	Forecast: - Updated leakage reduction plan	If leakage reduction is significantly off track in a WRZ, production of a revised leakage plan at WRZ level may be necessary.
Company-led consumption reduction	Past progress: - PCC (l/h/d) - Meter and water efficiency activity delivery - Measures reduction in usage following meter and water efficiency activity	Reported in the Annual Review, with more frequent reporting potentially required.
	Forecast: - Updated meter delivery programme	If meter delivery is significantly different to the plan, production of a revised metering plan may be necessary.
Government Action on consumption reduction	Past progress: - Water labelling policy implemented - Measures effectiveness of water labelling policy	Track policy implementation and calculate benefits at the appropriate time
	Forecast: - Commitment to future policy changes	We will track commitments to future policy changes which will improve water efficiency
Distribution Input	Past progress: - Outturn DI (Ml/d) - Dry year uplifted DI (Ml/d)	Reported monthly to the Environment Agency, and in the 6-monthly update and Annual Review If DI is off track, such that a supply-demand balance problem may result, additional options may need to be considered
	Forecast: - Forecast DI (Ml/d)	Distribution Input will be re-forecast as part of WRMP29.
Population	Past progress: - Measured population (000s)	Reported in the Annual Review
	Forecast: - Population forecasts - Water resources planning guideline policy	Population will be re-forecast as part of WRMP29. This will take account of revised local plans and other population growth forecasts, alongside any updates to policy/guidance.
Environmental Destination	Past progress: - Abstraction reduction scheme implementation and benefits	Progress will be reported via the WINEP reporting process. The effectiveness of sustainability reductions will inform the forecast of future reductions needed.
	Forecast: - Investigation outcomes, leading to per-AMP reductions confirmed	As investigations are carried out and more data is gathered, prioritisation will be carried out. Taking account of updated policy and guidelines, forecasts of licence reductions will be included in WRMP29.

Assessment Area	Metric(s)	How and when metric is tracked and reported externally
Climate Change	Past progress: - Global temperature (°C)	Forecasts in WRMP29 will account for updates in the interim.
	Forecast: - Updated UKCP forecasts - Water resources planning guideline	WRMP29 will include new information (if available) and will follow any updates to the WRPG.
Gateway desalination plant	Past progress: - Capability identified through use/testing (Ml/d)	Progress reports provided to the Environment Agency
	Forecast: - Maintenance and improvement plan	Progress reports provided to the Environment Agency
SRO Consenting and Delivery	Past progress: - Progress through RAPID programme and into DCO process	Reported through RAPID process – meetings, quarterly updates and Gated documentation
	Forecast: - Delivery timescales - Feasibility	Reported through RAPID process – meetings, quarterly updates and Gated documentation
Supply-demand balance	Past progress: - Supply-demand balance (Ml/d)	Annual Review
	Forecast: - Supply-demand balance forecast (Ml/d)	Updated forecasts produced for WRMP29.
Lower Thames	Past progress: - Findings from investigations - River Thames Scheme progress through DCO	Reporting on investigations circulated with Environment Agency River Thames Scheme progress reported by the project team
	Forecast: - River Thames Scheme – go/no-go and timing	River Thames Scheme progress reported by the project team

Evaluating progress using metrics

C.12. As we move into the future, our monitoring plan metrics will be used to evaluate progress against our plan and guide decisions where specific adaptations may be required. Table X highlights the key decisions which will be needed between now and our next WRMP, when decisions will be made, and the metrics and threshold which will influence them.

Table X: Monitoring Plan Metrics and Thresholds

When?	Metric(s)	Threshold	Decision
Annual Review 2025	Leakage and leakage forecast	Leakage under-delivery threatens forecast supply-demand balance*	Trigger additional adaptive plan measures (see Adaptive Plan: demand management monitoring plan)
Annual Review 2025	Lower Thames findings and River Thames Scheme progress	New solution needed and feasible	Proceed with solution development (see Adaptive Plan: Lower Thames)
Annual Review 2025	Lower Thames findings and River Thames Scheme progress	New solution needed but not feasible – Deployable Output of London WRZ reduced	Revisit aspects of WRMP24. See Adaptive Plan: Lower Thames[51]
Until c.2026	Teddington DRA Environmental Assessment	Option found to be not environmentally promotable due to environmental impacts which cannot be mitigated	Adopt alternative plan (see Adaptive Plan: Teddington DRA)
2025-28 (i.e., before next WRMP)	PCC, leakage, DI	Distribution input is higher than was planned, and threatens forecast supply-demand balance*	Trigger additional adaptive plan measures (see Adaptive Plan: demand management)
2025-28 (i.e., before next WRMP)	Gateway desalination plant progress and plan	Plant not able to deliver 75 Ml/d reliably	Either further investment in plant required in AMP8 or AMP9, or new supply sources needed in WRMP29. Possible that aspects of WRMP24 may need to be revisited.
2025-27 (i.e., before next WRMP)	Teddington consent	Consent not granted, or infeasibility identified, or not deemed environmentally promotable	Adopt alternative plan (see Adaptive Plan: Teddington DRA monitoring plan)
2025-28 (i.e., before next WRMP)	SESRO consent	Consent not granted, or infeasibility identified, or not deemed environmentally promotable	Adopt alternative plan (see Adaptive plan: SESRO)

[51] Please note that, as stated in our response to Issue 1.7, our consideration regarding the River Thames Scheme is that it is unlikely that the scheme would be consented if it is found that it has a negative impact on our water resources which cannot be mitigated. We do, however, acknowledge that there is a risk.

When?	Metric(s)	Threshold	Decision
2027-28 (next WRMP)	Water labelling policy and commitment to further action	Water labelling not implemented, or is ineffective	Trigger additional adaptive plan measures (see Adaptive Plan: demand management monitoring plan)
2027-28 (next WRMP)	WINEP Investigations and evidence from licence reduction implementation	Licence reduction scenario updated/confirmed	Follow adaptive plan pathway which aligns most closely
2027-28 (next WRMP)	Climate change and WRPG	Climate change impact forecasts and/or guidance updated and scenarios change the expected outcome	Follow adaptive plan pathway which aligns most closely
2027-28 (next WRMP)	Climate change and WRPG	WRPG changed to require greater consideration of climate change impacts on demand	Update climate change uplift methodology
2027-28 (next WRMP)	PCC and PCC forecast Leakage and leakage forecast Population and population forecast WINEP investigations and Environmental Destination Forecast SESRO progress	Licence reductions confirmed, SESRO consent confirmed, and combined supply-demand balance impact indicates surplus available*	Accelerate licence reductions to 2040 (see Adaptive plan: accelerated licence reductions)
2027-28 (next WRMP)	PCC and PCC forecast Leakage and leakage forecast Population and population forecast WINEP investigations and Environmental Destination Forecast	Combined supply-demand balance impact indicates additional new resources are required*	Identify Best Value Plan considering increased scale of need

When?	Metric(s)	Threshold	Decision
2032-33 (WRMP34)	WINEP Investigations and evidence from licence reduction implementation	Licence reduction scenario updated/confirmed	Follow adaptive plan pathway which aligns most closely
2032-33 (WRMP34)	Commitment to future water efficiency measures	No or limited further action on water efficiency by government*	Identify whether additional supply-side solutions are required
2032-33 (WRMP34)	PCC and PCC forecast Leakage and leakage forecast Population and population forecast WINEP investigations and Environmental Destination Forecast SESRO Consent	Licence reductions confirmed, SESRO delivery progressed, and combined supply-demand balance impact indicates surplus available	Accelerate licence reductions to 2045 (see Adaptive plan: accelerated licence reductions)

* Threshold value dependent on other factors which influence the supply-demand balance. When identifying the threshold value, we will follow the principles of the WRSE monitoring plan approach, which will use available headroom and target headroom to identify whether action is needed.

Adapting our plan

C.13. We have identified 5 key decision points for which specific adaptations to our plan may be required. These are:

- Does the short-term success of demand management indicate that secure supplies will be ensured without additional intervention?
- Lower Thames – is an engineering intervention needed, and is such an intervention feasible?
- Teddington DRA – is the option environmentally promotable and is consent granted?
- SESRO – is consent granted?
- Could confirmed licence reductions be accelerated?

C.14. These decisions are all focussed on factors which could cause us to divert from our preferred plan. In addition to these discrete decisions, we will link our monitoring plan to our adaptive plan in the longer term. Rather than causing us to divert from our preferred plan, our monitoring plan for the longer term will help us to identify the adaptive pathway from our plan which we are following most closely.

C.15. In the following sub-sections we highlight the adaptive plan decisions which would be made according to these discrete decisions, and then discuss our monitoring for the longer term and the link to our adaptive pathways.

Adaptive plan: Demand Management

C.16. In the short-term, much of our planned supply-demand balance improvement is reliant on demand-side interventions. Factors such as the weather can significantly impact the success of our demand management interventions, and so there is a level of risk in the short term.

C.17. As an example, in 2022/23, a combination of drought and freeze-thaw conditions led our leakage levels to increase sharply. The high level of leakage that resulted meant that a significant amount of leakage reduction was necessary within the remainder of the AMP7 (2020-2025) period for us to achieve our forecast starting position for WRMP24.

C.18. While demand-side risks exist in relation to both leakage reduction and consumption reduction, in order to identify the level of supply-demand balance risk in our plan, as a representative high-risk scenario, we have identified the supply-demand balance for AMP8 and AMP9 in each of our WRZs under a scenario in which 50% of our planned leakage reduction is achieved from 2022/23 onwards[52]. This scenario is unlikely but helps us to understand the magnitude of the risk and when it could materialise. Table X shows the supply-demand balance in our London and SWOX WRZs under this scenario. All other WRZs indicate significant surplus and so are not included here.

Table X: Supply-demand balance impacts of a scenario in which only 50% of planned leakage reduction is achieved

Zone/Scenario	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
London	2.7	-2.7	-7.4	-13.7	-43.9	-38.3	-35.7	-87.3	-70.9	-68.7
SWOX DYAA	18.6	16.4	15.2	13.6	11.5	13.6	12.6	-2.2	2.8	5.0
SWOX DYCP	9.5	6.6	4.9	3.2	1.6	3.3	1.9	-10.5	-7.6	-7.9

C.19. This forecast helps us to understand both the magnitude of the risk which exists, and when a supply-demand balance risk may materialise.

C.20. The analysis suggests that there would be risks in the London WRZ from early in the planning period. These risks are small through the beginning of AMP8, but increase in magnitude by 2030 and beyond. Supply-demand balance risk in the SWOX WRZ is unlikely to materialise until after 2032, which gives us more time to respond. Risks escalate as we look to increase our level of service to a 1 in 200-year level. Other WRZs have a higher level of surplus and so are not as sensitive to the delivery of our demand management programme.

C.21. Note that, in considering these risks, we have not considered risks in London beyond 2033, as our adaptive plan solution (Beckton Water Recycling) mitigates this risk (see Adaptive Plan: Teddington DRA).

[52] Please note that, while the leakage reduction profile included in the rdWRMP24 is relatively smooth, factors in our WRMP forecasts mean that the supply-demand balance forecasts are not smooth. The significant changes in the supply-demand balance forecast are: 2029-30 (London only) sustainability reduction at NNRW sources, 25 Ml/d; 2032-33 move to 1 in 200-year resilience level.

C.22. Reflecting on these risks, alongside recent resilience issues experienced in the Guildford WRZ, we have identified additional adaptive plan measures which could be investigated and/or adopted to manage our supply demand risk. As is noted, there is uncertainty surrounding some of these options; some would not be needed in our preferred plan scenario and so are not "low regret", while others would result in negative environmental impacts. As such, these options are not adopted as part of our Best Value Plan.

C.23. These options are listed in a decreasing order of preference. Separate tables are included for the London, SWOX and Guildford WRZs, and options in these WRZs would be considered according to the supply-demand balance risk which materialises (or is forecast). Before we adopt any of these options, we will (as discussed elsewhere in the monitoring plan) consider the other factors which contribute to our supply-demand balance, for example population growth and any change in uncertainty levels.

C.24. This range of solutions demonstrates that, should risks materialise in the short-term, we will be able to respond to ensure supply-demand balance. However, our overriding priority is to achieve the demand reduction plan as set out in our preferred plan, as these alternative options involve some element of risk and are not considered low-regret.

Table X - Adaptive plan options for London WRZ to mitigate risks around demand management

Option	Estimated DO Benefit (Ml/d)	Lead Time	Reason Option Not Considered/Included in WRMP24 preferred programme
Delivery of Southfleet and Greenhithe groundwater scheme	8.8	4 years	Lead time of 4 years, supply-demand balance position does not necessitate delivery in preferred plan scenario.
Delivery of Merton Groundwater Scheme	2	2 years	Lead time of 2 years, supply-demand balance position does not necessitate delivery in preferred plan scenario
Delivery of Honor Oak Groundwater Scheme(s)	1.7+1.4 = 3.1	3-8 years	Lead time of 3 and 5 years respectively, supply-demand balance position does not necessitate delivery in preferred plan scenario
Cancel Cockfosters and Perivale BSAs	15	3 months	Affinity Water resilience impacted
Mecana pre-treatment	TBC	Several years	DO Benefit uncertainty
Re-prioritisation of meter delivery to London WRZ	<20	<1 year	Would involve reducing metering delivery in other WRZs
Re-prioritisation of leakage reduction to London WRZ	<20	<1 year	Would involve reducing leakage delivery in other WRZs. Likely to incur additional cost.

Option	Estimated DO Benefit (Ml/d)	Lead Time	Reason Option Not Considered/Included in WRMP24 preferred programme
Focus on outage resulting in a reduction in outage allowance	10-20	<1 year	Low level of confidence in delivery, and so high risk for customers
EA LTOA changes – enhanced maintenance of weirs and/or reduced navigation	TBC	<1 year	Not within TW control
Media campaigns further enhanced	0-50	0	Low level of confidence in Ml/d benefits. Preferred plan already relies on demand reductions during drought events
Delay North Orpington GW source abstraction reduction	9	<1 year	Environmental and compliance impacts
Delay NNRW/New Gauge licence reductions	25	<1 year	Environmental and compliance impacts
Inclusion of Lower Thames drought permit options (TTF of 200/100/0 Ml/d) in supply-demand balance	50-100	<1 year	Environmental impacts. Low level of confidence in delivery.
Inclusion of "More before Level 4" demand-side restrictions	TBC	<1 year	Level of Service change
Temporarily lower level of service (1 in 50-year chance of L4 restrictions)	120	<1 year	Customers not protected from drought risk. Level of service change.

Table X - Adaptive plan options for SWOX WRZ to mitigate risks around demand

Option	Estimated DO Benefit (Ml/d)	Lead time	Reason Option Not Considered/Included in WRMP24 preferred programme
Woods Farm Groundwater Option – pull delivery timescale forward	2.4	3 years	Not needed until 2070s if preferred plan delivered
Moulsford Groundwater Option – pull delivery timescale forward	2	3 years	Not needed until 2030s if preferred plan delivered.
Focus on outage resulting in a reduction in outage allowance	1-2	<1 year	Low level of confidence in delivery, and so high risk for customers
Re-prioritisation of meter delivery to SWOX WRZ	1-2	<1 year	Would involve reducing metering delivery in other WRZs
Re-prioritisation of leakage reduction to SWOX WRZ	<5	<1 year	Would involve reducing leakage delivery in other WRZs. Likely to incur additional cost.
Inclusion of Farmoor drought permit in supply-demand balance calculation	35	<1 year	Uncertain benefit, as granting of permit not certain, and operational issues may inhibit benefit
Inclusion of "More before Level 4" demand-side restrictions	TBC	<1 year	Level of Service change
Temporarily lower level of service (1 in 50-year chance of L4 restrictions)	10	<1 year	Customers not protected from drought risk. Level of service change.

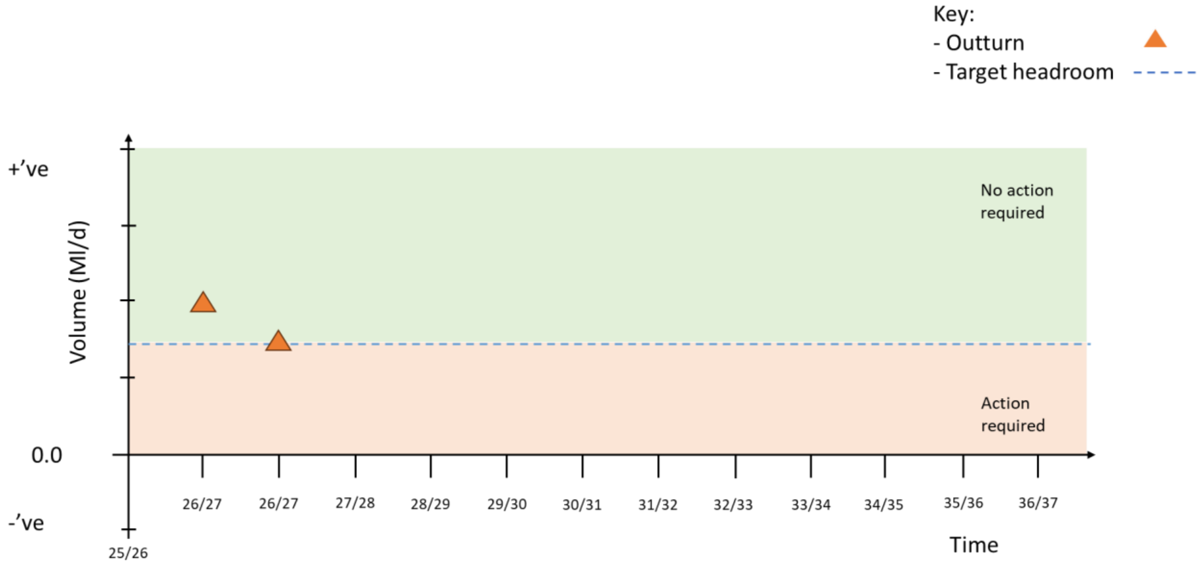
Table X -Adaptive plan options for Guildford WRZ to mitigate risks around demand

Option	Estimated DO Benefit (Ml/d)	Lead Time	Reason Option Not Considered/Included in WRMP24 preferred programme
Dapdune licence disaggregation	2.2 (peak only)	1 year	Not needed to achieve SDB
Investigate agreement with Affinity Water to temporarily or permanently cease Ladymead export	2.3	< 1 year	Impacts Affinity Water resilience
Investigate new import from SES Water (Reigate to Guildford)	5	5 years	5-year lead time. Not needed in preferred plan scenario for supply-demand balance.
Focus on outage resulting in a reduction in outage allowance	<0.5	<1 year	Low level of confidence in delivery, and so high risk for customers
Re-prioritisation of meter delivery to Guildford WRZ	<0.5	<1 year	Would involve reducing metering delivery in other WRZs
Re-prioritisation of leakage reduction to Guildford WRZ	<0.5	<1 year	Would involve reducing leakage delivery in other WRZs. Likely to incur additional cost.
Investigate combination of Shalford WTW expansion alongside licence increase	>5	TBC	Long lead time. Unlikely that licence would be granted.

C.25. In monitoring the success of our demand management programmes and other short-term risks in our plan, we will, in line with the WRSE Regional Group, adopt headroom (both reported and forecast) as the metric which will identify whether these additional measures are required. If our actual headroom falls below, or is forecast to fall below, target headroom, then we will need to act. Combining reported and forecast headroom is important because, as highlighted above, some actions can take several years to implement.

C.26. Headroom is a good measure to use in our monitoring plan as it factors in all of the uncertain elements of our plan, both on the supply-side and demand-side. As an example, if PCC does not fall in line with expectations but population does not rise in line with forecasts, then we need to consider the balance of these two things to work out whether action is needed to ensure the security of supply. Our forecast of headroom takes into account uncertainty around future population growth and consumption and so factors both of these elements.

C.27. The Figures below demonstrate how reported and forecast headroom will be used to trigger action. These are taken from the WRSE Regional monitoring plan, and other WRSE companies will be adopting the same approach.



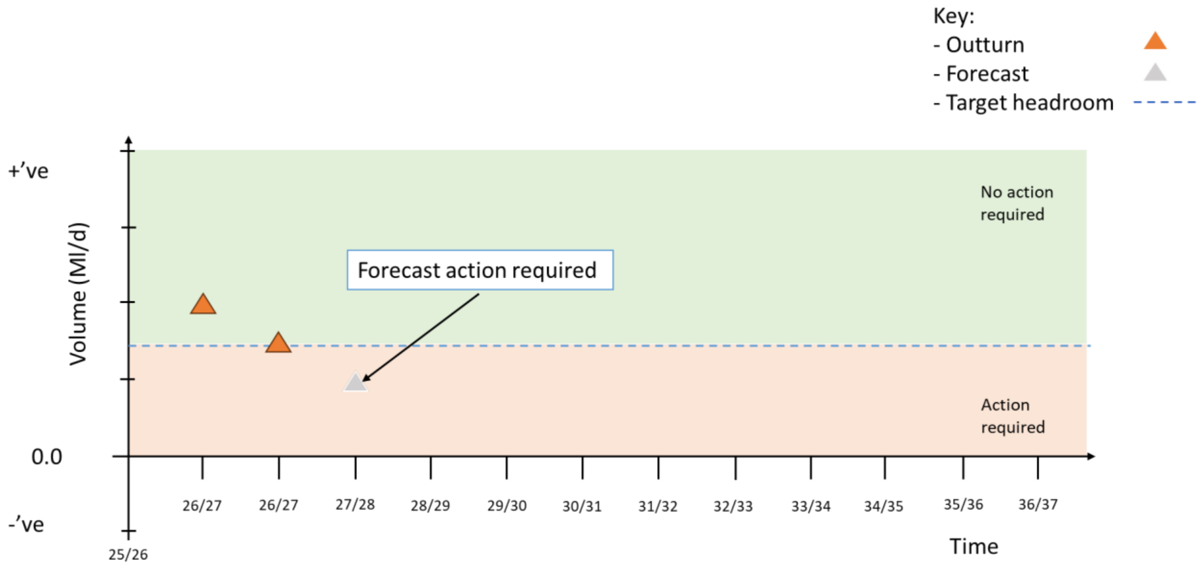


Figure X – WRSE Monitoring Plan Thresholds

Adaptive plan: Lower Thames

C.28. This component of the adaptive plan involves learning and monitoring and covers the period from now until we can confidently determine whether a solution is needed to maintain our currently stated Deployable Output for the London WRZ, accounting both for issues identified in the 2022 drought (see Appendix CC) and any exacerbation of these issues caused by the River Thames Scheme. This stage of the monitoring plan is required because, subject to the outcome of these investigations, Teddington DRA (our preferred solution) could be found not to be environmentally promotable. As such, this adaptive plan and the Teddington DRA adaptive plan are linked.

C.29. Our current schedule for the Teddington DRA scheme involves submission of a DCO application by mid-2026 for the scheme to be operational by Q1 2033. As such, our aim is to have this monitoring plan check completed in time to allow alignment with the consenting schedule. We anticipate that this will be around the time of our AR25 submission. The 2033 date is driven by the need to have new supplies to provide a 1 in 200-year level of resilience for our customers. The date of 2033 is a company target, not a statutory target. We have established through sensitivity testing that Teddington DRA remains our preferred solution, even if we delay this date up to 2035. As such, if this monitoring plan check is not complete by late 2025 we may delay our consent application and would accordingly delay our anticipated date for achievement of 1 in 200-year resilience, but would not alter our option selection.

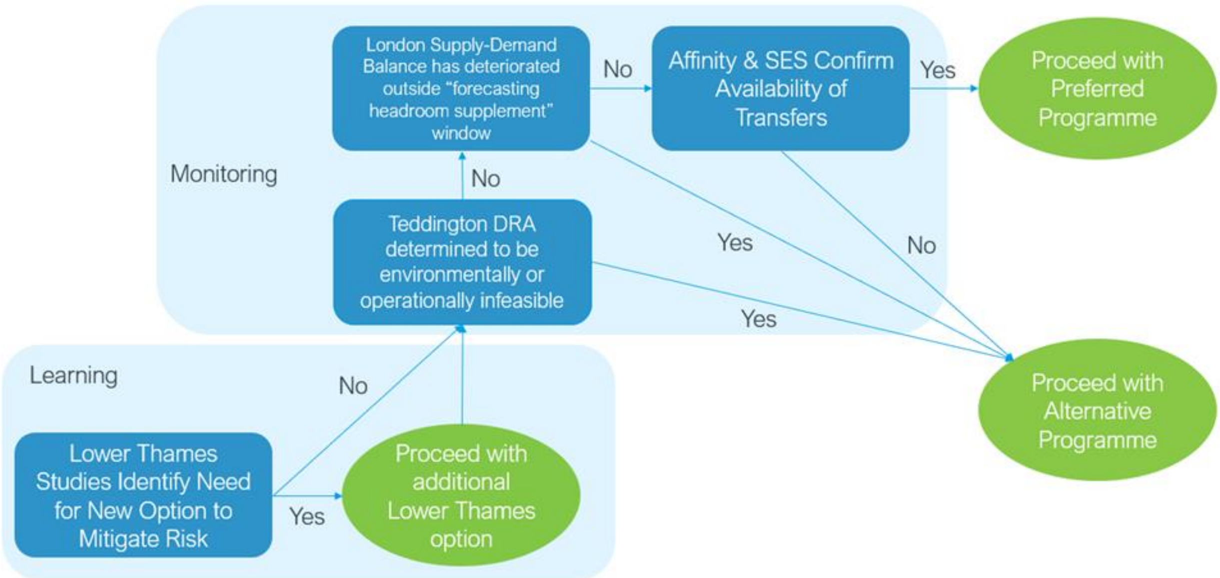


Figure X: Monitoring Plan, Lower Thames and Teddington DRA Triggers

C.30. The learning involves investigation, research, and modelling to determine: whether there are constraints on our abstraction which we do not currently capture within our water resources modelling; whether the River Thames Scheme (a flood alleviation scheme being developed by the Environment Agency and Surrey County Council) will exacerbate these constraints; and whether these constraints can be mitigated by operational changes by Thames Water and/or the Environment Agency, or if engineering interventions are necessary to remove these constraints.

C.31. If engineering interventions are necessary, then an options appraisal process, which will run in parallel to the problem identification process, will determine the preferred option for mitigating the risks which are identified. We will proceed with the development of the preferred option(s) subject to feasibility assessment and appropriate funding being in place.

C.32. We have confirmed, through sensitivity testing, that the Teddington DRA scheme remains the best option to provide 1 in 200-year resilience if constraints on the River Thames do not exist or exist but are mitigable through operational changes (either of these would be our preferred plan), or are found to exist but are mitigable by an engineering solution. If, however, we identify that constraints on our Lower Thames abstractions exist or will be created by the River Thames Scheme, and that an engineering solution is infeasible, we will need to revisit the decision made regarding option selection for the early part of the WRMP24 planning period (up to 2033).

Adaptive plan: Teddington DRA

C.33. The outcome of the monitoring to inform the adaptive plan for the Lower Thames will identify whether a new option is needed to mitigate issues around our Lower Thames abstractions, and whether such an option would be feasible. At this point, we will consider the following three checks which will determine whether we will adopt our preferred or alternative programme for the short-term. We anticipate that this will be around the time of our AR25 submission.

C.34. Our alternative programme substitutes the Teddington DRA option with an alternative Water Recycling scheme (Beckton or Mogden). Both Beckton and Mogden Water Recycling options are significantly more expensive and create greater environmental impacts than Teddington DRA (relying on membrane treatment and involving the construction of long tunnels), but are modular and could, over time, be scaled up to a 300 or 150 Ml/d recycling plants respectively (the chosen Teddington DRA size is, by contrast, 75 Ml/d). The modularity of the other Water Recycling plants means that they could be scaled up should it be found that additional water is needed in the short to medium term. The 150 Mm^3 SESRO option is our preferred option for delivering long-term security of supply, regardless of whether we adopt a Water Recycling option or the Teddington DRA, and so both our preferred and alternative plans for this monitoring phase include the SESRO 150 Mm^3 scheme.

C.35. The first monitoring check is whether ongoing environmental and operational investigations (carried out by the SRO team as part of the EIA or other assessments) have determined that the Teddington DRA is not environmentally (or otherwise) promotable. If the Teddington DRA has been found not to be promotable, we will adopt our alternative plan and undertake monitoring checks two and three to determine the scale of the Recycling option required.

C.36. The second monitoring check is whether the central forecast of our supply-demand balance trajectory for the early- to mid-2030s indicates that we are outside the "forecasting headroom supplement" envelope in the London WRZ.

C.37. We undertake a Target Headroom forecast to ensure that we leave an appropriate buffer to account for future risks. Our Target Headroom allowance for the short- to medium-term future is larger than the 'base year' (the year in which we undertake the assessment) because forecasting forward is more uncertain than making assessments of the current situation. It is not the case that we would anticipate having a headroom allowance as large as the forecast target headroom in future years, and we would instead expect to have a headroom allowance approximately equal to the 'base year' allowance when we assess our security of supply at a point in the future.

C.38. We have split our Target Headroom forecast into a 'base year' allowance and a 'forecasting supplement' (Figure below). At the point at which we undertake our monitoring checks, we will adjust our WRMP24 final plan supply-demand balance trajectory to account for the major short-term uncertainties in our plan, which are: the overall distribution input at the point in the future when we undertake the monitoring checks; our forecast leakage, informed by the success of our leakage reduction plan for the rest of AMP7; our forecast household consumption, informed by the success of our PCC reduction plan which includes the need for Government interventions and updates to population forecasts; our forecast of the availability and capability of the gateway desalination plant, and; amendments made to our baseline supply capability following assessment of feasible abstraction in the Lower Thames.

C.39. If we find that the combination of these factors leads to a deterioration in our supply-demand balance of more than the "forecasting supplement" in the early- to mid-2030s, then we will appraise whether we should adopt additional small solutions alongside the Teddington DRA scheme, adopt our alternative plan (a different water recycling option), or develop an additional water recycling option alongside Teddington DRA. This approach is aligned with the WRSE regional monitoring plan, which uses available headroom and target headroom to judge whether additional interventions are needed.

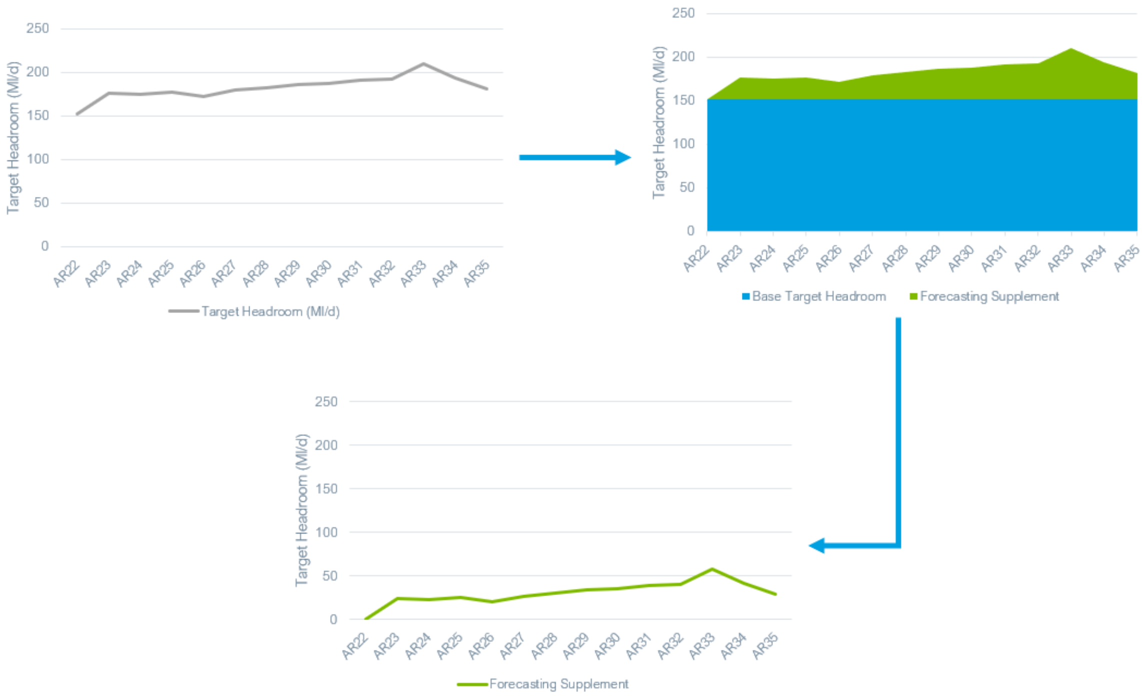


Figure X: Forecasting Headroom Supplement Calculation

C.40. The third monitoring check to be undertaken will be that the licence transfer option from Affinity Water (or an alternative transfer option, from SES Water) is still needed and available according to the best current information. This transfer is dependent on Affinity (or SES) achieving their demand reduction goals and, in the case of Affinity Water, gaining consent and successfully developing the Grand Union Canal SRO. Unless our supply-demand balance forecast position has improved by more than the total maximum transfer requirement in our preferred programme, if the Affinity Water (or SES water) transfer has been identified as being unavailable or significantly delayed, we will appraise whether alternative/additional options are needed and available and adopt small solutions, an alternative recycling option or an additional recycling option as necessary.

C.41. If we find that all three monitoring checks are passed, then we will proceed with our preferred programme.

Adaptive plan: SESRO

C.42. This adaptive plan concerns the SESRO development consent order. We have identified that the 150 Mm^3 SESRO scheme is the best value option to provide long-term resilience for our customers' supplies and for improving the environment. The 150 Mm^3 scheme, being the largest single-phase option which we can develop, also offers the greatest supply-demand balance benefit and so its selection as the best value option should proceed regardless of change in our forecast supply-demand balance resulting from the issues noted as short-term risks (e.g., achievement of demand management targets in the short term, Gateway desalination plant capability). Should the 150 Mm^3 SESRO be found to be infeasible or be denied consent we should seek consent for and develop an alternative SESRO size (the largest feasible size), and if SESRO is denied consent overall we will switch to our alternative plan and proceed with development and consenting of an alternative option, most likely the Severn Thames Transfer SRO.

Adaptive plan: Accelerated Licence Reductions

C.43. Our preferred plan includes the development of the 150 Mm^3 SESRO scheme by 2040. A significant reason for adopting the larger SESRO option is that it ensures resilience against the range of risks which we may encounter in the future. However, an additional benefit of our preferred plan is that, should these risks not emerge, there would be surplus available in the 2040s which could enable the delivery of licence reductions ahead of the 2050 date.

C.44. We have phased the delivery of our Environmental Destination Scenario between 2030 and 2050 so that we can identify and programme a coherent overall solution when considering new water resources and new infrastructure, rather than applying a piecemeal approach where reductions are accelerated in certain locations. The process of investigation, design and solution implementation is important and will take time when considering the scale of infrastructure (both new water resources and new network infrastructure) which is necessary.

C.45. In Section 5 of our WRMP we have identified those licence reductions which are currently scheduled for delivery in 2050, but which could be accelerated if surplus is available, if investigations confirm that they are necessary and if network solutions can be developed to the required timescales.

C.46. We will adopt the following strategy to bring together the evidence which is gathered through our WINEP investigations, our forecast of the supply-demand balance (accounting for the success of, and remaining risks relating to PCC and leakage reduction, alongside other risks referenced in our Monitoring Plan), and our learning regarding network solutions which will be required to enable licence reductions. This strategy involves 5 phases: monitor; forecast; develop; review; and implement. Adopting this strategy may allow us to deliver environmental benefit earlier than is scheduled, while ensuring resilience and efficiency.

C.47. This strategy will be implemented over the continuous learning and development process of the next two WINEP and WRMP cycles. The strategy is shown as a flow chart below.

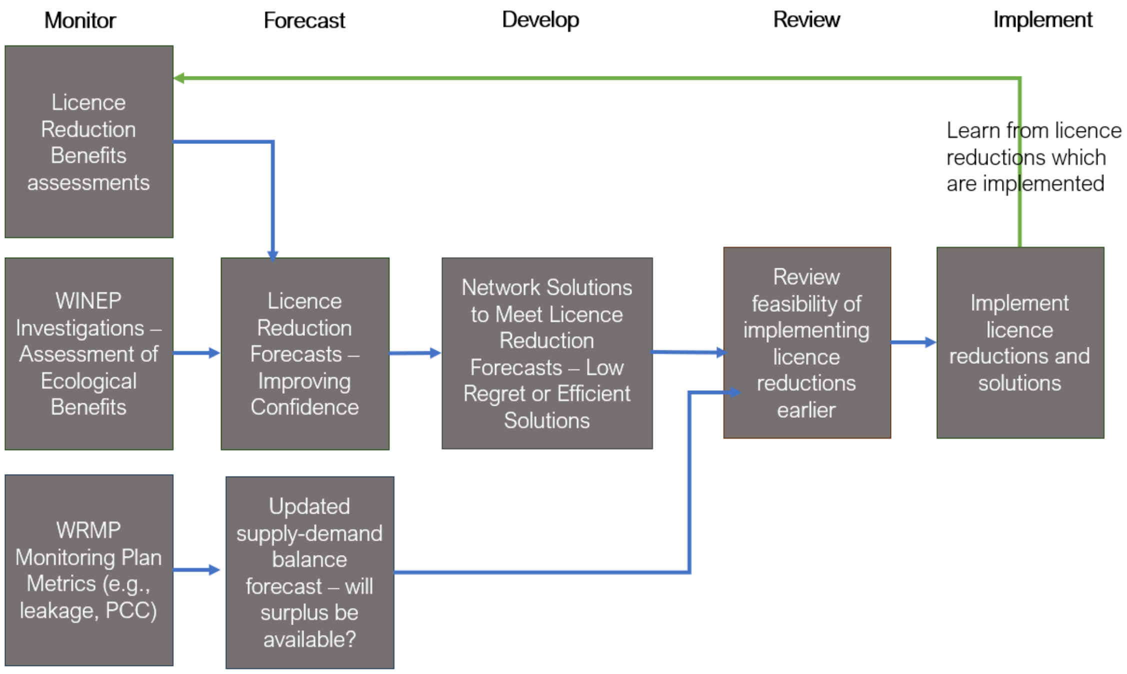


Figure X – WINEP Monitoring Plan

C.48. As is described in Section 5 of the WRMP, we have identified that licence reductions could be accelerated ahead of 2050 at the following source groups, subject to the outcomes of this review process:

- London – Sundridge and Westerham
- London – New Gauge & NNRW
- SWOX – Cotswolds

C.49. Reviews would be undertaken following AMP8 and AMP9 WINEP investigations, and following monitoring and re-forecasting of our supply-demand balance as we move towards WRMP29 and WRMP34.

C.50. If the monitoring and investigations are complete and the sustainability reductions confirmed in AMP8 and if our forecasts show that, subject to continued success in demand management, surplus is likely to be available, then we would accelerate the design of network solutions required to enable these licence reductions (where relevant) and would look to deliver them between 2040 and 2045. The same process will be undertaken in AMP9, and if a positive outcome is found then these reductions would be made between 2045 and 2050.

Adaptive Planning – Longer term

C.51. In our long-term planning, decisions which we make will always necessarily be based on a combination of observations and forecasts (with these forecasts being informed by regulatory guidance). This is because the large supply-side interventions which we can implement will take of the order of at least 10 years to develop, and so we must forecast ahead to highlight when investment is needed. This is particularly important when considering climate change impacts, as the impacts of climate change on drought risk to date are only observable through detailed climate modelling (i.e., they are not directly observable), and observable thresholds (e.g. total emissions or temperature rise) correlate poorly with drought risk outcomes (see WRMP24 Appendix U).

C.52. In addition, the overall supply-demand balance is clearly influenced by multiple factors. When determining whether investment is required, we must consider the cumulative impact of different factors. As such, we should consider risks in the round when making investment decisions.

C.53. In Table X, we have identified the principal factors which we will monitor (aligned with the earlier "metrics" table). For each factor, we have identified representative scenarios of outcomes which could occur, a 2027-28 indicator value (2027-28 being five years from the submission of our rdWRMP24, and so being around the likely date for publication of our WRMP29), and the impact on our supply-demand balance in 2040 if this scenario were to be realised.

C.54. Table X demonstrates that combinations of different factors could lead to very similar outcomes for our overall supply-demand balance. For example, a future in which we follow our preferred plan, but the government does not implement policy beyond water labelling and West Berkshire groundwater scheme is forecast to be unavailable from 2040 (total 2040 SDB change = -173 Ml/d) gives approximately the same overall impact as a future in which we follow our preferred plan, but our leakage reduction plan is only 50% as effective as we would like and the Gateway desalination plant is decommissioned (total 2040 SDB change = -164 Ml/d).

C.55. Through our annual review process we will track and report on these indicators, and will track progress towards the stated 2027-28 indicator values to give an idea of the likely future scenario we are facing. Our tracking will indicate whether we need to make interventions in addition to the selected SROs.

C.56. It is notable that many of the future scenarios listed would result in supply-demand balance detriment, which reflects the ambitious, policy-driven targets for demand management (e.g., there is a larger chance of under-delivery than over-delivery of PCC reduction).

C.57. As can be seen in Table X, the single largest supply-demand change that we could experience would be if the Environment Agency were to confirm sustainability reductions being required in accordance with the High scenario, with the delivery date accelerated to 2040. In this scenario, we would need to develop additional new resources.

C.58. A benefit of our preferred plan is that, in the 2040s, there exists a surplus of resource (note that this surplus does not exist from 2050 onwards), meaning that we could absorb some scenarios of adverse supply-demand balance impact without needing to resort to additional resource development in the medium-term. The surplus from the 150 Mm^3 SESRO and 75 Ml/d Teddington DRA together would be around 190 Ml/d in 2040, 140 Ml/d in 2045, and 0 Ml/d in 2050. By 2050, resource from the 150 Mm^3 SESRO and 75 Ml/d Teddington DRA would be fully utilised or very nearly fully utilised, meaning that no/little excess capacity would exist. The resilience to future medium-term risks but long-term efficiency is a clear benefit of our preferred programme and demonstrates that the schemes presented are an adaptable, efficient solution to the planning problem with which we are faced.

C.59. With the shorter-term elements of our monitoring plan ensuring delivery of the required supplies up to 2035, our long-term monitoring plan's main focus is the period 2035 onwards. Tracking of indicators will highlight whether, for example, additional intervention is needed to reduce leakage more quickly, whether tariffs should be introduced earlier, or whether additional supply options (small or large) may be required during this period. We will, however, of course ensure sufficiency of supply is forecast for 2040 and will respond if required.

Table X: - *Longer-term monitoring plan – metrics and impacts*

Assessment Area	Monitoring Activity and metric	Range of scenarios	2027-28 indicator	2040 Supply-Demand Balance Impact, Compared to "Situation 4" (positive = SDB improvement), Ml/d
Leakage reduction	Leakage, Ml/d	50% success	531	-116
		75% success	493	-58
		100% success	456	0
		50% reduction by 2040	<430, and innovative solutions identified	+43.5
Company-led consumption reduction	PCC, l/h/d	50% effective	143	-85
		75% effective	141	-43
		100% effective	139	0
Government action on demand reduction	Policy Commitment	Apathy	Water labelling implemented, no further commitment	-96
		Moderate	Water labelling implemented, commitment to minimum standards on white goods in 2030	-73
		Preferred plan	Water labelling implemented, commitment to minimum standards on white goods in 2030 and indication that buildings regulations changes will be made	0
Population	Population (000's) and guidance	Low demand & guidance changes	Growth follows ONS trajectory, guidance changes to require ONS forecast use	+159
		Low demand	Growth follows ONS trajectory, guidance still requires forecast using local authority plan	+89
		Preferred plan	Growth follows Local Plan Trajectory	0
Environmental Destination	Investigation indications and policy	High, accelerated	Investigations confirm reductions necessary, policy changes to accelerate all reductions to 2040	-372
		High	Investigations indicate all reductions necessary	0
		Medium	Investigations indicate medium scenario likely	+56
		Low	Investigations indicate low scenario likely	+56
Climate Change	Latest forecasts and guidance	Low	Forecasts and guidance suggest low scenario appropriate	+87

Assessment Area	Monitoring Activity and metric	Range of scenarios	2027-28 indicator	2040 Supply-Demand Balance Impact, Compared to “Situation 4” (positive = SDB improvement), Ml/d
		Medium	Forecasts and guidance suggest medium scenario appropriate	+40
		High	Forecasts and guidance suggest high scenario appropriate	0
		X High	Forecasts and guidance suggest impacts higher than high scenario	-75
West Berkshire Groundwater Scheme	EA communication and policy	Available 2040	Scheme likely to be available in 2040	0
		Unavailable 2040	Scheme likely to be decommissioned by 2040	-77
Gateway desalination plant	Site capability and reliability	75 Ml/d reliable	50 Ml/d reliable. Good progress towards 75 Ml/d	0
		50 Ml/d reliable	50 Ml/d possibly reliable, but indication that 75 Ml/d unlikely	-8
		Decommission	Indication that plant will be decommissioned	-48
Supply-demand balance	Supply-demand balance, DI, and WAFU, in Ml/d	Better than forecast	Surpluses larger than forecast	Dependent on combination of factors above
		Preferred plan	Supply-demand balance	0
		Worse than forecast	Deficits in some zones	Dependent on combination of factors above

WRMP29: Reconciliation Exercise

C.60. The final step in our monitoring plan will be undertaken when we produce WRMP29. At this point we will undertake a reconciliation exercise of our supply-demand balance trajectories against those included in WRMP24. This exercise will exclude changes in guidance introduced in the interim but will include consideration of the direction of travel for key drivers, alongside whether actions have been completed and whether these actions have resulted in the outcomes which we anticipated. We will reconcile our forecast supply-demand balance position in order to indicate the supply-demand balance trajectory that we look most likely to follow in order to indicate, based on current (WRMP24) guidance, the decisions that our WRMP24 would trigger us to make, as well as making an estimate of the outstanding uncertainty, and so comparing the envelope of forecasts that we would consider according to WRMP24 guidance. This will allow us to explain the impact of changes in policy and guidance made between WRMP24 and WRMP29. The factors considered and key questions which will be answered are listed in the Table below.

Factor	Factors Considered	Metric(s)
Leakage	Have we achieved our leakage reduction targets?	Ml/d
Meter installations and water efficiency	Have we met our targets for water meter installations and water efficiency visits? Have we seen the usage reductions we anticipated?	000’s l/h/d
Population growth	How does population and the number of properties compare with our forecasts?	000’s

Factor	Factors Considered	Metric(s)
Low-flow investigations	Do low-flow investigations carried out suggest that the "High", "Medium", or "Low" forecast is most likely?	Ml/d
Licence reductions – monitoring	Does our post-implementation of monitoring of licence reductions made suggest that they are effective in delivering ecological gain?	Qualitative/ quantitative discussion
Water labelling	Has water labelling been implemented? Has research shown that this introduction has been effective?	Yes/no l/h/d
White Goods – Minimum Standards	Have minimum standards on white goods been adopted?	Yes/no
Changes to buildings regulations	Will buildings regulations be updated to promote greater water efficiency?	Yes/no
Desalination plant availability	How well have we performed in our maintenance programme? What is our forecast for the plant's capability?	Update Ml/d
Climate change – demand	Have new climate change forecasts been released? Does observed and forecast warming indicate that we should alter our demand uplift approach?	Yes/no Ml/d
Climate change – supply	Have new climate change forecasts been released? If yes, do the revised forecasts alter our view of likely impacts?	Yes/no Ml/d
SRO	Have we obtained development consent for the SROs in our plan?	Yes/no

Table 11-X: WRMP29 Reconciliation – Factors Considered

Aligning our Monitoring Plan with the WRSE Regional Monitoring Plan

C.61. As described in the Adaptive Plan sections above (demand management and Teddington DRA), our monitoring plan makes use of target headroom, both reported and forecast. This is in line with the approach being taken by the WRSE Regional Group.

C.62. The WRSE Regional Group's monitoring plan will track the delivery of all companies' preferred plans. This includes the delivery of new water resource schemes, consumption reduction and leakage reduction. If adequate progress is not being made to address the projected deficit, then WRSE will be able to take a regional and coherent view regarding action which is needed.

C.63. In the revised WRSE Regional monitoring plan, WRSE has highlighted the metrics which will be monitored. These metrics align with those of our own monitoring plan, and so we will report our metrics into WRSE.

C.64. WRSE has included the Table below in the regional monitoring plan. As can be seen, this aligns well with the factors which we have described which could bring a change to our WRMP.

Table X – WRSE Monitoring Plan

Factors which could change the regional plan	Key issues to be monitored and resolved where possible
Environmental ambition	WRSE has worked with the EA and Natural England to develop the existing environmental ambition profiles, and to incorporate licence capping. The profiles will need to be reviewed to ensure they meet policy expectations, particularly regarding licence capping and the results of ongoing WINEP and environmental investigations.
Quantifying environmental benefits	WRSE will continue to work with our member companies, regulators and catchment partners to better understand schemes and ecological benefits from environmental ambition.
Demand side options	TUBs and NEUBs have been included in the regional plan as one of the measures to meet the challenges ahead. The default regional position is that this will remain the case unless there is feedback to change this policy position. WRSE have tested several different Government water efficiency policies. Government Policy C+ brings the region to 110 l/p/d by 2050 in a dry year, but this puts a lot of onus on Government to deliver a significant component of the plan. This will require careful monitoring as the plan progresses to review Government commitments.
Supply side options	Uncertainties relating to supply side schemes will be monitored and resolved where possible. Key schemes to monitor include SESRO, GUC, Hampshire Water Transfer and Water Recycling, and Teddington DRA. Drought orders and permits continue to be selected in the regional plan until 2040, however WRSE will monitor regulatory positioning on the continued use of drought orders and permits and adjust our approach accordingly. WRSE has investigated accelerated cessation of the use of drought orders and permits (2035) as well as delayed cessation (2045 and 2050). WRSE will continue to work with the All Company Working Group (ACWG) and the National Advisory Unit (NAU) to look at emerging substances relating to reuse and water recycling schemes and compliance with the Water Framework Directive.
Carbon reduction	We will monitor the cost of carbon and mitigation options.
Future environmental policies	WRSE will continue to work with Government and regulators throughout the regional planning process to inform and support resolution of outstanding environmental policy uncertainties.
Regional reconciliation	There will need to be further regional reconciliation to ensure consistency is maintained between the regions in future.

Multi-sector options	WRSE will continue to engage with stakeholders and multi-sector groups to improve our understanding of non-public water supply demand forecasts, potential multi-sector options, and impacts on non-public water supply sources from droughts and licence capping.
Drought resilience	We have tested several different implementation timescales for 1:500 year drought resilience timing. Unless there is a strong consultation response or regulatory direction, the default WRSE position is 2040 for achieving 1:500 year drought resilience.

Annex D: Further information in response to Issue 11.7

High cost options – reasons for selection

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason for Selection*
New Medmenham Surface Water WTW Ph1 (53 Ml/d Intake)	*24*	*24*	*The SWA WRZ has a significant need for new water resources in 2050. The options are to either build a treatment plant to treat water from SESRO (or STT), or to use the River Thames as a conduit and build a new intake and treatment plant at Medmenham. The use of the River Thames as a conduit, as opposed to constructing a long-distance pipeline, is the lower cost and better value option.*
Transfer - South East Water to Guildford	*10*	*10*	*The Guildford WRZ has limited resource options available. When a need emerges in this WRZ, selection of a high-cost option is inevitable, and this option is the lowest AIC option available to the WRZ.*
Non-Household PSUP High	*2.8175*	*2.8175*	*While upgrading meters to smart meters can be an expensive endeavour, it is an enabler of other activities which are very cost efficient, for example SBVs.*
Progressive Metering Programme (PMP) High	*42.6738*	*42.6738*	*While metering can be an expensive endeavour, it is an enabler of other activities which are very cost efficient, for example SHVs, and USPL reduction. Metering is also an important activity to undertake when aiming to hit the 110 l/h/d PCC target.*
Catchment Portfolio: Darent and Cray	*0.6*	*0.6*	*While this option brings little Deployable Output benefit, it will bring environmental benefit.*
Leakage Innovation High	*44.9993*	*44.9993*	*Meeting the 50% leakage reduction target is an important policy objective. Meeting this target will require extensive leakage reduction, which will be expensive and disruptive. In order to meet policy targets, this option is nonetheless included in the Best Value Plan.*

Mains Rehab High	*63.8139*	*63.8139*	*Meeting the 50% leakage reduction target is an important policy objective. Meeting this target will require extensive mains rehabilitation, which will be expensive and disruptive. In order to meet policy targets, this option is nonetheless included in the Best Value Plan.*
Metering Innovation (PSUP) High	*1.0608*	*1.0608*	*This option involves metering properties which are currently deemed unmeterable. While the cost-benefit ratio of this individual option is not good, it enables other more cost-beneficial options, which*
Planning and development of options, separated from construction of options (Oxford Canal and Kempton WTW)			*Necessary development activities preceding the construction of options which are selected. Planning and development is separated from construction where different options exist which would entail the same planning & development requirements.*
Catchment option portfolios			*Selected due to environmental benefits*
Bulk and Mini Bulk Meter Installation			*Required to enable USPL reduction associated with Bulk and Mini Bulk Meter Installation. This USPL reduction when considered alongside the meter installation presents very good value.*
Progressive Smart Meter Upgrade Programme			*Enables USPL reduction at sites where basic meters are upgraded to smart meters. The USPL reduction, when considered alongside meter installation, present very good value.*
Smart Metering Infrastructure			*Does not deliver WAFU benefit on its own, but is necessary to enable the wide range of benefits that smart metering deliver*

Low cost options – reasons for non-selection

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
Smarter Business Visits Low			*Mutually exclusive option, "Smarter Business Visits High" selected.* *As described in rdWRMP24 Section 8, demand management portfolios were developed. The High demand management portfolio was selected, as this ensures meeting government EIP targets. Low demand management portfolio does not meet these targets.* *The number (and so cost and benefit) of Smarter Business Visits included in the WRMP24 programme is dependent on the number of NHH smart meters installed. SBVs are a low-cost intervention on their own, but are considered as part of a wider programme of NHH demand reduction measures. As such, consideration of the programme level cost, rather than the option level cost is applicable.*
Raw Water System Upgrade - TLT Removal of Constraints	*n/a (see Capacity Ml/d for size)*	*450*	*This option does not generate a WAFU benefit on its own. AIC for this option is calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148 and Table 7-11, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
TWRM level controlled by new header tank and pumping station at Coppermills WTW	*n/a (see Capacity Ml/d for size)*	*450*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.*
Digital Engagement Tool High+	*10.2182*	*10.2182*	*Mutually exclusive option, "Digital engagement tool high" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken. The benefit and cost of a Digital Engagement Tool*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			has been assessed and found to be a good value option to include in our WRMP. However, as is described in Section 8, the decision to proceed with such a tool in our preferred programme would be a binary one, rather than one in which more/less investment would yield more/less benefit. As such, a digital engagement tool option has been included in each demand management portfolio with identical costs and benefits.
Digital Engagement Tool Medium	*10.2182*	*10.2182*	*Mutually exclusive option, "Digital engagement tool high" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken. The benefit and cost of a Digital Engagement Tool has been assessed and found to be a good value option to include in our WRMP. However, as is described in Section 8, the decision to proceed with such a tool in our preferred programme would be a binary one, rather than one in which more/less investment would yield more/less benefit. As such, a digital engagement tool option has been included in each demand management portfolio with identical costs and benefits.*
Additional conveyance from King George V Reservoir to break tank	*n/a (see Capacity Ml/d for size)*	*300*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148 and Table 7-11, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Intake Capacity Increase - Queen Mary	*n/a (see Capacity Ml/d for size)*	*300*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148 and Table 7-11, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Smarter Business Visits Medium	*23.4*	*23.4*	*Mutually exclusive option "Smarter Business Visits High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Smarter Business Visits play an important role in ensuring achievement of the EIP target for NHH demand reduction. Less reduction than is included in the Smarter Business Visits High option would not result in achievement of the EIP target.*
Smarter Business Visits High+	*56.3999*	*56.3999*	*Mutually exclusive option "Smarter Business Visits High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The costs and benefits of the Smarter Business Visits High and Smarter Business Visits High+ options are identical. This is because NHH metering programmes and resultant SBV installs have been maximised according to deliverability in both the High and High+ programmes.*
Additional conveyance from Queen Mary Reservoir to Kempton WTW	*n/a (see Capacity Ml/d for size)*	*800*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148 and Table 7-11, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Bulks USPL High+	*21.4322*	*21.4322*	*Mutually exclusive option "Bulks USPL High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Delivery of CSL benefit via the installation of bulk meters has been identified as a very cost efficient option. As such, the delivery programme has been based on maximum feasible delivery volumes. For this reason, the Bulks USPL Low, Medium, High and High+ options are all of the same cost and benefit.*
Bulks USPL Low	*21.4322*	*21.4322*	*Mutually exclusive option "Bulks USPL High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			Delivery of CSL benefit via the installation of bulk meters has been identified as a very cost efficient option. As such, the delivery programme has been based on maximum feasible delivery volumes. For this reason, the Bulks USPL Low, Medium, High and High+ options are all of the same cost and benefit.
Bulks USPL Medium	*21.4322*	*21.4322*	*Mutually exclusive option "Bulks USPL High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Delivery of CSL benefit via the installation of bulk meters has been identified as a very cost efficient option. As such, the delivery programme has been based on maximum feasible delivery volumes. For this reason, the Bulks USPL Low, Medium, High and High+ options are all of the same cost and benefit.*
NHH Internal Continuous Flow Fixes High+	*23.4999*	*23.4999*	*Mutually exclusive option "NHH Internal Continuous Flow Fixes High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The costs and benefits of the NHH internal continuous flow fixes High and High + options are identical. This is this option has been maximised according to deliverability in both the High and High+ programmes, in order to achieve EIP NHH demand reduction targets.*
Raw Water System Upgrade - Tunnel from Walthamstow 5 to Coppermills	*n/a (see Capacity Ml/d for size)*	*800*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148 and Table 7-11, a study was undertaken in which raw water system*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Intake Capacity Increase at King George V Reservoir	*n/a (see Capacity Ml/d for size)*	*360*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148 and Table 7-11, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
NHH Retailer Activity High+	*6.9998*	*6.9998*	*Mutually exclusive option "NHH Retailer Activity High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The costs and benefits of the NHH Retailer Activity High and High + options are identical. This is this option has been maximised according to deliverability in both the High and High+ programmes, in order to achieve EIP NHH demand reduction targets.*
Intake Capacity Increase - Datchet	*n/a (see Capacity Ml/d for size)*	*300*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148 and Table 7-11, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Coppermills WTW - Mecana 680Ml/d	*n/a (see Capacity Ml/d for size)*	*680*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.*
Coppermills WTW - Mecana 480Ml/d	*n/a (see Capacity Ml/d for size)*	*480*	*This option does not generate a WAFU benefit. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.*
Kempton WTW to Hampton Shaft	*n/a (see Capacity Ml/d for size)*	*150*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Non-Household PSUP USPL Saving High+	*3.7254*	*3.7254*	*Mutually exclusive option "*Non-Household PSUP USPL Saving High*" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *NHH smart meter upgrades are identified as a cost-effective option, and enable other interventions such as NHH continuous flow fixing.* *As such, the option costs and benefits of each of the Low, Medium, High and High+ variants of this option were based on deliverability. As such, the costs and benefits of these options are the same.*
Non-Household PSUP USPL Saving Low	*3.7254*	*3.7254*	*Mutually exclusive option "*Non-Household PSUP USPL Saving High*" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *NHH smart meter upgrades are identified as a cost-effective option, and enable other interventions such as NHH continuous flow fixing.* *As such, the option costs and benefits of each of the Low, Medium, High and High+ variants of this option were based on deliverability. As such, the costs and benefits of these options are the same.*
Non-Household PSUP USPL Saving Medium	*3.7254*	*3.7254*	*Mutually exclusive option "*Non-Household PSUP USPL Saving High*" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			NHH smart meter upgrades are identified as a cost-effective option, and enable other interventions such as NHH continuous flow fixing. *As such, the option costs and benefits of each of the Low, Medium, High and High+ variants of this option were based on deliverability. As such, the costs and benefits of these options are the same.*
Coppermills WTW - Mecana 200Ml/d	*n/a (see Capacity Ml/d for size)*	*200*	*This option does not generate a WAFU benefit. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.*
Green Redeem High+	*0.4425*	*0.4425*	*Mutually exclusive option "Green Redeem High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Green redeem identified as a cost-effective option as compared to other methods of HH consumption reduction.* *As such, the option costs and benefits of each of the Low, Medium, High and High+ variants of this option were based on deliverability. As such, the costs and benefits of these options are the same.*
Green Redeem Low	*0.4425*	*0.4425*	*Mutually exclusive option "Green Redeem High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Green redeem identified as a cost-effective option as compared to other methods of HH consumption reduction.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			As such, the option costs and benefits of each of the Low, Medium, High and High+ variants of this option were based on deliverability. As such, the costs and benefits of these options are the same.
Green Redeem Medium	*0.4425*	*0.4425*	*Mutually exclusive option "Green Redeem High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Green redeem identified as a cost-effective option as compared to other methods of HH consumption reduction.* *As such, the option costs and benefits of each of the Low, Medium, High and High+ variants of this option were based on deliverability. As such, the costs and benefits of these options are the same.*
Intake Capacity Increase - Chingford South	*n/a (see Capacity Ml/d for size)*	*100*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148 and Table 7-11, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Mini Bulks High+	*5.828*	*5.828*	*Mutually exclusive option "Mini Bulks USPL High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Delivery of benefit via the installation of bulk meters (and resultant CSL fixes) has been identified as a very cost efficient option. As such, the delivery programme has been based on maximum feasible delivery volumes. For this reason, the Mini Bulks Low, Medium, High and High+ options are all of the same cost and benefit.*
Mini Bulks Low	*5.828*	*5.828*	*Mutually exclusive option "Mini Bulks USPL High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Delivery of benefit via the installation of bulk meters (and resultant CSL fixes) has been identified as a very cost efficient option. As such, the delivery programme has been based on maximum feasible delivery volumes. For this reason, the Mini Bulks Low, Medium, High and High+ options are all of the same cost and benefit.*
Mini Bulks Medium	*5.828*	*5.828*	*Mutually exclusive option "Mini Bulks USPL High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Delivery of benefit via the installation of bulk meters (and resultant CSL fixes) has been identified as a very cost efficient option. As such, the delivery programme has been based*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			on maximum feasible delivery volumes. For this reason, the Mini Bulks Low, Medium, High and High+ options are all of the same cost and benefit.
Thames-Lee Tunnel extension from Lockwood PS to King George V Reservoir intake	*n/a (see Capacity Ml/d for size)*	*800*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148 and Table 7-11, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.*
TWRM extension - Coppermills to Honor Oak	*n/a (see Capacity Ml/d for size)*	*800*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Surbiton intake capacity increase with transfer to Walton inlet channel	*n/a (see Capacity Ml/d for size)*	*100*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148 and Table 7-11, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Household Wastage Fix High+	*4.2826*	*4.2826*	*Mutually exclusive option "Household Wastage Fix High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Delivery of benefit via HH wastage fixes has been identified as a very cost efficient option. As such, the delivery programme has been based on maximum feasible delivery volumes. For this reason, the Low, Medium, High and High+ options for this option are all of the same cost and benefit.*
Household Wastage Fix Low	*4.2826*	*4.2826*	*Mutually exclusive option "Household Wastage Fix High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Delivery of benefit via HH wastage fixes has been identified as a very cost efficient option. As such, the delivery programme has been based on maximum feasible delivery volumes. For this reason, the Low, Medium, High and High+ options for this option are all of the same cost and benefit.*
Household Wastage Fix Medium	*4.2826*	*4.2826*	*Mutually exclusive option "Household Wastage Fix High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Delivery of benefit via HH wastage fixes has been identified as a very cost efficient option. As such, the delivery programme has been based on maximum feasible delivery volumes. For this reason, the Low, Medium, High and High+ options for this option are all of the same cost and benefit.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
TWRM extension - Hampton to Battersea - Construction	*n/a (see Capacity Ml/d for size)*	*800*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.*
Replace pump infrastructure at Barrow Hill - TWRM	*n/a (see Capacity Ml/d for size)*	*32*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Cheam transfer to London Ringmain at Merton	*50*	*50*	*This option is an interconnector only, and so would not generate "resource" on its own.* *This option would require an export to be made from Sutton and East Surrey (SES) Water to our London WRZ. As such, this interconnector would need to be combined with either available surplus from SES water or the development of an option by SES to enable transfer.* *It may be that SES Water do not have surplus available to transfer to Thames Water at salient points in the planning horizon, and it is unlikely that the development of an option by SES to enable transfer to London would be, in aggregate, part of a best value solution.* *In some sensitivity runs we have seen this option be selected for use in the early 2030s, indicating that SES has surplus during this period and that London has a need. Our interpretation of the IVM results is that the need in London in c.2033 is large, and that either many small options and transfers are required to just achieve a supply-demand balance, or the Teddington DRA is required for 2033 (with alternative large options being more expensive). The sensitivity runs documented in rdWRMP24 Table 10-22 indicate that the WRSE model's least cost solution when excluding the Teddington DRA results in a more expensive plan than the least cost plan including Teddington DRA. As such, the*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			combination of options required to solve the deficit in London in 2033 may be more expensive than the DRA when considered together. An alternative interpretation is that the Teddington DRA, being the lowest AIC SRO option, would form part of any least cost plan in which there is a large need for water (larger than can be fulfilled by smaller options) in the London WRZ; in this case, given that the option would be selected in the long run anyway (the need in the WRSE region is so large that multiple SROs are needed in the long run), it may make sense to construct the Teddington DRA for use in the shorter term and then continue using it and then build further SROs later, rather than building many smaller options/transfers initially and then later building the Teddington DRA and other SROs.
Coppermills Tunnel to Woodford	*n/a (see Capacity Ml/d for size)*	*200*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
USPL Saving from Progressive Metering High+	*0.4402*	*0.4402*	*Mutually exclusive option "USPL Saving from Progressive Metering High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Completing our PMP programme has been defined as a necessary option (see rdWRMP24 Section 8), and the benefit and cost of USPL fixes resulting from meter installs depend on the number of meter installs conducted. As such the same cost and benefit of USPL savings is included in each demand management portfolio (Low, Medium, High and High+).*
USPL Saving from Progressive Metering Low	*0.4402*	*0.4402*	*Mutually exclusive option "USPL Saving from Progressive Metering High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Completing our PMP programme has been defined as a necessary option (see rdWRMP24 Section 8), and the benefit and cost of USPL fixes resulting from meter installs depend on the number of meter installs conducted. As such the same cost and benefit of USPL savings is included in each demand management portfolio (Low, Medium, High and High+).*
USPL Saving from Progressive Metering Medium	*0.4402*	*0.4402*	*Mutually exclusive option "USPL Saving from Progressive Metering High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Completing our PMP programme has been defined as a necessary option (see rdWRMP24 Section 8), and the benefit and cost of USPL fixes resulting from meter*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			installs depend on the number of meter installs conducted. As such the same cost and benefit of USPL savings is included in each demand management portfolio (Low, Medium, High and High+).
USPL Saving from Progressive Smart Upgrade Programme High+	*15.9901*	*15.9901*	*Mutually exclusive option "USPL Saving from Progressive Smart Upgrade Programme High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Completing our PSUP programme has been defined as a necessary option (see rdWRMP24 Section 8), and the benefit and cost of USPL fixes resulting from meter installs depend on the number of meter installs conducted. As such the same cost and benefit of USPL savings is included in each demand management portfolio (Low, Medium, High and High+).*
USPL Saving from Progressive Smart Upgrade Programme Low	*15.9901*	*15.9901*	*Mutually exclusive option "USPL Saving from Progressive Smart Upgrade Programme High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Completing our PSUP programme has been defined as a necessary option (see rdWRMP24 Section 8), and the benefit and cost of USPL fixes resulting from meter installs depend on the number of meter installs conducted. As such the same cost and benefit of USPL savings is included in each demand management portfolio (Low, Medium, High and High+).*
USPL Saving from Progressive Smart	*15.9901*	*15.9901*	*Mutually exclusive option "USPL Saving from Progressive Smart Upgrade Programme High" selected.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
Upgrade Programme Medium			*Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Completing our PSUP programme has been defined as a necessary option (see rdWRMP24 Section 8), and the benefit and cost of USPL fixes resulting from meter installs depend on the number of meter installs conducted. As such the same cost and benefit of USPL savings is included in each demand management portfolio (Low, Medium, High and High+).*
Walton to QM Reservoir	*n/a (see Capacity Ml/d for size)*	*300*	*This option does not generate a WAFU benefit. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
Import: Honor Oak to Near Rochester WTW (120Ml/d) Reverse	*120*	*120*	*This option is an interconnector only, and so would not generate "resource" on its own.* *This option would require an export to be made from Southern Water to our London WRZ. As such, this interconnector would need to be combined with either available surplus from Southern Water or the development of an option by Southern Water to enable transfer, or the development of an option by South East Water, transferred via Southern Water.* *The Kent portion of the WRSE Region has a high level of deficit and so surplus is not available in this part of the WRSE Region. The feasible solutions in the Kent portion of the WRSE Region are relatively expensive (compared to alternatives which London can be supplied by), and so the combined cost of new options and this interconnector would not form part of a least cost or best value plan.*
New Lower Thames Intake - Surbiton	*n/a (see Capacity Ml/d for size)*	*500*	*This option does not generate a WAFU benefit. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			options which are dependent on this system option is dependent not having been selected.
Import: Honor Oak to Near Rochester WTW - bi-directional (10Ml/d) Reverse	*10*	*10*	*This option is an interconnector only, and so would not generate "resource" on its own.* *This option would require an export to be made from Southern Water to our London WRZ. As such, this interconnector would need to be combined with either available surplus from Southern Water or the development of an option by Southern Water to enable transfer, or the development of an option by South East Water, transferred via Southern Water.* *The Kent portion of the WRSE Region has a high level of deficit and so surplus is not available in this part of the WRSE Region. The feasible solutions in the Kent portion of the WRSE Region are relatively expensive (compared to alternatives which London can be supplied by), and so the combined cost of new options and this interconnector would not form part of a least cost or best value plan.*
Import: Honor Oak to Near Rochester WTW (60Ml/d) Reverse	*60*	*60*	*This option is an interconnector only, and so would not generate "resource" on its own.* *This option would require an export to be made from Southern Water to our London WRZ. As such, this interconnector would need to be combined with either available surplus from Southern Water or the development of an option by Southern Water to enable transfer, or the development of an option by South East Water, transferred via Southern Water.* *The Kent portion of the WRSE Region has a high level of deficit and so surplus is not available in this part of the WRSE Region. The feasible solutions in the Kent portion of the WRSE Region are relatively expensive (compared to alternatives which London can be supplied by), and so the combined cost of new options and this interconnector would not form part of a least cost or best value plan.*
Import: Honor Oak to Near Rochester WTW -	*30*	*30*	*This option is an interconnector only, and so would not generate "resource" on its own.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
bi-directional (30Ml/d) Reverse			*This option would require an export to be made from Southern Water to our London WRZ. As such, this interconnector would need to be combined with either available surplus from Southern Water or the development of an option by Southern Water to enable transfer, or the development of an option by South East Water, transferred via Southern Water.* *The Kent portion of the WRSE Region has a high level of deficit and so surplus is not available in this part of the WRSE Region. The feasible solutions in the Kent portion of the WRSE Region are relatively expensive (compared to alternatives which London can be supplied by), and so the combined cost of new options and this interconnector would not form part of a least cost or best value plan.*
Import: Honor Oak to Near Rochester WTW - bi-directional (45Ml/d) Reverse	*45*	*45*	*This option is an interconnector only, and so would not generate "resource" on its own.* *This option would require an export to be made from Southern Water to our London WRZ. As such, this interconnector would need to be combined with either available surplus from Southern Water or the development of an option by Southern Water to enable transfer, or the development of an option by South East Water, transferred via Southern Water.* *The Kent portion of the WRSE Region has a high level of deficit and so surplus is not available in this part of the WRSE Region. The feasible solutions in the Kent portion of the WRSE Region are relatively expensive (compared to alternatives which London can be supplied by), and so the combined cost of new options and this interconnector would not form part of a least cost or best value plan.*
Import: Honor Oak to Near Rochester WTW - bi-directional (20Ml/d) Reverse	*20*	*20*	*This option is an interconnector only, and so would not generate "resource" on its own.* *This option would require an export to be made from Southern Water to our London WRZ. As such, this interconnector would need to be combined with either available surplus from Southern Water or the development of an option by Southern Water to enable transfer, or the development of an option by South East Water, transferred via Southern Water.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			The Kent portion of the WRSE Region has a high level of deficit and so surplus is not available in this part of the WRSE Region. The feasible solutions in the Kent portion of the WRSE Region are relatively expensive (compared to alternatives which London can be supplied by), and so the combined cost of new options and this interconnector would not form part of a least cost or best value plan.
Import: Honor Oak to Near Rochester WTW - bi-directional (40Ml/d) Reverse	*40*	*40*	*This option is an interconnector only, and so would not generate “resource” on its own.* *This option would require an export to be made from Southern Water to our London WRZ. As such, this interconnector would need to be combined with either available surplus from Southern Water or the development of an option by Southern Water to enable transfer, or the development of an option by South East Water, transferred via Southern Water.* *The Kent portion of the WRSE Region has a high level of deficit and so surplus is not available in this part of the WRSE Region. The feasible solutions in the Kent portion of the WRSE Region are relatively expensive (compared to alternatives which London can be supplied by), and so the combined cost of new options and this interconnector would not form part of a least cost or best value plan.*
Woodmansterne WTW to Epsom Downs	*10*	*10*	*This option is an interconnector only, and so would not generate “resource” on its own.* *This option would require an export to be made from Sutton and East Surrey (SES) Water to our London WRZ. As such, this interconnector would need to be combined with either available surplus from SES water or the development of an option by SES to enable transfer.* *It may be that SES Water do not have surplus available to transfer to Thames Water at salient points in the planning horizon, and it is unlikely that the development of an option and interconnector by SES to enable transfer to London would be, in aggregate, part of a best value solution.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			In some sensitivity runs we have seen this option be selected for use in the early 2030s, indicating that SES has surplus during this period and that London has a need. Our interpretation of the IVM results is that the need in London in c.2033 is large, and that either many small options and transfers are required to just achieve a supply-demand balance, or the Teddington DRA is required for 2033 (with alternative large options being more expensive). The sensitivity runs documented in rdWRMP24 Table 10-22 indicate that the WRSE model's least cost solution when excluding the Teddington DRA results in a more expensive plan than the least cost plan including Teddington DRA. As such, the combination of options required to solve the deficit in London in 2033 may be more expensive than the DRA when considered together. An alternative interpretation is that the Teddington DRA, being the lowest AIC SRO option, would form part of any least cost plan in which there is a large need for water (larger than can be fulfilled by smaller options) in the London WRZ; in this case, given that the option would be selected in the long run anyway (the need in the WRSE region is so large that multiple SROs are needed in the long run), it may make sense to construct the Teddington DRA for use in the shorter term and then continue using it and then build further SROs later, rather than building many smaller options/transfers initially and then later building the Teddington DRA and other SROs.
Smarter Home Visit (Optants) High+	*0.1062*	*0.1062*	*Mutually exclusive option "Smart Home Visit (Optants) High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The number of smarter home visits which may be undertaken is dependent on the number of meter installs which are undertaken. Given that this option is associated with optant meter installs, which we are not in control of, we have estimated the number of*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			optant meter installs we may expect, and have allocated SHV programme volume, benefit and cost based on the number of optant installs expected.
Smarter Home Visit (Optants) Low	*0.1062*	*0.1062*	*Mutually exclusive option "Smart Home Visit (Optants) High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The number of smarter home visits which may be undertaken is dependent on the number of meter installs which are undertaken. Given that this option is associated with optant meter installs, which we are not in control of, we have estimated the number of optant meter installs we may expect, and have allocated SHV programme volume, benefit and cost based on the number of optant installs expected.*
Smarter Home Visit (Optants) Medium	*0.1062*	*0.1062*	*Mutually exclusive option "Smart Home Visit (Optants) High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The number of smarter home visits which may be undertaken is dependent on the number of meter installs which are undertaken. Given that this option is associated with optant meter installs, which we are not in control of, we have estimated the number of optant meter installs we may expect, and have allocated SHV programme volume, benefit and cost based on the number of optant installs expected.*
Merton Shaft to Hampton 36" FMZ"	*n/a (see Capacity Ml/d for size)*	*60*	*This option does not generate a WAFU benefit. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Smarter Home Visit (PMP) High+	*1.9859*	*1.9859*	*Mutually exclusive option "Smart Home Visit (PMP) High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The number of smarter home visits which may be undertaken is dependent on the number of meter installs which are undertaken. Given that this option is associated with PMP installs, and that there is a set number of installs which we wish to complete (in order to ensure full meter penetration as quickly as feasible), we have determined the number of PMP installs we may expect, and have allocated the SHV programme volume, benefit and cost based on the number of PMP installs expected. As such, the cost and benefit of the four SHV PMP options (Low, Medium, High and High+) are the same*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
Smarter Home Visit (PMP) Low	*1.9859*	*1.9859*	*Mutually exclusive option "Smart Home Visit (PMP) High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The number of smarter home visits which may be undertaken is dependent on the number of meter installs which are undertaken. Given that this option is associated with PMP installs, and that there is a set number of installs which we wish to complete (in order to ensure full meter penetration as quickly as feasible), we have determined the number of PMP installs we may expect, and have allocated the SHV programme volume, benefit and cost based on the number of PMP installs expected. As such, the cost and benefit of the four SHV PMP options (Low, Medium, High and High+) are the same*
Smarter Home Visit (PMP) Medium	*1.9859*	*1.9859*	*Mutually exclusive option "Smart Home Visit (PMP) High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The number of smarter home visits which may be undertaken is dependent on the number of meter installs which are undertaken. Given that this option is associated with PMP installs, and that there is a set number of installs which we wish to complete (in order to ensure full meter penetration as quickly as feasible), we have determined the number of PMP installs we may expect, and have allocated the SHV programme volume, benefit and cost based on the number of PMP installs expected. As such, the cost and benefit of the four SHV PMP options (Low, Medium, High and High+) are the same*
Teddington to QM Reservoir	*n/a (see Capacity Ml/d for size)*	*300*	*This option does not generate a WAFU benefit. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			This option is a "raw water system reinforcement" option. As is described in paragraphs 7.140-7.148, a study was undertaken in which raw water system elements were identified according to the additional raw water resource utilised in West London and East London. The aim of this study was to identify additional system reinforcements which should be constructed if different amounts of new resource are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional reinforcements would be required, and if Beckton and SESRO are both selected different reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Woodford PS to Chigwell SR	*n/a (see Capacity Ml/d for size)*	*50*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Smarter Home Visit (PSUP) High+	*8.4937*	*8.4937*	*Mutually exclusive option "Smart Home Visit (PSUP) High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The number of smarter home visits which may be undertaken is dependent on the number of smart meter installs which are undertaken. Given that this option is associated with PSUP installs, and that there is a set number of installs which we wish to complete (in order to ensure a high level of smart meter penetration), we have determined the number of PSUP installs we can deliver, and have allocated the SHV programme volume, benefit and cost based on the number of PSUP installs expected. As such, the cost and benefit of the four SHV PMP options (Low, Medium, High and High+) are the same.*
Smarter Home Visit (PSUP) Low	*8.4937*	*8.4937*	*Mutually exclusive option "Smart Home Visit (PSUP) High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The number of smarter home visits which may be undertaken is dependent on the number of smart meter installs which are undertaken. Given that this option is associated with PSUP installs, and that there is a set number of installs which we wish to complete (in order to ensure a high level of smart meter penetration), we have determined the number of PSUP installs we can deliver, and have allocated the SHV programme volume, benefit*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			and cost based on the number of PSUP installs expected. As such, the cost and benefit of the four SHV PMP options (Low, Medium, High and High+) are the same.
Smarter Home Visit (PSUP) Medium	*8.4937*	*8.4937*	*Mutually exclusive option "Smart Home Visit (PSUP) High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *The number of smarter home visits which may be undertaken is dependent on the number of smart meter installs which are undertaken. Given that this option is associated with PSUP installs, and that there is a set number of installs which we wish to complete (in order to ensure a high level of smart meter penetration), we have determined the number of PSUP installs we can deliver, and have allocated the SHV programme volume, benefit and cost based on the number of PSUP installs expected. As such, the cost and benefit of the four SHV PMP options (Low, Medium, High and High+) are the same.*
STT-SESRO Link P2	*10.8*	*10.8*	*This option represents the additional Deployable Output benefit that would result from the conjunctive use of both the SESRO and STT SRO options. It is dependent on the construction of both SESRO and the STT.* *Since only one or other of SESRO and the STT is identified as being needed in the preferred programme, this option is not selected.*
TWRM Battersea Shaft to Nunhead Lower SR	*n/a (see Capacity Ml/d for size)*	*60*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
TWRM Streatham shaft to Norwood	*n/a (see Capacity Ml/d for size)*	*20*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Coppermills WTW to Finsbury Park FMZ	*n/a (see Capacity Ml/d for size)*	*65*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.*
New WTW at Kempton - 300Ml/d	*n/a (see Capacity Ml/d for size)*	*300*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *New WTW options are represented as options upon which other options are dependent. E.g., for SESRO to be utilised in West London, expanded treatment capacity is required.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			The WTW options selected are therefore dependent on the need and selection of resource options.
New WTW at Kempton - 150Ml/d	*n/a (see Capacity Ml/d for size)*	*150*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *New WTW options are represented as options upon which other options are dependent. E.g., for SESRO to be utilised in West London, expanded treatment capacity is required. The WTW options selected are therefore dependent on the need and selection of resource options.*
STT-SESRO Link C2	*6.5*	*6.5*	*This option represents the additional Deployable Output benefit that would result from the conjunctive use of both the SESRO and STT SRO options. It is dependent on the construction of both SESRO and the STT.* *Since only one or other of SESRO and the STT is needed, this option is not selected.*
Kempton WTW to Merton Shaft	*n/a (see Capacity Ml/d for size)*	*150*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *This option is a "network reinforcement" option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different*

Option	WAFU Benefit (Ml/d)	Capacity (Ml/d)	Reason(s) Option Not Selected
			additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
Advanced DMA High+	35.1961	35.1961	Mutually exclusive option “Advanced DMA High” selected. Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken. Delivery of the 50% leakage reduction target requires a significant volume of leakage reduction to be undertaken. Interventions included within the “Advanced DMA Intervention” category (E.g., Find and Fix, and calm systems management) are cost effective leakage reduction measures and so form the basis for any leakage reduction programme which aims to achieve 50% reduction. As such, the Advanced DMA Intervention within each demand management portfolio involves the same cost and benefit, as this option forms a cost-effective base on which other leakage reduction options should build. As such, the four Advanced DMA Intervention options (Low, Medium, High, High+) include the same costs and benefits.
Advanced DMA Low	35.1961	35.1961	Mutually exclusive option “Advanced DMA High” selected. Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken. Delivery of the 50% leakage reduction target requires a significant volume of leakage reduction to be undertaken. Interventions included within the “Advanced DMA

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			Intervention" category (E.g., Find and Fix, and calm systems management) are cost effective leakage reduction measures and so form the basis for any leakage reduction programme which aims to achieve 50% reduction. As such, the Advanced DMA Intervention within each demand management portfolio involves the same cost and benefit, as this option forms a cost-effective base on which other leakage reduction options should build. As such, the four Advanced DMA Intervention options (Low, Medium, High, High+) include the same costs and benefits.
Advanced DMA Medium	*35.1961*	*35.1961*	*Mutually exclusive option "Advanced DMA High" selected.* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *Delivery of the 50% leakage reduction target requires a significant volume of leakage reduction to be undertaken. Interventions included within the "Advanced DMA Intervention" category (E.g., Find and Fix, and calm systems management) are cost effective leakage reduction measures and so form the basis for any leakage reduction programme which aims to achieve 50% reduction. As such, the Advanced DMA Intervention within each demand management portfolio involves the same cost and benefit, as this option forms a cost-effective base on which other leakage reduction options should build. As such, the four Advanced DMA Intervention options (Low, Medium, High, High+) include the same costs and benefits.*
River Thames to Fobney Transfer	*40*	*40*	*This option is an interconnector and so does not generate a WAFU benefit on its own. Another option would be necessary alongside this interconnector to deliver an overall resource benefit. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			On the assumption that the 110 l/h/d PCC and 50% leakage reduction targets are achieved, the Kennet Valley WRZ only requires a relatively small volume of new supply sources. The deficit in Kennet Valley could be solved either through the T2ST (10 Ml/d) spur, or through the River Thames to Fobney Transfer, both alongside the development of groundwater options (use of the existing licence at Mortimer). We observe from IVM outputs that when the need in Kennet Valley is large, the River Thames to Fobney Transfer is selected (with resource provided by either SESRO or STT), while if the need is smaller, the T2ST spur is preferred. This makes sense as the T2ST spur option is low cost (being lower capacity).
T2ST (80 Ml/d T2ST) Spur to Kennet Valley - Speen	*10*	*10*	*This option is mutually exclusive with the selected T2AT (120 Ml/d T2ST) Spur to Kennet Valley, which has a very similar AIC. Given the significant resource requirement in Southern Water's Western Area, the 120 Ml/d T2ST spur is required, and so the spur off the 120 Ml/d spur is selected.*
New East London WTW - 300Ml/d	*n/a (see Capacity Ml/d for size)*	*300*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *New WTW options are represented as options upon which other options are dependent. E.g., for SESRO to be utilised in West London, expanded treatment capacity is required. The WTW options selected are therefore dependent on the need and selection of resource options.*
Henley to SWA Transfer – 5 Ml/d	*5*	*5*	*This is an interconnector option which does not generate WAFU on its own. To transfer water from Henley to SWA either requires surplus in the Henley WRZ, or the development of a new option.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			The 5 Ml/d Henley to SWOX transfer is selected. This transfer utilises available surplus in the Henley WRZ to provide water to a zone which has significant need for new water (SWOX). Further surplus in the Henley WRZ does not exist, and there are no feasible resource options in Henley which could be developed to facilitate further transfers out of the zone. As such, the need for selection of the Henley to SWOX transfer means that the Henley to SWA transfer is not selected and the Medmenham WTW option is selected to provide water for SWA instead.
T2ST (50 Ml/d T2ST) Spur to Kennet Valley - Speen	*10*	*10*	*This option is mutually exclusive with the selected T2AT (120 Ml/d T2ST) Spur to Kennet Valley, which has a very similar AIC. Given the significant resource requirement in Southern Water's Western Area, the 120 Ml/d T2ST spur is required, and so the spur off the 120 Ml/d spur is selected.*
New WTW at Kempton - 100Ml/d additional phase	*n/a (see Capacity Ml/d for size)*	*100*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *New WTW options are represented as options upon which other options are dependent. E.g., for SESRO to be utilised in West London, expanded treatment capacity is required. The WTW options selected are therefore dependent on the need and selection of resource options.*
Brookfield Lane (Cheshunt) PS to Hoddeson SR	*n/a (see Capacity Ml/d for size)*	*10*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			This option is a “network reinforcement” option. As is described in paragraphs 7.134-7.139 and Table 7-10, a study was undertaken in which network reinforcement elements were identified according to the additional treatment options selected in West London and East London. The aim of this study was to identify additional network reinforcements which should be constructed if different amounts of new treatment are utilised in different parts of London (e.g., if Beckton recycling were selected rather than SESRO, different additional network reinforcements would be required, and if Beckton and SESRO are both selected different network reinforcements would be required again). Options identified through this study were included as options on which resource options are made dependent. As such, they are only selected when the corresponding resource elements are selected as they do not bring benefit on their own. This option not having been selected is reflective of resource options which are dependent on this system option is dependent not having been selected.
New East London WTW - 200Ml/d	*n/a (see Capacity Ml/d for size)*	*200*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *New WTW options are represented as options upon which other options are dependent. E.g., for SESRO to be utilised in West London, expanded treatment capacity is required. The WTW options selected are therefore dependent on the need and selection of resource options.*
Transfer from WTW in Abingdon to SWA - 72Ml/d	*72*	*72*	*This option is an interconnector which would connect SESRO to the SWA WRZ. In order to provide benefit, it would need to be selected alongside a phase (or phases) of WTW at the SESRO site. As such, the low AIC of this option is not comparable with the AIC of the*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			selected option to transport water from SESRO to Medmenham using the River Thames and then abstract and treat it at Medmenham (in SWA). *An alternative option is selected to fulfil SWA WRZ's requirement for new water, which is the 24 Ml/d new Medmenham intake. The Medmenham option is also an interconnector (and associated WTW) which would utilise resource provided by SESRO. The Medmenham option is lower cost (despite having a higher AIC) as it is smaller and makes use of the River Thames when transferring water (as opposed to pipeline transfer for this option, alongside the necessary but separate option of treatment at SESRO). The need in the SWA WRZ is not so great as to require 72 Ml/d of water, and the 24 Ml/d Medmenham option is sufficient to fulfil the need.* *From sensitivity testing, we observe that when there is a large deficit in the SWA WRZ this option is preferred to the development of multiple phases of the Medmenham transfer, as it allows for transport of a large volume of water into the SWOX and SWA WRZs.*
New East London WTW - 150Ml/d	*n/a (see Capacity Ml/d for size)*	*150*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *New WTW options are represented as options upon which other options are dependent. E.g., for SESRO to be utilised in West London, expanded treatment capacity is required. The WTW options selected are therefore dependent on the need and selection of resource options.*
Household Innovation and Tariffs High+	*80.2082*	*80.2082*	*Mutually exclusive with selected option "Household Innovation and Tariffs High".* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			The Household Innovation and Tariffs options rely on interventions with as-yet unknown benefits, e.g., introduction of tariffs. The low, medium, high and high+ variants of this option involve varying levels of benefit being delivered within this as-yet undefined scope. Given the high reliance on as-yet unknown sources of demand savings (e.g., government-led demand savings), the High+ variant of this option is not considered an option to be selected within the best value plan, as the selected options ensure achievement of the 110 l/h/d policy objective.
Household Innovation and Tariffs Medium	*61.2581*	*61.2581*	*Mutually exclusive with selected option "Household Innovation and Tariffs High".* *Demand management options have been aggregated into portfolios, and selection at the portfolio level has been undertaken.* *An important objective in our WRMP, as per the WRPG, is that we plan to achieve 110 l/h/d PCC. The "High" demand management portfolio achieves this objective while the "Medium" portfolio does not.*
New Reservoir - SESRO 30+100mm3 - Phase 2: (TW: 55%)	*95.205*	*95.205*	*This option is the second part of a phased SESRO scheme. If selected, it must be preceded by the SESRO 30+100Mm3 Phase 1 scheme, which has an AIC of 293 p/m3. Delivery of both phases of the 2-phase SESRO scheme would be more expensive than delivery of a single phase 150 Mm3 scheme, with less benefit. As such, the phased option is not selected.*
New East London WTW - 100Ml/d	*n/a (see Capacity Ml/d for size)*	*100*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *New WTW options are represented as options upon which other options are dependent. E.g., for SESRO to be utilised in West London, expanded treatment capacity is required.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			The WTW options selected are therefore dependent on the need and selection of resource options.
New East London WTW - 100Ml/d additional phase	*n/a (see Capacity Ml/d for size)*	*100*	*This option does not generate a WAFU benefit on its own. AIC for this option calculated based on capacity and so cost-benefit comparison against options which bring WAFU benefit is not appropriate. The London WRZ has a deficit and so selection of options with a WAFU benefit is required.* *New WTW options are represented as options upon which other options are dependent. E.g., for SESRO to be utilised in West London, expanded treatment capacity is required. The WTW options selected are therefore dependent on the need and selection of resource options.*
New WTW - Abingdon - Phase 1	*n/a (see Capacity Ml/d for size)*	*24*	*This option does not generate WAFU benefit on its own. The option would treat water at the SESRO site and transfer it to SWOX and/or SWA. In order to provide WAFU benefit, it would need to be selected alongside a resource option (either SESRO or STT) and an interconnector (which could transport water to SWOX and/or SWA).* *Given that either SESRO or STT is identified as being required due to the magnitude of the planning problem which is posed, there is an option selection decision to be made as to whether it is preferable to treat water on site and transport it to SWOX and SWA, or to transport raw water to Farmoor (in SWOX, via pipeline) and Medmenham (in SWA, via the River Thames, treatment required).* *The magnitude of the planning problem in the SWOX and SWA WRZs is such that <24 Ml/d is required in each of these WRZs. 24 Ml/d is the minimum size of WTW/transfer to each WRZ which has been considered. As such, the decision is whether to develop two phases of treatment at SESRO and to transport it across SWOX and SWA, or to transport raw water and treat in the WRZ of need.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			The WRSE IVM indicates it is more cost effective to transport raw water (via pipeline and the River Thames) and treat it where it is needed than it is to develop a large amount of treatment and transport treated water. As described in rdWRMP24 Section 11, we will continue to appraise raw and treated water transfers from SESRO for use in SWOX, considering the overall need for potable water as there will be a balance between the impacts of Environmental Destination (closing sources from which potable water is produced) alongside demand reduction.
Henley to SWA Transfer - 2.4 Ml/d	*2.4*	*2.4*	*This is an interconnector option which does not generate WAFU on its own. To transfer water from Henley to SWA either requires surplus in the Henley WRZ, or the development of a new option.* *The 5 Ml/d Henley to SWOX transfer is selected. This transfer utilises available surplus in the Henley WRZ to provide water to a zone which has significant need for new water (SWOX). Further surplus in the Henley WRZ does not exist, and there are no feasible resource options in Henley which could be developed to facilitate further transfers out of the zone. As such, the need for selection of the Henley to SWOX transfer means that the Henley to SWA transfer is not selected and the Medmenham WTW option is selected to provide water for SWA instead.*
Kennet Valley to SWOX Transfer - 6.7 Ml/d	*6.7*	*6.7*	*Both the Kennet Valley and SWOX WRZs require new water resources. Transferring water from one WRZ of need to another would not be part of a least cost or best value plan.*
New WTW Abingdon - Additional Phase 2	*n/a (see Capacity Ml/d for size)*	*24*	*See New WTW – Abingdon – Phase 1.* *This option is a second phase of the option New WTW – Abingdon – Phase 1, and so the non-selection of this option follows from the non-selection of that option.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
New WTW Abingdon - Additional Phase 3	*n/a (see Capacity Ml/d for size)*	*24*	*See New WTW – Abingdon – Phase 1.* *This option is a third phase of the option New WTW – Abingdon – Phase 1, and so the non-selection of this option follows from the non-selection of that option.*
STT-SESRO Link P1	*3.6*	*3.6*	*This option represents the additional Deployable Output benefit that would result from the conjunctive use of both the SESRO and STT SRO options. It is dependent on the construction of both SESRO and the STT.* *Since only one or other of SESRO and the STT is identified as being needed in the preferred programme, this option is not selected.*
STT-SESRO Link C1	*3.6*	*3.6*	*This option represents the additional Deployable Output benefit that would result from the conjunctive use of both the SESRO and STT SRO options. It is dependent on the construction of both SESRO and the STT.* *Since only one or other of SESRO and the STT is identified as being needed in the preferred programme, this option is not selected.*
Transfer from WTW in Abingdon to SWA - 48Ml/d	*48*	*48*	*This option is an interconnector which would connect SESRO to the SWA WRZ. In order to provide benefit, it would need to be selected alongside a phase (or phases) of WTW at the SESRO site. As such, the low AIC of this option is not comparable with the AIC of the selected option to transport water from SESRO to Medmenham using the River Thames and then abstract and treat it at Medmenham (in SWA).* *An alternative option is selected to fulfil SWA WRZ's requirement for new water, which is the 24 Ml/d new Medmenham intake. The Medmenham option is also an interconnector (and associated WTW) which would utilise resource provided by SESRO. The Medmenham option is lower cost (despite having a higher AIC) as it is smaller and makes use of the River Thames when transferring water (as opposed to pipeline transfer for this*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			option, alongside the necessary but separate option of treatment at SESRO). The need in the SWA WRZ is not so great as to require 48 Ml/d of water, and the 24 Ml/d Medmenham option is sufficient to fulfil the need.
STT 500: Lake Vyrnwy stage 3 (30Mld - 51-80)	*19.3*	*19.3*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline and preceding Vyrnwy support options, and so cannot be selected before these options. The STT pipeline option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*
STT 400: Lake Vyrnwy stage 3 (30Mld - 51-80)	*19.3*	*19.3*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline and preceding Vyrnwy support options, and so cannot be selected before these options. The STT pipeline option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
STT 300: Lake Vyrnwy stage 3 (30Mld - 51-80)	*19.3*	*19.3*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline and preceding Vyrnwy support options, and so cannot be selected before these options. The STT pipeline option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*
Henley to SWOX Transfer – 2.4 Ml/d	*2.4*	*2.4*	*The magnitude of the deficit in SWOX and magnitude of surplus available in the Henley WRZ means that the larger 5 Ml/d transfer is more cost-effective.*
Teddington Direct River Abstraction (Indirect Water Recycling) 50 MLD - (75 Ml/d connection)	*46*	*46*	*The larger 75 Ml/d Teddington DRA option is selected (mutually exclusive with this option). The larger option is more cost effective (lower AIC).*
STT 500: Lake Vyrnwy stage 5 (30Mld - 111-140)	*19.3*	*19.3*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline and preceding Vyrnwy support options, and so cannot be selected before these options. The STT pipeline option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.
STT 400: Lake Vyrnwy stage 5 (30Mld - 111-140)	*19.3*	*19.3*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline and preceding Vyrnwy support options, and so cannot be selected before these options. The STT pipeline option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*
STT 300: Lake Vyrnwy stage 5 (30Mld - 111-140)	*19.3*	*19.3*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline and preceding Vyrnwy support options, and so cannot be selected before these options. The STT pipeline option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.
STT Canal: Lake Vyrnwy stage 3 (30Mld - 51-80)	*19.3*	*19.3*	*This is an STT support option only. It is dependent on the prior construction of the STT canal variant and preceding Vyrnwy support options, and so cannot be selected before these options. The STT canal option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*
New WTW - Radcot - Additional Phase	*24*	*24*	*See New WTW – Additional Phase. This option must follow the selection of an initial phase of WTW at Radcot.*
New WTW - Radcot	*24*	*24*	*This option would treat water from the STT and use it to provide treated water in SWOX.* *As per other comments in this table, SESRO is preferred over STT and so this option is not selected.* *Further, sensitivity runs using the IVM indicate that the preferred option for use of water from the STT would involve raw water transfer to Farmoor (lower AIC), or treatment at the Abingdon WTW option (lower AIC). As such, this option is not the preferred option for treatment of water from the STT, regardless of its selection.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
STT 500: Lake Vyrnwy stage 1 (25Mld - 0-25)	*12.8*	*12.8*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline, and so cannot be selected before this option. The STT pipeline option has a high AIC.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*
STT 400: Lake Vyrnwy stage 1 (25Mld - 0-25)	*12.8*	*12.8*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline, and so cannot be selected before this option. The STT pipeline option has a high AIC.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*
STT 300: Lake Vyrnwy stage 1 (25Mld - 0-25)	*12.8*	*12.8*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline, and so cannot be selected before this option. The STT pipeline option has a high AIC.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
			Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.
Oxford Canal - Cropredy	*10.3*	*10.3*	*This option is mutually exclusive with the Oxford Canal – Duke's Cut option, which is selected in the preferred plan.* *The selected variant of the Oxford Canal option has a significantly lower AIC than this option variant.*
STT Canal: Lake Vyrnwy stage 5 (30Mld - 111-140)	*19.3*	*19.3*	*This is an STT support option only. It is dependent on the prior construction of the STT canal variant and preceding Vyrnwy support options, and so cannot be selected before these options. The STT canal option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
STT 500: Lake Vyrnwy stage 7 (20Mld - 161-180)	*12.8*	*12.8*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline and preceding Vyrnwy support options, and so cannot be selected before these options. The STT pipeline option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*
STT 400: Lake Vyrnwy stage 7 (20Mld - 161-180)	*12.8*	*12.8*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline and preceding Vyrnwy support options, and so cannot be selected before these options. The STT pipeline option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
STT 300: Lake Vyrnwy stage 7 (20Mld - 161-180)	*12.8*	*12.8*	*This is an STT support option only. It is dependent on the prior construction of the STT pipeline and preceding Vyrnwy support options, and so cannot be selected before these options. The STT pipeline option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*
New Reservoir - SESRO 80+42Mm3 - Phase 2: (TW: 55%)	*37.895*	*37.895*	*This option is the second part of a phased SESRO scheme. If selected, it must be preceded by the SESRO 80+42Mm3 Phase 1 scheme, which has an AIC of 147 p/m3. Delivery of both phases of the 2-phase SESRO scheme would be more expensive than delivery of a single phase 150 Mm3 scheme, with less benefit. As such, the phased option is not selected.*
New Medmenham Surface Water WTW Enhancement (53 Ml/d Intake)	*24*	*24*	*The need for water in the SWA WRZ is not so great as to require this Medmenham WTW enhancement variant, which can only be selected once the Phase 1 variant has been selected. The selected single-phase Medmenham option provides the water which is required in this zone.*
New Medmenham Surface Water WTW Enhancement (80 Ml/d Intake)	*24*	*24*	*The need for water in the SWA WRZ is not so great as to require this Medmenham WTW variant. The selected Medmenham option (which is smaller and so lower cost, despite having a lower AIC) provides the water which is required in this zone.*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
STT Canal: Lake Vyrnwy stage 1 (25Mld - 0-25)	*12.8*	*12.8*	*This is an STT support option only. It is dependent on the prior construction of the STT canal variant, and so cannot be selected before these options. The STT canal option and is an option with a high AIC.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*
STT Canal: Lake Vyrnwy stage 7 (20Mld - 161-180)	*12.8*	*12.8*	*This is an STT support option only. It is dependent on the prior construction of the STT canal variant and preceding Vyrnwy support options, and so cannot be selected before these options. The STT canal option and phase 2 of Vyrnwy support are both options with high AICs.* *Considering issues such as the spatial and temporal need for new water resources across the WRSE region, use and interpretation of WRSE IVM model outputs is preferable to comparison of the costs and benefits of individual components of STT support, as these options would need to be selected alongside other STT option components in order to be comparable with SESRO. Consideration of the cost and best value metrics of programmes which include STT instead of SESRO is detailed in Table 10-21, and further description is given in Sections 10 and 11 of the WRMP.*
NHH New Tariff Structure (High+)	*5.9998*	*5.9998*	*Mutually exclusive with no cost and identical benefit (NHH New Tariff Structure High) selected*

Option	*WAFU Benefit (Ml/d)*	*Capacity (Ml/d)*	*Reason(s) Option Not Selected*
Alternative government led demand reduction programmes	*Various*	*Various*	*Policy decision made to adopt 110 l/h/d target. Gov-led programme assumed in preferred plan allows for 110 l/h/d target to be met.*

Annex E - Further information to be included in WRMP Appendix X in response to Issue 11.5

System complexity example – treatment and interconnectors

E.1. In this example, two WRZs each have a deficit of 50 Ml/d. There are options available for each WRZ which deliver potable resource (i.e., they include all option elements), as well as a raw water resource option which could be used either in WRZ1 or in WRZ2. If the raw option were used in WRZ1 then an interconnector would be required but a new WTW would not (with there being excess capacity at an existing treatment works), while if the raw option were to be used in WRZ2 then a new WTW and interconnector would be needed.

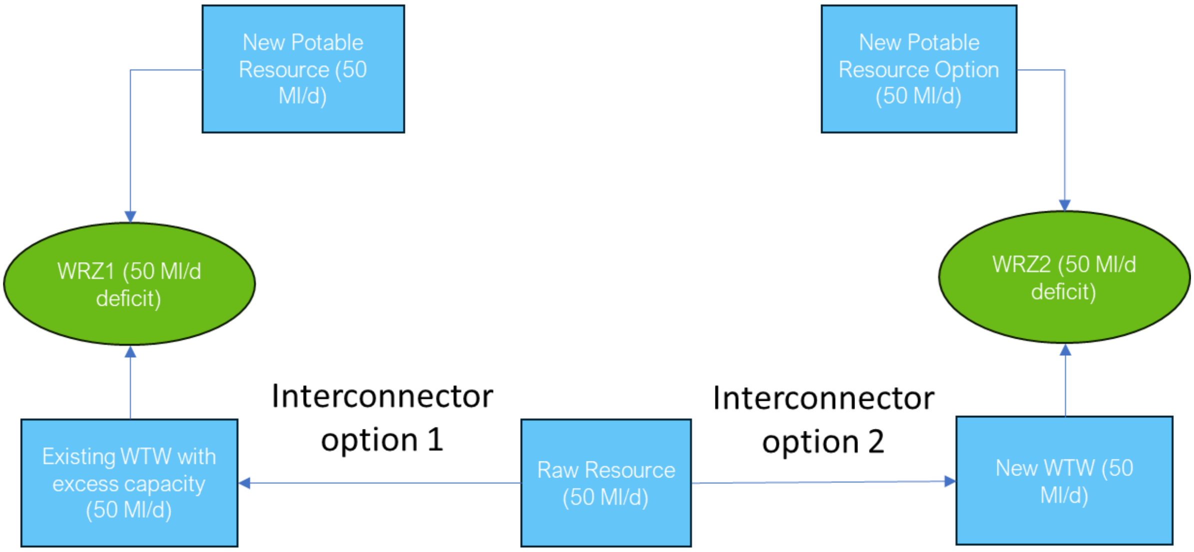
E.2. In this example, it would not be possible to define a single option which incorporates all assets required to utilise the raw water resource, because the raw water resource could be used in different WRZs but could not be used in both zones at the same time. Instead, the IVM would include separate elements to represent the raw resource, each potable resource, each interconnector and each treatment element.

E.3. Given that, according to the costs of the different options and the timing at which different deficits occur, there may be different optimum solutions. In this case, splitting options into resource, interconnector and treatment options is required to ensure the overall optimal solution is identified. For example, if the new potable options were very expensive and high opex requirements, with the potable option in WRZ1 being extremely expensive, and if WRZ2's deficit occurred later in the planning period than the deficit in WRZ1, one (complex) optimum solution could exist whereby the raw resource and interconnector 1 are developed.

E.4. In this example, the investment model would use the following features to ensure the correct solution:

- *Water from the "raw resource" element would be defined as raw, and so the model would require that resource goes through a treatment element, before satisfying demand*
- *Water from the "potable resource" elements would be defined as potable, and so the model would be able to satisfy demand with water from these elements without including treatment*
- *The "raw resource" would be allocated a "resource" value*
- *The "potable resource" options would be allocated a "resource" value*
- *The "interconnector" elements would have a capacity, but would not be allocated a resource value (i.e., constructing interconnector 2 and the WTW would not allow for the demand to be satisfied)*

E.5. The inclusion of these factors in modelling ensure that, where interconnectors are required they are constructed, but that the benefits of interconnectors are not double counted.



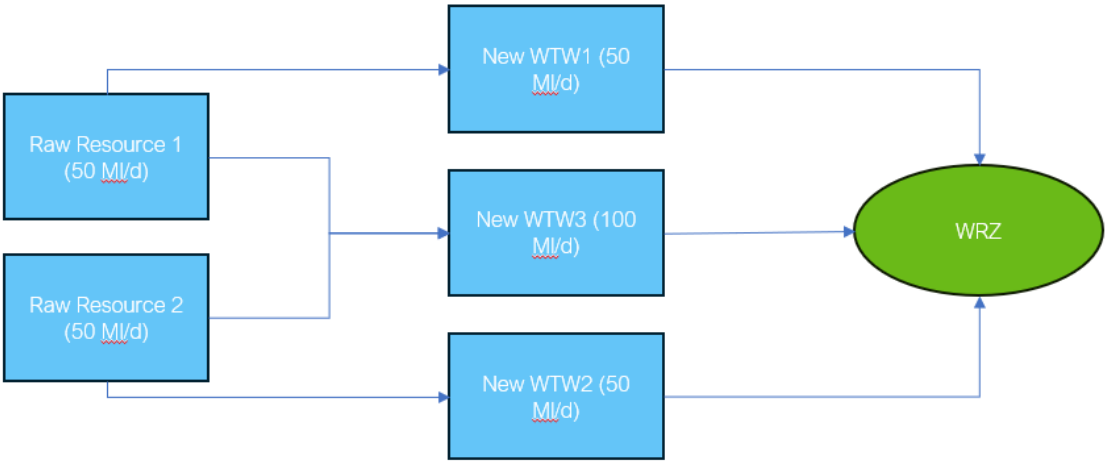
System complexity example – treatment 2

E.6. *In this example, two different raw water resource options could be built with different treatment options.*

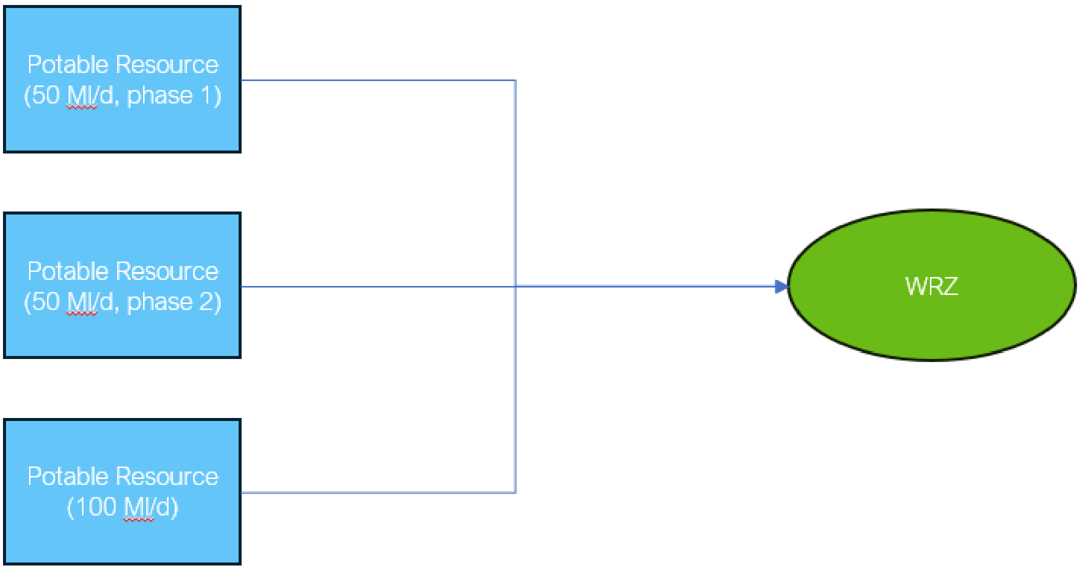
E.7. *In this example, according to the profile of need, it could be that any of the following is the optimum plan:*

- *One raw water option is constructed with a small WTW*
- *One raw water option is constructed with a small WTW, and then a second raw water option is constructed with a second small WTW*
- *Both raw water options are constructed at the same time, with a larger treatment works which can treat the water provided from both resource options*
- *One raw water option could be built first, along with the larger treatment works; the second raw water option could then be built later with no need to build a larger treatment works*

E.8. *By considering the raw water options and WTWs as separate option elements, the IVM would be able to identify the optimum solution for the long term.*



System complexity example – phased options



E.9. *In this example, a single 100 Ml/d phase of a potable resource option may be cheaper to build than two 50 Ml/d phases. However, according to the need in a given scenario (or according to differing needs in different adaptive branches), building resources in phases may be the optimum approach. It may also be that the second phase of the scheme would be cheaper than the first (for example, if land acquisition is required). In this case, a dependency would be included to note that the "phase 2" option could not be built until the "phase 1" option is built.*

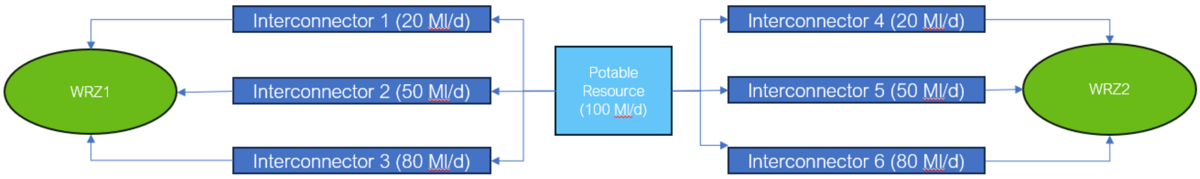
System complexity example – shared resources

E.10. *In this example, a single potable resource option could be used to fulfil needs in one of two resource zones, and different interconnector options may exist to connect the resource to each*

WRZ. According to the scale and timing of need in each WRZ in different adaptive branches, the potable resource could be shared among the two WRZs in different proportions.

E.11. In this case, having separate “resource” and “interconnector” option elements is required, and they cannot be combined.

E.12. In this case, the “potable resource” element would be allocated a resource, but it would be required that an interconnector option connect the resource to either of the WRZs. Each of the interconnector options would be allocated a capacity but would not be allocated a resource.



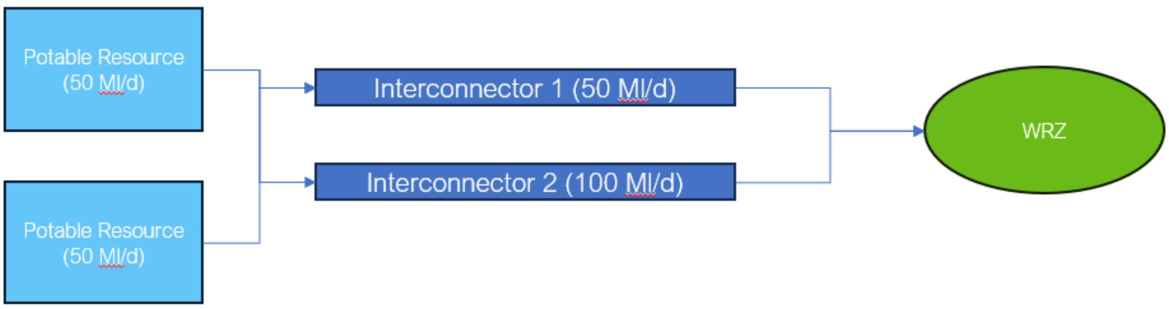
System complexity example – interconnectors 1

E.13. In this example, two different potable resource options (for example a desalination plant and a direct reuse plant, with the same site used for both) could make use of the same interconnector options, and different sized interconnector options could be developed.

E.14. In this case, depending on the timing and scale of need across different adaptive plan scenarios, it could be that one or both resource options are required. According to the overall scale of need, it may be that the larger or smaller interconnector is needed.

E.15. In this case:

- *The potable resource options would be allocated “resource”, but it would be required that an interconnector option connect either resource to the WRZ*
- *The interconnector options would not be allocated “resource”, but would be allocated a “capacity”*



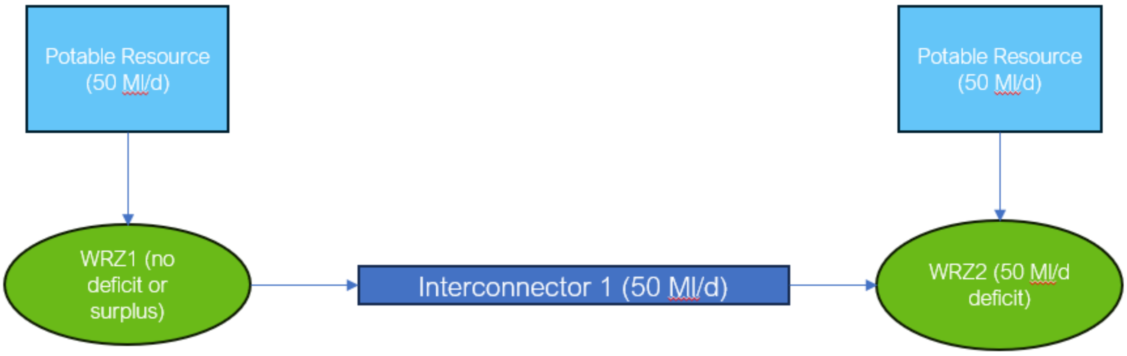
System complexity example – interconnectors 2

E.16. *In this example, there exists a WRZ with no surplus or deficit and another WRZ with a deficit. There is a potable resource option available to each WRZ, and an interconnector option to transfer water from WRZ1 to WRZ2.*

E.17. *If it is the case that the potable resource option available to WRZ2 is very expensive, it may be more efficient to build the potable resource option for WRZ1 and the interconnector, rather than the potable resource option for WRZ2.*

E.18. *In this case:*

- *The potable resource options would be allocated "resource", and the resource options would be connected to the relevant WRZ*
- *The interconnector option would not be allocated "resource", but would be allocated a "capacity"*



System complexity – dependencies

E.19. *As is described in Section 7 of our WRMP, we have considered the wider system reinforcements which would be necessary should treatment expansion be undertaken in a combination of East and West London. These wider system reinforcement options are included as "dependent" options. In this case, the combinations of treatment options in East and West London are made dependent on the construction of different system options.*

Annex F: Calibration of WARMS2

F.1. The following Figures show the hydrological validation summary of the WARMS2 Water Resources Model. The validation exercise was carried out in 2015 and used a period of 2005-2010 to compare WARMS2 modelled flows with observed flows. This period was selected recognising that inclusion of a drought event in the validation period is necessary, but also recognising that the large denaturalising influences in the Thames catchment (which change according to abstractions and discharges) mean relatively recent events should be used.

F.2. The Figures demonstrate that the hydrological models in WARMS2 are well calibrated, with NSE and log-NSE values above 0.9 at the most salient gauging locations, and thus the flows from WARMS2 are suitable as the basis for further modelling.

River Thames at Farmoor - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

Statistics	Calibration (Observed)	Description
NSE	0.93	Nash-Sutcliffe Efficiency
Log NSE	0.96	Log_N Nash-Sutcliffe Efficiency
Correlation	0.97	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.98	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	1.04	Modelled volume / Observed volume
RMSE	322.35	Root mean square error
RMSE Q50-Q95	122.62	Root mean square error for data between Q50 and Q95
Mean Flow	1446 (1385)	Mean flow
Q50	964 (976)	Flow exceeds this value 50% of the time
Q95	257 (251)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	**Label**	**Rainfall and Evaporation**
TA31	A1 U. Thames	Cotswolds West (6010)
TA32	A2 Churn	Cotswolds West (6010)
TA33	A3 Ampney	Cotswolds West (6010)
TA34	A4 Coln	Cotswolds West (6010)
TA2	A5 Leach	Cotswolds West (6010)
TA3	A6 Windrush	Cotswolds West (6010)

Catchment Area

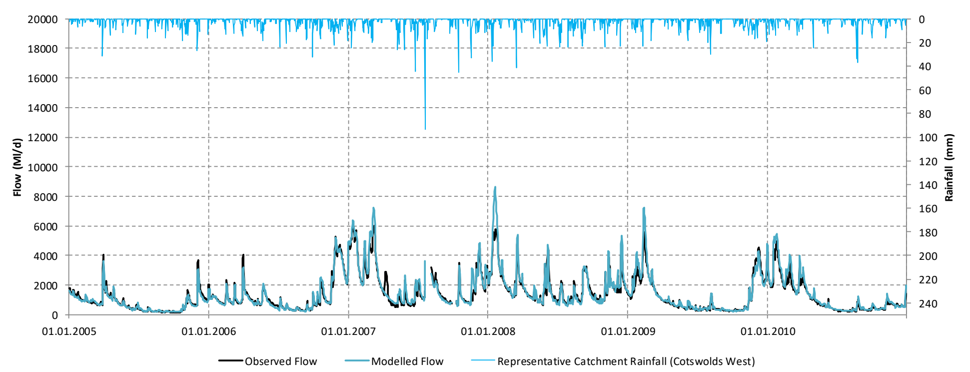
Grid Ref: SP4380006800

Area: 1600 km^2

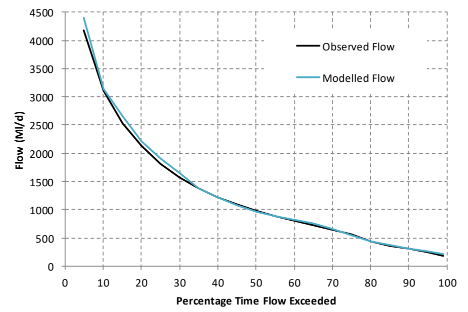
Station Ref No: 39129

Note

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

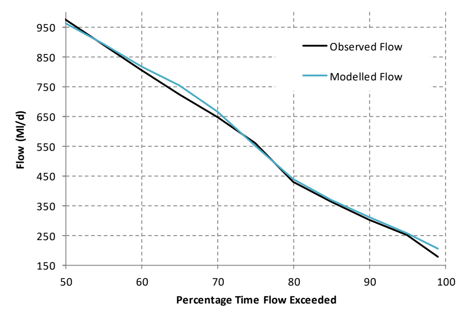


Figure F-1: WARMS2 Validation Summary – Thames at Farmoor

River Thames at Day's Weir - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

Statistics	Calibration (Observed)	Description
NSE	0.99	Nash-Sutcliffe Efficiency
Log NSE	0.99	Log_N Nash-Sutcliffe Efficiency
Correlation	1.00	Pearson's product-moment correlation coefficient (r)
Log Correlation	1.00	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	1.01	Modelled volume / Observed volume
RMSE	258.30	Root mean square error
RMSE Q50-Q95	88.99	Root mean square error for data between Q50 and Q95
Mean Flow	2657 (2641)	Mean flow
Q50	1682 (1624)	Flow exceeds this value 50% of the time
Q95	422 (374)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	**Label**	**Rainfall and Evaporation**
TA31	A1 U. Thames	Cotswolds West (6010)
TA32	A2 Churn	Cotswolds West (6010)
TA33	A3 Ampney	Cotswolds West (6010)
TA34	A4 Coln	Cotswolds West (6010)
TA2	A5 Leach	Cotswolds West (6010)
TA3	A6 Windrush	Cotswolds West (6010)
TA4	B1 Evenlode	Cotswolds East (6020)
TA6	G3 Ock	Berkshire Downs (6070)
TA7	G4 Ginge	Berkshire Downs (6070)

Catchment Area

Grid Ref: SU5690093600

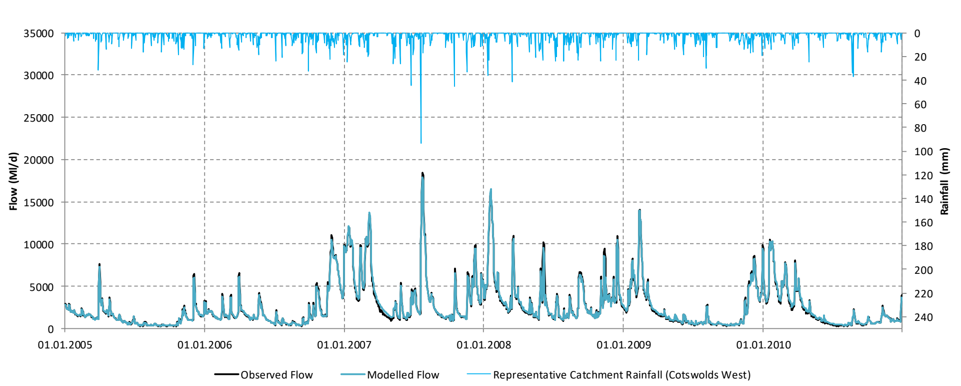
Area: 3445 km^2

Station Ref No: 39002

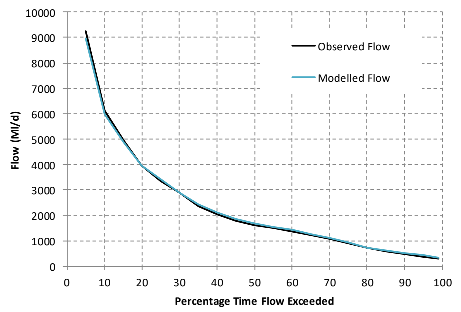
Note

The rainfall-runoff models listed above all contribute to the total flow at Day's Weir. Cotswolds West rainfall has been selected as most representative of the catchment and is used in the graph below.

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

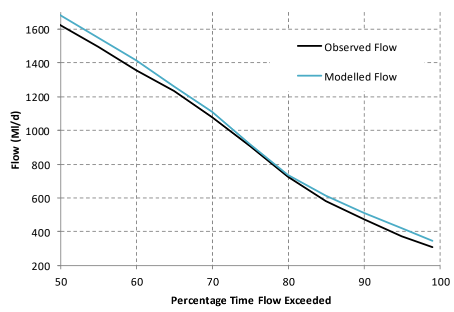


Figure F-2: WARMS2 Validation Summary – Thames at Days Weir

River Thames at Reading - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

Statistics	Calibration (Observed)	Description
NSE	0.98	Nash-Sutcliffe Efficiency
Log NSE	0.99	Log_N Nash-Sutcliffe Efficiency
Correlation	0.99	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.99	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	1.01	Modelled volume / Observed volume
RMSE	465.61	Root mean square error
RMSE Q50-Q95	135.43	Root mean square error for data between Q50 and Q95
Mean Flow	3215 (3197)	Mean flow
Q50	2052 (2039)	Flow exceeds this value 50% of the time
Q95	516 (482)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	**Label**	**Rainfall and Evaporation**
TA31	A1 U. Thames	Cotswolds West (6010)
TA32	A2 Churn	Cotswolds West (6010)
TA33	A3 Ampney	Cotswolds West (6010)
TA34	A4 Coln	Cotswolds West (6010)
TA2	A5 Leach	Cotswolds West (6010)
TA3	A6 Windrush	Cotswolds West (6010)
TA4	B1 Evenlode	Cotswolds East (6020)
TA6	G3 Ock	Berkshire Downs (6070)
TA7	G4 Ginge	Berkshire Downs (6070)
TA5	N3 Thame	Chilterns East - Colne (6140)
TA8	G8 Mill	Berkshire Downs (6070)
TA30	G7 Pang	Berkshire Downs (6070)

Catchment Area

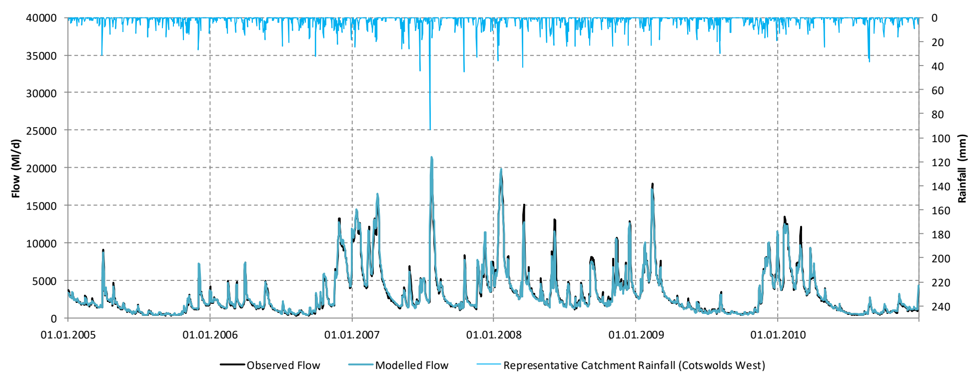
Grid Ref: SU7180074100 Area: 4640 km^2

Station Ref No: 39130

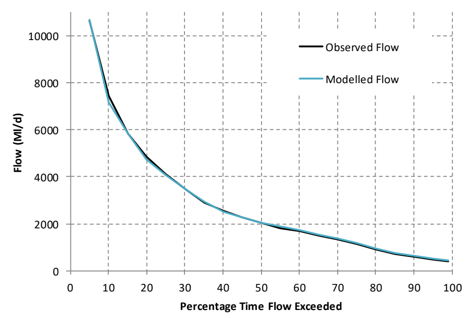
Note

The rainfall-runoff models listed above all contribute to the total flow at Reading. Cotswolds West rainfall has been selected as most representative of the catchment and is used in the graph below.

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

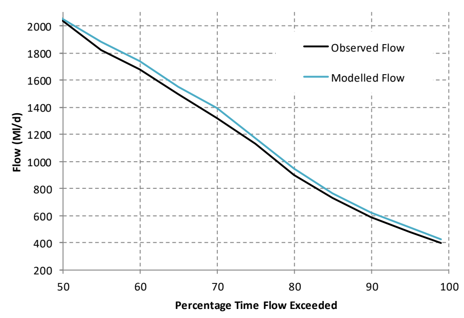


Figure F-3: WARMS2 Validation Summary – Thames at Reading

River Thames at Windsor - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

Statistics	Calibration (Observed)	Description
NSE	0.98	Nash-Sutcliffe Efficiency
Log NSE	0.98	Log_N Nash-Sutcliffe Efficiency
Correlation	0.99	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.99	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	1.01	Modelled volume / Observed volume
RMSE	622.72	Root mean square error
RMSE Q50-Q95	241.70	Root mean square error for data between Q50 and Q95
Mean Flow	5184 (5113)	Mean flow
Q50	3542 (3586)	Flow exceeds this value 50% of the time
Q95	1196 (1210)	Flow exceeds this value 95% of the time

Catchment Area

Grid Ref: SU9800077200 — Area: 7100 km^2

Station Ref No: 39072

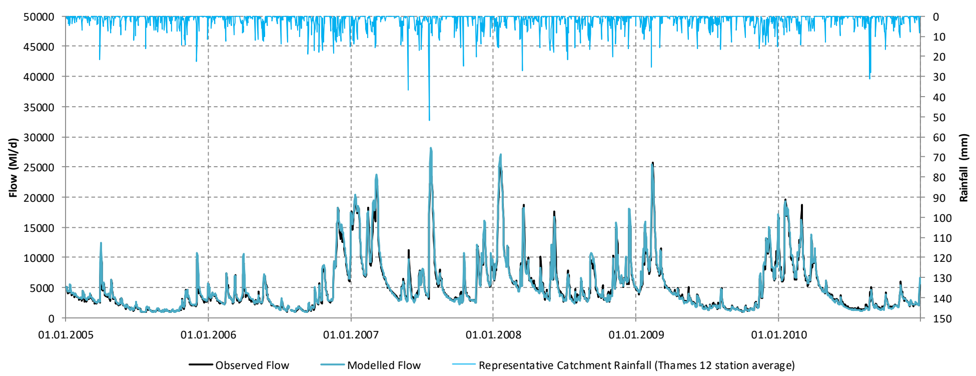
Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	**Label**	**Rainfall and Evaporation**
TA31	A1 U. Thames	Cotswolds West (6010)
TA32	A2 Churn	Cotswolds West (6010)
TA33	A3 Ampney	Cotswolds West (6010)
TA34	A4 Coln	Cotswolds West (6010)
TA2	A5 Leach	Cotswolds West (6010)
TA3	A6 Windrush	Cotswolds West (6010)
TA4	B1 Evenlode	Cotswolds East (6020)
TA6	G3 Ock	Berkshire Downs (6070)
TA7	G4 Ginge	Berkshire Downs (6070)
TA5	N3 Thame	Chilterns East - Colne (6140)
TA8	G8 Mill	Berkshire Downs (6070)
TA30	G7 Pang	Berkshire Downs (6070)
TA1	G1 U. Kennet	Berkshire Downs (6070)
TA12	G5 Knighton	Berkshire Downs (6070)
TA23	G2 Lambourn	Berkshire Downs (6070)
TA29	G6 Enborne	Berkshire Downs (6070)
TA14	P1 Upper Loddon	North Downs - Hampshire (6162)
TA15	P2 Blackwater	North Downs - Hampshire (6162)
TA13	M1 Thames direct (Nth - Henley)	Chilterns West (6130)
TA10	M3 Thames direct (Sth - Henley)	Chilterns West (6130)
TA9	M2 Wye	Chilterns West (6130)

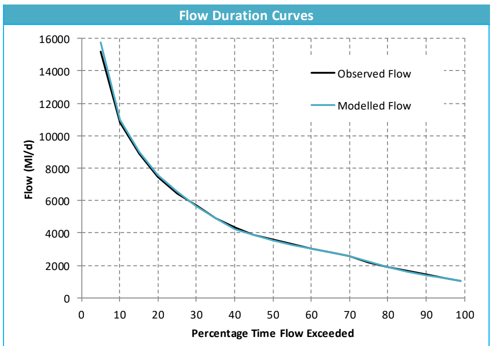
Note

The rainfall-runoff models listed above all contribute to the total flow at Windsor. The rainfall shown on the graph below is the average of 12 stations located across the Thames region.

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

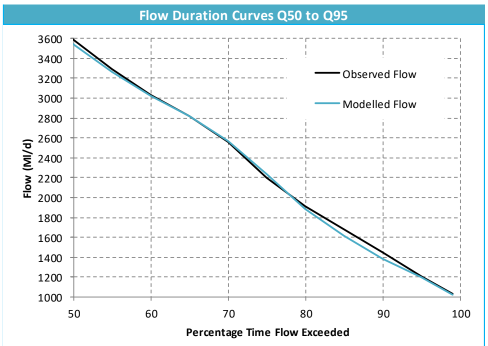


Figure F-4: WARMS2 Validation Summary – Thames at Windsor

River Colne at Denham - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

Statistics	Calibration (Observed)	Description
NSE	0.69	Nash-Sutcliffe Efficiency
Log NSE	0.81	Log_N Nash-Sutcliffe Efficiency
Correlation	0.85	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.91	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	1.01	Modelled volume / Observed volume
RMSE	90.40	Root mean square error
RMSE Q50-Q95	44.49	Root mean square error for data between Q50 and Q95
Mean Flow	345 (341)	Mean flow
Q50	300 (316)	Flow exceeds this value 50% of the time
Q95	142 (145)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	**Label**	**Rainfall and Evaporation**
TA26	N2 Colne	Chilterns East - Colne (6140)

Catchment Area

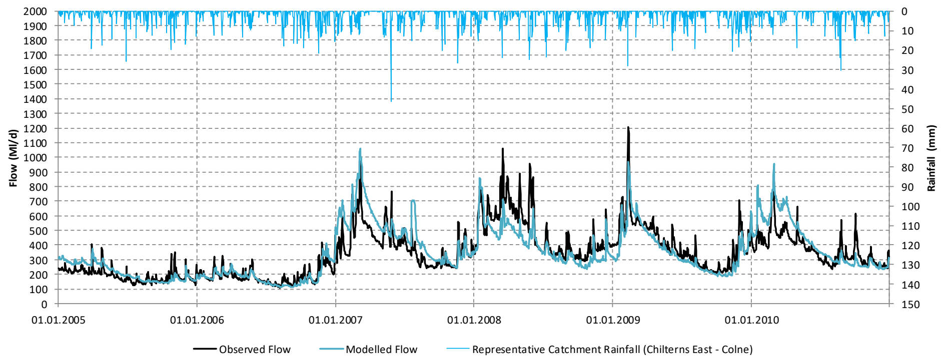
Grid Ref: TQ0520086300

Area: 743 km^2

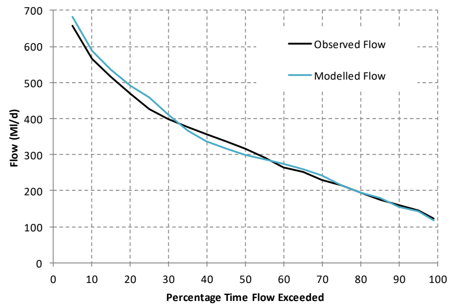
Station Ref No: 39010

Note

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

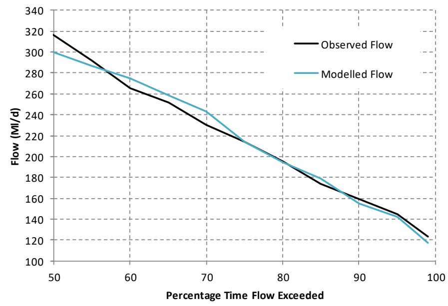


Figure F-5: WARMS2 Validation Summary – Colne at Denham

River Misbourne at Denham Lodge - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

Statistics	Calibration (Observed)	Description
NSE	-1.81	Nash-Sutcliffe Efficiency
Log NSE	0.26	Log_N Nash-Sutcliffe Efficiency
Correlation	0.68	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.83	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	1.46	Modelled volume / Observed volume
RMSE	13.95	Root mean square error
RMSE Q50-Q95	8.36	Root mean square error for data between Q50 and Q95
Mean Flow	25 (17)	Mean flow
Q50	21 (16)	Flow exceeds this value 50% of the time
Q95	4 (4)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	Label	Rainfall and Evaporation
TA11	N1 Misbourne & Alderbourne	Chilterns East - Colne (6140)

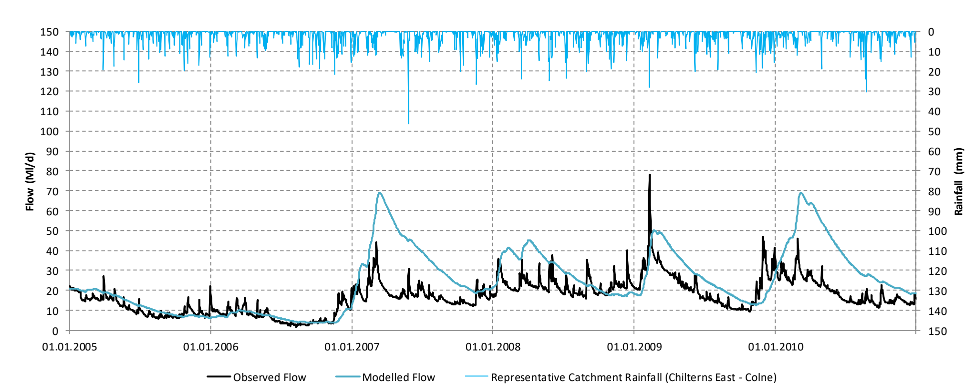
Catchment Area

Grid Ref: TQ0470086400 | Area: 95 km²

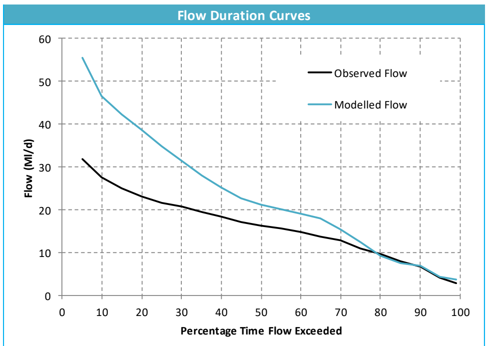
Station Ref No: 39102

Note

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

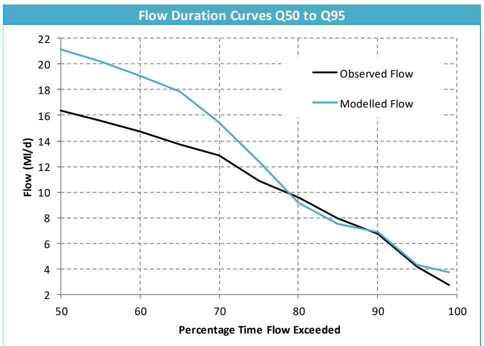


Figure F-6: WARMS2 Validation Summary – Misbourne at Denham Lodge

River Wey at Tilford - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

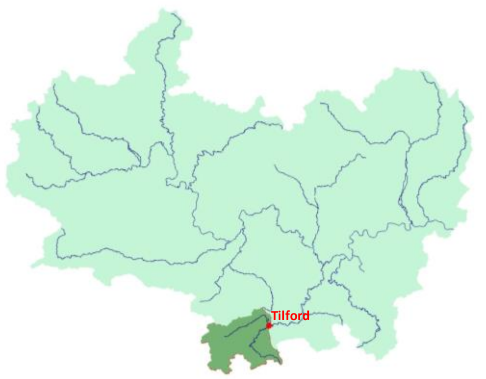
Statistics	Calibration (Observed)	Description
NSE	0.62	Nash-Sutcliffe Efficiency
Log NSE	0.77	Log_N Nash-Sutcliffe Efficiency
Correlation	0.79	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.90	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	1.03	Modelled volume / Observed volume
RMSE	131.06	Root mean square error
RMSE Q50-Q95	32.48	Root mean square error for data between Q50 and Q95
Mean Flow	265 (257)	Mean flow
Q50	202 (194)	Flow exceeds this value 50% of the time
Q95	107 (112)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	Label	Rainfall and Evaporation
TA16	S1 Wey	Wey Greensand (6190)

Catchment Area

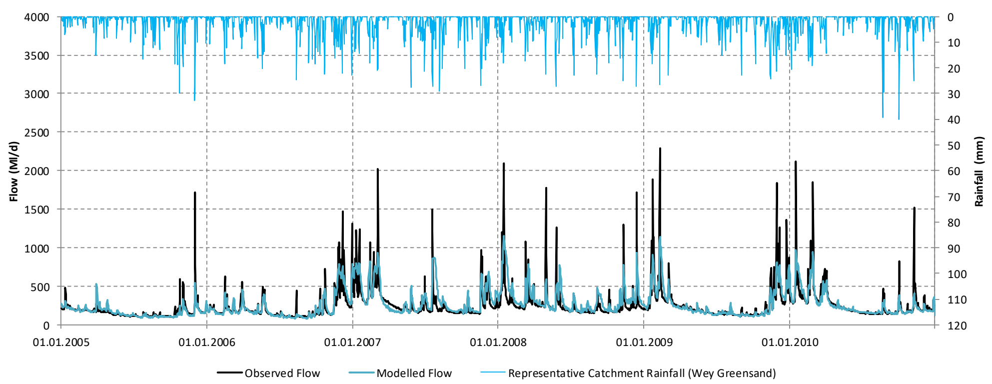
Grid Ref: SU8740043200 Area: 396 km^2



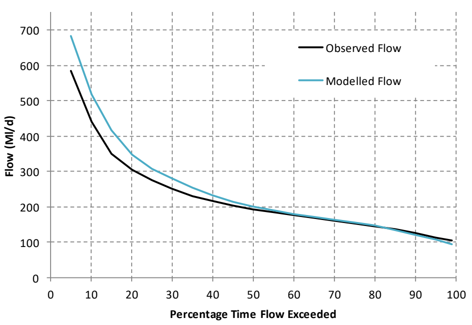
Station Ref No: 39011

Note

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

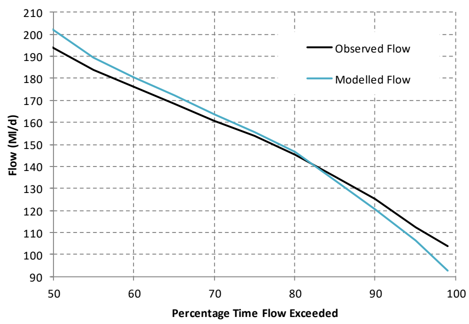


Figure F-7: WARMS2 Validation Summary – Wey at Tilford

River Tillingbourne at Shalford - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

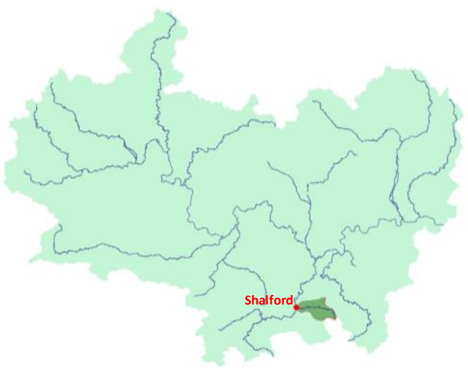
Statistics	Calibration (Observed)	Description
NSE	0.41	Nash-Sutcliffe Efficiency
Log NSE	0.40	Log_N Nash-Sutcliffe Efficiency
Correlation	0.77	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.82	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	1.15	Modelled volume / Observed volume
RMSE	12.82	Root mean square error
RMSE Q50-Q95	8.96	Root mean square error for data between Q50 and Q95
Mean Flow	48 (41)	Mean flow
Q50	46 (37)	Flow exceeds this value 50% of the time
Q95	26 (26)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	**Label**	**Rainfall and Evaporation**
TA17	V1 Tillingbourne	Wey Greensand (6190)

Catchment Area

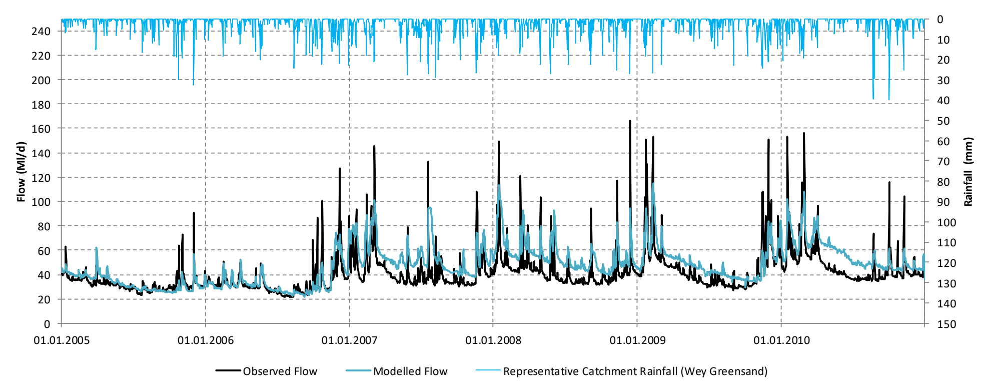
Grid Ref: TQ0000047700 Area: 59 km^2



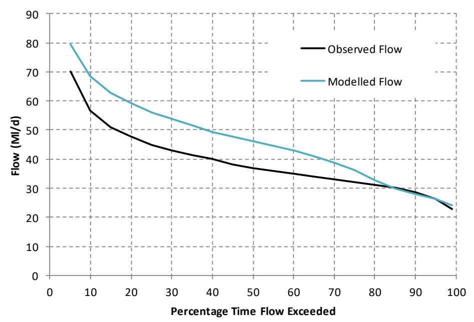
Station Ref No: 39029

Note

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

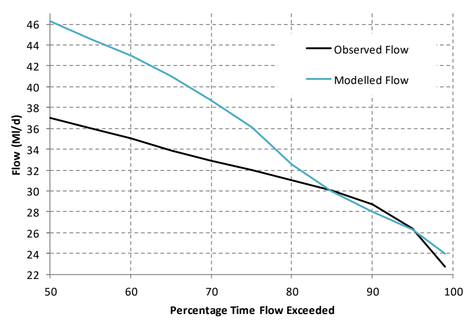


Figure F-8: WARMS2 Validation Summary – Tillingbourne at Shalford

River Wey at Guildford - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

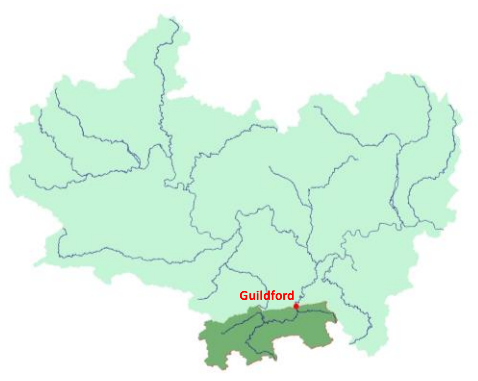
Statistics	Calibration (Observed)	Description
NSE	0.63	Nash-Sutcliffe Efficiency
Log NSE	0.79	Log_N Nash-Sutcliffe Efficiency
Correlation	0.82	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.89	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	0.93	Modelled volume / Observed volume
RMSE	276.56	Root mean square error
RMSE Q50-Q95	65.87	Root mean square error for data between Q50 and Q95
Mean Flow	474 (510)	Mean flow
Q50	371 (362)	Flow exceeds this value 50% of the time
Q95	198 (200)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	Label	Rainfall and Evaporation
TA16	S1 Wey	Wey Greensand (6190)
TA18	S2 Wey Inflow	Wey Greensand (6190)
TA17	V1 Tillingbourne	Wey Greensand (6190)

Catchment Area

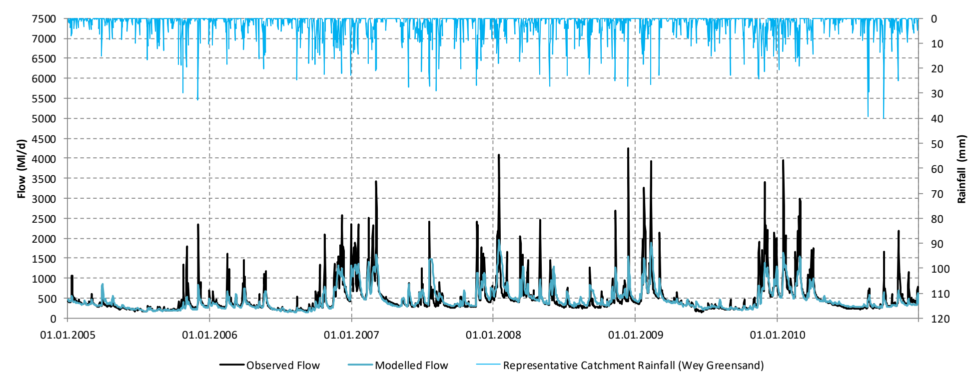
Grid Ref: SU9940049500 Area: 690 km²



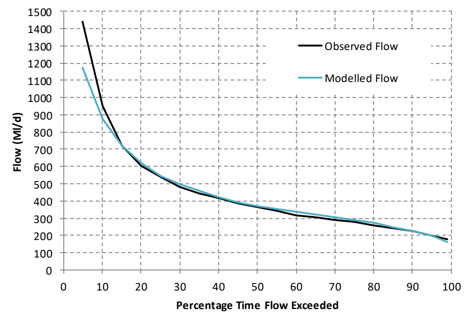
Station Ref No: 39141

Note

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

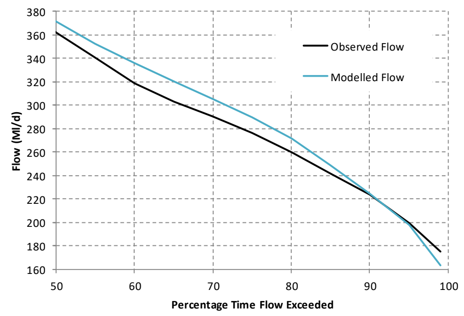


Figure F-9: WARMS2 Validation Summary – Wey at Guildford

River Mole at Esher - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

Statistics	Calibration (Observed)	Description
NSE	0.49	Nash-Sutcliffe Efficiency
Log NSE	0.69	Log_N Nash-Sutcliffe Efficiency
Correlation	0.71	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.84	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	0.88	Modelled volume / Observed volume
RMSE	401.29	Root mean square error
RMSE Q50-Q95	119.07	Root mean square error for data between Q50 and Q95
Mean Flow	407 (465)	Mean flow
Q50	257 (284)	Flow exceeds this value 50% of the time
Q95	127 (124)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit Component	Label	Time Series Assigned Rainfall and Evaporation
TA22	Y1 Mole LGS	North Downs - South London (6230)
TA21	T2 Mole Chalk	Wey Greensand (6190)
TW1	Mole u/s T2	North Downs - South London (6230)

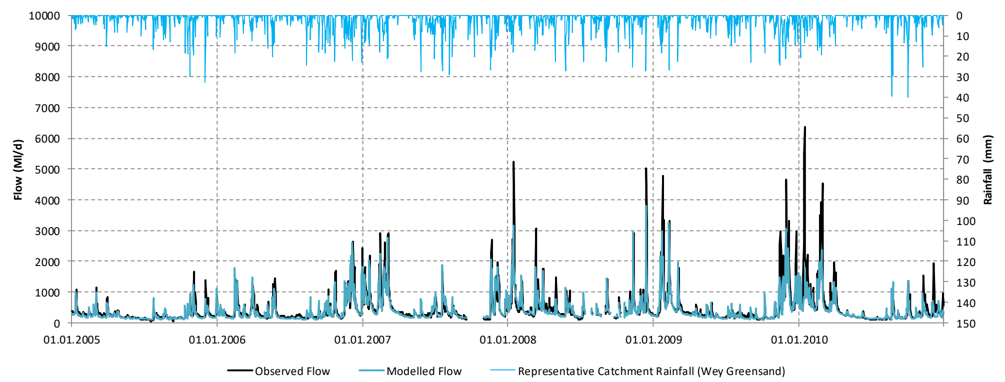
Catchment Area

Grid Ref: TQ1300065300 Area: 465 km²

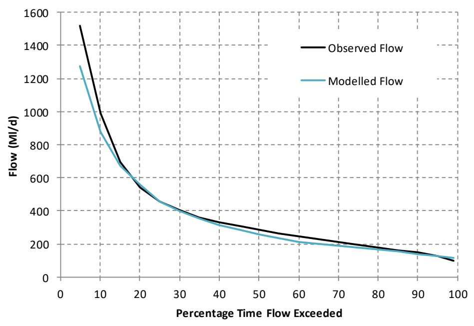
Station Ref No: 39104

Note
The rainfall-runoff models listed above all contribute to the total flow at Esher. The representative rainfall chosen for presentation on the graph below is for the Wey Greensand rainfall area.

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

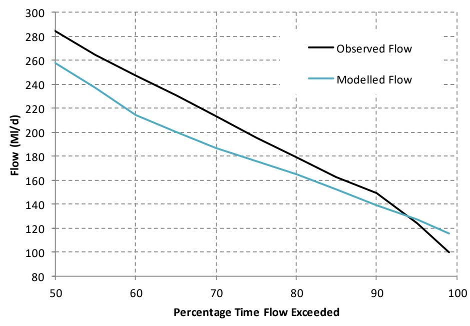


Figure F-10: WARMS2 Validation Summary – Mole at Esher

River Hogsmill at Kingston - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

Statistics	Calibration (Observed)	Description
NSE	0.58	Nash-Sutcliffe Efficiency
Log NSE	0.54	Log_N Nash-Sutcliffe Efficiency
Correlation	0.77	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.76	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	0.97	Modelled volume / Observed volume
RMSE	37.16	Root mean square error
RMSE Q50-Q95	14.79	Root mean square error for data between Q50 and Q95
Mean Flow	103 (106)	Mean flow
Q50	90 (89)	Flow exceeds this value 50% of the time
Q95	65 (65)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	Label	Rainfall and Evaporation
TW2	Hogsmill	North Downs - South London (6230)

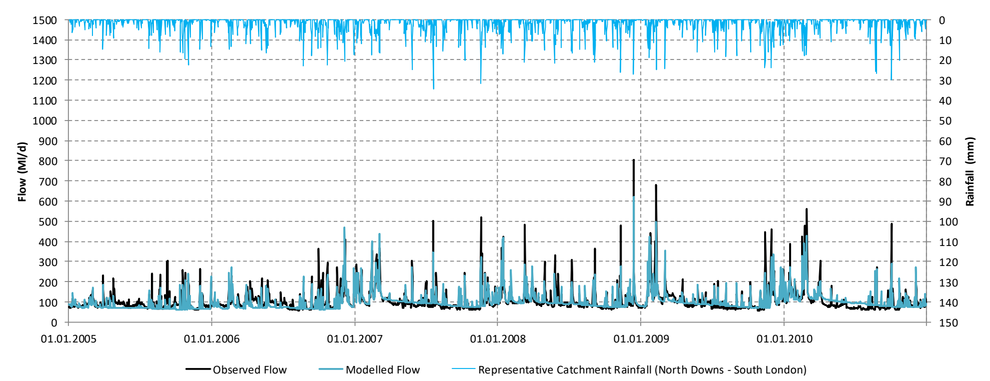
Catchment Area

Grid Ref: TQ1820068700 Area: 69 km^2

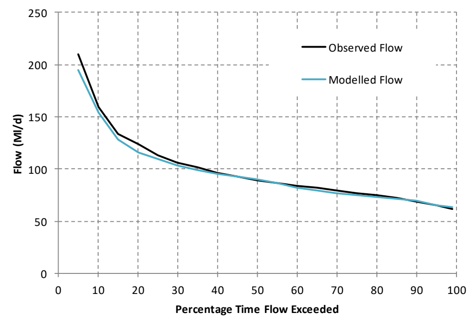
Station Ref No: 39012

Note

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

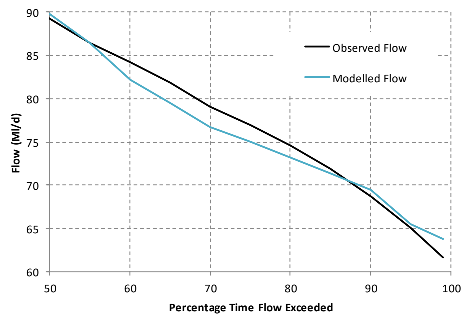


Figure F-11: WARMS2 Validation Summary – Hogsmill at Kingston

River Thames at Teddington - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

Statistics	Calibration (Observed)	Description
NSE	0.97	Nash-Sutcliffe Efficiency
Log NSE	0.98	Log_N Nash-Sutcliffe Efficiency
Correlation	0.99	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.99	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	1.03	Modelled volume / Observed volume
RMSE	1009.03	Root mean square error
RMSE Q50-Q95	348.74	Root mean square error for data between Q50 and Q95
Mean Flow	7344 (7097)	Mean flow
Q50	5180 (5061)	Flow exceeds this value 50% of the time
Q95	2064 (2049)	Flow exceeds this value 95% of the time

Catchment Area

Grid Ref: TQ1770069800 Area: 9948 km^2

Station Ref No: 39001

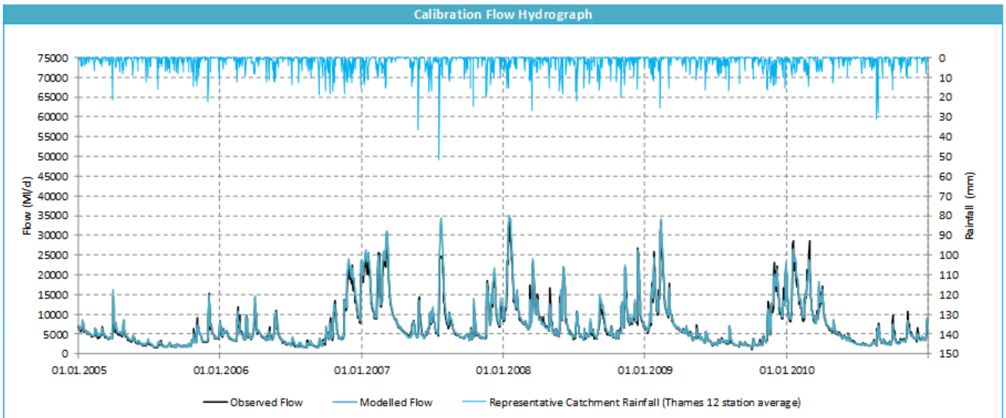
Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	Label	Rainfall and Evaporation
TA31	A1 U. Thames	Cotswolds West (6010)
TA32	A2 Churn	Cotswolds West (6010)
TA33	A3 Ampney	Cotswolds West (6010)
TA34	A4 Coln	Cotswolds West (6010)
TA2	A5 Leach	Cotswolds West (6010)
TA3	A6 Windrush	Cotswolds West (6010)
TA4	B1 Evenlode	Cotswolds East (6020)
TA6	G3 Ock	Berkshire Downs (6070)
TA7	G4 Ginge	Berkshire Downs (6070)
TA5	N3 Thame	Chilterns East - Colne (6140)
TA8	G8 Mill	Berkshire Downs (6070)
TA30	G7 Pang	Berkshire Downs (6070)
TA1	G1 U. Kennet	Berkshire Downs (6070)
TA12	G5 Knighton	Berkshire Downs (6070)
TA23	G2 Lambourn	Berkshire Downs (6070)
TA29	G6 Enborne	Berkshire Downs (6070)
TA14	P1 Upper Loddon	North Downs - Hampshire (6162)
TA15	P2 Blackwater	North Downs - Hampshire (6162)
TA13	M1 Thames direct (Nth - Henley)	Chilterns West (6130)
TA10	M3 Thames direct (Sth - Maidenhea	Chilterns West (6130)
TA9	M2 Wye	Chilterns West (6130)
TA11	N1 Misbourne & Alderbourne	Chilterns East - Colne (6140)
TA26	N2 Colne	Chilterns East - Colne (6140)
TA16	S1 Wey	Wey Greensand (6190)
TA18	S2 Wey Inflow	Wey Greensand (6190)
TA19	T1 Wey Chalk	Wey Greensand (6190)
TA17	V1 Tillingbourne	Wey Greensand (6190)
TA22	Y1 Mole LGS	North Downs - South London (6230)
TA21	T2 Mole Chalk	Wey Greensand (6190)
TW1	Mole u/s T2	North Downs - South London (6230)
TW2	Hogsmill	North Downs - South London (6230)

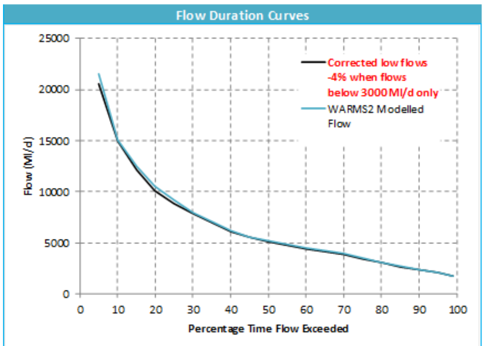
Note

The rainfall-runoff models listed above all contribute to the total flow at Teddington. The rainfall shown on the graph below is the average of 12 stations located across the Thames region.

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

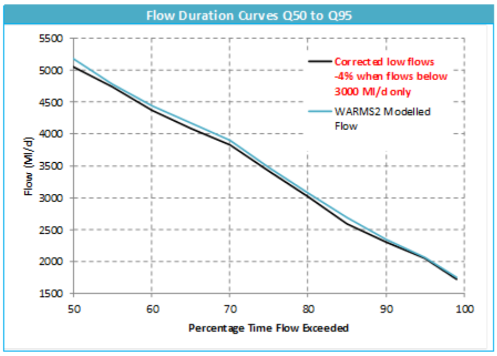


Figure F-12: WARMS2 Validation – Thames at Teddington

River Lee at Feildes Weir - Calibration Report

Model Run Details: With NEFF, AR12 data, v23c, Mole Update, 24/07/2015

Statistics	Calibration (Observed)	Description
NSE	0.64	Nash-Sutcliffe Efficiency
Log NSE	0.74	Log_N Nash-Sutcliffe Efficiency
Correlation	0.81	Pearson's product-moment correlation coefficient (r)
Log Correlation	0.88	Log_N Pearson's product-moment correlation coefficient (r)
Volume Error	1.04	Modelled volume / Observed volume
RMSE	204.53	Root mean square error
RMSE Q50-Q95	74.95	Root mean square error for data between Q50 and Q95
Mean Flow	425 (410)	Mean flow
Q50	308 (318)	Flow exceeds this value 50% of the time
Q95	153 (159)	Flow exceeds this value 95% of the time

Contributing Rainfall-Runoff Models

Aquator Aquifer Unit		Time Series Assigned
Component	**Label**	**Rainfall and Evaporation**
TA28	L1 Upper Lee	Lee Chalk (6600)
TA27	L2 Stort	Rainfall = Lower Lee (6506) Evaporation = Lee Chalk (6600)

Catchment Area

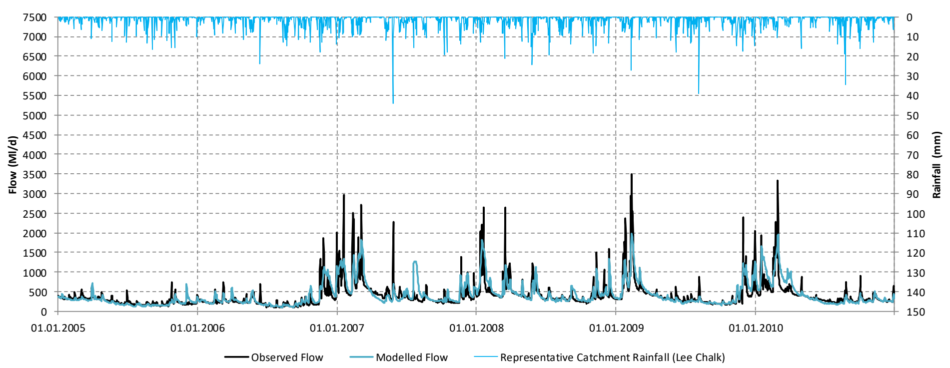
Grid Ref: TL3900009200 Area: 1036 km^2

Station Ref No: 38001

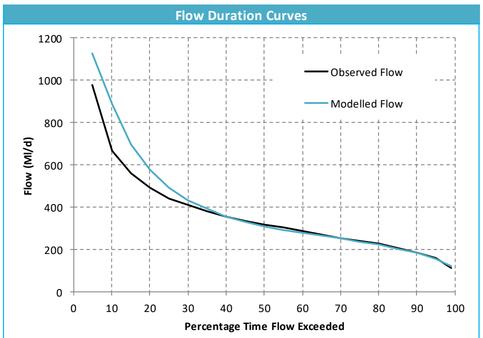
Note

The rainfall-runoff models listed above both contribute to the total flow at Feildes Weir. Lee Chalk rainfall has been selected as most representative of the catchment and is used in the graph below.

Calibration Flow Hydrograph



Flow Duration Curves



Flow Duration Curves Q50 to Q95

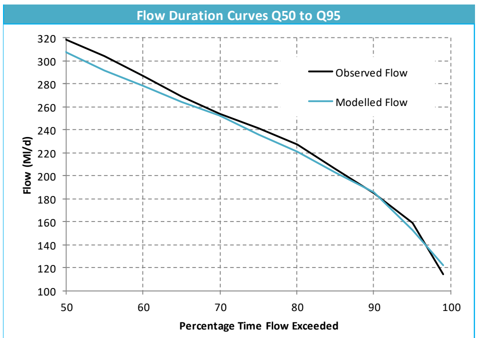


Figure F-13: WARMS2 Validation – Lee at Feildes Weir

F.3. Alongside the validation of the hydrological models, validation of WARMS2 as a water resources model was also undertaken in 2015.

F.4. To validate the model a period of drawdown of the London reservoir system was used so as to ensure that the model reflects operational use in a reasonably accurate manner. The validation aimed to ensure that the model reflects the use of operational assets given the water available for abstraction, licences and operating agreements, sources available and constraints on operational use, and to ensure that the water balance was carried out correctly. The London model was also validated against the dry period of 2006, which is a recent event that offered scope for validation. A significant amount of operational data was collated to test the response of the model for 2006. The inputs to the model also included the Environment Agency record of "Natural" river flows at Teddington and Feildes Weir together with the effluent discharge from Rye Meads STW, which are the flows that feed London's water resource system.

F.5. In the validation exercise, checks were undertaken to ensure that the model's outputs and calculations were undertaken correctly. The key model output, London's reservoir storage, is shown in Figure F-14. This demonstrates that the WARMS2 model is well calibrated and thus is suitable as the basis for further modelling.

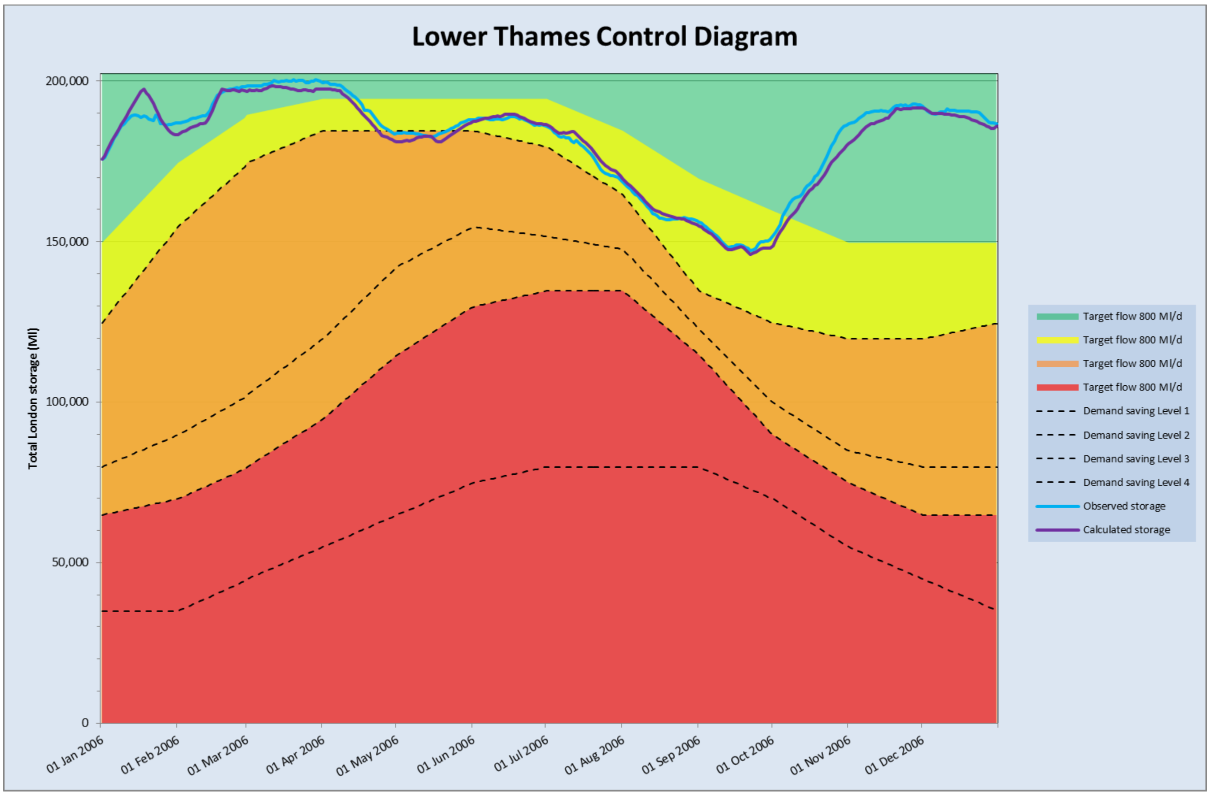


Figure F-14: WARMS2 Validation – London Reservoir Storage

Thames Water

It's everyone's water