Water Resources Management Plan 2024

Section 7 – Appraisal of Resource Options

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Background and Introduction

Section 7 describes:

- How we have identified our Feasible List and Constrained List of water resource options
- The associated system elements that are required to deliver the Constrained List of resource options into supply
- The further option development that has been conducted on the Constrained List of options to inform programme appraisal
- The process for development of option metrics, including costs, environmental scoring, carbon calculations and resilience scoring

As part of our work with Water Resources South East (WRSE) to develop a regional plan for the south east, we have collaborated with other water companies in the region to develop a consistent approach to options appraisal. We have also supported dedicated WRSE workstreams to look at the exploration and development of certain option types. These are: a) multi-sector options (for inclusion in the regional plan, rather than company WRMPs), b) intra-regional and inter-zonal transfers, c) catchment options and d) resilience options. Changes since WRMP19:

The options appraisal work undertaken at WRMP19 followed a mature methodology to comprehensively identify a wide range of unconstrained options which were subject to screening and further development to form our constrained list of options. As such, our WRMP19 constrained options list has formed a solid foundation that we have built on for WRMP24. We have largely followed the same methodologies for WRMP24 and have identified in this document where these have been updated; examples include our generic options list and our approach to quantitative risk and optimism bias, both of which have been aligned with the WRSE's methodologies.

A notable update to this work has been in consideration of the fact that, for the first time, we are trying to compile an options list that satisfies a regional rather than company supply area needs. This means that we have submitted more options into the WRSE investment model than we would into our investment model, and we have used the WRSE model as a mechanism to further screen options based on the regional need.

We have included our existing intra-company transfers to help build connections within the WRSE investment model. In line with updates to the WRPG, we have also included our Temporary Use Bans and Non-Essential Use Bans as WRMP options, as well as those of our drought permits that are deemed to be minimally impactful in consultation with our regulators, which is a change from WRMP19.

We have worked extensively with WRSE to support the identification of new options that could better improve the connectivity and resilience across our region, improving our collective supply security. This innovative work has by its nature generated options which are entirely new. This has meant that they are not developed to the level we would usually seek to progress options before screening them to be included in the investment modelling, but we have included these options in the WRSE modelling to understand their potential benefit to the

region. Where options have potential, they have been further developed and fed back into the WRSE model to develop the final regional plan and our WRMP24.

In a new development for this planning cycle, 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. We have ensured that our process is transparent, proportionate and non-discriminatory. Our BAF can be found on our website.

For WRMP24, Thames Water options have been identified as either Strategic Resource Options (SROs) or non-SRO options. SROs were identified by Ofwat in the PR19 Final Determination to be developed to be 'construction ready' for the 2025-2030 period. Their development funding was divided between companies who were required to work together and with regulators to deliver the work. Delivery of the SROs is subject to a formal gated process which is governed by the Regulators' Alliance for Progressing Infrastructure Development (RAPID)[1]. Detailed progress reports on the feasibility and design of these options are required at each gate to assess the merits of the options ongoing development. The gate one reports for our SROs were published in July 2021[2] and the gate two reports were published in November 2022.

Note on terminology:

At WRMP19 the terminology 'Reuse' was used, the terminology at WRMP24 has moved on to be 'Water Recycling'. The WRMP documents refer to options as recycling options however feasibility reports refer to reuse as these were drafted at WRMP19. The terms Reuse and Recycling can be considered interchangeable.

At WRMP19 the terminology Abingdon Reservoir was used, this has been further developed and is now referred to as South East Strategic Reservoir Option (SESRO). When referring to different reports and information it is necessary to refer to both these names. In reading the WRMP documents Abingdon Reservoir and SESRO are used interchangeably and refer to the same option.

Introduction

Purpose of section

7.1 Section 7 summarises the approach that has been followed for identifying water resource options and how screening has been applied to determine the Constrained List of options that has been taken forward into programme appraisal to develop the regional plan and our WRMP. The section then summarises the information that has been gathered on the Constrained List of options.

7.2 Option dossiers have been prepared for the Constrained List of options. The dossiers should be read in conjunction with the reports as detailed in Figure 7-1.

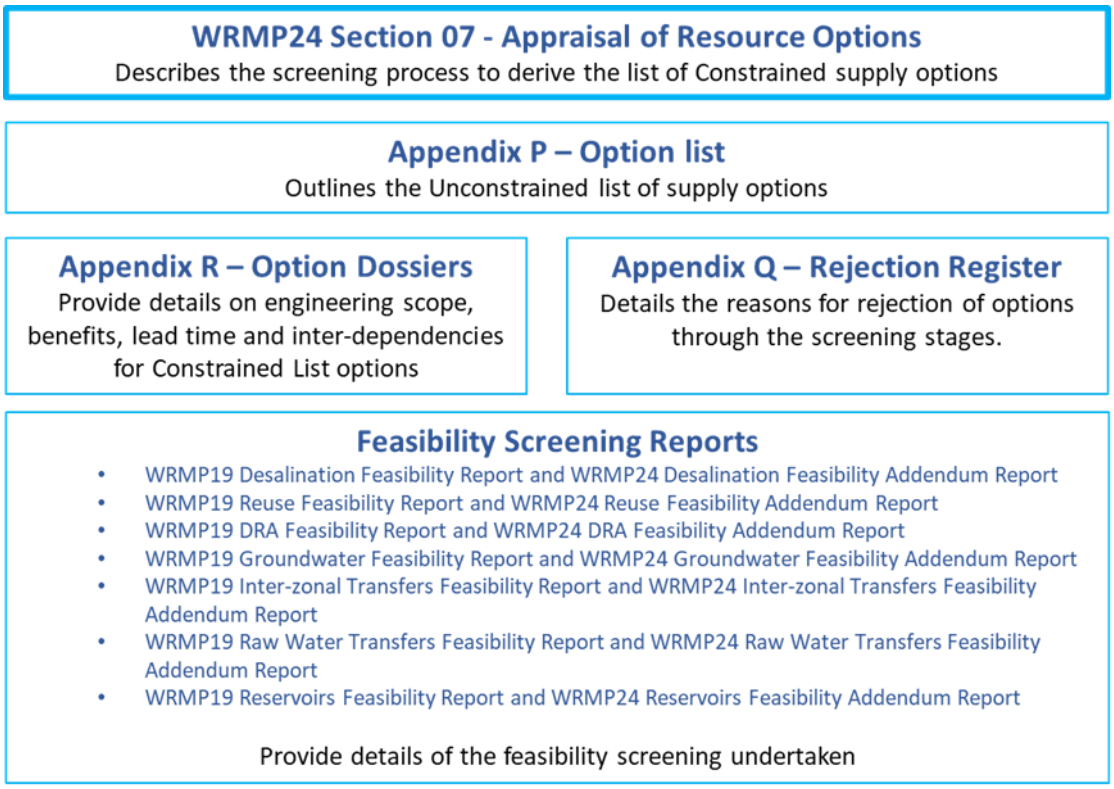

Figure 7-1: Overview of WRMP24 Supply options reports

Structure of this section

7.3 Following this introduction, Section 7 summarises:

- The generic option type screening we have conducted
- The feasibility assessments we carried out to define the Feasible List of specific resource options
- The cross-option studies we conducted to identify raw water system, treatment and network reinforcement requirements needed to deliver potable water to customers
- A further screening exercise that considered outputs of the feasibility reports to produce a Constrained List of elements to be carried forward for further development
- The further development conducted with regard to elements on the Constrained List to inform programme appraisal that was completed by Water Resources South East (WRSE) on a regional scale

- Drought Permit options considered as part of the WRMP24 process
- Temporary Use Bans (TUBs), Non-Essential Use ban (NEUBs) and media campaign options which have been identified and developed through the WRMP24 process
- Existing transfers which have been included in the WRSE modelling to allow flow of water around the Thames region and the WRSE region
- References to the sources of further information available in respect to the elements on the Constrained List and work carried out by WRSE for the region or by the Strategic Resource Option (SRO) teams

Approach to water resource option development

7.4 Following the principles of the Water Resources Planning Guideline[3] (WRPG), a phased approach to developing water resource options for WRMP24 has been undertaken so that efforts to reduce uncertainties are focused on issues that could reasonably be expected to influence option screening decisions. An overview of the approach to reviewing and assessing resource options in the preparation of WRMP24 is shown in Figure 7-1. The approach comprises: option identification and definition (including generic option screening and review of the WRMP19 rejection register); water company option screening; option development; and investment modelling.

7.5 We have adopted a 2-stage approach to water company option screening; feasibility assessment by option type, followed by further option screening of all feasible options. These are described in more detail below.

7.6 The objective of option identification and definition was to:

- Review the water resource options carried forward from WRMP19
- Review options in our WRMP19 Rejection Register to identify any options which have the potential to provide benefit to other companies in the WRSE region, to achieve 1:500 drought resilience and long-term environmental benefits
- Identify new options to be considered in addition to the existing WRMP19 options, including new offers of options from third parties

7.7 The output of this stage is the Unconstrained List of options.

7.8 Feasibility Assessment: options on the Unconstrained List were assessed following the three-stage methodology in accordance with the WRMP19 approach:

- The WRMP19 screening of options was reviewed and updated, where new information was available
- New options were assessed using the WRMP19 Feasibility methodology
- Backchecking was undertaken to assess whether changes since WRMP19 impact on the WRMP19 screening decisions
- Where applicable, further stakeholder engagement was undertaken to identify if an option is feasible

7.9 Updates to the WRMP19 feasibility assessments, assessment of new options and backchecking are presented in Addendums to the WRMP19 Feasibility Reports which are published on our website: https://www.thameswater.co.uk/about-us/regulation/water-resources. These should be read alongside our WRMP19 feasibility report for each type

[3] Environment Agency, 2022, Water Resources Planning Guideline, https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline

of option, please contact consultation@thames-wrmp.co.uk for access to these documents.

7.10 The output of this stage is the Feasible List of options.

7.11 Further Option Screening: further screening was undertaken where options were subject to a combined limit (for example, to protect the environment in the estuarine Thames, we consider that there is an upper limit to the total volume of desalination and recycling schemes that we could implement in the middle Tideway), or where an option would be mutually exclusive with another option (for example, options which use the same water source). Where possible, we have not screened options out where mutual exclusivities or combined upper limits exist. Instead, we have represented these limits and constraints in our investment modelling, thereby allowing the investment model to select the option that brings the greatest benefit to the WRSE region. In some cases, we have either undertaken multiple scenario runs using our investment model to identify options which are universally preferred over other mutually exclusive options (and have screened out options which are not preferred in this case) or have undertaken detailed appraisal, for example through the gated Strategic Resources Options (see section below) development process, to find preferred option variants. In these cases options were screened before full investment modelling was undertaken and options were not included in the constrained list.

7.12 Feasible options which meet the criteria for Further Option Screening were passed through to the Constrained List of options.

7.13 The output of this stage is the Constrained List of options.

7.14 Option Development: Constrained List options were developed for inclusion in the investment model and WRMP24 documentation. In this context, development means determining as a minimum an indicative design of an option, and carrying out cost, carbon emissions, and environmental assessments based on these designs.

- Conceptual designs were prepared for new Constrained List options
- WRMP19 conceptual designs were updated, where there have been material changes
- Costs have been updated using a methodology developed by the All Company Working Group (ACWG, a group composed of all water companies who are developing major water resources options) and WRSE, in order that our option costs are developed in a consistent way and are comparable with option costs developed by other companies in the region and country.
- Carbon emissions associated with the development and use of options have been updated using the WRSE/ACWG Cost Consistency Methodology
- Environmental assessments, comprising Strategic Environmental Assessment (SEA), Habitats Regulations Assessment (HRA), Water Framework Directive (WFD), Invasive Non-Native Species (INNS), Natural Capital (NC), and Biodiversity Net Gain (BNG), have been updated or carried out so that all option costs include necessary environmental mitigation measures, and in order that we can compare the environmental costs and benefits associated with different options, including rejection on environmental grounds where appropriate. Please see Section 9 of the WRMP for more details on environmental assessments.
- Deployable Output (DO) values, DO being a measure of the supply benefit that a given option brings under drought conditions, have been updated in accordance with the WRSE methodology

- Resilience assessment of options has been carried out in accordance with the WRSE Resilience Framework, and the metrics generated by this assessment are used to compare options as part of programme appraisal.

7.15 Options on the Constrained List have then been subject to programme appraisal using the WRSE investment model to determine the Best Value plan for the water supply/demand deficit to ensure that supply balances demand, taking account of relevant future forecast water resource scenarios. As described in Section 6 and Section 10, our investment modelling is now based on a fully adaptive approach so that our plan is sufficiently robust to adjust to the significant future uncertainties we face and make the right investments at the right time.

7.16 Conceptual designs were developed for Constrained List options for inclusion in the WRSE investment model. Option development backchecking was then completed through inspection of investment programmes suggested by the WRSE Investment Model to identify changes to screening and, as a result, the Feasible and Constrained Lists. Any required changes to the Feasible and Constrained Lists were made and included in the next round of investment modelling.

7.17 The steps above are broadly consistent with the options appraisal process carried out in producing our WRMP19. There are, however, several notable changes between our WRMP19 and WRMP24 options appraisal processes, which are worth highlighting:

- Focus on Environmental Assessments: The use of Natural Capital accounting and assessment of the potential for mitigation measures needed to ensure the statutory minimum of 10% Biodiversity Net Gain for those options which require planning permission. This marks a step change in the environmental assessments that we have undertaken in our water resources option development. This work is described in further detail in Section 9.
- Regional and National Consistency: The development and adoption of regionally and nationally consistent methodologies for cost and carbon assessment have driven a more comparable options development process across different companies.
- Regional approach to Investment Modelling: In WRMP19, we appraised options and carried out investment modelling in order to determine the Best Value plan considering only the Thames Water supply area. In WRMP24, we have appraised options considering their potential utility for multiple companies in the WRSE region and have undertaken our investment modelling to ensure that WRSE companies' WRMPs present a Best Value plan for the region as a whole.
- Strategic Resources Options Gated Process: As described in the next section, in PR19, Ofwat allocated funding to develop several large, strategic, inter-company water resources solutions. These options have undergone a greater amount of development than would otherwise have been the case, leading to a greater degree of confidence in their cost, carbon, and environmental assessments.

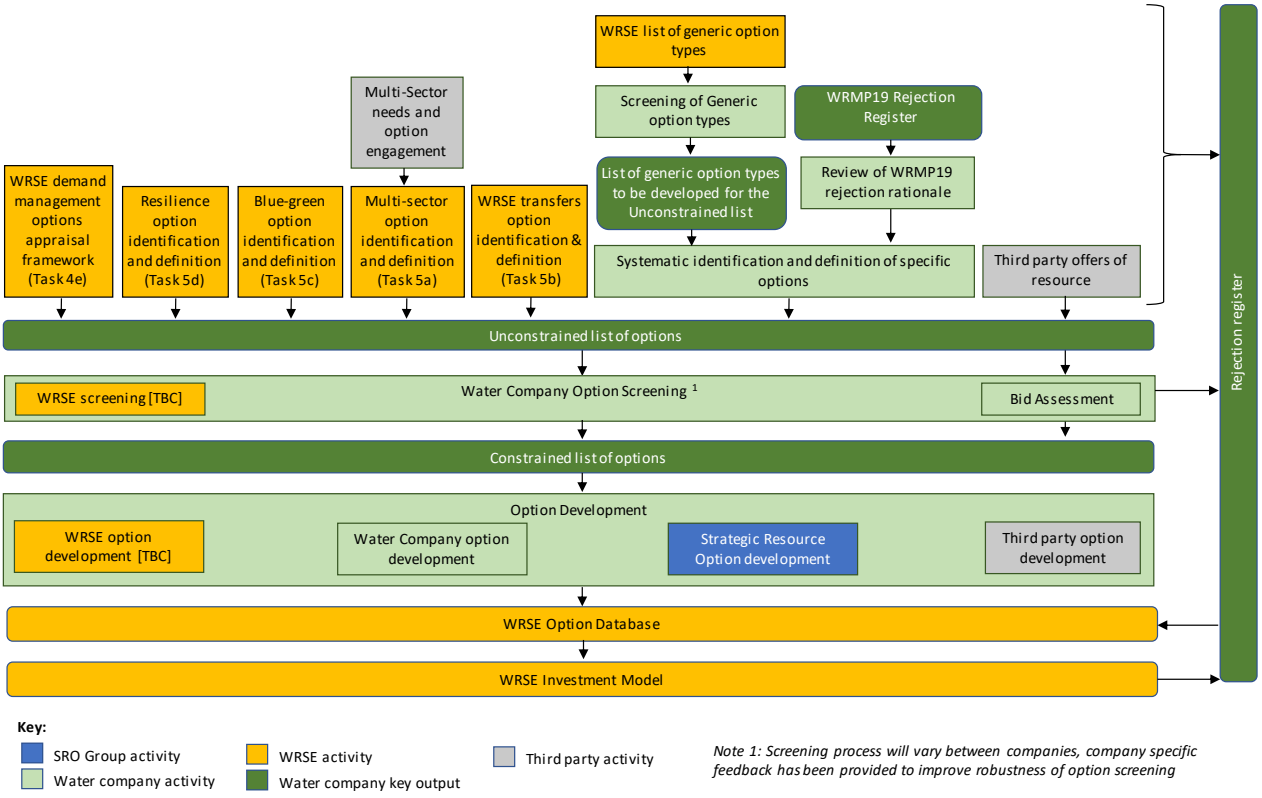

Figure 7-2: WRMP24 Options Appraisal Process

Strategic resource options

7.18 For WRMP24, Thames Water options have been identified as either SROs or non-SRO options. "SROs" are those solutions that were identified as such by Ofwat in its PR19 Final Determination[4]. These are large, strategic options potentially shared by different water companies. Companies have been given ring-fenced funding to investigate and develop options through the SRO process. Other water resource options are referred to as non-SROs. Three SROs have been identified that will bring direct deployable output (DO) benefits to Thames Water:

- South East Strategic Reservoir Option (SESRO) or Abingdon Reservoir: a new reservoir in Oxfordshire, with different sizes being considered
- Severn to Thames Transfer (STT): a transfer of water from the River Severn to the River Thames, which could involve the use of resources owned and operated by United Utilities and/or Severn Trent Water to increase the resilience and supply benefit of such a transfer
- London Water Recycling: water recycling schemes whereby effluent from sewage treatment works would be treated to a very high standard, suitable for discharge to rivers and re-abstraction for drinking water purposes. Several different locations and technologies are being considered within the umbrella of the London Water Recycling SRO

7.19 In addition to the three options which would bring resource to Thames Water, we are also involved in the development of two transfer SROs:

[4] Ofwat (2019), PR19 final determinations, Strategic regional water resource solutions appendix

- Thames to Affinity Transfer (T2AT): a transfer of water from the Thames region (facilitated by one or more of the new Thames Water resources highlighted above) to Affinity Water, who operate supplies in North London and across parts of the Home Counties
- Thames to Southern Transfer (T2ST): a transfer of water from the Thames region (again, facilitated by the new resources above) to Southern Water in Hampshire. Two smaller transfers from the T2ST pipeline have been explored to supply our Kennet Valley Water Resource Zone (WRZ). One of these transfers has been included on our Constrained List and submitted into WRSE's investment model for programme appraisal

7.20 Both transfer options bring the potential for 'conjunctive use', whereby water supply systems can be operated efficiently to bring about overall water resources benefits which are more resilient than the sum of their parts.

7.21 The conjunctive use benefit of the T2ST option is being further investigated by the SRO teams. Therefore, this benefit is not currently well established and is not included in WRSE modelling. This will continue to be investigated and will be reflected in WRMP modelling at WRMP29.

7.22 SRO options are subject to a gated regulatory process which has been defined by Ofwat. This chapter provides an overview of the SRO options, and further information, at an equivalent level of detail to non-SRO options, is included in Appendix R, Option Dossiers. The more detailed work carried out by the SROs to meet the requirements of the gated process is contained in Gate 1 and Gate 2 reports, which are publicly available on the Thames Water website[5]. RAPID's draft and final decision for Gate 1 and draft and final decision for Gate 2 are also on our website.

Stakeholder engagement

7.23 As part of the development of the South East regional plan and our final WRMP24 we have worked closely with regulators and stakeholders. This section focuses on the engagement undertaken with stakeholders as part of the process to identify, appraise and evaluate resource options.

7.24 WRSE developed a technical method statement on option appraisal which set out the objectives and components of the options appraisal process; the range of options to be considered; the information required for the option assessment and the approach to assessment. WRSE consulted on the method statement, as part of the wider consultation on the technical method statements and held a specific webinar[6] on option appraisal. Further to feedback, WRSE updated and republished[7] the method statement this included clarification on the rejection reasoning and the quality assurance process. The approach has been used consistently by WRSE and the water companies and is in line with regulatory guidance.

7.25 We put forward the Constrained List options included in WRMP19 to WRSE for consideration in the regional plan. We had followed a robust methodology to identify, screen and develop the options to prepare a Constrained List of options for WRMP19 and this work included close engagement with stakeholders as presented in WRMP19 Section 7 and Appendix S. As such, our WRMP19 constrained options list provided a solid foundation that we built on for WRMP24 and we have engaged with stakeholders where

[5] https://www.thameswater.co.uk/about-us/regulation/strategic-water-resource-solutions
[6] Option Appraisal Technical Method Statement webinar, September 2020
[7] WRSE Method Statement Option Appraisal, September 2021

there have been changes to an option such as discussions held with the Canal and Rivers Trust on the Oxford canal transfer.

7.26 We also sought proposals from third parties via the Bid Assessment Framework (BAF)[8] which was used to administer the receipt and assessment of third-party proposals and ensure that these options were considered equally with other options.

7.27 WRSE identified a gap in the option set regarding catchment solutions. This led to engagement with regulators, Rivers Trusts, catchment partnerships, and local authorities through a series of interactive workshops in early 2021 to identify potential catchment options and nature-based solutions. Water companies collated the relevant information for their own supply areas, seeking further information from stakeholders as required. For Thames Water a total of 161 options were identified; around a quarter were river restoration measures, with substantial numbers of water retention measures (including natural flood management and wetland creation) and nutrient and sediment reduction measures. We assessed the options to establish their feasibility, indicative costs and wider socio-economic and resilience benefits[9]. Options with sufficient level of assessment and which meet the requirements for options to be included in the WRMP have been progressed through either the WRMP, Drainage and Wastewater Management Plan (DWMP) or business plan pathways, whilst those options that are less mature may be developed further to improve the quality of the information available and consideration in subsequent planning rounds.

7.28 WRSE worked closely with the Environment Agency and Natural England throughout the option appraisal process and provided access to the option database to enable timely data and information sharing.

7.29 As part of our pre-consultation activities on our WRMP24, we also worked closely with regulators to discuss and seek feedback on potential options.

- Discussions with the Environment Agency (EA) focused on the work to identify and update the options assessments including the rationale for rejection of options; potential groundwater options, catchment, drought, inter-regional transfers and resilience options; the update to the Feasibility Report and agreement on the status of Deephams water recycling which was agreed to be incompatible with the environmental ambition flow targets that the Environment Agency is seeking for the Lower River Lee (the result being the inclusion of the Deephams option on the Constrained List after c.2060, but exclusion prior to this point).
- Discussions with Natural England (NE) focused on the SEA, HRA and WFD assessments, the output of the assessment of options, and our reviews of emerging policy changes, mainly where this meant that options needed to be rejected on environmental grounds
- Discussions with the Drinking Water Inspectorate (DWI) mainly focused on the work to examine the drinking water quality risks and ensure compliance with drinking water quality requirements

7.30 WRSE hosted a programme of webinars in May and June 2021 to present the work on option appraisal, share information with the wider stakeholder community on the option types and provide the opportunity for stakeholders to comment ahead of the start of investment modelling in autumn 2021.

[8] https://www.thameswater.co.uk/about-us/regulation/water-resources - Bid Assessment Framework
[9] Further information provided in Framework for identifying and appraising existing and new catchment options, Water Resources south East, May 2022

7.31 There has also been considerable engagement as part of the work to examine and develop the SROs. This has included engagement with regulators and strategic and technical stakeholders to share the programmes of studies and seek input to specific workstreams. The engagement has included dialogue with the Cotswold Canals Trust on the Severn Thames Transfer; the Port of London Authority on London water recycling; and Group Against Reservoir Development, Wilts and Berks Canal Trust and local authority and parish council representatives in the proximity of the South East Strategic Reservoir Option. The nature of the engagement and response to stakeholder feedback is reported in detail in the SROs Gate 1[10] and Gate 2[11] reports which are published on our website www.thameswater.co.uk/sro.

Taking a system approach

7.32 For new water resources to be put into supply, reinforcements are often required to other parts of the water supply system downstream of the resource, including to the raw water conveyance system, water treatment works and water distribution infrastructure. In many cases, these water supply system reinforcements are common to a number of different water resource options; for example, water from a regulating reservoir such as SESRO or water from a Severn-Thames Transfer could both require treatment in West London. The supply system elements may also be implemented at a different time than water resource elements, for example, if a zone is resource-constrained and has sufficient treatment/network capacity in the short term but will require reinforcements in the medium to long term as demand increases. For these reasons, separate supply system elements have been developed for new water resources, raw water conveyance, raw water system reinforcements, treatment reinforcements, and treated water network reinforcements.

7.33 Cross-option studies have been carried out to identify the supply system reinforcement elements required and to establish the system operating philosophy. Figure 7-3 illustrates examples of how the different supply system elements combine to make up an overall water resources option.

[10] https://www.ofwat.gov.uk/regulated-companies/rapid/the-rapid-gated-process/gate-one-submissions-and-final-decisions/
[11] https://www.ofwat.gov.uk/regulated-companies/rapid/the-rapid-gated-process/gate-two/

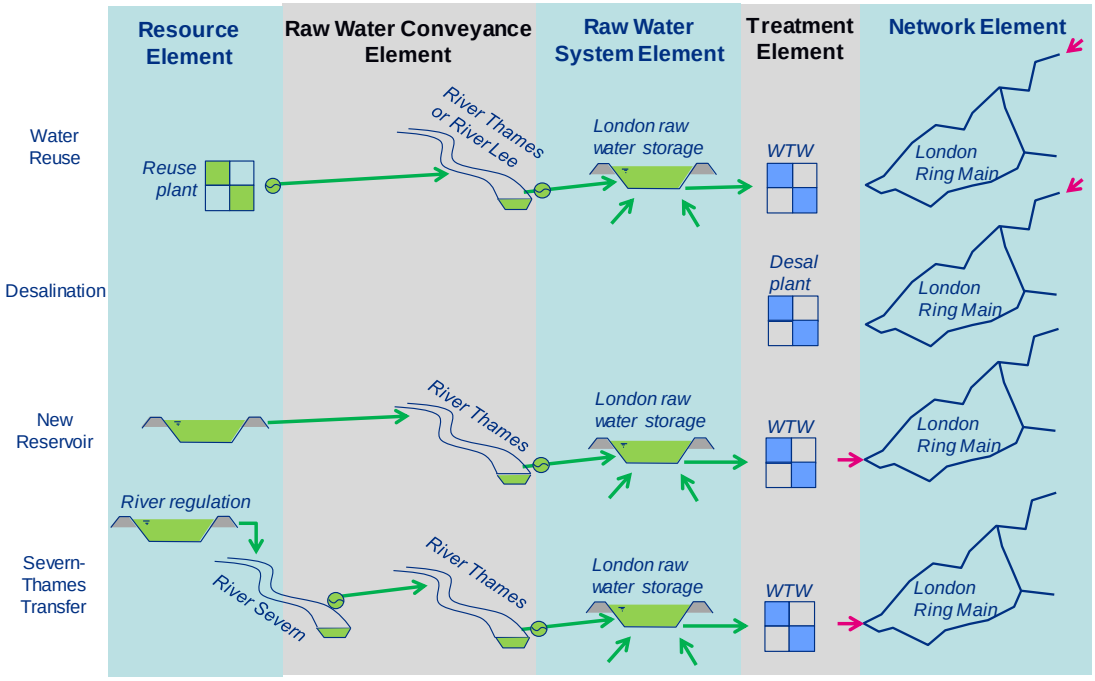

Figure 7-3: Separation of water resource options into supply system elements

Generic screening

7.34 The starting point for water resource option development is the generic list of resource option types (e.g. reservoirs, water transfers) as defined by WRSE based on the UKWIR Water Resources Planning Tools report. The list has been reviewed to identify option types that have potential for providing feasible specific water resource options for the Thames Water supply area. A summary of the results of the generic screening exercise that we carried out is shown in Table 7-1.

7.35 Water resource option types that have been rejected are marked with a cross in Table 7-1. A summary of reasons for rejection can be found in Table 7-2, with further detail provided in the rejection register (see Appendix Q).

7.36 Resource option types that were assessed as having potential to provide specific options for WRMP24 are marked with a tick in Table 7-1. For these option types the table also references the report that goes on to identify feasible specific options for our supply area.

7.37 Generic option types are split into Blue-Green infrastructure, Hard infrastructure, and Response to Regional Events. Refer to WRSE report for further description of the option types.

7.38 WRSE recommended that a review is undertaken by each water company to identify generic option types where options were not considered during WRMP19. As part of their recommendations, WRSE have provided a list of generic option types which is updated from the UKWIR list. Each generic option type has been reviewed and a decision has been made as to whether the option type has passed or failed the generic screening assessment for WRMP24. Table 7-1 includes the generic option type list together with a summary of the results of the screening assessment.

Scheme Type / Sub type	Screening decision	Report containing option identification
Catchment management schemes - Flow augmentation and licensing	✓	Framework for identifying and appraising existing and new catchment options, WRSE, May 2022
Catchment management schemes - Terrestrial habitat creation/management	✓	Framework for identifying and appraising existing and new catchment options, WRSE, May 2022
Catchment management schemes - Natural water retention measures	✓	Framework for identifying and appraising existing and new catchment options, WRSE, May 2022
Catchment management schemes - Fisheries management	✓	Framework for identifying and appraising existing and new catchment options, WRSE, May 2022
Catchment management schemes - River Restoration	✓	Framework for identifying and appraising existing and new catchment options, WRSE, May 2022
Catchment management schemes - Sustainable Urban Drainage Systems (SUDS)	✓	Framework for identifying and appraising existing and new catchment options, WRSE, May 2022
Catchment management schemes - Nutrient and sediment reduction	✓	Framework for identifying and appraising existing and new catchment options, WRSE, May 2022

Scheme Type / Sub type	Screening decision	Report containing option identification
Catchment management schemes - Pesticide reduction	✓	Framework for identifying and appraising existing and new catchment options, WRSE, May 2022
Catchment management schemes - Integrated catchment management	✓	Framework for identifying and appraising existing and new catchment options, WRSE, May 2022
Catchment management schemes - Knowledge exchange, education, and agricultural activity	✓	Framework for identifying and appraising existing and new catchment options, WRSE, May 2022
Desalination	✓	WRMP19 Desalination Feasibility report and WRMP24 Desalination Feasibility addendum
Groundwater sources	✓	WRMP19 Groundwater Feasibility report and WRMP24 Groundwater Feasibility addendum
Artificial Storage and Recovery wells (or Aquifer Storage and Recovery (ASR))	✓	WRMP19 Groundwater Feasibility report and WRMP24 Groundwater Feasibility addendum
Aquifer recharge /Artificial recharge (AR)	✓	WRMP19 Groundwater Feasibility report and WRMP24 Groundwater Feasibility addendum
Tidal barrage	×	Appendix Q: Rejection Register
Conjunctive use operation of sources	✓	Appendix R: Option Dossiers
Joint (“shared asset”) resource	✓	Gate 2 SRO documents
Asset Transfers	✓	Third party option type. This generic option type was not rejected however no options were received through the Bid Assessment Framework (BAF)
Options to trade other (infrastructure) assets	✓	Third party option type. This generic option type was not rejected however no feasible options were received through the BAF
Abstraction licence trading	✓	Third party option type. This generic option type was not rejected however no feasible options were received through the BAF (one offer received and rejected on environmental grounds)
Distribution capacity expansion	×	Appendix Q: Rejection Register WRMP19 network reinforcement cross option report
Redevelopment of existing resources with increased yields	×	Appendix Q: Rejection Register (Note: Redevelopment of existing groundwater options within the existing licences is considered under the groundwater feasibility report WRMP19 Groundwater Feasibility report and WRMP24 Groundwater Feasibility addendum)
Increase water treatment works (WTW) capacity	✓	WRMP19 Water treatment works cross options report
New reservoir	✓	WRMP19 Reservoir Feasibility report and WRMP24 Reservoir Feasibility addendum SESRO Gate 1 and 2 submissions

Scheme Type / Sub type	Screening decision	Report containing option identification
Reclaimed water, water reuse, effluent re-use	✓	WRMP19 Water Reuse Feasibility report and WRMP24 Water Reuse Feasibility addendum. London Effluent Recycling SRO Gate 1 and 2 submissions
Direct river abstraction	✓	WRMP19 DRA Feasibility report and WRMP24 DRA Feasibility addendum. London Effluent Recycling SRO Gate 1 and 2 submissions.
Bulk transfers into region	✓	WRMP19 Raw Water Transfers Feasibility report, WRMP24 Raw Water Transfers Feasibility addendum. STT Gate 1 and 2 submissions.
Bulk transfers within region	✓	WRMP19 Interzonal Feasibility report, WRMP24 Interzonal Feasibility addendum.
Drought intervention - Drought order	✓	Drought Plan 2022 https://www.thameswater.co.uk/about-us/regulation/drought-plan Our drought plan | Regulation | About us | Thames Water Drought orders are considered as options in the Drought Plan however none of these Drought Orders were identified as WRMP options
Drought intervention - Drought permit	✓	Drought Plan 2022 https://www.thameswater.co.uk/about-us/regulation/drought-plan
Change in Level of Service to enhance water available for use (WAFU)	✓	Drought Plan 2022 https://www.thameswater.co.uk/about-us/regulation/drought-plan
Imports (icebergs)	×	Appendix Q: Rejection Register
Rain cloud seeding	×	Appendix Q: Rejection Register
Drought intervention - recommission abandoned sources	✓	Drought Plan 2022 https://www.thameswater.co.uk/about-us/regulation/drought-plan Our drought plan | Regulation | About us | Thames Water
Tankering of water - Road Tankering	×	Appendix Q: Rejection Register
Tankering of water - Sea Tankering	×	Appendix Q: Rejection Register
Drought intervention - Temporary transfer	×	Appendix Q: Rejection Register

Table 7-1: Summary of generic water resource option type review

Scheme	Screening decision	Rejection reasoning
Tankering of water - Sea Tankering	✘	A proposal by Waterlevel for tankering from sources in Norway has been considered by WRSE. This concluded that while technically feasible at full utilisation (one tanker per day) it would be excessively costly, in particular for use in London where use over a long duration (up to 18 months) is required to deliver the full resource benefit. As a drought measure at very low utilisation, sea tankering could become economical and it is therefore included as a potential 'More Before Level Four' drought measure in Thames Water's Drought Plan, though the long lead time for preparatory works (6-9 months or greater) limits this option's applicability to only those events where potentially very severe drought risk exists in the winter before a summer drawdown. The decision was made that options from this generic option type should not be included in the investment model for Thames Water as a range of operational costs had not been included in the cost submission (e.g. pipelines and treatment in receiving WRZs) and because the utilisation was not properly accounted for in option costing.
Tankering of water - Road Tankering	✘	It is difficult to plan road tankering options significantly in advance, as the locations of likely available resource and the location of the water shortage are not known. Nevertheless, it is an option that has been employed in previous droughts such as in Yorkshire in 1995. It is included as a potential 'More Before Level Four' drought measure in Thames Water's Drought Plan. This option type's applicability is, however, limited to response to local, temporary drought 'hot-spots', with road tankering being infeasible across large WRZs due to operational feasibility. The decision was made by WRSE that options from this generic option type should not be included in the investment model.
Icebergs	✘	The option to import icebergs has been rejected on the basis that the techniques involved are not sufficiently advanced for commercial use and because of the high level of uncertainty around scheme yield. Also, as the Thames Estuary is designated under the EA Habitats Directive, an Appropriate Assessment is likely to be required. As part of this, the company would be required to demonstrate that there are no feasible alternative options, which is not the case.
Rain cloud seeding	✘	Rain cloud seeding has been rejected on the basis that the techniques involved are not sufficiently advanced for commercial use and because there is a high level of uncertainty that the scheme would provide significant yield.
Tidal barrage	✘	The option for the use of the Thames Barrage to impound fresh water has been rejected as this option would limit the navigation of the River Thames to both private and commercial traffic resulting in disproportionate social and economic costs. It would

Scheme	Screening decision	Rejection reasoning
		also limit the passage of aquatic life which would cause significant ecological damage. The option could also result in raising the groundwater levels in the surrounding areas which could increase the incidence of flooding and cause damage to services and historic buildings in London.
Redevelopment of existing resources with increased yields	✘	We rejected redevelopment of reservoirs' storage on the basis that it is not possible unless sufficient surplus reservoirs are available to compensate for the loss of storage and the consequent risks to security of supply that would therefore result whilst the reservoir is being redeveloped. While short-term outages may be managed, it is expected that redevelopment of existing resources would require longer-term periods of outage. The provision of the surplus resources would be likely to be required for several years to allow the redevelopment of existing sources. Redevelopment of existing groundwater options within the existing licences is considered under the groundwater feasibility report. Redevelopment of existing resources with increased yield options are constrained by existing abstraction licences. We review asset performance against abstraction licences through ongoing operational procedures and consider that there are no current constraints which could be addressed through WRMP options.
Drought intervention - Temporary transfer	✘	A range of transfers have been identified as potential water resources options. In the event of a severe drought, consideration would be given as to whether there are surplus resources available from neighbouring WRZs that could be made available through other transfer pipelines. The location of these zones with available resource is not known in advance. The decision was made by WRSE that options from this generic option type should not be included in the investment model due to the unpredictable nature of these events.

Table 7-2: Rejection reasoning for generic water resource option types

Direct Potable Recycling

7.39 While water recycling has passed generic screening, only indirect water recycling (IPR) is considered. This section discusses the reasons for rejecting direct water recycling options.

7.40 Direct potable recycling (DPR) occurs when wastewater is treated to drinking water standards and is either blended with water from other sources at the WTW or in the drinking water network, without discharge to an environmental buffer. Direct potable recycling is relatively uncommon. Examples include the Windhoek DPR plant in Namibia, where treated wastewater has been blended with potable water for more than 40 years, and the Wichita Falls and Big Spring in Texas, with more DPR schemes to be expected in the future in the USA.

7.41 There are some benefits from implementing DPR:

- The highly treated wastewater is not subject to potential environmental contamination and an environmental permit for discharge is not required
- All treated wastewater will serve as drinking water. If returned to an environmental buffer some of the treated wastewater could be lost through evaporation or infiltration, or not abstracted
- The scheme would likely cost less as the treated wastewater would not be subject to further abstraction and treatment costs

7.42 However, there are various reasons for not proposing a DPR scheme. These include:

- Removal of barriers in a widely applied multi-barrier approach to the production of safe drinking water:
  - The environment buffer contributes to mitigate risks from chemical and microbial contaminants
  - Dilution of the treated wastewater by the environmental buffer will reduce contaminant concentrations
  - Removal of these contaminants will start in the environment, either by sedimentation, adsorption or photolysis
- Lack of knowledge: the UK is far behind countries such as the USA, Australia, Namibia and Singapore in terms of planned water recycling and does not have the knowledge to operate water recycling plants for potable water applications. For most of the countries cited above, water recycling started many years ago with the implementation of Non-Potable Recycling (NPR) systems. Once enough knowledge about the technology used has been gained, IPR and then DPR were implemented. In the UK, while unplanned IPR is common place, NPR plants are still rare, although there are a number of schemes now in planning.
- Reduction of reaction time: in the event of treatment failure, the reaction time to avoid contaminated water entering the drinking water supply system will be reduced

7.43 For those reasons, we are not promoting the implementation of a DPR scheme until the more widely practised option of IPR has been more widely practised in the UK.

Water resource feasibility assessment

Approach to feasibility assessment

7.44 For the water resource option types that have passed the generic screening, feasibility assessments have been conducted.

7.45 In WRMP19 feasibility reports were produced for each option type (Raw Water Transfers, Reservoirs, Water Reuse (now Recycling), Direct River Abstraction, Desalination, Inter-zonal Transfers and Groundwater). This has been reviewed for WRMP24 and any updates to the WRMP19 feasibility reports are described in the WRMP24 feasibility report addendums. The feasibility process determines those options to be taken forward for more detailed assessment and those which should be rejected as potential water resource options. It is a high-level overview of the feasibility of the options and not a full engineering feasibility assessment.

7.46 A staged approach has been adopted for the feasibility assessment:

- Stage 1: a systematic search was conducted to identify potential new resources of each type; these collectively form the Unconstrained List of resource elements (see Appendix P) that were then screened against absolute constraints (pass/fail)
- Stage 2: the performance of each potential new resource was evaluated qualitatively against a number of criteria that enabled differentiation between options of that type
- Stage 3: the performance of the potential new resources was assessed in further detail (e.g. including costing)
- Validation: verification and review of the final list of specific resource elements was undertaken to determine the Feasible List

7.47 The feasibility assessment methodology uses a multi-staged assessment approach, with a total of four stages (see Figure 7-4) that progressively determine the best sites or options for each option type based on a suite of assessment criteria. The assessment criteria becomes more detailed at each stage.

7.48 At Stage 1 the assessment has been undertaken against criteria on a pass / fail basis.

7.49 The approach adopted for the assessment of the performance of sites or options (Stages 2 and 3) uses a "traffic light" Red / Amber / Green (RAG) system to display the findings of the assessment and to demonstrate how sites or options perform against a range of assessment criteria. An option validation process (Stage 4) then confirms the options that will progress through to the further screening stage. The objective of the methodology is to home in on the most appropriate solutions and to provide information that can be used to make a selection between mutually exclusive options.

7.50 Where RAG assessments are used, they are intended to provide information for comparison and therefore an option that has a Red assessment against one or more criteria is not automatically rejected from the process. However, a Red assessment is an indicator that the option performs poorly in this area and it may be appropriate to undertake more investigation, consider amendments or mitigation measures to confirm feasibility before the option is taken forward.

7.51 The seven feasibility reports include different types of engineering options and therefore the method is flexible to either focus on site selection-based assessments (e.g. Reservoirs) or linear options (e.g. Raw Water Transfer pipelines). Where appropriate the

reports assess 'resource' options and 'conveyance' options separately through Stages 1 to 3 and consider combined options during validation (Stage 4).

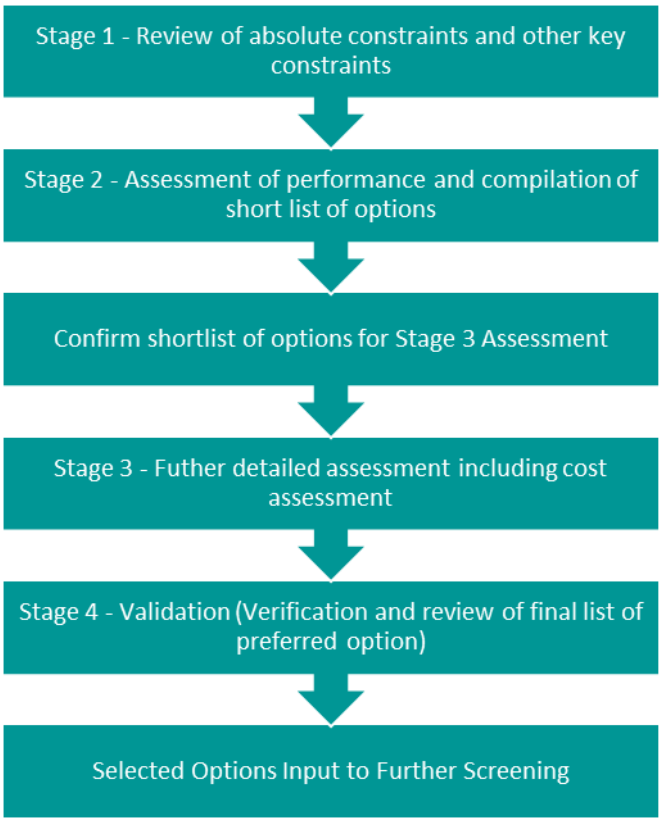

Figure 7-4: Feasibility Assessment Methodology

7.52 The feasibility assessment process has incorporated a suite of property, legal, planning, environmental and engineering assessment criteria. For each water resource option feasibility report, a shorter list of appropriate criteria were then chosen and amended to reflect the option type under consideration.

7.53 Further detail relating to the criteria used at each stage of the feasibility assessment can be found within each of the feasibility reports and feasibility addendums.

Stage 1 Feasibility Assessment

7.54 Option identification was completed at WRMP19 and reviewed and backchecked at WRMP24. For further information on this process refer to WRMP feasibility reports and WRMP24 feasibility addendums. At Stage 1, criteria are assessed on a pass / fail basis against a list of absolute and other key constraints which is applied to the options (refer to feasibility reports and addendums for further information on the criteria). Table 7-3 sets out the full list of Stage 1 assessment criteria and identifies which criteria were applied to each option type. Further details on how the criteria were applied to each option type is contained within each feasibility report. Where options are failing Stage 1 the reasoning is included in Appendix Q, Scheme Rejection Register.

	Reservoirs	Water Reuse (Recycling)	Raw Water Transfers	Desalination	Direct River Abstraction	Inter-zonal transfers	Groundwater	Typical meaning of pass or fail
Property/legal criteria								
Water Rights (regulatory or legal barriers)			Y					Are there any regulatory or legal barriers that would prevent Thames Water from utilising the resource? If there are, it fails.
Sufficient area	Y			Y	Y			Is there sufficient space for the option requirements? If not, it fails.
Proximity to potential abstraction points/ Connectivity to wider infrastructure system				Y	Y		Y	Is there a significant distance between the abstraction point and treatment location? If so, it fails. Is there a significant distance between the treatment location and preferred locations for discharge to the network? If so, it fails.
Planning, socio-economic & environmental criteria								
National / International nature conservation sites (ex pipelines)	Y	Y	Y	Y	Y		Y	If the site has national / international designations (i.e. Ramsar sites, Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Sites of Special Scientific Interest (SSSI) it fails.
National / International heritage sites (ex pipelines)	Y	Y	Y	Y	Y		Y	If the site has international designations, it fails.
Areas of major built development	Y	Y					Y	If a significant area of built development would need to be demolished it fails.
Potential impact on downstream abstractors		Y	Y	Y	Y			If a site would impact on downstream abstractors it fails.
Water Availability (CAMS Status)			Y		Y		Y	If there is not sufficient flow at the location of abstraction and are there any anticipated adverse effects on the waterbody due to abstraction, it fails. If the resource is unlikely to be available in the short and long-term if fails.
Environmental impact neutrality (i.e. brine can be disposed of safely)				Y				Is it possible to discharge desalination by-products without negative impact? Is there a waterbody available to discharge the effluent from the

	Reservoirs	Water Reuse (Recycling)	Raw Water Transfers	Desalination	Direct River Abstraction	Inter-zonal transfers	Groundwater	Typical meaning of pass or fail
								desalination process without causing adverse effects? If not, site fails.
Realistic prospect of acceptable abstraction licence					Y		Y	If an existing abstraction licence is affected it fails.
WRZ export potential for water transfers						Y		Is there an availability of surplus water at the donor zone throughout the planning horizon of works (80 years in London and SWOX and 25 years in the rest areas in Thames Valley)?
Engineering criteria								
Is the option drought resilient			Y		Y		Y	Is the source considered to be particularly vulnerable to drought conditions? If vulnerable, it fails.
Areas of permeable strata	Y							If the site is not located in an area with impermeable strata, it fails.
Clay thickness of 10m or less	Y							If there is less than 10m depth of clay beneath the site it fails.
Compatible with Thames Water's water Recycling considerations		Y						Options should be Indirect Potable Recycling. Effluent discharge should be into the tidal range of the River Thames or discharges into the River Thames' tributaries will have no detrimental environmental impact, otherwise it fails.
Sites which would provide water for London Water Resource zone (WRZ)		Y						If an option is unable to provide a water resource usable within the London WRZ it fails.
Source Quality (Treatability)			Y	Y	Y		Y	Is the quality of the source currently treatable, within reasonable cost and technical feasibility? If not, it fails.

Table 7-3: Stage 1 Criteria

Stage 2 Feasibility Assessment

7.55 Having eliminated any sites or options which failed the Stage 1 constraints assessment, Stage 2 of the study then assesses the remaining sites or options against further criteria based on a set of broad engineering, legal and property and environmental themes.

7.56 Not all the criteria identified at Stage 2 are relevant to all the option types, the reasons for not applying particular criteria are recorded in each feasibility report.

7.57 The outcome of Stage 2 is a matrix showing performance of each site or option against each of the criteria, along with a summary description of overall performance and whether the site or option is rejected or taken forward for further consideration. The matrix is presented in the feasibility reports.

7.58 Not all the engineering, legal and property and environmental criteria identified are relevant for the high-level Stage 2 assessment, some will only be used in Stage 3 as more detailed assessment is undertaken. Equally some of the criteria considered at Stage 2 are further assessed in more detail at Stage 3, when the option is further developed. Table 7-4 below shows the Stage 2 criteria, the circle indicates which options have considered the criterion as part of the Stage 2 assessment.

Criteria	Stage 2 Criteria	Reservoirs	Water Reuse (Recycling)	Raw Water Transfers	Desalination	Direct River Abstraction	Groundwater	Inter-zonal transfers
Property / legal criteria								
Ownership of site and tenancies	Y	●	●	●	●	●	●	●
Estimated land acquisition cost	Y	●	●	●	●	●		
Planning, socio-economic & environmental								
Planning Policy & history	N							
Land use and land use quality	Y	●	●	●	●	●		
Flood plain encroachment	Y	●	●	●	●	●	●	●
Landscape character sensitivity	Y	●	●	●	●	●		●
Views & visual amenity	Y	●	●	●	●	●		●
Employment local economy	N							
Nature conservation & biodiversity	Y	●	●	●	●	●	●	●
Opportunity for biodiversity improvement	N							
Archaeology and the historic environment	Y	●	●	●	●	●		●
Non-traffic impact of construction on local residents	Y	●	●	●	●	●	●	
Impact of construction on local residents and traffic	Y	●	●	●		●		●
Impact on residential dwellings	Y	●		●				
Recreational benefit	Y	●		●				
Impact on recreation	Y	●	●	●	●	●		●
Water resources & water quality	Y	●	●	●	●	●	●	

Engineering Criteria								
Network reinforcement requirements	Y		●			●	●	●
Criteria	Stage 2 Criteria	Reservoirs	Water Reuse (Recycling)	Raw Water Transfers	Desalination	Direct River Abstraction	Groundwater	Inter-zonal transfers
Material use and local availability	Y	●						
Variation in topographical levels	Y	●						
Length of conveyance routes	Y	●	●	●	●	●		●
AIC (Normalised Costs)	N							
Pumping Head	Y		●	●	●	●	●	●
Water source and availability	Y		●	●	●	●	●	
Cost/benefit of further investigation to validate yield	Y						●	
Water treatability/process complexity	N							
Access during construction and operation	Y	●	●	●	●	●		●
Resilience	Y			●		●	●	
Power supply	N							
Connectivity to waste system	Y		●	●	●	●		
Hydrogeological suitability	Y						●	
Construction Complexity	Y	●	●	●	●	●	●	●
Operational Complexity	Y		●	●		●	●	●

Table 7-4: Stage 2 Assessment Criteria

7.59 RAG classifications are used to describe the performance of each site. These predominately signify:

- Red – issue or constraint can be overcome, but will be very challenging
- Amber – issue or constraint can be overcome
- Green – no constraint posed

7.60 The output from Stage 2 is a matrix for each site describing its performance against relevant criteria along with a written summary of which site or option performs best and should be taken forward to Stage 3. Where options are screened out at Stage 2 the reasoning is included in Appendix Q, Scheme Rejection Register.

Stage 3 Feasibility Assessment

7.61 Stage 3 of each feasibility assessment ensures that key issues that could constrain or affect the implementation of options on the short-list are considered. The issues are assessed in greater depth than at Stage 2, including regard being given to cost as well as the potential for mitigation measures to be employed. Although the assessment is still based on a high-level engineering / design basis at this stage.

7.62 Table 7-5 below shows the Stage 3 criteria, the circles indicate which options have considered the criterion as part of the Stage 3 assessment.

Criteria	Stage 3 Criteria	Reservoirs	Water Recycling	Raw Water Transfers	Desalination	Direct River Abstraction	Groundwater	Inter-zonal transfers
Property / legal criteria								
Ownership of site and tenancies	Y		●	●	●	●		●
Estimated land acquisition cost	N							
Planning, socio-economic & environmental								
Planning Policy & history	Y	●	●	●	●	●		
Land use and land use quality	Y	●	●	●	●	●		
Flood plain encroachment	Y	●	●	●	●	●		●
Landscape character sensitivity	Y	●	●	●	●	●		●
Views & visual amenity	Y	●	●	●	●	●		●
Employment local economy	Y	●	●	●	●	●		
Nature conservation & biodiversity	Y	●	●	●	●	●	●	●
Opportunity for biodiversity improvement	Y	●	●	●	●	●		
Archaeology and the historic environment	Y	●	●	●	●	●		●
Non-traffic impact of construction on local residents	Y	●	●	●	●	●		
Impact of construction on local residents and traffic	Y		●			●		
Impact on residential dwellings	N							
Recreational benefit	N							
Impact on recreation	Y	●	●	●	●	●		●
Water resources & water quality	Y	●	●	●	●	●	●	
Engineering Criteria								
Network reinforcement requirements	N							
Material use and local availability	N							
Variation in topographical levels	N							
Length of conveyance routes	Y		●	●	●	●		●
AIC (Normalised Costs)	Y	●	●	●	●	●	●	●
Pumping Head	N							
Water source and availability	Y		●	●		●	●	
Cost/benefit of further investigation to validate yield	N							

Criteria	Stage 3 Criteria	Reservoirs	Water Recycling	Raw Water Transfers	Desalination	Direct River Abstraction	Groundwater	Inter-zonal transfers
Water treatability/process complexity	Y		●	●	●	●		
Access during construction and operation	N							
Resilience	N							
Power supply	Y		●	●	●	●		
Connectivity to waste system	N							
Hydrogeological suitability	N							
Construction Complexity	Y	●	●	●	●	●		●
Operational Complexity	N							

Table 7-5: Stage 3 Assessment Criteria

7.63 RAG classifications continue to be used to describe the performance of each site. These predominately signify:

- Red – issue or constraint can be overcome, but will be very challenging
- Amber – issue or constraint can be overcome
- Green – no constraint posed

7.64 The output from Stage 3 is a further matrix for each site describing its performance against relevant criteria along with a written summary of which site or option performs best and should be taken forward to Validation. Where options are screened out at Stage 3 the reasoning is included in Appendix Q, Scheme Rejection Register.

Stage 4 Option Validation

7.65 The validation stage reviews the output of Stage 3 and provides confirmation of the recommendations for options to pass onto further screening. In some studies, the resource and conveyance elements are brought together and reviewed as a complete option in this section of the report.

7.66 As part of the validation the risks and uncertainties of the options that have passed Stage 3 are reviewed to identify if these will materially affect the overall assessment results.

7.67 The validated list of options from each feasibility study is taken forward into further screening. Where options are screened out at validation the reasoning is included in Appendix Q, Scheme Rejection Register.

Costing Methodology

7.68 The costing methodology used for WRMP24 is substantially the same as the WRMP19 methodology, however updates have been made to the following key areas of the estimations in order to ensure consistency with the other WRSE companies and to bring costs up to current rates:

- General updates to the costs to incorporate any updates to TW cost models and to update the inflation index date
- Option names and IDs have been updated to align with WRSE approach
- Following the All Company Working Group (ACWG) Cost Consistency Methodology Costs have been reviewed and updated for all existing WRMP19 options, and costs have been developed for all new options identified in WRMP24.
- Optimism bias has been updated to use ACWG methodology
- Quantitative risk has been applied to all non-standard options as per ACWG methodology
- Planning and development costs have been identified separately from construction costs for large options, following the WRSE methodology and as required for the purposes of programme appraisal

7.69 Figure 7-5 shows the costing processes followed for WRMP19 and WRMP24. Key updates for WRMP24 as outlined above will be explained in further detail throughout this section.

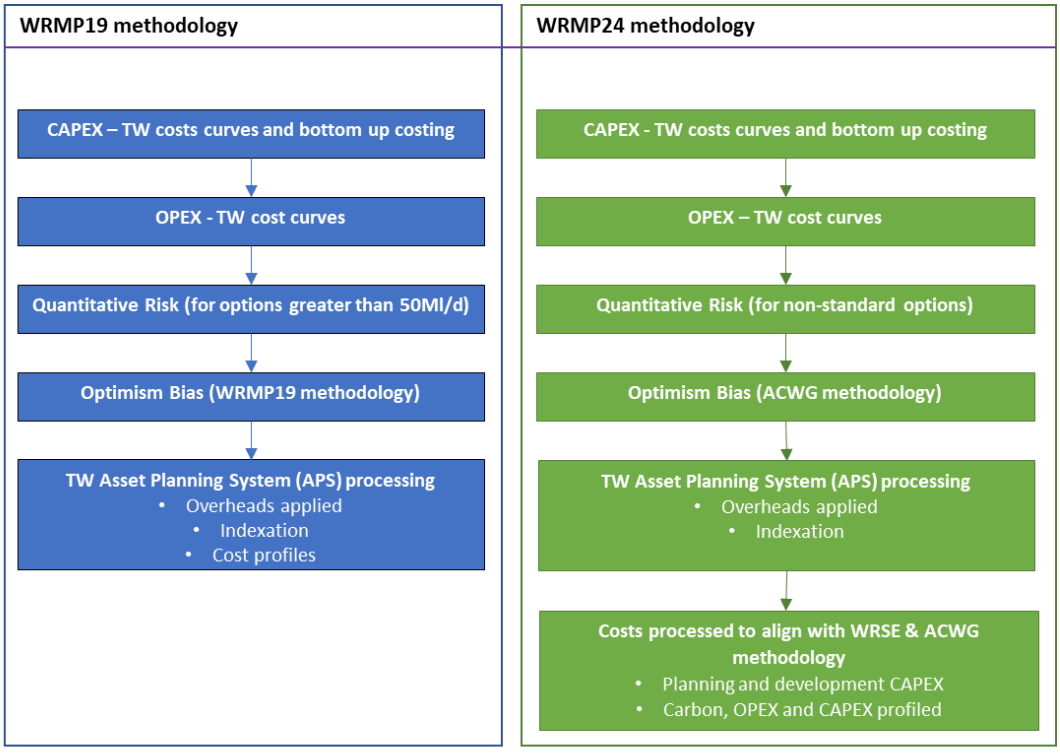

Figure 7-5: WRMP19 and WRM24 Approach Comparison

Carbon Assessment

7.70 Carbon is calculated for all options; this is estimated using Thames Water Engineering Estimating System (EES) models. Two types of carbon are calculated; capital carbon associated with materials, goods and services and operational carbon primarily associated with consumption of electricity, gas and chemicals once a project becomes operational.

7.71 Estimating capital carbon is undertaken within Thames Water Asset Planning System (APS) using the following approaches:

- Where capex has been estimated using EES and an applicable EES carbon model exists – the driver values used to derive the EES capex value are also used in the EES carbon model to derive a capital carbon value (in tCO_2e)
- Where capex has been estimated using a 'Non-EES' approach (i.e. there is no applicable EES cost model and hence no applicable EES carbon model) the capex estimate is used to derive the capital carbon value (in tCO_2e) based on tCO_2e/£ relationship built into APS. APS includes approximately one hundred tCO_2e/£ relationships which are assigned to different non-EES process codes.
- Where capex has been estimated using EES but an applicable EES carbon model does not exist – the EES capex estimate is used to derive the capital carbon value (in tCO_2e) based on the same tCO_2e/£ relationships (built into APS) that were used with 'Non-EES' capex estimates

7.72 The Thames Water EES models are split by EES coding structure. Calculations look at three main elements of work to calculate the carbon value for given construction requirements. These include:

- Labour: assessment of the number of workers required, the main carbon driver is travel and fuel
- Plant: assessment of the equipment required to perform the task. A significant carbon driver here is fuel
- Materials: carbon is calculated using data from the University of Bath Inventory of Carbon and Energy database[12] of tCO_2e per kg per weight of material

7.73 The combination of these factors gives total tCO_2e per 1 unit of measure and is stored in EES curves.

7.74 Project data is collected by Thames Water Capital Delivery team for scope and cost in accordance with our coding structure. This data is imported into the EES system. Carbon is automatically calculated using this data. Using this data, EES calculates tCO_2e for each option which is considered, and is converted to a cost for carbon which is used in the WRSE investment model.

7.75 As cost data is collected and imported into the system, the carbon is automatically calculated based upon code, volume, size and/or attributes unique to the project.

7.76 EES curves and the Asset Planning System (APS) are audited periodically during submissions for business plans by Ofwat's nominated consultants, currently Arup. An independent TW assurance is also carried out, this is currently completed by Mott MacDonald. The principles behind the carbon calculations and data were rigorously checked as part of PR19 submissions by Mott MacDonald, the process for carbon calculations is unchanged since this check was completed.

7.77 Emissions associated with electricity use during operation have been calculated using Government published datasets (by BEIS)[13], providing consistency in estimating the

[12] Hammond, G. P., & Jones, C. I. (2008). Embodied energy and carbon in construction materials. Proceedings of the Institution of Civil Engineers - Energy, 161(2), 87-98. https://doi.org/10.1680/ener.2008.161.2.87

[13] Department for Business, Energy & Industrial Strategy, 2023, Valuation of energy use and greenhouse gas emissions, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1129242/valuation-of-energy-use-greenhouse-gas-emissions-for-appraisal.pdf

carbon emissions arising from electricity consumed. This component will largely be decarbonised as the UK electrical grid transitions to more renewable generation, and this is reflected in the emissions which are calculated; however, we are still striving to promote efficiency and reduce electrical consumption to help make that transition easier.

7.78 Using methods described above, estimates of carbon emissions have been prepared for each option, including:

- Capital carbon
- Operational carbon excluding from electricity (fixed and variable)
- Electricity requirement, which is converted into carbon emissions using time-variant factors within the WRSE investment model (fixed and variable) aligned with BEIS guidance[14]

7.79 Carbon estimates calculated in APS are fed into the WRSE investment model.

7.80 With the carbon assessments covering construction and use, and with the WRSE investment model considering the need for 'repeat' capital emissions through asset replacement, the carbon assessments are well aligned with PAS2080 lifecycle stages A1-A5 and B1-B6.

7.81 The issue of uncertainty in carbon accounting is something which UK water companies are currently grappling with and will continue to be reviewed at WRMP29. There are two types of uncertainty in carbon assessments – one is relevant to emissions factors associated with specific materials/products (currently most water companies are using industry average factors) and one is a scoping uncertainty (associated with having the right scope of assets/activities when producing a carbon estimate).

7.82 To reduce the uncertainty in the carbon estimates over time, we expect to use more supplier-specific carbon data for major materials and products rather than industry generic emissions inventories, as the level of detail in an option's development increases. For scoping uncertainty, we expect this to reduce as WRMP projects are scoped with more confidence as they move through project lifecycle stages through to delivery.

7.83 WRSE developed a cost consistency methodology report which undertook a review of water company approaches for WRMPs and then undertook benchmarking of carbon estimates to bring greater consistency across the region. The WRSE approach incorporates the best practice guidance developed by UKWIR.

7.84 As part of the least cost modelling process, we optimised costs based on rates derived by the Treasury. The Treasury's Green Book recommends that costs and benefits occurring in the first 30 years of a programme, project or policy be discounted at an annual rate of 3.5% (Social Time Preference Rate) and recommends a schedule of declining discount rates thereafter. We have also based the carbon costs on the latest Green Book supplementary guidance on the valuation of energy use and greenhouse gas emissions

[14] Department for Business, Energy & Industrial Strategy, 2023, Valuation of energy use and greenhouse gas emissions, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1129242/valuation-of-energy-use-greenhouse-gas-emissions-for-appraisal.pdf

for appraisal[15]. Carbon costs have also taken account of the de-carbonisation of the grid in the future.

7.85 As most of these schemes will not be built until several years from now, time is available to work with the supply chain (e.g. steel and concrete manufacturers) to find new lower carbon solutions to construction. The All Company Working Group (ACWG), made up of the water companies with Strategic Resource Options (SROs), have engaged with the supply chain to develop scenarios on how different materials may decarbonise over time in the next 60 years. These are only scenarios and there is no guarantee that such materials will decarbonise without leadership and action in the supply chain over time. This engagement has produced emission reduction estimates for most facets of construction, ranging from the types of construction equipment moving around on site, to the type of steel that might be used in future pipelines. Three different scenarios have been produced, a worst case, middle case and best-case scenario; to allow for the industry moving slower or faster than expected. In order to present a conservative view, the "worst-case" scenario was adopted for inputs into the WRSE investment model.

7.86 For further information on WRSE approach to investment modelling and costing refer to Draft Regional Plan Water Resources South East, Technical Annex 1: The challenge we face and how we prepared our plan, November 2022 (wrse-draft-regional-plan-technical-annex-1-nov-2022.pdf).

7.87 Each of the SRO projects has reviewed opportunities for low-capital carbon alternatives following the All Company Working Group Carbon Ambition Methodology. Further information can be found in Section 6 of the SRO Gate 2 reports. Both SRO and non-SRO options have been selected through the investment model, which considers carbon as a key criteria through a monetised approach. Further opportunities for decarbonisation will be developed as the selected options are further developed. To take meaningful steps towards decarbonisation, non-SRO options will need to be further developed through the usual design process. In cases where options are selected far in the future these will need to be revisited closer to the time to ensure the latest technology is considered for decarbonisation.

Further Screening

7.88 New resource elements have been carried forward from the feasibility assessment onto the Feasible List for further screening. Further screening has been carried out on options which are subject to a combined limit, are mutually exclusive with another option or required further stakeholder engagement to determine viability. Multiple scenario runs of the WRSE investment model have been used to inform the further screening. The output of this stage is the Constrained List of options. Feasible options which did not meet the criteria for further option screening were rejected and are not included on the Constrained List of options.

[15] Department for Business, Energy & Industrial Strategy, 2023, Valuation of energy use and greenhouse gas emissions, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1129242/valuation-of-energy-use-greenhouse-gas-emissions-for-appraisal.pdf

SRO options

7.89 Options identified by Ofwat at PR19 as SROs have been developed through the Gated process in parallel to the WRMP24 process, as a result SRO options are further developed than other WRMP options. As the SRO options have been developed backchecking has been completed to ensure there is no change to feasibility assessments. Any changes made are reported in the feasibility addendums. Details of the SRO option development can be found in the Gate 1 and 2 reports published on our website[16].

Identifying third party options

7.90 We have sought to identify potential third-party water resource options through three main approaches:

1) Request for proposals for water resources through the Bid Assessment Framework (BAF) [Bid Assessment Framework (thameswater.co.uk)] 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.

2) Bilateral discussions with other water companies.

3) Active engagement with regional water resource planning groups including the Water Resources in the South East Group (WRSE), Water Resources West (WRW), Water Resources East Group (WRE) and the West Country Water Resources Group (WCWR).

7.91 Where we have been offered new options by third parties, we have taken them through a fair, proportionate evaluation process as laid out in our BAF.

7.92 When suppliers get in touch with us to offer a supply or demand option to us, we encourage them to complete a PQQ1 (initial) survey online so that we can understand the basic details of the option – the questions we ask are included with our Bid Assessment Framework and have been carefully designed to match the options appraisal criteria that we use within our Best Value Planning process. These factors include volume to be supplied (or saved), drought resilience of this as relevant, deliverability and cost. If an option is assessed as passing this stage (using the same thresholds and standards to judge against as applied to in-house options), then the supplier is offered the opportunity for co-funding by Thames Water to develop the option further, subject to mutually agreeable terms being drawn up and signed. If suppliers wish to instead self-fund the next stage of development, they are treated equally to those requesting co-funding. The suppliers proceed through a process of providing more detailed information to us via the PQQ2 and PQQ3 surveys, the contents of which are also available in our BAF and mirror our BVP criteria for later stages of options appraisal.

7.93 In our options appraisal and investment modelling process, we use the most up to date information available for each option, whether proposed by a third party or in-house, to compare options and ultimately develop our Best Value Plan. If and how each option is ultimately featured in our plan is dictated by how the option performs across the best value criteria compared to the other options under consideration. We have received a number of option proposals that are less well understood where conversations to develop a shared understanding of the benefits and impacts of these is ongoing; these are predominantly

[16] https://www.thameswater.co.uk/about-us/regulation/strategic-water-resource-solutions

sea tankering options. We will continue these discussions and update our position on these as these options are developed over future planning cycles.

Co-development of Options

7.94 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

7.95 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.

7.96 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.

7.97 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 through our Catchment Fund

7.98 We're currently offering up to £15,000 per farm business to help farmers in target areas protect water quality[17]. 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 7-6: Catchment Fund Target Areas and associated Figure 7-6. 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[18].

[17] 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
[18] Catchment Fund additional information https://www.thameswater.co.uk/media-library/home/about-us/responsibility/smarter-water-catchments/catchment-fund-additional-information.pdf

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
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 Foundry 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

Catchment	Catchment type	Water quality target (s)	Project partner
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

Table 7-6: Catchment Fund Target Areas

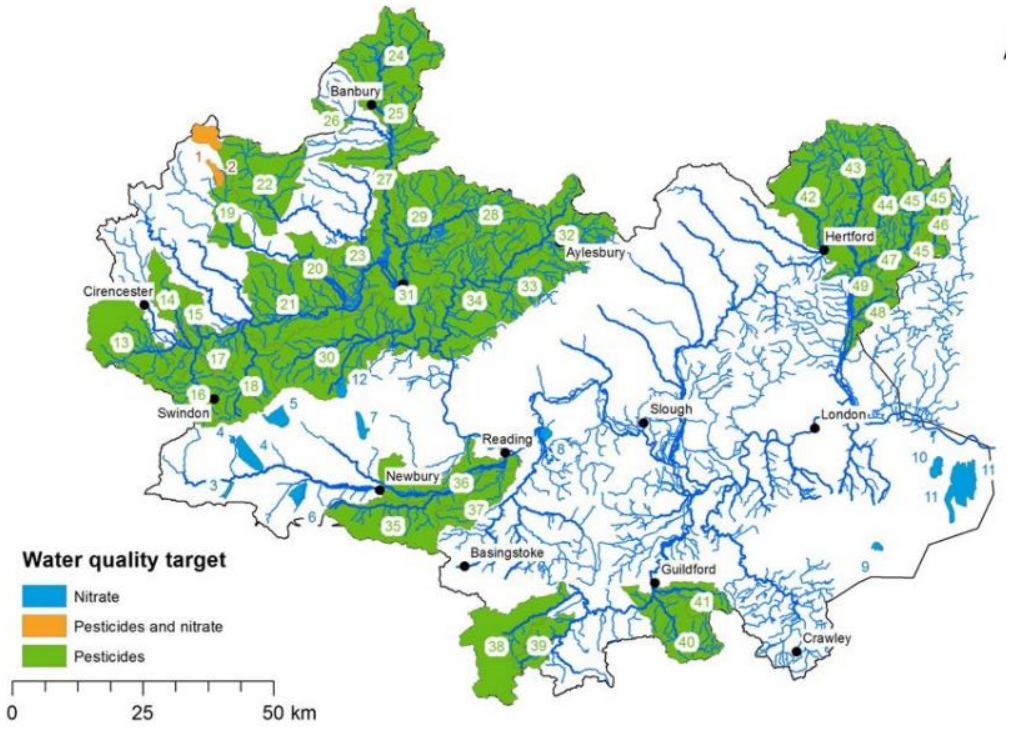

Figure 7-6: *Catchment Fund Target Area Map*

Request for proposals for water resources

7.99 In preparation for WRMP24, on 16 March 2020 we published a Periodic Indicative Notice via OJEU to invite third party organisations to register interest in providing a water resources or demand management option. We regularly update this notice, updating via the UK Find a Tender service (UK FAT) post Brexit (26 March 2021 and 6 April 2022). A summary of the responses received related to new water resource options is set out in Table 7-7.

Company	Nature of supply option	Volume (Ml/d)	WRMP24 status
Tankering by sea			
Albion Water (now WaterLevel/ EDRS)	Raw water tankering by sea from Norway.	30 - 440	Assessment at WRMP14 found tankering by sea to be excessively costly to supply our geographic area. Albion (now WaterLevel/EDRS) engaged further with us and with WRSE during preparation of WRMP24 through the stakeholder engagement process. However, the assessment of the option remains that it is infeasible as a water resource option, for reasons of uncertainty relating to DO, utilisation, cost and carbon. Tankering has therefore not been developed as a water resources option. Option considered in generic option screening section. This option has continued to be developed by the supplier over the course of the preparation of the WRMP24 plan. This work will continue in the short-term and over the next planning cycle in dialogue with water companies across the U.K. including Thames Water.
Raw Water Purchase			
RWE Npower	Temporary agreement in relation to Didcot power station abstraction licence.	22.6 Ml/d	Extension to existing (AMP7) agreement over temporary licence trade. Included in Programme Appraisal as a constrained list option for use between 2025 and 2030. RWE and Thames Water have a current (AMP7) licence trade agreement whereby RWE will reduce their consumptive abstraction at Didcot Power Station, allowing for increased abstraction downstream by Thames Water. Through consultation with RWE it has been confirmed that this agreement could, if selected, be extended through AMP8, but that RWE may require the water on which this trade is based after 2030. As such this option is only available between 2025 and 2030.
Pump House Water Ltd	Offer of a bulk supply from an existing pumping station served by multiple boreholes in Upton which is under private ownership. This source was previously under Thames Water ownership.	Unknown	The bidder made contact with Thames Water by email on the 18th May 2021. After consideration of the bid in line with our BAF process, the option was rejected owing to material concerns that, based on the site's history, the abstraction would be unacceptable on environmental grounds. This decision was communicated to the bidder on the 25 May 2021. Confirmed the licence has been revoked, this option was therefore rejected without screening.
Well 1 Oy	Offer of shares providing access to raw water to be made available at a harbour	5 Ml/d	We have assessed this option alongside the other sea tankering options offered to us. While we do not as yet consider this option type to be feasible, we will continue to work with and

Company	Nature of supply option	Volume (Ml/d)	WRMP24 status
	in Finland for onward tankering by Thames Water.		communicate with all suppliers of this option type as development of this scheme type matures.
Thomas Schumann Capital LLC	Offer of raw or treated glacier water tankered from Greenland, available for 20 years.	Unknown	We have assessed this option alongside the other sea tankering options offered to us. While we do not as yet consider this option type to be feasible, we will continue to work with and communicate with all suppliers of this option type as development of this scheme type matures.
Cenergist Ltd	This option involves the retro-fitting of flow controllers to properties.	Unknown	This bidder's option is known to Thames Water, alongside others in the market, and we have reviewed the insight from other water company trials with interest. We are looking to trial this technology as part of our water efficiency programme ahead of or within AMP8.
Grundfos Pumps Ltd	Two solutions proposed, comprising analytics software and a hardware solution for pressure management and pumping optimisation in distribution networks.	Unknown	Because the demand management solutions proposed are of a type that we already implement as a business, we have encouraged the bidder to re-contact us to offer these solutions when we next go out to the market to procure these services. We are not able to contract for demand management solutions directly as part of our WRMP process.

Table 7-7: Status of OJEU/UK FAT water resource options

Bilateral discussions with other water companies

7.100 Since WRMP19 we have continued to engage on a bilateral basis with other water companies (and via WRSE and other regional groups) to identify and develop potential new resource options in the form of:

- Inter-company raw water transfers[19] – these are assessed in the WRMP19 Raw Water Transfers Feasibility Report and WRMP24 Addendum
- Inter-company treated water transfers[20] – these are assessed in the WRMP19 Inter-Zonal Transfer Feasibility Report and WRMP24 Addendum

7.101 Companies that are willing to offer water to supply us include: South East Water, Severn Trent Water, SES Water, Canal and River Trust, RWE and United Utilities.

7.102 With the regional planning groups we have also engaged with other companies concerning their future deficits and how we may be able to provide water to address these.

[19] Raw Water Transfers Feasibility Report, Mott MacDonald, September 2018
[20] Inter-zonal Water Transfers Feasibility Report, Mott MacDonald, February 2018

Regional groups (WRSE)

Overview of WRSE

7.103 Our approach to water resources planning has moved from one of being company focussed in WRMP19 to being regionally focussed in WRMP24. Our supply forecast, demand forecast, allowance for uncertainty, and approach to options development and appraisal have all followed regionally aligned methods, and our investment modelling approach is to determine the Best Value plan for the WRSE region, rather than considering Thames Water customers in isolation.

7.104 Regarding feasibility assessment of water resources options, WRSE has introduced new initiatives to ensure that all feasible options are considered. The first of these was the analysis of company rejection registers to identify options rejected by one company which could be feasible for a different company, while the second was the identification and development of option types with specific potential benefits to regional planning. These were: a) Multisector options (for inclusion in regional rather than company WRMPs), b) intra-regional, inter-zonal transfers, c) Catchment options and d) Resilience options. These workstreams are described in further detail in WRSE reports published on their website (Home | WRSE - Water Resource South East). WRSE also encouraged the proposal of options from third parties.

7.105 A summary of third-party options submitted to WRSE is described in Table 7-8.

Option	Organisation	Description	Assessment
RWE raw water purchase	RWE	In 2021, RWE made an offer through the WRSE stakeholder engagement tool of up to 45 Ml/d of resource in the River Thames, proposing both licence trade schemes and schemes involving new Water Treatment Works.	Options have been screened by Thames Water and Affinity Water.
Mendip quarries	West Country Water Resources (WCWR)	RAPID's gap analysis identified potential for redevelopment of a quarry in the Mendips as a potential reservoir.	Pre-feasibility report and Gate 1 submission have been prepared by Wessex Water and South West Water to include the option as a potential resource for either WCWR, or WRSE. The regional reconciliation has ruled out this transfer in all scenarios for WRSE companies' use as the water is required to meet the West Country regional demands. It is therefore rejected as an option to supply Thames Water.
Extreme Drought	WaterLevel	Proposal for sea tankering of water from Norway to London and Kent for use in extreme	Categorised as a 'more before 4' option and as such has not been included in the

Option	Organisation	Description	Assessment
Resilience Service		drought. Includes for insurance premium to cover costs of up to 6 months of daily deliveries of up to 60 Ml/d.	Feasible List for the regional plan. This option has continued to be developed by the supplier over the course of the preparation of the r WRMP24 plan. This work will continue in the short-term and over the next planning cycle in dialogue with water companies across the U.K. including Thames Water. Option also considered above in third party options.
Community water recycling scheme for new developments	Albion Water	Community water recycling scheme for new developments.	Water companies are not submitting individual demand management options to WRSE for the regional plan but instead are providing combined demand management strategies. The proposals should be considered by companies as part of delivery of those strategies.
Community engagement	South East Rivers Trust	Collection of suggestions around demand management and catchment management.	Water companies are not submitting individual demand management options to WRSE for the regional plan but instead are providing combined demand management strategies. The proposals should be considered by companies as part of delivery of those strategies.
Nitrate Treatment	Agua GB	Nitrate treatment solution which could provide cost efficiencies for schemes which require nitrate treatment in the future.	Where companies are developing nitrate removal schemes then the option provides an opportunity that could be reviewed by companies when estimating option costs.

Table 7-8: Summary of Third-Party Options Submitted to WRSE

7.106 The WRSE regional investment model incorporated the constrained list of options from the six WRSE water companies to develop a cost-efficient adaptive programme, as well as alternative programmes which have been appraised to determine the regional Best Value plan (see WRMP24 Sections 10 and 11). Further details on the WRSE regional model can be found in the published document on the WRSE website.

WRSE Regional Approach

7.107 As has been described, 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), a database which stores option data. The DLP is then used to provide inputs to the WRSE investment model, ensuring smooth and reliable data input to the investment model.

7.108 Resource options and associated system elements have been developed to be used in the WRSE investment model such that single resource options could be used by any company for whom such use is feasible. For example, the Teddington DRA has been developed by Thames Water (through the London Water Recycling SRO), but conveyance elements exist within the investment model such that the option could be used by Affinity Water, if this presents a cost-effective solution.

7.109 Regional transfer options have been developed through WRSE to move water around the southeast more easily by 2060, making use of surplus where it exists in the region, and allowing new resource to be transferred across the region. These options work alongside the resource options to supply the southeast region. We have screened regional transfer options identified through work completed by WRSE that could transfer water into the Thames Water area.

7.110 In some cases, the high-level options development process followed by WRSE has resulted in transfer options which would require system enhancements that have not been developed. In other cases, risk-based screening decisions have been taken, for example screening out newly developed WRSE transfers which would be reliant on the implementation of TUBs/NEUBs by the donor company, or where the ability of a company to supply water through a transfer in the future would be solely dependent on the success of demand reduction activities.

7.111 Further information on WRSE work on transfer options can be found in WRSE regional plan. We have taken three options forward from this work:

- a transfer from SES from Reigate to Guildford of either 5 or 20 Ml/d
- a transfer from SES from Cheam to London (Merton)
- a transfer from SES from Woodmansterne to London (Epsom Downs)

7.112 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.
- Collation of all catchment options included on 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.

7.113 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). Around a quarter of the options identified were river restoration measures, with substantial numbers of water retention measures (including natural flood management and wetland creation) and nutrient and sediment reduction measures. Smaller numbers of integrated catchment management and terrestrial habitat creation measures were proposed.

7.114 The catchment options were subject to screening and assessment to establish their wider socio-economic and resilience benefits[21], and their overall feasibility, as far as was permitted by the information available for each option. An initial exercise was also carried out to estimate the cost of delivering these options on a consistent basis. This work will be developed further over this and successive planning cycles to improve the quality of the information available for the proposed options and mature the screening and development process for catchment options.

7.115 The options that were progressed through this screening process were then compiled into catchment portfolios to compare the proposed options with regards to their contribution to current and future catchment challenges, targeting catchment deficits, catchment issues, problem characterisation and future problems. Standard options (Portfolio 1) were those identified to address the deficit issues and environmental need, both now and with any predicted changes in the future, and these portfolios of options were inputted into WRSE's investment model to develop to regional plan.

7.116 We have identified three schemes (below) 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 have been 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. Our existing programmes to support development and delivery of catchment options are described in Section 2.

Water Source	Water Resource Zone	Maximum Potential Deployable Output Benefit	Water Quality Risks
Bean Wellfield (Groundwater)	London	0.1 Ml/d	Nitrates, turbidity
Green Street Green (Groundwater)	London	0.3 Ml/d	Nitrates
Wilmington (Groundwater)	London	0.2 Ml/d	Nitrates

[21] Further information provided in Framework for identifying and appraising existing and new catchment options, Water Resources South East, May 2022

Table 7-9: Nature-based solutions programme options

Existing trade agreements and export options

7.117 Through collaboration with WRSE regional group and other regional groups export transfer options have been identified which benefit other water companies by transferring water from the Thames Water area. These options are reflected in the receiving water company's WRMP. A list of these options is provided below:

- up to 120 Ml/d to Southern Water via Thames Water to Southern Water Transfer (T2ST)
- up to 100 Ml/d to Affinity Water via Thames Water to Affinity Water Transfer (T2AT)
- up to 10 Ml/d export from London (Perivale) to Affinity
- up to 5 Ml/d export from London (Cockfosters) to Affinity

7.118 Our existing exports to other WRSE companies have been included in the WRSE IVM, this allows these transfers to be ended or amended as part of the Best Value Plan. Existing exports include:

- Supply to Affinity Water at Sunnymeads WTW from Wraysbury reservoir, c.2Ml/d average but larger capacity available in emergencies
- Supply to Affinity Water from London to Fortis Green, up to 27 Ml/d[22]
- Supply to Affinity Water from London to Hampstead Land, up to 0.2 Ml/d
- Supply to Affinity Water from Guildford to Ladymead. Up to 2.27 Ml/d

7.119 In addition, we have an agreement with Essex and Suffolk to export up to 94.25 Ml/d from King George V and William Girling Reservoirs. We have agreed with Essex and Suffolk that the maximum export quantity can by reduced to 71.25 Ml/d until 2035, after 2035 Essex and Suffolk forecast a requirement for the full transfer capacity to be available.

7.120 These options have not been included in Appendix P, Q and R as they are existing options. Section 11 provides details of which of these options has been retained in the plan.

Option DO Assessment

7.121 In order to determine the benefit that different options would bring, we determine their Deployable Output (DO) benefits. Deployable Output is a measure of the supply capability of a water resource system under specified (generally drought) conditions and our option DO assessment involves determining how much more water we could supply from a WRZ if that option were available. Our Baseline DO assessment is described in Section 4, with further detail in Appendix I.

7.122 Our option DO assessment follows methods set out in the WRSE method statement on Deployable Output[23]. This involves triaging options to identify an appropriate level of sophistication to apply in option DO calculation. We have a large number of potential options, and the calculation of DO can be very computationally intensive, and so we need to identify those options where effort is needed, and those options where a more simplified approach will give an acceptable answer.

[22] Following discussion with Affinity Water, it has been identified that, while the contractual maximum volume for this transfer is 27 Ml/d (6 million gallons per day), current infrastructure constraints limit its capacity to 14 Ml/d
[23] Water Resources South East, 2021, Method Statement: Calculation of deployable Output, https://www.wrse.org.uk/media/sbblilys/method-statement-depolyable-output-aug-21.pdf

7.123 Tier 1: For large options where the DO benefit is very dependent on the weather (for example, new reservoirs and the Severn-Thames Transfer) we have applied the same methods as our baseline DO assessment when determining option DO benefits. This involved the use of stochastic datasets, and the determination of a '1 in 500-year' Deployable Output. For these options we have also conducted a climate change impact assessment using the same methods as applied in our baseline DO assessment.

7.124 Tier 2: For smaller options where the DO is dependent on the weather, or for large options where DO is not very dependent on the weather (for example effluent recycling or desalination schemes), we have conducted a DO assessment using historical weather datasets (historical weather datasets being around 100 years in length, compared to 19,200 years for stochastic datasets), with our assumption being that these options' supply capability will be approximately the same under 1 in 100-year (worst historical) and 1 in 500-year (the standard of resilience against which we are required to measure our supply capability) drought events.

7.125 Tier 3: For small options where the DO is not particularly dependent on the weather, option DO has been simply assumed to be equal to that option's 'yield' capability, where the yield is the amount of water that it is assumed could be produced by a scheme. In these cases, no water resources modelling has been carried out.

7.126 As described in this chapter, we have assessed the system reinforcements that may be needed to enable supply options to release their full supply benefit. As such, we have calculated the DO benefit of options assuming that all necessary system reinforcements are in place, later ensuring that option dependencies are set up such that resource options are dependent on required system reinforcements.

7.127 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.

7.128 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.

7.129 For the reasons highlighted above, for our larger solutions we undertake all Deployable Output modelling using a staged process. In this process (see Figure 7- 7: Deployable Output Calculation Process), 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".

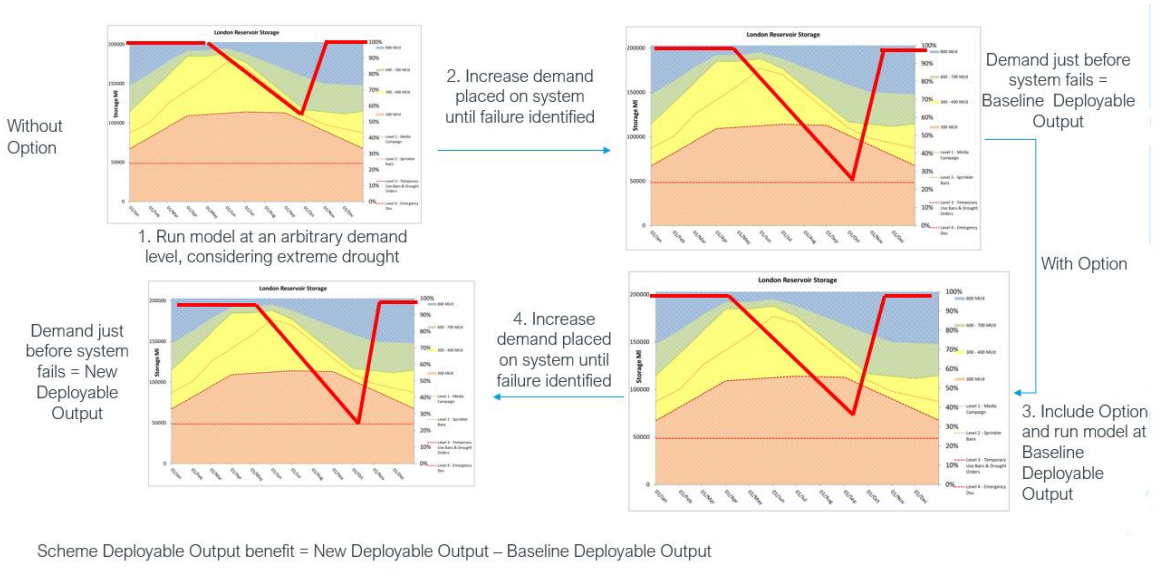

Figure 7- 7: Deployable Output Calculation Process

7.130 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)

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

7.132 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

7.133 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.

7.134 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 in 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).

7.135 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 7- 8 *London Drawdown from a Model Run in which fixed % LTA Rainfall Scenarios were used*) 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.

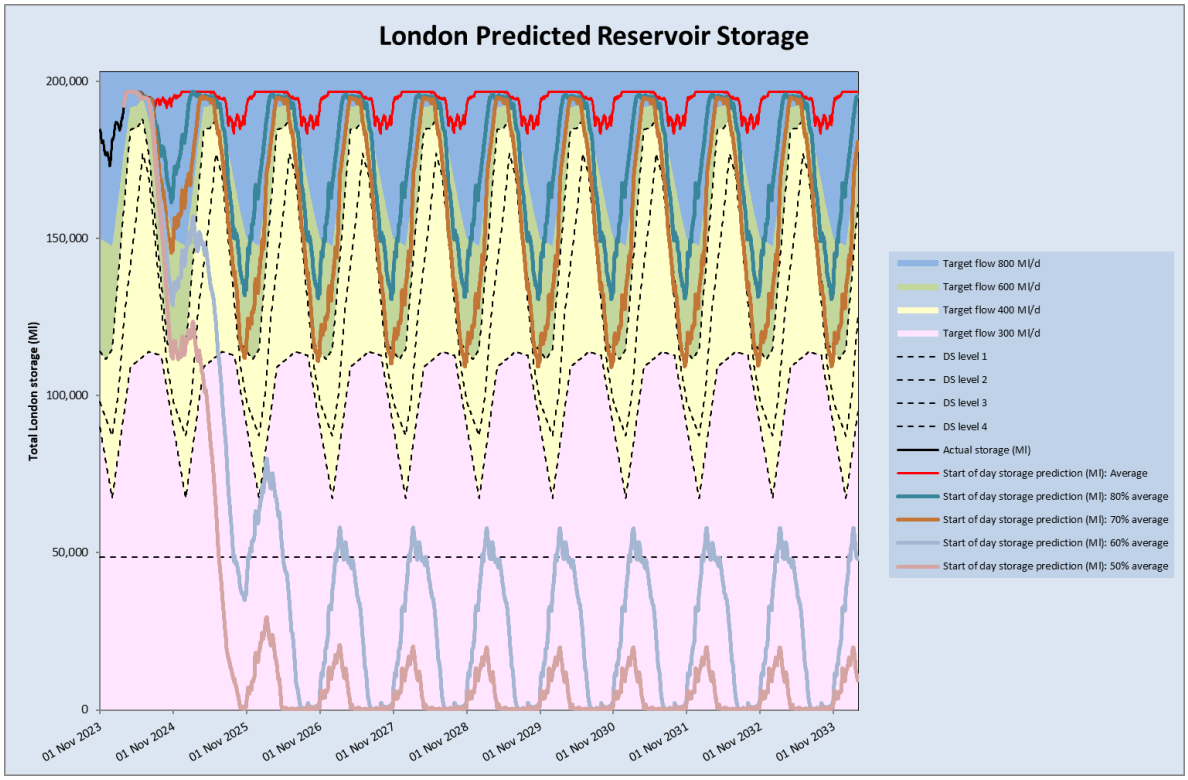

Figure 7- 8 *London Drawdown from a Model Run in which fixed % LTA Rainfall Scenarios were used*

7.136 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.

SESRO

7.137 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[24] = 144,450, which is close to the usable volume of the reservoir.

7.138 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).

[24] Note: 321 Ml/d is the release volume which was identified through an iterative modelling exercise seeking the maximum Deployable Output benefit from the reservoir. The use of 15 months is illustrative, recognising an approximately 18-month drawdown period, with a likely winter hiatus of approximately 3 months. These figures are intended to be an illustrative interpretation which make sense of model results.

7.139 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. The Table 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.

Table 7- 10: System Yield and Yield Output Benefit Example

	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*

7.140 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.

Transfers to other companies in the South East Region

7.141 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.

7.142 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 to mitigate the risk of emptying reservoirs.

7.143 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.

7.144 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.

7.145 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.

7.146 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.

Feasible List

7.147 The output from the feasibility reports was the Feasible List of water resource options. The specific options in the Feasible List are summarised in Table 7-11 below. The table features some options which are phased – these are options which can be built in a modular way, which gives us flexibility to meet incremental increases in need over time.

7.148 For those options that have not been carried forward to the Constrained List an explanation of the reasons for rejection is included in Appendix Q: Scheme rejection register.

Option type	Name	Capacity[25] (Ml/d)	Deployable Output Benefit (Ml/d) 1 in 2 average	1 in 500 average	1 in 500 peak	Commentary
London WRZ						
Water Recycling	Recycling Beckton - 380 Ml/d[26]	380	316	316	316	There are no critical changes since screening at WRMP19. Refer to London Water Recycling Gate 2 submission for development of the engineering design and environmental assessment since WRMP19. Tier 2 DO calculation carried out, and so DO benefit is WRMP19 DO benefit, reduced to reflect removal of demand savings during a drought from DO. Assumed that climate change does not impact DO benefit as recycling scheme yield is resilient up to Level 4 restrictions.
	Recycling Beckton - 300 Ml/d[27]	300	252	252	252	
	Recycling Beckton - 200 Ml/d	200	172	172	172	
	Recycling Beckton - 150 Ml/d	150	130	130	130	
	Recycling Beckton - 100 Ml/d	100	89	89	89	
	Recycling Beckton - 50 Ml/d	50	46	46	46	
	Recycling Mogden - 150 Ml/d	150	130	130	130	
	Recycling Mogden - 100 Ml/d	100	88	88	88	
	Recycling Mogden - 50 Ml/d	50	46	46	46	
	Deephams Recycling – 46.5 Ml/d[28]	46.5	42	42	42	The option is on the Feasible List with the constraint that the scheme is not implemented till post c.2060 due to the option presenting a substantial environmental risk if implemented prior to this period. Tier 2 DO calculation carried out, and so DO benefit is WRMP19 DO benefit, reduced to reflect removal of demand savings during a drought from DO. Assumed that climate change does not impact DO benefit as recycling scheme yield is resilient up to Level 4 restrictions.
	Crossness Recycling - 190 Ml/d	190	164	164	164	Rejected at further screening, therefore not included on Constrained List. Tier 2 DO calculation carried out, and so DO benefit is WRMP19 DO benefit, reduced to reflect removal of demand savings during a drought from DO. Assumed that climate change does not impact DO benefit as recycling scheme yield is resilient up to Level 4 restrictions. This applied to schemes below. Refer to London Water Recycling Gate 2 submission for development of the engineering design and environmental assessment since WRMP19.
	Crossness Recycling - 150 Ml/d	150	130	130	130	Rejected at further screening, therefore not included on Constrained List.
	Crossness Recycling - 100 Ml/d	100	89	89	89	Rejected at further screening, therefore not included on Constrained List.
	Crossness Recycling - 90 Ml/d	90	79	79	79	Rejected at further screening, therefore not included on Constrained List.
	Crossness Recycling - 50 Ml/d	50	46	46	46	Rejected at further screening, therefore not included on Constrained List.
	Recycling Mogden S Sewer – 50 Ml/d	50	46	46	46	Rejected at further screening, therefore not included on Constrained List.

[25] Capacity is stated in Ml/d unless stated otherwise.

[26] A WRMP19 review of cumulative effects of Thames Water WRMP19 options on the receptor environment in the Middle Thames Tideway identified that if there is more than a 15-20% decrease (275-366 Ml/d) in freshwater inputs to the Middle Tideway normal salinity patterns could be substantially affected. The London Water Recycling SRO has therefore considered options up to 300 Ml/d, however at WRMP19 a maximum capacity of 380 Ml/d was assessed as feasible for Beckton Reuse. The 380 Ml/d option remains on the Feasible List while further work is ongoing to review the cumulative impact of options on the Middle Tideway salinity. Through the SRO package of work the cumulative effects have continued to be investigated.

[27] Option is phased in WRSE investment model option, see Appendix R for details of phasing

[28] Following completion of the further studies by Thames Water, a joint review of the findings with the Environment Agency has established that a Deephams STW Reuse option is incompatible with the environmental ambition flow targets that the Environment Agency is seeking to deliver for the Lower River Lee through WRSE and the Environment Agency's Environmental Destination work. The option has been included on the Constrained List for implementation after c.2060 as it could be considered following delivery of measures under the EA's Environmental Destination work.

Option type	Name	Capacity[25] (Ml/d)	Deployable Output Benefit (Ml/d) 1 in 2 average	1 in 500 average	1 in 500 peak	Commentary
	Recycling Mogden S Sewer – 25 Ml/d	25	23	23	23	Dry Weather Flow (DWF) monitoring data was gathered during the London Effluent Recycling SRO Gate 2 stage, which showed DWF values of 33 to 36 Ml/d. This is substantially below a DWF of 60 Ml/d required to support a 50 Ml/d Mogden South Sewer scheme. As a result, only a smaller deployable output c.25 Ml/d is possible, the 50Ml/d option is rejected after the additional wastewater benefits of the option are reviewed. Refer to London Water Recycling Gate 2 submission for development of the engineering design and environmental assessment since WRMP19.
Desalination	Crossness Desalination (Blended) – 300 Ml/d[29]	300	267	267	267	Tier 2 DO calculation carried out, and so DO benefit is WRMP19 DO benefit, reduced to reflect removal of demand savings during a drought from DO. Assumed that climate change does not impact DO benefit as recycling scheme yield is resilient up to Level 4 restrictions.
	Crossness Desalination (Blended) – 250 Ml/d	250	222	222	222	
	Crossness Desalination (Blended) – 200 Ml/d	200	178	178	178	
	Crossness Desalination (Blended) – 150 Ml/d	150	133	133	133	
	Crossness Desalination (Blended) – 100 Ml/d	100	89	89	89	
	Crossness Desalination (Blended) –50 Ml/d	50	44	44	44	
	Beckton Desalination - 150 Ml/d	150	133	133	133	Tier 2 DO calculation carried out, and so DO benefit is WRMP19 DO benefit, reduced to reflect removal of demand savings during a drought from DO. Assumed that climate change does not impact DO benefit as desalination scheme yield is resilient.
	Beckton Desalination – 100 Ml/d	100	89	89	89	
	Beckton Desalination – 50 Ml/d	50	44	44	44	
Raw Water Transfer (resource	Mythe abstraction reduction - 15 Ml/d – STT resource	15	10	10	14	Rejected at further screening, therefore not included on Constrained List. See STT Unsupported
	Minworth STW effluent diversion Phase 2 – 115 Ml/d – STT resource	115	74	74	103	See STT Unsupported
	Minworth STW effluent diversion Phase 1 – 58 Ml/d– STT resource	58	37	37	53	See STT Unsupported
	Netheridge STW effluent diversion - 35 Ml/d – STT resource	35	24	24	34	See STT Unsupported
	Shrewsbury Redeployment – 25 Ml/d – STT resource	25	14	14	19	Rejected at further screening, therefore not included on Constrained List. See STT Unsupported
	Lake Vyrnwy - 25 Ml/d – STT resource	25	0	13	18	
	Lake Vyrnwy - 50 Ml/d – STT resource	50	0	29	41	See STT Unsupported
	Lake Vyrnwy - 80 Ml/d – STT resource	80	0	48	68	See STT Unsupported
	Lake Vyrnwy - 110 Ml/d – STT resource	110	0	68	96	See STT Unsupported
	Lake Vyrnwy - 140 Ml/d – STT resource	140	0	87	123	See STT Unsupported

[29] Option is phased in WRSE investment model option, see Appendix R for details of phasing.

Option type	Name	Capacity[25] (Ml/d)	Deployable Output Benefit (Ml/d) 1 in 2 average	1 in 500 average	1 in 500 peak	Commentary
	Lake Vyrnwy - 160 Ml/d – STT resource	160	0	100	141	See STT Unsupported
	Lake Vyrnwy - 180 Ml/d – STT resource	180	0	112	160	See STT Unsupported
	Oxford Canal - Cropredy resource[30]	15	10.3	10.3	10.3	Tier 2 DO calculation carried out, and so DO benefit is WRMP19 DO benefit, reduced to reflect removal of demand savings during a drought from DO. Yield previously been found to be resilient to 1 in 200-year drought, but not investigated further.
Raw Water Transfer (conveyance)	STT - Raw Water Transfer Deerhurst to Culham - 300 Ml/d	300	80	80	80	Commentary reflects all STT options, i.e., unsupported pipeline and support options. Tier 1 DO calculation undertaken using WRSE Pywr model, involving a 'full stochastic' DO assessment, and incorporating the impact of climate change as per the WRSE standard approach to climate change assessment. For support sources, DO benefit values incorporate assumptions around losses in the River Severn between release point and Deerhurst. Unsupported STT has been assumed to give supply benefit to London WRZ only, unless accompanied by SESRO. Support sources can give benefit to Southern, Affinity, and Thames Valley zones as needed. The London WRZ has large reservoirs and is vulnerable to long (12-18m) periods of drawdown, whereas other TW zones and Affinity/Southern WRZs do not have as large an amount of storage and so are more vulnerable to short drought periods, during which the unsupported STT has risk of giving no benefit. Refer to River Severn to River Thames Transfer (STT) Gate 2 submission for development of the engineering design and environmental assessment since WRMP19.
	STT - Raw Water Transfer Deerhurst to Culham 400 Ml/d	400	107	107	107	
	STT - Raw Water Transfer Deerhurst to Culham - 500 Ml/d	500	134	134	134	
	STT - Cotswold Canal - 300 Ml/d	300	80	80	80	Rejected at further screening, therefore not included on Constrained List
Reservoir	SESRO / Abingdon Reservoir - 150 Mm^3	150 Mm^3	271	271	271	Tier 1 DO calculation undertaken using WRSE Pywr model, involving a 'full stochastic' DO assessment, and incorporating the impact of climate change as per the WRSE standard approach to climate change assessment. Refer to South East Strategic Reservoir Option (SESRO) Gate 2 submission for development of the engineering design and environmental assessment since WRMP19.
	SESRO / Abingdon Reservoir - 125 Mm^3	125 Mm^3	230	230	230	
	SESRO / Abingdon Reservoir - 100 Mm^3	100 Mm^3	185	185	185	
	SESRO / Abingdon Reservoir - 75 Mm^3	75 Mm^3	149	149	149	
	SESRO / Abingdon Reservoir – 50 Mm^3	50 Mm^3	103	103	103	Rejected at further screening, therefore not included on Constrained List
	SESRO / Abingdon Reservoir – 30 Mm^3	30 Mm^3	66	66	66	Rejected at further screening, therefore not included on Constrained List
	SESRO / Abingdon Reservoir Phased - 80 + 42 Mm^3	80 Mm^3 + 42 Mm^3	224 (155.1 + 68.9)	224 (155.1 + 68.9)	224 (155.1 + 68.9)	Tier 1 DO calculation undertaken using WRSE Pywr model, involving a 'full stochastic' DO assessment, and incorporating the impact of climate change as per the WRSE standard approach to climate change assessment. Note the SESRO Phase 1 30 Ml/d option can be selected without Phase 2 100 Ml/d, this differs from the 30 Ml/d rejected options as it sets up the site to allow further expansion. The single phase 30 Ml/d option would block future expansion. The single-phase option is rejected on the basis that the site is the only location suitable for a larger reservoir, it would therefore not be appropriate to block this site with a small reservoir preventing any future development.
	SESRO / Abingdon Reservoir Phased – 30 + 100 Mm^3	30 Mm^3 + 100 Mm^3	238 (65.5 + 173.1)	238 (65.5 + 173.1)	238 (65.5 + 173.1)	

[30] Two Oxford Canal options have been identified. The Cropredy option supplies the London Water Resource zone by transfer of water to canal at Cropredy for discharge to River Cherwell and subsequent discharge to the River Thames. The second option supplies SWOX through a conveyance pipeline from Duke's Cut on the Oxford Canal to the River Thames upstream of the existing Farmoor intake.

Option type	Name	Capacity[25] (Ml/d)	Deployable Output Benefit (Ml/d) 1 in 2 average	1 in 500 average	1 in 500 peak	Commentary
	Site 41 - Chinnor Reservoir 30 Mm^3	30 Mm^3	66	66	66	Values as modelled for SESRO option adopted for other reservoir locations. As such, Tier 1 DO calculation undertaken using WRSE Pywr model, involving a 'full stochastic' DO assessment, and incorporating the impact of climate change as per the WRSE standard approach to climate change assessment.
	Site 36 - Marsh Gibbon Reservoir - 75 Mm^3	75 Mm^3	149	149	149	
	Site 36 - Marsh Gibbon Reservoir - 50 Mm^3	50 Mm^3	103	103	103	
	Site 36 - Marsh Gibbon Reservoir - 30 Mm^3	30 Mm^3	66	66	66	
	Site 37 - Ludgershall - 50 Mm^3	50 Mm^3	103	103	103	Rejected at further screening, therefore not included on Constrained List
	Site 37 - Ludgershall - 30 Mm^3	30 Mm^3	66	66	66	Rejected at further screening, therefore not included on Constrained List
	Site 43 - Aylesbury - 50 Mm^3	50 Mm^3	103	103	103	Rejected at further screening, therefore not included on Constrained List
	Site 43 - Aylesbury - 30 Mm^3	30 Mm^3	66	66	66	Rejected at further screening, therefore not included on Constrained List
	Site 42 - Haddenham - 30 Mm^3	30 Mm^3	66	66	66	Rejected at further screening, therefore not included on Constrained List
Direct River Abstraction	Teddington DRA – 50 Ml/d [31]	50	46	46	46	Tier 2 DO calculation carried out, and so DO benefit is WRMP19 DO benefit, reduced to reflect removal of demand savings during a drought from DO. Assumed that climate change does not impact DO benefit as recycling scheme yield is resilient up to Level 4 restrictions. Refer to London Water Recycling Gate 2 submission for development of the engineering design and environmental assessment since WRMP19.
	Teddington DRA – 75 Ml/d	75	67	67	67	
	New river abstraction from River Lee at Three Mills Lock and transfer to Lockwood Thames-Lee Tunnel Extension	35	n/a	n/a	n/a	Rejected at further screening, therefore not included on Constrained List.
Raw Water Purchase	Didcot Raw Water Purchase	22.6	0	22.6	22.6	Tier 2 DO calculation carried out. Amended version of AR22 option DO benefit used. Assumed that climate change does not impact DO benefit. This option is only available 2025-2030.
	Chingford Raw Water Purchase	20	n/a	n/a	n/a	Rejected at further screening, therefore not included on Constrained List.
	Lower Thames Licence Trade	Up to 50 Ml/d	0	Up to 50 Ml/d	Up to 50 Ml/d	This option is dependent on Affinity Water delivering GUC.
Aquifer Recharge	Kidbrooke Aquifer Recharge/Aquifer Storage and Recovery (SLARS1)	8	8	8	8	Tier 3 DO Approach used. Several DO benefits not reappraised between WRMP19 and WRMP24. DO benefits not reappraised through water resources modelling, and are either WRMP19 values, or nominal scheme yields.
	South London Artificial Recharge Scheme (SLARS) – Merton Abbey	6	6	6	5	
	South London Artificial Recharge Scheme (SLARS) - Streatham	7	5	5	7	
Aquifer Storage and Recovery	South East London (Addington) Aquifer Storage and Recovery	3	3	3	5	
	Thames Valley Central Aquifer Storage and Recovery	3	3	3	5	
	ASR Horton Kirby[32]	5	5	5	5	
	Groundwater Addington	2.7	2.7	2.7	5.7	
	London Confined Chalk (north)	2	2	2	2	

[31] Since the WRMP24 feasibility assessment London Effluent Reuse SRO has continued to undertake environmental investigations and river modelling; any changes to option feasibility as a result of this work will be reflected in the final WRMP24
[32] ASR Horton Kirby and Southfleet & Greenhithe Groundwater schemes were included in the WRMP19 Preferred Programme for London for delivery in AMP7 (2020-25). Since WRMP19 the delivery of these options has been deferred beyond the end of AMP7 as the supply demand balance in the London WRZ is in surplus. They are therefore included as WRMP24 Options

Option type	Name	Capacity[25] (Ml/d)	Deployable Output Benefit (Ml/d) 1 in 2 average	1 in 500 average	1 in 500 peak	Commentary
Groundwater [33]	Southfleet/Greenhithe (new WTW)[32]	8.8	8.8	8.8	8.8	
	Merton Recommissioning	2	2	2	6	
	New River Head Removal of Constraints	3	3	3	3	
	GW – Honor Oak	1.4	1.4	1.4	2.7	
	Honor Oak Increase DO	1.7	1.7	1.7	1.7	
Catchment Management [34]	Bean Wellfield (Groundwater)	0.1	n/a	n/a	n/a	DO benefit based on estimated reduction in process losses from reduced contamination enabled through catchment management scheme.
	Green Street Green (Groundwater)	0.3	n/a	n/a	n/a	
	Wilmington (Groundwater)	0.2	n/a	n/a	n/a	
Inter-Company Transfers	Cheam to Merton Transfer (15 M/d)	15	15	15	15	
	Woodmansterne WTW to Epsom Downs	10	10	10		10
	Thames to Affinity Transfer - Conjunctive Use Benefit	25 Ml/d per 50 Ml/d of T2AT transfer utilisation, up to a maximum benefit of 50 Ml/d. Derived through modelling study carried out as part of T2AT SRO scheme. See T2AT SRO scheme documentation for details.				
	SESRO / STT interconnector - Conjunctive Use Benefit	DO for connection with STT (Deerhurst pipeline) is 3.6-10.8 Ml/d, depending on pipeline capacity and reservoir size.				
SWOX WRZ						
Raw Water Transfer (resource)	Oxford Canal - BCN Surplus – Raw Water Transfer Resource (Duke's Cut	15	12	12	12	Scheme DO not reappraised between WRMP19 and WRMP24. See description of Oxford Canal options for London WRZ.
Raw Water Transfer (conveyance)	Severn Thames Transfer, Deerhurst – Culham: see London WRZ for sizes		n/a	n/a	n/a	
	Oxford Canal – Duke's Cut to Farmoor 15Ml/d Pipeline	15	n/a	n/a	n/a	
New Reservoir	Abingdon Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	
	Chinnor Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	
	Marsh Gibbon Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	
	Ludgershall Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	Rejected at further screening, therefore not included on Constrained List.

[34] Only Catchment Management Options with a DO benefit have been included on the Feasible list.

Option type	Name	Capacity[25] (Ml/d)	Deployable Output Benefit (Ml/d) 1 in 2 average	1 in 500 average	1 in 500 peak	Commentary
	Aylesbury Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	Rejected at further screening, therefore not included on Constrained List.
	Haddenham Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	Rejected at further screening, therefore not included on Constrained List.
Groundwater	Moulsford 1	2	2	2	3.5	Scheme DO not reappraised between WRMP19 and WRMP24. Scheme DO not impacted by climate change
	Woods Farm Increase DO	2.4	2.4	2.4	2.9	Scheme DO not reappraised between WRMP19 and WRMP24. Scheme DO not impacted by climate change.
Removal of Constraints to DO	Ashton Keynes borehole pumps - Removal of Constraints to DO	2	0	0	2.04	Scheme DO not impacted by climate change.
Internal Inter-Zonal Transfer	Henley to SWOX – 2.4 Ml/d	2.4	n/a	n/a	n/a	
	Henley to SWOX – 5 Ml/d	5	n/a	n/a	n/a	
	Kennet Valley to SWOX - 6.7 Ml/d	4.5	n/a	n/a	n/a	
	Kennet Valley to SWOX - 2.3 Ml/d	2.3	n/a	n/a	n/a	
SWA WRZ						
Raw Water Transfer	Severn Thames Transfer, Deerhurst – Culham: see London WRZs for sizes					
New Reservoir	Abingdon Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	
	Chinnor Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	
	Marsh Gibbon Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	
	Ludgershall Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	Rejected at further screening, therefore not included on Constrained List.
	Aylesbury Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	Rejected at further screening, therefore not included on Constrained List.
	Haddenham Reservoir: see London WRZs for sizes and DO	n/a	n/a	n/a	n/a	Rejected at further screening, therefore not included on Constrained List.
Groundwater	Taplow Increase DO	5.7	0	0	5.7	Scheme DOs not impacted by climate change. Tier 3 DO assessment, so DO benefit based on Source DO benefit.
	Datchet Increase DO	1.6	1.6	1.6	6.2	
	Dorney Increase DO	4.3	0	0	4.3	
Internal Inter-Zonal Transfer	Henley to SWA - 2.4 Ml/d	2.4 Ml/d	n/a	n/a	n/a	
	Henley to SWA – 5 Ml/d	5 Ml/d	n/a	n/a	n/a	
Inter-Company Transfers	Wessex to SWOX Charlton WTW to Minety SR and from there to Flaxlands SR in South Swindon.	2.9 Ml/d	n/a	n/a	n/a	Rejected at further screening, therefore not included on Constrained List.

Option type	Name	Capacity[25] (Ml/d)	Deployable Output Benefit (Ml/d) 1 in 2 average	1 in 500 average	1 in 500 peak	Commentary
Guildford WRZ						
Groundwater	Dapdune Licence Disaggregation	2.2 Ml/d	0	0	2.2	Scheme DO not reappraised between WRMP19 and WRMP24. Not impacted by climate change.
Removal of Constraints to DO	Dapdune Removal of constraints to DO	1 Ml/d	0	0	1	Scheme DO not reappraised between WRMP19 and WRMP24. Not impacted by climate change.
Inter-Company Transfers	SEW to Guildford Hogsback SR (SEW) to Mount SR (TW-Guildford)	10 Ml/d	10	10	10	Scheme DO not reappraised between WRMP19 and WRMP24.
	Reigate to Guildford - 5 Ml/d	5 Ml/d	n/a	n/a		n/a
	Reigate to Guildford - 20 Ml/d	20 Ml/d	n/a	n/a		n/a
	Kennet Valley WRZ					
Groundwater	Mortimer Disused Source (Recommission)	4.5 Ml/d	4.5	4.5	4.5	Scheme DO not reappraised between WRMP19 and WRMP24. Not impacted by climate change.
Removal of Constraints to DO	East Woodhay borehole pumps Removal of Constraints to DO	2.1 Ml/d	0	0	2.1	Scheme DO not reappraised between WRMP19 and WRMP24. Not impacted by climate change.
Internal Inter-Zonal Transfer	T2ST Spur: Culham to Newbury (Potable)	10 Ml/d	n/a	n/a		n/a

Table 7-11: Feasible List of resource options

System reinforcements

7.149 At WRMP19 cross-option studies were conducted to identify the water treatment, raw water system and treated water transmission reinforcements required to deliver the new resources into distribution. These are described below. In many cases the same system reinforcements are required for a number of different water resources and the timing of the need for the system reinforcements may also not coincide with the need for water resources. The system reinforcements were therefore developed as separate system elements that can be combined with water resource elements when developing an overall programme. Demand management options that are selected also have a significant impact on the requirement for additional system reinforcements.

7.150 The WRSE investment model is not, at present, able to distinguish between supply-demand balance benefits brought through new resources and those brought through demand reductions measures. This has implications for system reinforcement selection because, in a large conjunctive use zone such as London WRZ, the required amount of treatment is dependent on the volume of demand present, rather than the volume of resource present.

7.151 The approach taken in the WRSE investment modelling has been a conservative one in which new resource must be treated at new treatment elements (aside from a small 'spare' drought capacity associated with existing treatment assets), which in turn triggers network reinforcement elements. This means that required system reinforcement elements will be included, but that excess investment in the longer term may be being assumed in our resultant investment programmes.

7.152 An additional challenge in determining required system reinforcements is posed by the large, uncertain potential future licence reductions that have been developed into 'Environmental Destination scenarios. We do not yet know which sources will be subject to future licence reductions as investigations need to be carried out in AMP8 and AMP9 to determine which licence reductions would result in ecological benefits (see Section 5). Different future scenarios of licence reduction would, however, result in very different needs for system reinforcement.

7.153 The WRSE investment model considers each of our WRZs as a lumped entity and so is not able to distinguish between, for example, loss of licence at south east London groundwater sources or north east London surface water sources. The system reinforcement requirements associated with loss of over 100 Ml/d of licence in south east London (as could occur under some environmental destination scenarios) would be entirely different to those required to offset licence reductions at surface water abstractions in north east London, but due to the uncertainty associated with these licence reductions and the structure of the WRSE investment model we are not able to consider these system reinforcements within our optimisation exercise. We are able to consider additional required system reinforcements through subsequent 'post-processing' activities (see below) but cannot include these within the main optimisation exercise. Environmental Destination licence reductions would need to be made by 2050, and so we will have time to consider appropriate system reinforcements in the future, when we are able to observe how population growth and demand reduction has impacted demand at a sub-zonal level, alongside knowledge of which licence reductions will be required.

7.154 For options selected in the first 10 years of the plan period as part of the Best Value Plan, we will be updating our post-processing work to further consider which system support elements are required to enable these options to provide benefit to the system. The environmental impacts of any needed support elements will be assessed as per our existing methodologies and the results incorporated into the HRA in-combination and SEA and WFD cumulative effects assessments of the preferred plan.

Water treatment cross option study

7.155 A cross-option study has been undertaken to investigate feasible options for additional treatment capacity. The WRSE investment model selects WTW based on the modelled water resource options that are selected. Two options have been identified in London, with sites at:

- Kempton WTW for additional resources from the west (e.g. SESRO, Severn Thames Transfer, Oxford Canal Transfer, Marsh Gibbon Reservoir), including a new connection into the Thames Water Ring Main (TWRM)
- East London WTW for additional resources from the east (e.g. Beckton and Deephams Recycling) – this could entail redevelopment of the existing Coppermills works or development of a new WTW at alternative sites in East London, as there is no further space on the existing Coppermills site

7.156 For the SWOX WRZ two sites have been identified for additional treatment:

- Abingdon WTW for resources from the SESRO / Abingdon Reservoir
- Radcot WTW for resources from the Severn-Thames Transfer

7.157 For the SWA WRZ two options have also been identified for additional treatment of resources from either the SESRO / Abingdon reservoir or the Severn-Thames Transfer:

- Abingdon WTW for treated water transfer into the north of the SWA area via SWOX
- A new river abstraction from the River Thames and treatment works in the vicinity of Medmenham supplying the south of SWA

7.158 Since draft WRMP24 further water balance modelling has been undertaken for London WRZ which indicates that an increase in the overall WTW capacity may not be required before 2040. The modelling also identified potential constraints moving water from the WTW to areas of demand. A WTW upgrade may be appropriate to as part of the solution to these geographic constraints.

Network reinforcement cross option study

7.159 A cross-option study has been undertaken to identify supply network reinforcement requirements for London. The report identified six interventions that could be required, including two extensions to the TWRM, with the necessary reinforcements dependent on whether the additional water resource is treated in east or west London. The network reinforcement requirements identified are:

1) Replace pump infrastructure at New River Head
2) Replace pump infrastructure at Barrow Hill
3) TWRM extension - Hampton to Battersea
4) TWRM level controlled by new header tank and pumping station at Coppermills WTW

5) TWRM extension - Coppermills to Honor Oak

6) Resolve issues with supply to Surbiton during TWRM outage

7.160 The matrix in Table 7-12 shows which of these reinforcements would be required for different combinations of new treatment capacity, depending upon whether the additional water resource is available for treatment to the east or the west of the existing TWRM. It can be seen that initially no reinforcement may be required. The precise timing of the requirement for individual network reinforcements is optimised as part of programme appraisal but will also depend on the demand management options selected as part of the programme appraisal process.

		East Ml/d								
		0	100	200	300	400	500	600	700	800
West (Ml/d)	0	-	-	5	4,5	4,5	4,5	4,5	1,4,5	1,4,5
	100	1	1	3,4,5	3,4,5	3,4,5	3,4,5	4,5	1,4,5	
	200	1,3	1,3	3,4	3,4,5	3,4,5	3,4,5	3,4,5		
	300	1,3	1,3	1,3,4	3,4,5	3,4,5	3,4,5			
	400	1,3	1,3	1,3,5	3,4,5	3,4,5				
	500	1,3,5,6	1,3,5,6	1,3,5	1,3,5					
	600	1,2,3,5,6	1,3,5,6	1,3,5,6						
	700	1,2,3,5,6	1,2,3,5,6							
	800	1,2,3,5,6								

Table 7-12: Network reinforcement requirements for additional water resources treated in east or west London

7.161 Additional network reinforcement elements have been identified that are specific for individual options. These include:

- Tunnel from Beckton to Coppermills WTW for blending of water from Beckton and Crossness desalination options
- Tunnel from Crossness desalination plant site to Beckton to extend the Beckton-Coppermills tunnel to Crossness so that it can transfer resource from the proposed desalination plant at Crossness
- Pipeline from the proposed Abingdon WTW to Long Crendon to supply SWA

7.162 Further work is being undertaken to identify local supply network reinforcements required to accommodate growth however these interventions are outside the scope of the WRMP and so are not included as specific reinforcement elements.

7.163 Since draft WRMP24 further water balance modelling has been undertaken for London WRZ and identified potential network constraints and associated local deficits which would require network upgrades before 2040. The water balance modelling has identified the following potential network upgrades:

- Merton TWRM Shaft to Hampton 36 Flow Monitoring Zone (FMZ)
- Kempton WTW to Merton TWRM Shaft
- Battersea TWRM Shaft to Nunhead Service Reservoir
- Coppermills 70” Tunnel to Woodford FMZ
- Coppermills WTW to Finsbury Park and Woodford C FMZs

- Woodford PS to Chigwell Service Reservoir
- Park Lane TWRM Shaft to Putney Service Reservoir
- Brookfield Lane (Cheshunt) Pumping Station to Hoddesdon Service Reservoir
- Streatham TWRM Shaft to Norwood Service Reservoir

7.164 More detailed modelling will be undertaken to confirm the need for network upgrades and identify best value options prior to WRMP29.

Raw water system cross option study

7.165 A cross-option study has been undertaken to identify supply reinforcements required to the raw water system (between the point of abstraction and the WTW inlet) for the different water resource options. This is of particular relevance for options that augment resources in the River Thames or the River Lee (including new reservoir options, raw water transfers, water recycling and some direct river abstraction options). The study used currently available models of the raw water system for the River Thames and River Lee abstractions.

7.166 The study identified ten interventions that may be required, the most significant including an extension to the Thames Lee Tunnel, a second Spine Tunnel and additional conveyance from Queen Mary Reservoir to Kempton WTW. The necessity for the reinforcements will be dependent on the water resource options selected and whether they enter the raw water system in east or west London. The identified raw water system reinforcements, divided between east and west London, are:

East London

1) King George V Reservoir intake capacity increase.
2) Chingford South intake capacity increase.
3) Thames Lee Tunnel extension from Lockwood pumping station to King George V Reservoir intake.
4) Thames Lee Tunnel upgrade to remove existing constraints to maximise transfer capacity (not shown in Table 7-13).
5) Additional conveyance from King George V Reservoir to break tank.
6) Second Spine Tunnel from break tank to Reservoir 5 upstream of Coppermills WTW.

West London

7) Datchet intake capacity increase with transfer to Queen Mother and Wraysbury Reservoirs.
8) Littleton intake capacity increase with transfer to Queen Mary Reservoir.
9) Surbiton intake capacity increase with transfer to Walton inlet channel.
10) Additional conveyance from Queen Mary Reservoir to Kempton WTW.

7.167 The matrix in Table 7-13 shows which of these reinforcements are required depending upon the additional water resource added to the east and west London raw water systems. It can be seen that initially no reinforcement may be required. The precise

timing of the requirement for individual reinforcements is optimised as part of programme appraisal.

		Additional Raw Water Resource in East (Ml/d)								
		0	100	200	300	400	500	600	700	800
Additional Raw Water Resource in West (Ml/d)	0	-	3	1,3,5	1-3,5,6	1-3, 5, 6	1-3, 5, 6	1-3, 5, 6	1-3, 5, 6	1-3, 5, 6
	100	-	3	1,3,5	1-3,5,6	1-3, 5, 6	1-3, 5, 6	1-3, 5, 6	1-3, 5, 6	
	200		3	1,3,5	1-3,5,6	1-3, 5,6	1-3, 5, 6	1-3, 5, 6		
	300		3	1,3,5	1-3,5,6	1-3, 5, 6	1-3, 5, 6			
	400	7	3,7	1,3,5,7	1-3,5-7	1-3, 5-7				
	500	7/8,10	3,7/8,10	1,3,5,7/8,10	1-3,5-7/8,10					
	600	7/8,10	3, 7/8,10	1,3,5,7/8,10						
	700	7/8,10	3, 7/8,10							
	800	7/8,10								

Table 7-13: Raw water system reinforcement requirements for additional water resources in east or west London

7.168 For the Deephams Water Recycling option two alternative conveyances have been considered, depending upon whether the Thames Lee Tunnel extension is developed. If the extension is developed then Deephams Water Recycling would discharge into it, otherwise a separate pipeline conveyance element has been included from Deephams to King George V Reservoir intake.

7.169 Additional potential raw water systems upgrades have been identified for Thames Valley WRZs:

- A new river abstraction from the River Thames to supply a new WTW near Medmenham, as above
- A new river abstraction from the River Thames to as an alternative supply to the existing Fobney WTW
- A new transfer from Abingdon WTW to Farmoor Services reservoir to transfer water from SESRO / Abingdon Reservoir

7.170 Since draft WRMP24 we have carried out initial analysis of the 2022 drought specific learnings in relation to our abstractions from the Lower Thames and the benefits. This analysis has revealed that constraints may exist on the Lower Thames which mean that, during times of low flow, we are not able to abstract sufficient volumes of water to allow us to hit the 300 Ml/d Teddington Target Flow.

7.171 The modelling identified the following potential raw water system upgrades to address these constraints:

- A new river abstraction from the River Thames near Teddington and transfer to Queen Mary Reservoir
- A new river abstraction from the River Thames near Surbiton and transfer to Queen Mary Reservoir
- A new river abstraction from the River Thames near Walton and transfer to Queen Mary Reservoir

Our ability to abstract on the Lower Thames is expected to be further impacted by the River Thames flood relief scheme being developed by the Environment Agency and Surrey County Council. The scheme would involve building two channels alongside the Thames, and would result in a reduction to the amount of water we could abstract from the Lower Thames, including during droughts, increasing our drought risk. Modelling to understand the impact of the flood relief scheme during severe droughts is being undertaken by the River Thames Scheme team, but results were not available in time to incorporate in the WRMP24

7.172 More detailed modelling and option assessment will be undertaken to confirm the raw water system upgrades needed to address both the learning from 2022 drought and the future impacts associated with the flood relief scheme (Please see section 11, Monitoring Plan).

Further screening of water resource options

Approach to further screening

7.173 The water resource elements that passed the validation stage of the feasibility assessments form the Feasible List. Where these elements were subject to a combined limit or were mutually exclusive with another option they have then been subjected to a further screening stage to produce the Constrained List of options for investment modelling in the WRSE model. The further screening process used the WRSE investment model to identify options which performed well and were selected for a range of different planning scenarios.

7.174 This screening process brought together all water resource option types and compared them using a consistent set of criteria. Where options have been rejected an explanation is provided in the Rejection Register (Appendix Q: Scheme rejection register).

7.175 The further screening process compared water resource options using the WRSE investment model.

7.176 Backchecking was undertaken following completion of the SROs' appraisal of alternative options within the SROs gated process. The backchecking reviewed the feasibility assessments in light of any new information and, where appropriate the feasibility assessments were updated. The SRO appraisals are presented in the Gate 1 and Gate 2 submissions. Any updates to the feasibility assessment as included in the WRMP24 Feasibility Report Addendums.

7.177 Backchecking was also undertaken following the inter-regional reconciliation of the regional plans to reflect any change in status of the options on the Feasible List.

7.178 Feasible options which meet the criteria for Option Further Screening are included in Constrained List of options.

Results of further option screening

7.179 To arrive at the Constrained List of options from the Feasible List, further option screening decisions have been made by analysing WRSE model scenario runs. Rather than imposing rigid rules to make screening decisions, the focus has been on ensuring that there is a clear and robust reasoning for each screening decision which has then been recorded in Appendix Q: Scheme rejection register and WRSE's exclusion record.

7.180 Options were further screened where they were subject to a combined limit, mutually exclusive with another option or required further stakeholder engagement (including inter-regional reconciliation) to confirm feasibility. Table 7-14 provides a summary of the options subject to a combined limit which were rejected at further option screening. Through this process the following options have been rejected and are not included on the Constrained List of options:

- Crossness Recycling
- Ludgershall Reservoir
- Aylesbury Reservoir
- Haddenham Reservoir

Option	Commentary on further screening
Crossness Recycling (up to a capacity of 190 Ml/d)	Investigations at WRMP19 identified that the cumulative impact of developing multiple water recycling, desalination and DRA schemes could increase salinity in the Thames Tideway, resulting in moderate, probably reversible impacts on potentially sensitive ecological receptors as a result of disruption of communities. To mitigate this the decrease in freshwater inputs to the Tideway should be limited to no more than 275-366 Ml/d. The total additional capacity of water recycling and desalination options, that remove fresh water from the Thames Tideway, has therefore been limited to a maximum of 366 Ml/d in the regional water resources plan. Beckton, Crossness and Deephams indirect recycling options would all convey treated water to the same discharge location on the River Lee upstream of the intake to King George V reservoir. It is envisaged that indirect recycling at Beckton would require the construction of a conveyance tunnel from Beckton to Lockwood Shaft on the TLT Extension, while direct recycling would require a tunnel from Beckton to Coppermills WTW for blending. The water conveyance distance, whether to Lockwood Shaft or to Coppermills WTW is greater from Crossness than it is from Beckton and it is envisaged that the Crossness recycling treated water would be conveyed to Beckton STW from where it would utilise the same conveyance as Beckton Recycling. Deephams recycling could also utilise the Beckton recycling conveyance as it is expected to pass close to the Deephams site. The combined maximum capacity of Beckton and Deephams recycling options exceeds the 366 Ml/d combined limit. Crossness recycling has been rejected on the basis that there are more water recycling options than could reasonably be required and it is the least favourable recycling option measured against the cost dimension on the Feasible List. **Consideration of other options subject to the combined limit** Options have been included in the investment model such that supply up to the combined limit could be provided in full by either desalination or recycling. Crossness Desalination and Beckton Desalination options have therefore been included on the Constrained List without further screening. This is to allow the model with maximum possible flexibility in option selection.
Beckton Recycling (380 Ml/d)	Investigations at WRMP19 identified that the cumulative impact of developing multiple water recycling, desalination and DRA schemes could increase salinity in the Thames Tideway, resulting in moderate, probably reversible impacts on potentially sensitive ecological receptors as a result of disruption of communities. To mitigate this the decrease in freshwater inputs to the Tideway should be limited to no more than 275-366 Ml/d. The total additional capacity of water recycling and desalination options, that remove fresh water from the Thames Tideway, has therefore been limited to a maximum of 366 Ml/d in the regional water resources plan.

Option	Commentary on further screening
	The London Water Recycling SRO has therefore considered options up to 300 Ml/d for Beckton Recycling, however at WRMP19 a maximum capacity of 380 Ml/d was assessed as feasible. The 380 Ml/d option remains on the Feasible List while further work is ongoing to review the cumulative impact of options on the Middle Tideway salinity.
Ludgershall - 30 & 50 Mm^3	The options feeding into the upper Thames River are subject to a combined discharge limit of 600 Ml/d. This limit applies to STT, SESRO, Chinnor Reservoir, Marsh Gibbon Reservoir, Ludgershall Reservoir, Aylesbury Reservoir and Haddenham Reservoir. Scenario runs of the investment model were undertaken to assess which options within the combined limit are selected. STT and SESRO were selected as preferred options and in combination reach the 600 Ml/d discharge limit.
Aylesbury - 30 & 50 Mm^3	
Haddenham - 30 Mm^3	Marsh Gibbon and Chinnor have been included on the Constrained List to provide reservoir options up to the discharge limit, in combination with SESRO, this is to allow the model maximum possible flexibility in option selection. These reservoirs were selected in preference to Ludgershall, Aylesbury and Haddenham as they perform better against Stage 3 Feasibility criteria. Ludgershall, Aylesbury and Haddenham reservoirs have therefore been rejected at Further Screening.

Table 7-14: Further Screening of options subject to a combined limit

7.181 Table 7-15 details the options which were rejected at Further Screening due to mutual exclusivity with other options. SESRO / Abingdon Reservoir (50 Mm^3 and 30 Mm^3 options) and River Lee DRA were rejected at Further Screening.

Option	Commentary on further screening
SESRO / Abingdon Reservoir– 50 Mm^3 SESRO / Abingdon Reservoir– 30 Mm^3	At WRMP19 SESRO / Abingdon Reservoir 30 Mm^3 and 50 Mm^3 single phase options were rejected as these options would limit development of larger capacity options on the same site. This rejection reasoning was backchecked at WRMP24 and found to remain valid. The investment model continues to select larger capacity SESRO / Abingdon Reservoir options confirming the reason for rejecting these options. For further details on rejection reasoning refer to Appendix Q – Rejection Register. Note: The Constrained List of options includes a phased reservoir option for 30 + 100 Mm^3. The first phase of 30 Mm^3 could be selected without the second 100 Mm^3 phase.
River Lee DRA (New river abstraction from River Lee at Three Mills Lock and transfer to Lockwood Thames-Lee Tunnel Extension)	River Lee DRA is mutually exclusive with Deephams Recycling. At WRMP19 River Lee DRA was rejected following fine screening as Deephams Recycling was found to be the preferred option. This was backchecked at WRMP24. Deephams Recycling was again found to be the preferred option and River Lee DRA was rejected as a result. Neither Deephams Recycling of Lower Lee DRA can be delivered before c.2060, this does not change the screening decision. For

Option	Commentary on further screening
	further details on rejection reasoning refer to Appendix Q – Rejection Register.
Cotswold Canal 100 Ml/d Cotswold Canal 300 Ml/d	At WRMP19 both 100 Ml/d and 300 Ml/d the Cotswold Canal STT was rejected by comparison with the Deerhurst Pipeline STT option for the following reasons: • Higher Normalised Cost • Greater operational complexity • Greater construction complexity • Higher risk of spread of non-native invasive species than the pipeline. For the RAPID Gate 2 design stage, a study was undertaken by STT SRO to identify a preferred Interconnector option which would provide 'best value' to water company customers when considering environmental and social impacts and benefits, resilience, and cost. The study assessed a range of site and route options including direct pipeline options and other options utilising reconstructed sections of the Cotswold Canals supplemented with pipeline to create alternative route options. The assessment identified a preferred interconnector option, based on the information available at Gate 2 and subject to further engagement and public consultation, that would transfer water from the River Severn to the River Thames through a direct pipeline from Deerhurst to Culham (see STT SRO Gate 2 submission for more information). The study recognised that options that utilised reconstructed sections of the Cotswold Canals could provide opportunities for enhancement of tourism and recreation. However, it was concluded that selecting a canal-based option for water transfer would not provide best value, with a direct pipeline option: • Performing better overall against a range of environmental and resilience criteria • Having the lowest Net Present Cost (including monetised social, natural capital and carbon impacts and benefits), being approximately 25% cheaper than other options A further assessment was also undertaken to assess the potential opportunities for tourism and recreation that could be realised with the full restoration of the canal. This concluded that the additional benefits gained by integrating canal restoration with a water supply transfer are outweighed by the impacts and costs. To test this conclusion, across a range of different planning scenarios, the Cotswold Canal has been included in WRSE investment model. The investment model consistently selects the pipeline interconnector in preference to the canal interconnector. Furthermore, the draft WRSE best value regional plan selects a 400 or 500Ml/d capacity pipeline transfer in many scenarios, including the WRSE preferred plan (options incorporating sections of canal would be limited to 300Ml/d maximum capacity). The Cotswold Canal is therefore rejected at Further Screening.

Option	Commentary on further screening
	Whilst this reflects the assessment and findings for Gate 2 and WRMP24, before any final decisions are made and as part of any future phases of the STT development, the preferred option and other alternatives considered would be subject to further engagement and consultation with stakeholders and also reaffirmation/back checking.

Table 7-15: Further Screening of options which are mutually exclusive

7.182 Table 7-16 details the options which were rejected at Further Screening following further stakeholder engagement. Chingford Raw Water Purchase was rejected at Further Screening.

Option	Commentary on further screening
Chingford Raw Water Purchase -	Chingford is an existing agreement to export water from east London to Essex and Suffolk Water. There is an agreed reduction in the transfer that provides a benefit to London. This option is for continuation of the agreed reduction in the export quantities from 2035/36, providing c.20 Ml/d deployable output for London. Further discussions were undertaken with Essex and Suffolk at WRMP24. Through these discussions it was confirmed that Essex and Suffolk would not be able to continue the agreement, this option is therefore rejected from Thames Water's WRMP24 options. For further details on rejection reasoning refer to Appendix Q – Rejection Register.
Wessex to SWOX: Charlton WTW to Minety SR and from there to Flaxlands SR in South Swindon	Wessex Water have confirmed that the water is no longer available for transfer in 2040.
Shrewsbury (STT Resource)	A backchecking exercise was carried out following reconciliation of the regional plans. Mythe and Shrewsbury are required to meet the needs of WRW and are therefore not available to WRSE. These options are therefore rejected at further screening and are not on our Constrained List.
Mythe (STT Resource)	

Table 7-16: Further Screening of options following further stakeholder engagement

Constrained List

7.183 Programme appraisal has considered both resource elements from the Constrained List and system elements to provide the best value 50-year programme to address future water supply requirements.

7.184 Where a resource option requires the delivery of one or more system elements in order to deliver the water resource benefits, dependencies are included in the WRSE investment model to ensure that these requirements are taken into account in the programme appraisal. For example, the first phase of Beckton Recycling would require the construction of conveyance tunnels from Beckton to Lockwood and from Lockwood to

River Lee, upstream of King George V reservoir intake. The dependencies in the WRSE investment model ensure that the conveyance tunnels are included with the first phase of Beckton Recycling but are not repeated in any later phases.

7.185 In some cases, the system elements are not dependent on specific resource options and therefore cannot be linked to specific resource options in the WRSE investment model. An example is the potential need for upgrades to the west London raw water systems to abstract additional water provided by resource options that supply additional water to the River Thames. There are multiple options that could provide additional water in the River Thames including Severn Thames Transfer, Abingdon reservoir (SESRO) and the Oxford Canal Transfer; the combination of options needs to be considered together to determine the system upgrades required. In these cases, the system elements are where appropriate post processed into the Preferred Plan, rather than being selected by the WRSE investment model.

7.186 A summary of the elements included on the Constrained List is provided in Table 7-17 for the London WRZ and in Table 7-18 for the Thames Valley WRZs. The tables indicate how the system elements combine with each resource element to provide an overall supply option.

Option Type	Resource Element		Conveyance Element		Raw Water System	Treatment Element	Network Element
	Location	DO DYAA Ml/d	Location	Nominal Capacity Ml/d		Location	
Water reuse	Deephams	42	Deephams to KGV	60	See raw water system matrix	East London	See network reinforcement matrix
			Deephams to TLT extension				
	Beckton 50 Ml/d	46	Beckton to Lockwood shaft	800		East London	
	Beckton 100 Ml/d	89					
	Beckton 150 Ml/d	130					
	Beckton 200 Ml/d	172					
	Beckton 300 Ml/d	252					
	Reuse Mogden - 150 Ml/d	130	Mogden to Walton	150		Kempton	
	Reuse Mogden - 100 Ml/d	88					
	Reuse Mogden - 50 Ml/d	46					
	Reuse Mogden S Sewer - 25 Ml/d	23	N/A			Kempton	
DRA	Teddington DRA – 50 Ml/d	46	Teddington Outfall	75	See raw water system matrix	Kempton & East London	See network reinforcement matrix
	Teddington DRA – 75 Ml/d	67	Teddington to Thames Lee Tunnel	75			
Raw Water Transfer	Vyrnwy	29/43/57/78/86/103	Deerhurst to Culham	300/400/500	See raw water system matrix	Kempton	See network reinforcement matrix
	Netheridge to River Severn	24					
	Minworth (Phase 1 and 2)	70					
	Oxford Canal	10.3	N/A				
Desalination	Beckton Desalination - 150 Ml/d	133	N/A		N/A	N/A	See matrix plus Beckton to Coppermills
	Beckton Desalination – 100 Ml/d	89					
	Beckton Desalination – 50 Ml/d	44					
	Crossness Desalination (Blended) – 300 Ml/d	267	N/A		N/A	N/A	As above plus Crossness to Beckton
	Crossness Desalination (Blended) – 250 Ml/d	222			Beckton-Crossness		
	Crossness Desalination (Blended) – 200 Ml/d	178					
	Crossness Desalination (Blended) – 150 Ml/d	133					
	Crossness Desalination (Blended) – 100 Ml/d	89					
	Crossness Desalination (Blended) –50 Ml/d	44					
New Reservoir	SESRO / Abingdon Reservoir - 150 Mm³	271	N/A		See raw water system matrix	Kempton	See network reinforcement matrix
	SESRO / Abingdon Reservoir - 125 Mm³	230					
	SESRO / Abingdon Reservoir - 100 Mm³	185					
	SESRO / Abingdon Reservoir - 75 Mm³	149					
	SESRO / Abingdon Reservoir Phased - 80 + 42 Mm³	224 Ml/d (155.1 + 68.9)					
	SESRO / Abingdon Reservoir Phased – 30 + 100 Mm³	238 Ml/d (65.5 + 173.1)					
	Chinnor Reservoir 30 Mm3	66				Kempton	
	Marsh Gibbon Reservoir - 75 Mm³	149				Kempton	
	Marsh Gibbon Reservoir - 50 Mm³	103					
	Marsh Gibbon Reservoir - 30 Mm³	66					
Aquifer Recharge	AR/SLARS - Kidbrooke (SLARS1)	8	N/A		N/A	N/A	N/A
	AR Merton (SLARS3)	6					
	AR Streatham (SLARS2)	7					
Aquifer Storage and Recovery	ASR South East London (Addington)	3	N/A		N/A	N/A	N/A
	ASR Thames Valley/Thames Central	3					
	ASR Horton Kirby	5					
Groundwater	GW - Addington	2.7	N/A		N/A	N/A	N/A
	GW - London Confined Chalk (north)	2					
	GW - Southfleet/Greenhithe (new WTW)	8.8					
	GW - New River Head Removal of Constraints	3					
	GW - Honor Oak	1.4					
	Honor Oak Increase DO	1.7					
Raw Water Purchase	Didcot Raw Water Purchase	22.6	N/A		See raw water system matrix	Kempton	See network reinforcement matrix
	Lower Thames Licence Trade	50	N/A				
Catchment Management	Bean Wellfield (Groundwater)	0.1	N/A		N/A	N/A	N/A
	Green Street Green (Groundwater)	0.3					
	Wilmington (Groundwater)	0.2					
Inter-co. transfers			Cheam to Murton	15	N/A	N/A	N/A
			Woodmansterne WTW to Epsom Downs	10			

Table 7-17: Constrained List for London WRZs

	Option Type	Resource Element Location	DO Ml/d ADPW	Conveyance Element Location	Nominal Capacity Ml/d	Raw Water System	Treatment Element Location	Network Element Location
Swindon & Oxfordshire (SWOX)	**Raw Water Transfer**	**Severn Thames Transfer** (See London WRZ for support elements)	See London Constrained list table	**Deerhurst to Culham**	300 400 500	N/A	**Radcot WTW** 24 Ml/d each phase	Transfers to service reservoir included in WTW elements
		Oxford Canal	12	**Dukes Cut to Farmoor**	15			
	New Reservoir	**SESRO / Abingdon Reservoir - 150 Mm3**	271	**Abingdon to Farmoor Reservoir** (if treatment capacity not required	24	N/A		
		SESRO / Abingdon Reservoir - 125 Mm3	230					
		SESRO / Abingdon Reservoir - 100 Mm3	185					
		SESRO / Abingdon Reservoir - 75 Mm3	149				**Abingdon SWOX WTW** (if treatment capacity rqd) 24 Ml/d each phase	Transfers to service reservoir included in WTW elements
		SESRO / Abingdon Reservoir Phased - 80 + 42 Mm3	224 Ml/d (155.1 + 68.9)					
		SESRO / Abingdon Reservoir Phased – 30 + 100 Mm3	238 Ml/d (65.5 + 173.1)					
		Chinnor Reservoir 30 Mm3	66	N/A			TBC	TBC
		Marsh Gibbon Reservoir - 75 Mm3	149					
		Marsh Gibbon Reservoir - 50 Mm3	103					
		Marsh Gibbon Reservoir - 30 Mm3	66					
	Groundwater	**Woods Farm Increase DO**	2.9	N/A		N/A	N/A	N/A
		GW - Moulsford 1	3.5	N/A		N/A	N/A	N/A
	Removal of constraints to DO	**Ashton Keynes borehole pumps**	2.04	N/A		N/A	N/A	N/A
	Inter-zonal transfers			**Henley to SWOX**	2.4	N/A	N/A	N/A
					5			
		GW - Mortimer disused source	4.5	**Kennet Valley to SWOX**	6.7			
					2.3			
Slough, Wycombe & Aylesbury (SWA)	**Raw Water Transfer**	**Severn Thames Transfer**[#] (See London WRZ for support elements)	See London Constained list table	**Deerhurst to Culham**	300/400/500	N/A	**Abingdon SWA WTW**	**Abingdon to north SWA**
						New intake 80 / 53	**Medmenham WTW**	Transfers to service reservoir included in WTW elements
		Oxford Canal	12					
	New Reservoir[#]	**SESRO / Abingdon Reservoir - 150 Mm3**	271	N/A		N/A	**Abingdon SWA WTW**	**Abingdon to north SWA**
		SESRO / Abingdon Reservoir - 125 Mm3	230					
		SESRO / Abingdon Reservoir - 100 Mm3	185					
		SESRO / Abingdon Reservoir - 75 Mm3	149			**New intake 80 / 53**	**Medmenham WTW**	Transfers to service reservoir included in WTW elements
		SESRO / Abingdon Reservoir Phased - 80 + 42 Mm3	224 Ml/d (155.1 + 68.9)					
		SESRO / Abingdon Reservoir Phased – 30 + 100 Mm3	238 Ml/d (65.5 + 173.1)					
		Chinnor Reservoir 30 Mm3	66	N/A		**New intake 80 / 53**	**Medmenham WTW**	
		Marsh Gibbon Reservoir - 75 Mm3	149	N/A				
		Marsh Gibbon Reservoir - 50 Mm3	103					
		Marsh Gibbon Reservoir - 30 Mm3	66					
	Raw Water Purchase	**Didcot**	22.6	N/A		**New intake 80 / 53**	**Medmenham WTW**	Transfers to service reservoir included in WTW elements
	Groundwater	**Taplow Increase DO**	5.7	N/A		N/A	N/A	N/A
		Datchet Increase DO	6.2					
		Dorney Increase DO	4.3					
	Inter-zonal transfers			Henley to SWA	2.4 / 5	N/A	N/A	N/A
Guildford	**Groundwater**	**Dapdune licence disaggregation**	2.2	N/A		N/A	N/A	N/A
	Removal of constraints to DO	**Dapdune removal of constraints**	1	N/A		N/A	N/A	N/A
	Inter-co. transfers			SouthEast Water to Guildford	10	N/A	N/A	N/A
				SES Reigate to Guildford	5			
					20			
Kennet Valley	**Groundwater**	**GW - Mortimer disused source (recommission)**	4.5	N/A		N/A	N/A	N/A
	Removal of constraints to DO	**East Woodhay borehole pumps**	2.1	N/A		N/A	N/A	N/A
	Inter-zonal transfers			T2ST KV Spur: Culham to Newbury (Potable)	10	N/A	N/A	N/A

Table 7-18: Constrained List for Thames Valley WRZs

Further option development for the Constrained List

Conceptual design

7.187 For water resource elements on the Constrained List, Conceptual Designs have been prepared. The Conceptual Designs provide information on the location of the works, engineering and land requirements, dependencies with other elements, construction impacts, environmental and social mitigations, DO, programme assumptions and risks.

7.188 Conceptual Designs were developed for options which are Further Screened in order to understand factors which are used in the model scenario runs including Deployable Output benefit (DO), lead time, Capital Expenditure (CAPEX), Operating Expenses (OPEX), costed risk, carbon impact, customer preference, environmental scoring and resilience scoring. Further details on the WRSE regional investment model can be found in the published WRSE draft regional plan documents.

7.189 The information gathered from the Conceptual Designs was used as the basis for updating cost estimates, developing a risk register, and for conducting the Environmental Assessment of options.

Cost and risk

7.190 For all elements on the Constrained List a review of feasibility stage costs was conducted. Costs were updated to reflect conceptual designs, where these have changed from the feasibility stage. Unit rates were updated for material cost items where confidence in the feasibility stage estimates was low. We take the conceptual design of an option and break it down into its constituent parts. We then take unit rates for the costs of different components of a water resources option, for example pumps, filters, and tunnels, and bring these together to estimate a total cost for each option.

7.191 The categorisation of options as standard or non-standard has been defined for WRMP24 by the All Company Working Group Cost Consistency Methodology to ensure consistency across Water Companies. Quantitative Cost Risk Assessments (QCRA) have been completed for all non-standard options on the Constrained List. A risk register was developed and estimates of likelihood and consequence of risks occurring (in terms of additional costs above those initially estimated) were assigned. Monte Carlo analysis[35] was used to combine these estimates to provide a probability distribution for risk.

7.192 An allowance for optimism bias was applied to all elements at feasibility stage to reflect the potential cost implications of as yet unknown factors. This optimism bias assessment is based on the maturity of option design (there being greater potential for additional costs when option designs are immature) and our experience in delivering such options (a greater optimism bias being needed for more innovative option types where we may have underestimated cost elements based on our and/or UK water industry inexperience). The optimism bias allocation from the feasibility stage assessment for each option was scaled back to reflect the level of confidence around solution delivery at conceptual design stage.

[35] A Monte Carlo simulation is a mathematical technique that simulates the range of possible outcomes for an uncertain event. Predictions are based on an estimated range of values instead of a fixed set of values and evolve randomly.

For elements where a risk allowance was applied from the risk register, the scaling back of optimism bias was revisited following completion of the risk register to avoid double counting of risk between optimism bias and the bottom-up allowance of risk identified through the risk register. Optimism bias was calculated using the All Company Working Group methodology.

Strategic environmental assessment

7.193 For all elements on the Constrained List an SEA was conducted. Further information on the Strategic Environmental Assessment appraisal (and all environmental assessments undertaken on our options) can be found in WRMP24 Section 9: Environmental appraisal. For options with sufficient information available, an HRA and WFD were also conducted, and NC and BNG assessments where these options are expected to change the land use of a site. INNS assessments were carried out in response to a risk assessment across our constrained list options identifying those that required more detailed assessment. These assessments were not undertaken for less mature options (new regional transfers and catchment options) because the option information currently available for these emerging options is not sufficiently detailed to make these assessments meaningful. We will develop this information as we continue to screen these options.

7.194 The environmental assessments have been used to help us identify any further mitigation required to reduce the impact of our options as needed. Should any of the options have failed these assessments as a result of not being able to sufficiently mitigate adverse impacts, they would have been rejected and placed on the rejection register.

7.195 We have included the costs of this mitigation within our option costs, as well as accounting for the cost of delivering 10% biodiversity net gain as mandated for options requiring planning permission. The cost of delivering 10% BNG has been accounted for within the optimism bias included within our option costs. We are working with WRSE to further develop our understanding of the costs and strategies available to us to deliver this gain. The environmental assessments of our options have been used to generate environmental metrics (SEA+, SEA -, BNG and NC) that have been used in the WRSE investment model to identify our Best Value plan.

7.196 For further detail on environmental assessments carried out please refer to Section 9. The suite of environmental metrics can be found in the Thames Water WRMP24 supporting information technical note: Environmental and Resilience Metrics Summary Table.

Resilience assessment

7.197 All of the elements on our Constrained List were subject to a resilience assessment in line with WRSE's resilience assessment framework. These assessments have been used to generate metrics that have been used in the WRSE investment model to identify our Best Value plan.

7.198 Environmental and resilience metrics have also been defined for feasible options where the investment model was used as part of further screening.

7.199 The suite of metrics (environmental, resilience, and customer preference) have been defined for supply-side options. For a description of the process followed to derive resilience metrics please see WRSE Resilience Method Statement Report. The suite of

environmental and resilience metrics can be found in the supporting information technical note: Environmental and Resilience Metrics Summary Table.

Further investigations into Constrained List options

7.200 The options on the Feasible List and Constrained List are assessed as being feasible based upon existing knowledge. At this stage of project development, it is inevitable that uncertainties will exist, and as part of option development a number of investigations are ongoing to further reduce uncertainty. Risk will be reviewed over the lifetime of the project through to construction.

Drought Permits

7.201 We have identified a number of drought permit options that could be used to augment existing water supplies in the event of a severe drought. Drought permits are options that enable water companies to abstract more water than permitted by their abstraction licences. These options are only available in drought situations and require the water company to demonstrate that there has been an exceptional shortage of rainfall. They are initially issued for a six-month period but may be extended for a further six months if the drought persists. These drought permit options are set out in more detail in our Drought Plan and its appendices[36].

7.202 In our WRMP19 we did not consider drought permits as options that we should rely on to provide security of supply, due to the fact that drought permit applications can be declined (i.e., these options do not provide a secure source of supply), and due to the negative environmental impacts that they bring. As such, we effectively rejected drought permits at the generic screening stage.

7.203 In line with updates to WRPG to permit the use of drought options as WRMP options, through the WRSE regional planning process we have engaged with the Environment Agency to identify those drought permits which we could reasonably consider as sources to rely upon in a drought in the shorter term and which have a minimal environmental impact, and so we have included a small number of drought permit options as supply-side options in our investment modelling.

7.204 The volumes associated with each drought permit are uncertain because the yields will be subject to the impact of the severe drought that would trigger their implementation. The Drought Plan provides an indication of the yield that would be expected from each option. An estimate of this yield has been produced for each feasible drought permit option, and the associated resource benefit volumes used for modelling of scenarios by WRSE. The drought permit options generally exist where we have water sources that are restricted or have been closed because of their potential to exacerbate low flows in rivers. Therefore, the options, in most cases, would have some adverse environmental impact if implemented. In each case the environmental impact has been assessed and Environmental Assessment Reports produced, and these have been used in the production of a Habitats Regulations Assessment and a SEA for the Drought Plan. These assessments have been used to generate environmental metrics for the WRSE modelling as above. The prolonged use of drought permits during severe drought events would be likely to cause significant environmental damage. This is discussed in our Drought Plan and Appendices.

7.205 These drought permit options do currently provide an important resource to ensure continuity of supply in the event of severe drought. It is also important to consider that the yield of these options would decrease through time as the drought severity intensifies. In addition, there is a risk that drought permits may not be granted or renewed for a further period of six months if the Environment Agency / Secretary of State consider the actual or potential environmental impact would be too great.

7.206 Our drought plan contains an assessment of actions that we would seek to take in the event of a severe drought. These actions include applying for and implementing drought

[36] Thames Water draft Drought Plan, 2022

permits. The assessment that we have undertaken for our drought plan assumes that we would apply for, and have granted, all drought permits that we could apply for, with a prioritisation process included whereby we would apply for less damaging permits first.

7.207 To plan for a resilient water supply system that relies on the frequent use of drought permits is not appropriate in the long-term, due to their association with environmental damage. We have appraised each of our drought permits to identify whether each of them would be reasonable to rely on in the shorter term, considering the potential for environmental damage that they pose. We have shared this appraisal with the Environment Agency and have agreed a small number of drought permits that could be relied upon in the short-term, and these are therefore considered as options, as outlined in Table 7-19.

7.208 Aside from the small number of drought permit options identified through this process, these temporary supply options are not taken forward for inclusion in our programme appraisal. However, they do provide a short-term unsustainable option which would need to be implemented in the event that a severe drought occurs in the near-term. We believe that, in the long-term, alternative options should be developed to provide resilience to more severe droughts. In this respect our approach is consistent with that adopted by other water companies and set out in the Water Resources Planning Guideline.

7.209 Our WRMP24 ensures a reduction in the frequency of reliance on drought permits by increasing resource availability and becoming resilient to 1 in 200 year and 1 in 500-year drought events. The company will only rely on drought permits during severe drought events, i.e. events which, as they begin to unfold, suggest that they could be very severe in terms of the incidence of occurrence.

Drought Permit	WRZ	Yield (Ml/d), assumed as DO benefit for DYAA and DYCP conditions
Gatehampton	SWOX	3.5
Playhatch	Kennet Valley	4.1
Shalford	Guildford	5
Sheeplands/Harpsden	Henley	5.6

Table 7-19: Summary of Drought Permit Options

Demand Restrictions During a Drought Event

7.210 As described in our drought plan, during droughts, we seek to manage demand for water initially through media campaigns to increase awareness of drought, highlighting things that customers can do to use water more efficiently. We can also put in place temporary use bans (TUBs, previously known as hosepipe bans) to restrict water use and restrictions on non-essential use (NEUBs) by commercial customers. We lay out in our drought plan the maximum frequencies with which we expect to implement these measures, in accordance with customer preference; these are known as our Levels of Service.

7.211 The WRPG for this planning cycle, unlike at WRMP19, requires that we consider options related to our Levels of Service as feasible options to be considered through the options appraisal and programme appraisal process, rather than being incorporated into either our baseline demand or supply forecasts.

7.212 As such, we have calculated the benefits for these options and included them in our investment modelling as part of our constrained list of options. A description of these options for each Level of Service is below:

7.213 Level 1 (1 year in 5 on average)

- Media campaign: Wide-scale communications activity to encourage voluntary reduction in water usage

7.214 Level 2 (1 year in 10 on average)

- Temporary Use Bans (TUBs): 11 categories of use (largely domestic), banning the use of a hosepipe
- Enhanced media campaign: Enhancement of above activity

7.215 Level 3 (1 year in 20 on average)

- Non-Essential Use Bans (NEUBs): Application to Defra to grant 10 categories of non-essential use restrictions affecting commercial businesses

7.216 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. We have worked with the other WRSE water companies to align our implementation of specific demand restrictions and associated exemptions.

7.217 An option per level for each WRZ was added to the constrained list of options to be considered in our investment modelling. All options were selectable by the model under 1 in 10 (average) and 1 in 500 (average and peak) scenarios, with dependencies built in such that media campaigns had to be selected first, followed by TUBs, followed by NEUBs.

7.218 We have assessed the benefit that we get from these options. For annual average conditions, this includes consideration of how long during a drought some measures would be in place (e.g., if an option has a 10 Ml/d impact but would only be implemented for half a drought, it would only have a 5 Ml/d benefit). In addition, we have considered that measures that we can implement during drought periods may have reducing benefits as society's overall water efficiency improves. The demand reduction we see during drought periods is associated with reduced discretionary consumption, and if people are

generally more water efficient the benefit of reductions in discretionary use will be reduced. Table 7-20 shows the benefits associated with these options at the beginning of our planning period. The benefit of these options over the planning period can be seen in our WRMP tables.

	L1 (Ml/d SDB benefit)		L2 (Ml/d SDB benefit)		L3 (Ml/d SDB benefit)	
	DYAA	DYCP	DYAA	DYCP	DYAA	DYCP
London	17.2	N/A	79.7	N/A	6.6	N/A
SWOX	4.7	12.2	19.9	45.3	1.2	4.0
SWA	3.0	6.2	8.8	22.9	0.6	2.0
Kennet Valley	2.1	4.3	6.2	16.0	0.4	1.4
Guildford	1.0	2.3	3.0	8.3	0.2	0.7
Henley	0.3	0.7	0.8	2.5	0.1	0.2

Table 7-20: Option benefits at start of the planning period

Existing transfers

7.219 We have included our existing intra-company transfers to help build connections within the WRSE investment model.

Option Name	Option Description	Capacity (Ml/d)
Thames Water (SWA) to Thames Water (SWOX)	Potable Water Transfer - Thames Water (SWA) to Thames Water (SWOX) Three individual transfers: Radnage to Bledlow Stokenchurch to Chinnor Ashenden to Horspath (bidirectional)	 0.35 1.91 1.26
Thames Water (Kennet Valley) to Thames Water (Henley)	Potable Water Transfer - Thames Water (Kennet Valley) to Thames Water (Henley)	1.78

Table 7-21: Summary of Existing Transfer Options

Sources of further information

7.220 The following supporting information is available:

- Feasibility reports
  - WRMP19 Raw Water Transfer Feasibility report, Mott MacDonald, September 2018 and WRMP24 Raw Water Transfer Feasibility Addendum, Mott MacDonald August 2023
  - Groundwater Feasibility report, Mott MacDonald, September 2018 and WRMP24 Groundwater Feasibility Addendum, Mott MacDonald August 2023
  - New Reservoirs Feasibility report, Mott MacDonald, July 2017 and WRMP24 New Reservoirs Feasibility Addendum, Mott MacDonald August 2023
  - Water Reuse Feasibility report, Mott MacDonald, September 2018 and WRMP24 Water Reuse Feasibility Addendum, Mott MacDonald August 2023
  - Desalination Feasibility report, Mott MacDonald, February 2018 and WRMP24 Desalination Feasibility Addendum, Mott MacDonald August 2023
  - Direct River Abstraction Feasibility report, Mott MacDonald, September 2018 and WRMP24 Direct River Abstraction Feasibility Addendum, Mott MacDonald August 2023
  - Inter-Zonal Transfer Feasibility report, Mott MacDonald, February 2018 and WRMP24 Inter-Zonal Transfer Feasibility Addendum, Mott MacDonald August 2023
- Network Reinforcement Cross Option study, Mott MacDonald, January 2018
- Raw Water System Cross Option study, Mott MacDonald, January 2018
- Water Treatment Cross Option study, Mott MacDonald, January 2018
- Discharge Design Standards Cross Option study, Mott MacDonald, February 2018
- Operating Philosophy, Mott MacDonald, February 2018
- Conceptual Design Reports – these are available at our offices in Reading (Clearwater Court) by appointment
- Constrained List Scheme Dossiers, Appendix R
- A full list of related WRSE reports is available at https://www.wrse.org.uk/

7.221 Please contact Thames Water for access to any of these documents.

Annex A: Changes Made Between Plan Iterations

7.222 The text in the boxes below summarises the changes made to this Section between dWRMP24 and rdWRMP24, and rdWRMP24 and final WRMP24.

Changes between draft WRMP24 and revised draft WRMP24:

- Following feedback from Ofwat, we have included more information about the feasibility assessment methodology and criteria adopted
- Following feedback from Ofwat, we have included further detail around how third-party options have been appraised as part of our options appraisal
- Following feedback from the Environment Agency, we have provided an expanded description of our approach to carbon emissions assessment.
- In a limited number of cases, we have introduced new options or altered our screening assessment of options to reflect ongoing work or new information, this includes ongoing work by the SRO teams.
- Following the 2022 drought (see Appendix CC), we have begun exploring the need for new raw water system elements in West London

Changes between revised draft WRMP24 and Final WRMP24:

- Following feedback from our regulators, we included more information on our approach to assessing DO benefits, contextualising them in system-wide performance rather than isolated options


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