Strategic regional water resource solutions: Preliminary feasibility assessment

Gate One Submission for: London Effluent Reuse SRO

July 2021

Contents

Glossary and Abbreviations

Term	Definition
London Effluent Reuse SRO	Term to describe the Strategic Resource Option group for all four London Effluent Reuse schemes as set out in the PR19 Final Determination.
London Effluent Reuse scheme	Term when describing an individual option of the SRO.
Beckton Effluent Reuse scheme	Option to develop a water reuse/recycling plant at Beckton STW including effluent abstraction, treatment and conveyance scope.
Mogden Effluent Reuse scheme	Option to develop a water reuse/recycling plant for Mogden STW effluent including abstraction, treatment and conveyance scope.
Mogden South Sewer scheme	Option to develop a sewage reuse/recycling plant for South Sewer sewage upstream of Mogden STW, including abstraction, treatment and conveyance scope.
Teddington DRA scheme	Option to develop a water reuse plant at Mogden STW taking effluent for tertiary treatment then discharging to River Thames including abstraction, treatment and conveyance scope.
Biodiversity Net Gain	An approach which aims to leave the natural environment in a measurably better state than beforehand.
Biodiversity Units	Once the proposed habitats are known, a calculation is completed to determine the Biodiversity Net Gain that would be achieved. The amount of net gain is expressed as 'Biodiversity Units'. These units can then be sold to developers who need to deliver net gain away from their development site.
Concentrate	The concentrated waste stream produced by the Reverse Osmosis membranes.
Conveyance	Refers to the assets which make up a transfer of fluid from one location to another, e.g. pipeline, tunnel, pumping station and outfall.
Costed risk	Method of attributing a likely cost range to project risks based on probability, time effect and cost magnitude.
Deployable Output	The output for specified conditions for a water resources system as constrained by; source yield; licensed quantities; abstraction assets; raw water transfer assets; treatment; water quality; and levels of service.
Final Determination (FD)	A set of documents published by Ofwat in December 2019 that specify the obligations during AMP7
F909	Thames Water Costing input worksheet.
Gated process	The 4 phases of solution-progress in 2020-25 where regulators will review progress and determine how and if solutions should proceed further through the process
Optimism bias	The demonstrated systematic tendency for appraisers to be over-optimistic about key project parameters, including capital costs, operating costs, project duration and benefits delivery.
Reverse Osmosis	A water purification process that uses a partially permeable membrane to separate ions, unwanted molecules and larger particles from water. Used in this report to refer to the treatment process utilising this technology.
Pipe jacking	A technique for installing underground pipelines, ducts and culverts also known as micro-tunnelling.
Reach A	Freshwater River Thames Reach A: a length of the river from Shepperton Lock to Affinity Water Walton intake.

Term	Definition
Reach B	Freshwater River Thames Reach B: a length of the river from Affinity Water Walton intake to Thames Water Walton intake.
Reach C	Freshwater River Thames Reach C: a length of the river from Thames Water Walton intake to Teddington Weir.
Reach D	Estuarine Thames Tideway Reach D: a length of the river from Teddington Weir to Battersea Park.
Reach E	Estuarine Thames Tideway Reach E: a length of the river from Battersea Park to Tower Bridge.
Reach F	Estuarine Thames Tideway Reach F: a length of the river from Tower Bridge to 3 km seawards Beckton STW.
Reach G	Freshwater River Lee Reach G: a length of the river from Newman's Weir on the Enfield Island Loop to Chingford abstractions.
Reach H	Freshwater River Lee Reach H: a length of the river from Chingford abstractions to Three Mills Lock.
Reach I	Estuarine Bow Creek (tidal Lee) Reach I: a length of the river from Three Mills Lock to Thames Tideway.

Acronym	Definition
1-in-200-year	A severe drought – the design drought year for WRMP19
AA	Appropriate Assessment - under the Habitats Regulations
ACWG	All Company Working Group
ADPW	Average Day Peak Week (Demand)
AIC	Average Incremental Cost
AMP	Asset Management Plan
AOP	Advanced Oxidation Process
APS	Asset Planning System (Thames Water system)
AWRP	Advanced Water Recycling Plant
BEC	Beckton Effluent Water Reuse Facility (AWRP)
BNG	Biodiversity Net Gain
CAP	Competitively Appointed Provider
Capex	Capital expenditure
CPES	Conceptual & Parametric Engineering System
DBOM	Design, Build, Operate & Maintain
DCO	Development Consent Order – planning under the Planning Act 2008
Defra	Department for Environment, Food and Rural Affairs
DO	Deployable Output
DPC	Direct Procurement for Customers
DRA	Direct River Abstraction
DWI	Drinking Water Inspectorate
DYAA	Dry Year Annual Average - The annual average value of water demand, deployable output or some other quantity over the course of a dry year.
DYCP	Dry Year Critical Period. The time in a dry year when demand is greatest, often termed the peak week. Also commonly known as the summer peak period.
EA	Environment Agency

Acronym	Definition
EES	Engineering Estimating System
EIA	Environmental Impact Assessment
GIS	Geographic Information System
HRA	Habitats Regulations Assessment
INNS	Invasive Non-Native Species
IP	Infrastructure Provider
ITT	Invitation to Tender
KGV	King George V Reservoir
LCK	Lockwood (referring to Lockwood Pumping Station/Tunnel Reception Shaft for Beckton Effluent Reuse scheme)
M&E	Mechanical & Electrical
MCDA	Multiple Criteria Decision Analysis
Ml/d	Mega litres per day
MOG	Mogden Effluent Water Reuse Facility (AWRP)
MSS	Mogden South Sewer Water Reuse Facility (AWRP)
NC	Natural Capital
NPV	Net Present Value
NSIP	Nationally Significant Infrastructure Project - under the Planning Act 2008
Opex	Operating expenditure
PR19	Price Review 2019
RAPID	Regulatory Alliance for Progressing Infrastructure Development
RO	Reverse Osmosis
SEA	Strategic Environmental Assessment
SRO	Strategic Resource Option
STW	Sewage Treatment Works
TBM	Tunnel Boring Machine
TED	Teddington DRA Tertiary Treatment Plant (TTP) – at Mogden STW
TLT	Thames Lee Tunnel
TTP	Tertiary Treatment Plant
TWUL	Thames Water Utilities Ltd
UF	Ultrafiltration
UV	Ultra-Violet
UVAOP	UV Advanced Oxidation Process
WAFU	Water Available for Use
WBS	Work Breakdown Structure – a workstream aligned to RAPID's expectations
WFD	Water Framework Directive
WQRA	Water Quality Risk Assessment
WRMP19	Water Resources Management Plan 2019
WRMP24	Water Resources Management Plan 2024
WRSE	Water Resource South East
WRZ	Water Resource Zone
WTW	Water Treatment Works

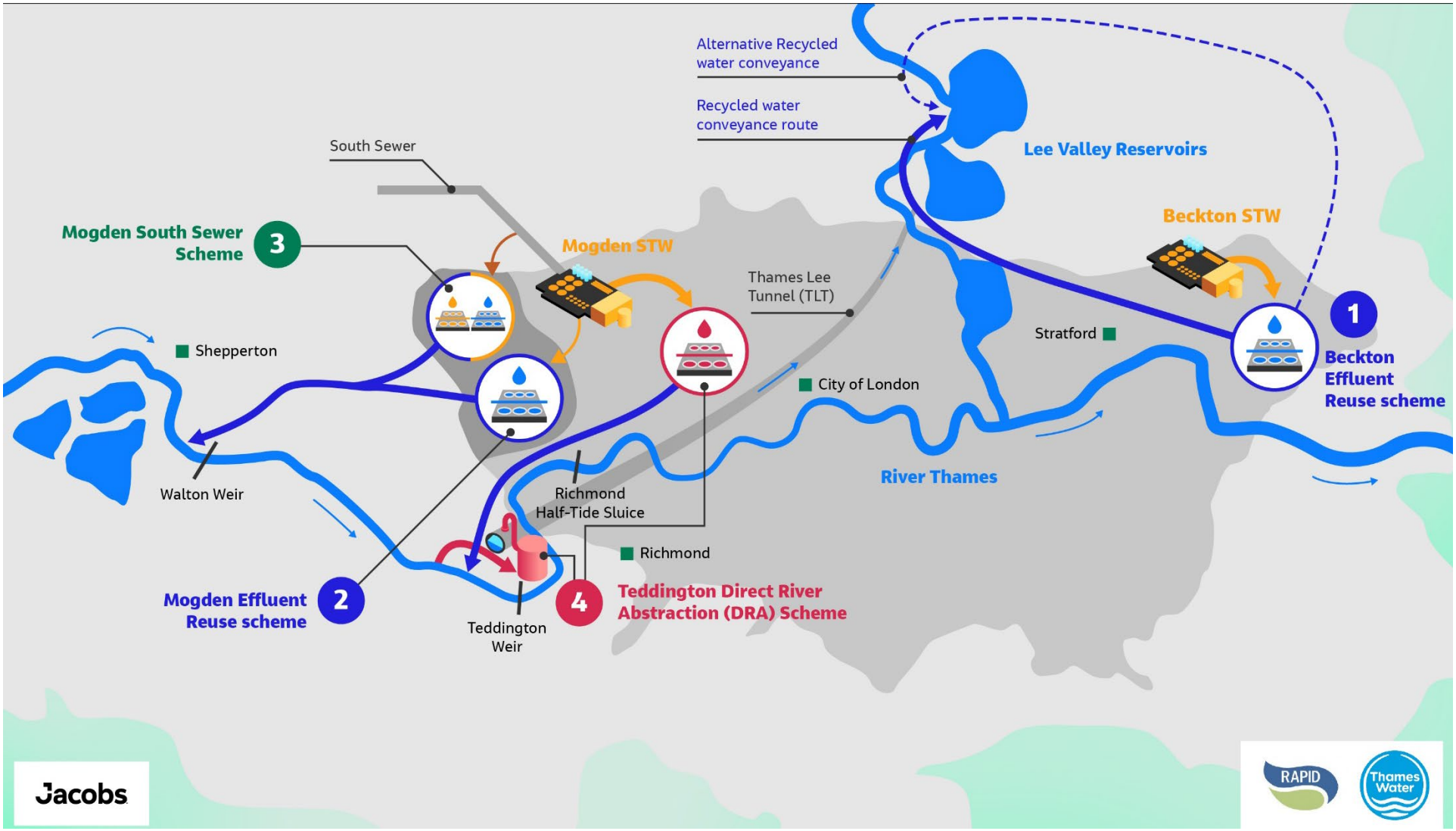

Figure 1-1 London Effluent Reuse SRO – Scheme Overview

1 Executive Summary

Overview

1.1 The London Effluent Reuse Strategic Resource Option (SRO) comprises four potential schemes of various size configurations: Beckton Effluent Reuse, Mogden Effluent Reuse, Mogden South Sewer and Teddington Direct River Abstraction (DRA). Abstracted effluent or sewage in these schemes would be treated through an Advanced Water Recycling Plant (AWRP), or a Tertiary Treatment Plant (TTP) in the case of Teddington DRA and discharged to the River Thames or the River Lee Diversion respectively where it can be abstracted as a raw water resource. This SRO is a viable set of solution options that includes a range of treatment schemes and conveyance components, which in combination deliver a resilient supply of raw water to the London Water Resource Zone (WRZ).

1.2 Thames Water Utilities Ltd (TWUL) has worked collaboratively to refine designs, cost and risk of the schemes, undertake appraisals and develop on the work done for WRMP19. All assessments have used Water Resource South East (WRSE) and/or the All Company Working Group (ACWG) methodologies to ensure consistency, with open engagement with key stakeholders. TWUL confirm that no 'showstoppers' have been identified through Gate 1. On this basis, we recommend that all schemes and options should advance to Gate 2 for further analysis and refinement.

Scheme Name	Description of Scheme	Constraint	Scheme Sub-Options	
Beckton Effluent Reuse scheme (BEC) (East London)	Final effluent harvest, reuse, convey recycled water King George V (KGV) reservoir, either direct via pipeline or via Lockwood pumping station through tunnels	Maximum capacity of 300 Ml/d	Advanced Water Recycling Plant (AWRP) options	50 Ml/d
				100 Ml/d
				150 Ml/d
			Conveyancing (choice of combined two tunnels option or alternative pipeline option)	Beckton - Lockwood Tunnel
				Lockwood-KGV Reservoir Tunnel
				Pipeline Beckton-KGV Reservoir (100 Ml/d)
Mogden Effluent Reuse scheme (MOG) (West London)	Final effluent harvest, reuse, convey recycled water to River Thames at Walton	Combined maximum capacity of 200 Ml/d made up of: MOG – 200 Ml/d max MSS – 50 Ml/d max TED – 150 Ml/d max	AWRP options	50 Ml/d
				100 Ml/d
			Conveyancing	All streams
Mogden South Sewer scheme (MSS) (West London)	Sewage harvest, treatment, reuse, convey recycled water to River Thames at Walton		AWRP phase and conveyancing	50 Ml/d
Teddington DRA scheme (TED) (West London)	Final effluent harvest, tertiary treatment and convey treated effluent to River Thames. DRA for discharge to Thames Lee Tunnel (TLT). Extension of TLT (as per Beckton Effluent Reuse sub-option) may be required.		Tertiary treatment	50 Ml/d
				75 Ml/d
			Conveyancing	Abstraction & Thames Lee Tunnel Connection
				Mogden STW - Teddington Tunnel

Key Findings

- Based on the high-level delivery programme developed for Gate 1, the SRO would meet the RAPID requirement to be "construction ready" early in Asset Management Plan 8 (AMP8) subsequent to Competitively Appointed Provider (CAP) award (or equivalent) in 2027. The projected Water Available for Use (WAFU) date would be by latest July 2032 for

the four schemes based on a Development Consent Order (DCO) application aligned with latest published Final WRMP24 date, but 12 months earlier with earliest WRMP24 date.

- If the programme is to progress based on TWUL's WRMP19 Alternative Plan, the earliest possible WAFU date for a reuse scheme would be in 2030.
- The ACWG cost methodology has been applied for the four scheme options. The scope and costs at Gate 1 have been refined and remain comparable with those presented at WRMP19, for directly-comparable options. Unit capital costs have been derived using TWUL benchmarked cost curves. Where costs curves were not available, benchmarking has been undertaken on unit rates to build up base capital costs for the schemes.
- Environmental impacts of the construction of the schemes are similar with some negative but largely temporary effects. Operational impacts may exist and development through Gate 2 would determine the scale and propose further mitigation measures.
- The benefits include resilience to climate change and water supply reliability, supporting economic and population growth through regional resilience in water provision and the contribution to a more sustainable water resources management system. The magnitude of those benefits are linked to the sizing of each scheme.
- The three schemes with AWRP's have mitigated the majority of risk to drinking water safety, with further mitigation to changes in customer perceptions of hardness and taste potentially required. The fourth scheme, Teddington DRA, would not cause a change to drinking water safety due to the discharge location being below all raw water abstraction points.
- A number of procurement options have been considered at this stage with either Direct Procurement for Customers (DPC) or Design, Build, Operate & Maintain (DBOM) procurement models being suitable.
- The recommended approach to planning is through a Section 35 Direction under the Planning Act 2008 where schemes do not automatically qualify under the Act. However, making an application for planning permission under the Town and Country Planning Act 1990 offers a viable alternative route.
- Project finances have been carefully managed through Gate 1 with the definition of a proportionate scope of work aligned to stakeholder expectations and the competitive tendering of work packages. Wherever possible work has been procured across joint River Thames SROs to bring cost savings and consistency.
- Assurance of this submission has been completed in line with TWUL processes and in the context of RAPID's assessment criteria for robustness, consistency and uncertainty. The conclusions are that the London Effluent Reuse SRO submission satisfies the Gate 1 criteria and meets key stakeholders' expectations. The SRO is supported by the TWUL board and we therefore recommend that all options progress through to Gate 2.

Key Risks

- Key programme risks are associated with the timing and integration of WRSE, WRMP24 and planning processes.
- Key environmental risks are associated with providing a greater understanding of the magnitude and scale of any impacts and mitigating sufficiently.
- Key consenting risks are associated with regulators granting timely licences for relevant aspects associated with the scheme operation.
- Land risks are associated with ensuring sufficient land is available for development for the reuse treatment facilities and not allocated for other developments.
- Engineering risks are associated with additional Capex costs due to issues such as re-routing of conveyance options and insufficient power supply from the local network requiring Distribution Network Operator upgrades.

2 Solution Description

Outline of the Solution

2.1 The London Effluent Reuse SRO incorporates four schemes that need to progress through a formal gated process of review and possible selection of one or more schemes for approval by the Regulatory Alliance for Progressing Infrastructure Development (RAPID): Beckton Effluent Reuse, Mogden Effluent Reuse, Mogden South Sewer and Teddington DRA. Abstracted effluent or sewage in these schemes would be treated in each case through an Advanced Water Recycling Plant (AWRP) / Tertiary Treatment Plant (TTP) and discharged to the River Thames or the River Lee Diversion to be abstracted as a raw water resource.

2.2 The costs associated with the elements of the London Effluent Reuse SRO are detailed in Section 10. The social and environmental benefits, including drinking water quality considerations are contained in Section 5. The cost for each gated stage is in Section 14.

2.3 The Dry Year Annual Average (DYAA) Deployable Output (DO) has been calculated at an interface point with WRSE, which is at the discharge of recycled water/treated effluent into the raw water catchment. These schemes shall be operated largely during the time in a dry year when demand is greatest, e.g. Dry Year Critical Period (DYCP). Hence the DYAA equivalent for Deployable Output has been calculated.

2.4 For the different SRO scheme treatment capacities which are being considered, the total DO derived from TWUL DO modelling is shown in Table 2-1. The DO modelling has established that the DO benefit for these schemes is the same for 1:2, 1:200 and 1:500 year drought scenarios as the schemes provide the full capacity yield in all scenarios.

Table 2-1 Elements of the London Effluent Reuse SRO System and their DO values

Scheme Capacity (Ml/d)	Deployable Output Benefit (Ml/d)			
	Beckton Effluent Reuse	Mogden Effluent Reuse	Mogden South Sewer	Teddington DRA
50	46	46	46	46
75	-	-	-	67
100	89	88	-	92
150	130	129	-	134
200	172	169	-	-
300	252	-	-	-
Note: Combinations of options are feasible with in-combination DO				

Scheme Descriptions/Overview

2.5 The paragraphs below illustrate the layout of the four schemes that are part of the London Effluent Reuse SRO, as seen in the overview schematic in Figure 1-1.

1. **Beckton Effluent Reuse scheme:** Final effluent from the Beckton Sewage Treatment Works (STW) in East London would be treated at a new AWRP within the STW site boundary. The treated water would then be pumped to a proposed discharge location on the River Lee Diversion above the inlet for King George V Reservoir (KGV) to supplement the raw water supply to the Lee Valley reservoirs (denoted as the "Conveyancing Sub-options". Scheme capacity: up to 300 Ml/d in 50, 100 or 150 Ml/d phases.
2. **Mogden Effluent Reuse scheme:** Final effluent from Mogden STW would be pumped to a new AWRP located at a site near Kempton Water Treatment Works (WTW). The recycled water would be discharged into the River Thames upstream of the existing TWUL Walton

intake (all conveyancing elements for all water/waste streams denoted as “Conveyancing (All Streams)” sub-option. Scheme capacity: up to 200 Ml/d in 50 or 100 Ml/d phases.

3. **Mogden South Sewer scheme:** Sewage would be abstracted from the South Sewer which supplies Mogden STW and pumped to a new sewage treatment and AWRP, located at a site near Kempton WTW, for treatment. Recycled water would be discharged into the River Thames upstream of the existing TWUL Walton intake. Scheme capacity: up to 50 Ml/d in one phase.
4. **Teddington DRA scheme:** Mogden STW effluent would be subject to tertiary treatment at a new plant on the STW site. The treated water would be transferred to a discharge location upstream of Teddington Weir. The tertiary treated effluent discharge would directly compensate flows taken from a new abstraction on the River Thames, upstream. The abstracted water would be pumped into the nearby Thames Lee Tunnel (TLT) for transfer to the Lee Valley reservoirs in East London. Scheme capacity: up to 150 Ml/d in 50 or 75 Ml/d phases. There is a potential of the TLT extension from Lockwood (as per Beckton Effluent Reuse scheme) being required but is not included at this stage (paragraph 2.11) .

Options and Configurations Considered

2.6 Through the WRSE regional planning process, it will be decided whether one or more of the London Effluent Reuse SRO schemes are selected. Along with the phased DO options, this provides a range of configuration options under consideration for the reuse treatment and conveyance works for this SRO. The configurations are governed by a number of constraints, as well as a number of assumptions made at this stage:

- Teddington DRA, Mogden Effluent Reuse and Mogden South Sewer schemes are all dependent on sewage flows to Mogden STW, and therefore there is a limit to the total yield of these options in combination (200 Ml/d combined scheme capacity).
- Available effluent/sewage (sufficient to produce 300 Ml/d of recycled water for Beckton Effluent Reuse, 50 Ml/d output for Mogden South Sewer scheme, 150 Ml/d capacity for Teddington DRA scheme and 200 Ml/d output for Mogden Effluent Reuse scheme).
- Land constraints – i.e., unlikely to have space for multiple stages of lower DO treatment phases (e.g. six phases of 50 Ml/d not possible for the Beckton Effluent Reuse scheme).
- Conveyance constraints – tunnel size less than 3.5 m inner diameter is not considered practicable in view of the necessary safety provisions for mechanised tunnel construction in drives more than 1 km in length; therefore, pipeline sub-option preferable for lower flows (e.g. 100 Ml/d or less for the Beckton scheme).
- Environmental & Third Party – projects will require an Environmental Impact Assessment (EIA); projects must have customer and stakeholder acceptance; schemes need to be consented and permitted.

2.7 A base case or preferred configuration at this stage is not proposed until the WRSE investment modelling is completed, or later in Gate 2.

Resilience Benefits

2.8 Delivery of a water reuse option would provide water resource benefit to the London WRZ and the South East region by bridging the water-supply deficit. However, the resilience benefits of the London Effluent Reuse SRO schemes are typically low in comparison to other SRO options. This is due to high complexity of the treatment systems, low adaptability to infrequent or periodic use, and long planning and lead times for the large conveyance elements. Resilience scoring has been completed by WRSE using resilience metrics which cover both transient shocks and stresses and longer-term/chronic stresses by splitting the metrics into three indices: reliability, evolvability and adaptability.

Interaction between Proposed Water Resource Solutions

2.9 There are multiple interactions between the London Effluent Reuse SRO schemes, as well as with the other SROs. A summary is listed below.

2.10 Inter-relationship with other SROs and non-SRO WRMP options:

- The additional water resource from this SRO could provide a resource for the Thames to Affinity Transfer (T2AT SRO).
- The Beckton Effluent Reuse solution is linked with the proposed Beckton Desalination WRMP non-SRO option as it is likely that the conveyance solutions would be in close proximity to one another as well as leading to potential salinity implications for the middle Thames Tideway.
- Environmental effects associated with the cumulative impact of developing options that would decrease freshwater inputs to the middle Thames Tideway.

2.11 Exclusivity or dependency with other London Effluent Reuse SRO schemes:

- As per paragraph 2.6, the combined DO is limited by environmental factors for the West London schemes (Mogden Effluent Reuse, Mogden South Sewer and Teddington DRA).
- Mogden Effluent Reuse and Mogden South Sewer schemes are inter-connected due to the shared location of the treatment sites and constrained by footprint and access requirements, therefore it is unlikely that both would be selected.
- Teddington DRA scheme is linked to the Beckton Effluent Reuse scheme due to the TLT connection at Teddington, combined with the potential TLT extension from Lockwood pumping station to King George V reservoir. There remains a potential of the TLT extension from Lockwood (as per Beckton Effluent Reuse scheme) being required but is not included as defined scope at this stage for the Teddington DRA scheme. This will be defined and confirmed following WRSE modelling through 2021/2022.

2.12 Water resource options may require several elements (from source to treated water transfer) to be implemented for the resource option to deliver benefit. This could include enhancements to raw water systems, WTW's and distribution networks. This is being considered separately by TWUL via WRMP24 projects. There are no foreseen implications for the SRO schemes due to any planned upgrades at the source STW's.

Compliance with National Framework and Regional Plans

2.13 These SRO schemes are included in the WRMP24 Unconstrained List of options, having been identified in the WRMP19 Water Reuse Feasibility Report and TWUL WRMP24 Feasibility Report Update March 2021. This process was undertaken by TWUL for developing regional resilience plans in line with the National Framework for regional planning and the Water Resources Planning Guideline by the EA (2021).

2.14 The London Effluent Reuse SRO configurations will be reflected in the regional plans for the recipient region (WRSE), to ensure transfer of water to where it is needed to deliver resilience for the 1 in 500-year drought in accordance with the National Framework. The SRO would meet the statutory and regional water resources plans, consenting strategy, delivery and commercial strategy and wider government policy.

3 Outline Project Plan

Programme overview

3.1 Up to Gate 1, all key milestones have been met including regional submissions to WRSE earlier in 2020 and 2021. At this stage and noting the complexity of the projects and the

inter-relationship with WRMP24, the programme remains on track to proceed through planning, WRMP24, procurement and the gated process in parallel to be 'construction ready' in early Asset Management Plan 8 (AMP8) with construction start following Competitively Appointed Provider (CAP) award (or equivalent) in 2027.

3.2 If the programme were to progress based on TWUL's WRMP19 Alternative Plan[1], the earliest possible WAFU date for a reuse scheme would be 2030. This assumes a 7 to 8-year planning-design, development and construction duration and a TWUL Decision Point to progress the Alternative Plan in 2022/23.

3.3 Figure 3-1 below presents a programme for London Effluent Reuse SRO showing the inter-relationships between different regulatory processes. The programme presents a worst-case planning programme based on establishing a need case for schemes in a published Final WRMP24 by early 2025.

3.4 On the basis of the current programme, following a period for planning-design and development after Gate 2, the construction phase is expected to be able to commence in 2027. Earlier WRMP24 publication could result in construction being able to commence up to 12 months earlier.

3.5 The projected WAFU dates are calculated based on the latest published Final WRMP24 date and subsequent planning consent. For each of the four schemes, the latest WAFU dates are as follows:

- Beckton Effluent Reuse 100 Ml/d capacity option – latest WAFU date July 2032.
- Mogden Effluent Reuse 100 Ml/d capacity option – latest WAFU date April 2032.
- Mogden South Sewer 50 Ml/d capacity option – latest WAFU date May 2031.
- Teddington DRA 75 Ml/d capacity option – latest WAFU date August 2031.

3.6 Should the Final WMRP24 be published in late-2023, the WAFU dates for all schemes could be up to 12 months earlier ranging between mid-2030 to mid-2031.

[1] Final WRMP19 (April 2020) - Section 10 Programme appraisal and scenario testing.

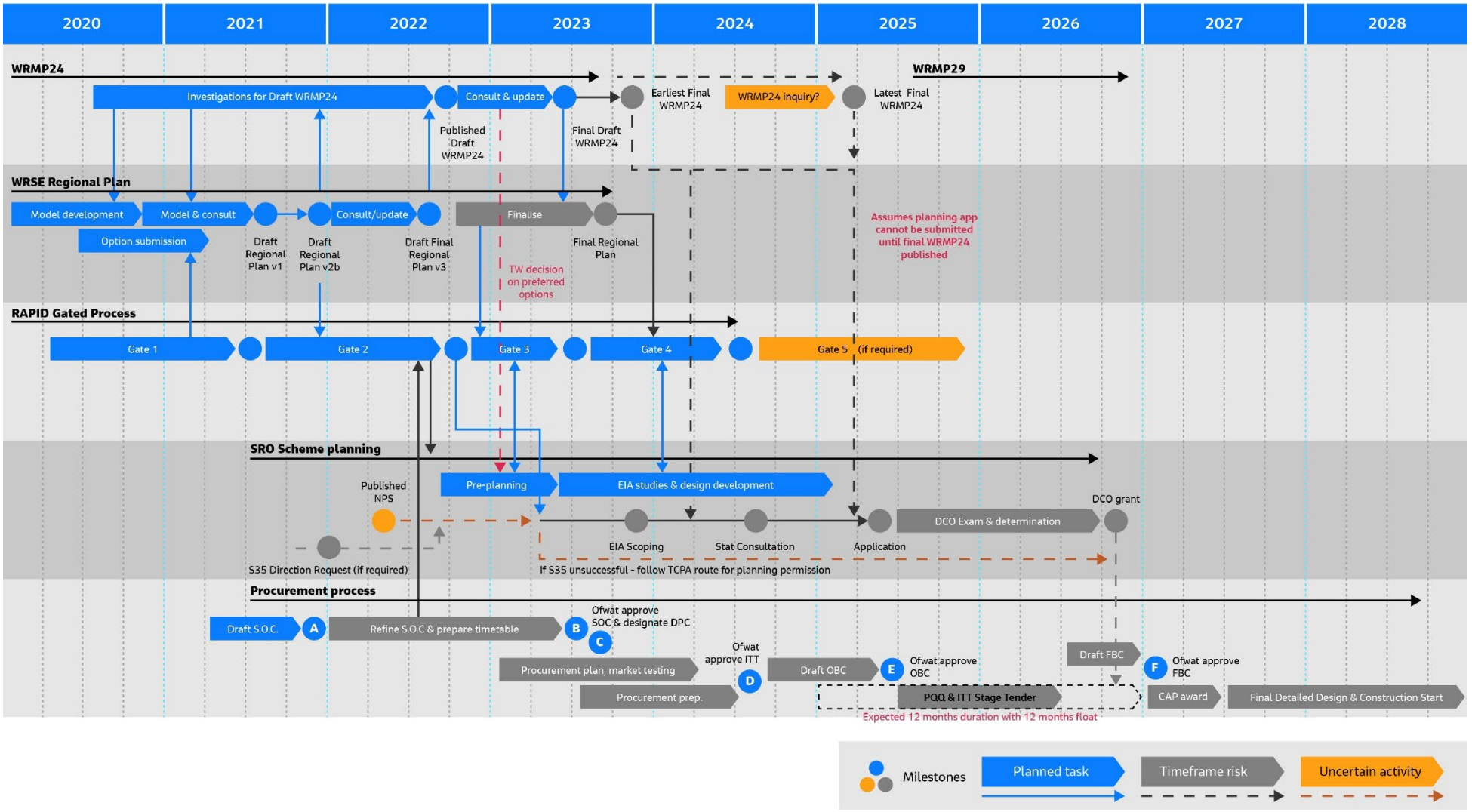

Figure 3-1 London Effluent Reuse SRO Worst Case Overview Programme – showing interrelationships between water resource, planning and procurement based on Latest Final WRMP24

Phasing of Key Activities and Decisions

3.7 The key phases and decision points beyond Gate 1 are outlined in Table 3-1.

Table 3-1 Key Phases for London Effluent Reuse SRO Development

Key Phase	Description & Key Activities	Completion Date
RAPID Gate 2	Continued work on options refinement, solution feasibility, conceptual design, and environmental appraisal with associated regulator and technical stakeholder engagement. In addition, timely input to WRSE regional planning and draft WRMP24 supported by progression of the scheme procurement strategy.	Gate 2 October 2022
Decision prior to or at RAPID Gate 2 TWUL Decision on Preferred Option(s)	Decision on which scheme(s) or sub-option(s) proceed into Gate 3 made during or at the end of Gate 2 with decisions based on WRSE regional plan outputs, development of plans for draft WRMP24 and input from regulators. Decision by TWUL to progress with the WRMP19 Preferred Plan or switch to the WRMP19 Alternative Plan.	Gate 2 by October 2022 End 2022/early 2023
RAPID Gate 3 / 4 Ofwat procurement Control Points B & C	Development of the chosen scheme(s) or sub-option(s). Development of SOC and procurement plans including progress through Ofwat's Control Points B and C.	Gate 3 summer 2023 Gate 4 summer 2024 Control Points B&C summer 2023
Ofwat's procurement Control Point D	Development of procurement plan, market testing and preparation of Invitation to Tender (ITT) ready for Ofwat approval at Control Point D	Control Point D early 2025
Planning application	Following publication of WRMP24, formal application for development consent under the Planning Act 2008 (or alternative route) followed by examination and decision. During this period, the Full Business Case (FBC) would be developed.	Application mid-2025. Consent late 2026
Ofwat's procurement Control Point F	Final procurement and approval of FBC (Control Point F) and subsequent award of a CAP, enabling scheme delivery to progress.	Control Point F early 2027 CAP award mid 2027
Construction Phase Start	Start of construction phase from CAP award through to WAFU. Date dependent on publication of WRMP24 with latest dates presented.	Commence mid 2027 Finish latest 2032

Assumptions and Dependencies

3.8 The programme and delivery plan are dependent upon a number of key assumptions and dependencies that will be managed through the programme risk management process.

- The National Policy Statement on Water Resources by Defra is published before the start of planning activities and the content remains largely unchanged from the draft version in terms of the tests and need for a scheme determined by a published WRMP.
- Issues and concerns arising from stakeholders identified during Gate 2 and Gate 3 can be addressed and mitigated to a satisfactory conclusion.
- Development consent is granted within prescribed determination timescales.
- The preferred direction of travel at this stage being DPC or DBOC model – see Section 6.
- In order to de-risk the future delivery programme, it will be necessary to start the formal procurement of a CAP (Pre-Qualification Questionnaire (PQQ), ITT and negotiation) before consent, but not appoint the CAP until the DCO is made.

Information Status and Recommendations

3.9 The Gate 1 submission confirms that all schemes presented are feasible and can be delivered within the timeframes set out by RAPID and if required as early as 2030 as set out in WRMP19. It is proposed that all London Effluent Reuse SRO options should be progressed beyond Gate 1, to further assess their feasibility, combinations and phasing in greater detail. Confirmation of the preferred options and the need for the scheme will be based on outputs from the WRSE regional modelling process during Gate 2.

3.10 There is no missing data to report at Gate 1, and all activities planned and agreed with stakeholders for progression through Gate 1 have been undertaken. A forward action plan for Gate 2 activities has been prepared and is summarised in Section 15 and will form part of the engagement with stakeholders early in Gate 2.

4 Technical Information

Initial Configuration/Sub-options

4.1 Section 2 outlines the London Effluent Reuse SRO solution, including the four schemes and their sub-components. It also defines the options and the configurations considered.

4.2 The optimum combination of the sub-options will be determined through WRSE investment modelling, with a quantitative benefits assessment to be done at Gate 2 as set out in Section 10, and through further consideration of environmental impacts and mitigation.

Operation and Maintenance Requirements

4.3 The scheme infrastructure would be operated alongside the existing distribution and supply network. Initial modelling completed by TWUL, and experience from other water companies, indicates that it is better to limit the number of interfaces between water reuse infrastructure and the existing network as it minimises potential negative impacts to the existing distribution network and therefore customers. The scheme would operate intermittently as required during periods of drought.

4.4 Each scheme is expected to be operated in a mode where the facilities are prepared and commissioned to minimise the duration of the start-up sequence when the scheme is required (i.e. when demand is greater or forecast to be greater than what can be supplied from all other sources). Refer to paragraph 6.9 for further detail of Operation and Utilisation for each scheme. In the event of a quality failure, each scheme will “fail safe”, via a run-to-waste back to the relevant source STW.

4.5 It is proposed that the schemes should be controlled in a manner to implement the following functionality, and to ensure that the control system is compatible with the long-term TWUL strategy in this area:

- Single flow set point – automatic configuration of the treatment plant to meet this point;
- Automated parametric adjustment and automated membrane care when offline;
- Distributed Control System – to enable ongoing operation in the event of communications failures, etc.;
- Central control for all London Effluent Reuse schemes;
- Advanced data acquisition to facilitate optimisation of plant and maintenance; and
- Extrapolation of data to develop long-term planning.

Operation of Beckton Effluent Reuse Scheme

4.6 Final effluent from Beckton STW would be treated at a new AWRP at Beckton STW. The design of the AWRP has been developed in alignment with the TWUL methodology focusing on Water Framework Directive (WFD) compliance. This provides a standard of treatment globally accepted for indirect reuse through Ultrafiltration (UF), Reverse Osmosis (RO) and UV Advanced Oxidation Process (UVAOP), globally referred to as Full Advanced Treatment. The recycled water would then be pumped via a tunnel to Lockwood Pumping Station and then via an extension to the TLT to the River Lee Diversion, upstream of the inlet for KGV. The Lockwood to KGV tunnel (TLT extension) may be built prior to the Beckton to Lockwood Tunnel.

4.7 All waste flows will be combined with final effluent from Beckton STW and discharged to the River Thames via the existing STW outfall, in the Estuarine Thames Tideway Reach.

Operation of Mogden Effluent Reuse Scheme

4.8 Final effluent from Mogden STW would be pumped to a new AWRP near Kempton WTW. After Full Advanced Treatment (as detailed above in paragraph 4.6), the recycled water would be pumped into the River Thames upstream of the Walton WTW intake.

4.9 A waste stream consisting of UF backwashes, neutralisation UF clean-in-place chemicals and RO clean-in-place chemicals will be pumped to the inlet of Mogden STW. The RO concentrate will be pumped separately to Mogden STW where it will be combined with final effluent and discharged to the River Thames via the existing STW outfall.

Operation of Mogden South Sewer Scheme

4.10 Sewage would be abstracted from the South Sewer adjacent to Kempton Park WTW and pumped to a new AWRP, incorporating an upstream sewage treatment phase. This AWRP follows a similar process to the Beckton Effluent Reuse AWRP; however, Mogden South Sewer does not require UF due to the Membrane Bioreactor plant in the sewage treatment stages. The recycled water is then pumped into the River Thames upstream of the Walton WTW intake.

4.11 All the waste streams from the treatment stages, except the RO concentrate, will be pumped back to the South Sewer. The RO concentrate will be pumped to Mogden STW where it will be combined with final effluent and discharged to the River Thames via the existing STW outfall. Due to the biological treatment processes employed in the sewage treatment, a 'minimum flow' operating regime is recommended for the Mogden South Sewer scheme, and would be operated above this only when required, i.e. when demand is greater or forecast to be greater than what can be supplied from all other sources. Refer to paragraph 6.9. This differs from the proposed operation of the other schemes in this SRO.

Operation of Teddington DRA Scheme

4.12 Final effluent from Mogden STW would be treated at a new Tertiary Treatment Plant (TTP) at Mogden STW built on the site of the existing storm tanks, though with a smaller footprint. The recycled water would be pumped into the River Thames upstream of the Teddington Weir. As part of the scheme, raw water would be abstracted from the River Thames upstream of the recycled water discharge location and would be pumped into the TLT for transfer to the Lee Valley reservoirs in East London. As the discharge location for the recycled water would be in the most downstream section of the non-tidal section of the River Thames, as well as being downstream of all the existing raw water intake points of WTWs, the design for the treatment plant is focused on meeting water quality consent parameters for discharge to the River Thames. The process comprises tertiary nitrification to reduce ammonia levels, and chemical dosing and tertiary filtration to reduce phosphorus and Biological Oxygen Demand (BOD).

4.13 The operation of nitrifying sand filters and mechanical cloth filters would result in backwashing and desludging waste streams that will be collected in an equalisation tank before being returned to the inlet of the Mogden STW.

Maintenance

4.14 Regular maintenance of the treatment plants would be required throughout the year, especially for the RO plants to maintain the condition of membrane modules and operational works to ensure the facilities are ready to come into service when required. Refer to Table 4-1 for detail of the London Effluent Reuse SRO scheme elements and general maintenance requirements.

Table 4-1 Maintenance Requirements – London Effluent Reuse SRO Schemes

Area	Element	BEC	MOG	MSS	TED	Maintenance
Sewage Treatment	Inlet works and primary settlement tank			✓		Requirement for full operation and maintenance of the facility including preventative and reactionary maintenance, chemical handling, sludge handling and effluent quality monitoring. TWUL have experience with these technologies. Weekly membrane maintenance chemical cleaning – MBR Biannual membrane recovery chemical cleaning – MBR Facility will require a number of weeks start-up before fully operational – due to biological processes.
	Activated sludge plant with biological nutrient removal			✓		
	Membrane Bioreactor (MBR) and sludge stream			✓		
Advanced Water Recycling Plant (AWRP)	Ultrafiltration (UF)	✓	✓			Full operation and maintenance of the facility including preventative and reactionary maintenance, chemical handling, sludge handling and water quality monitoring. Infrequent (monthly) membrane chemical cleaning – UF and RO. Continual maintenance for all M&E equipment. Full backwash for AWRP before operation
	Reverse Osmosis (RO)	✓	✓	✓		
	UV treatment (UVAOP)	✓	✓	✓		
	Remineralisation and chemical dosing	✓	✓	✓		
	Waste stream	✓	✓	✓		
Tertiary Treatment Plant	Nitrifying sand filters				✓	Full operation and maintenance of the facility including preventative and reactionary maintenance, chemical handling and water quality monitoring. TWUL have experience with these technologies. Continual maintenance for all M&E equipment.
	Mechanical cloth filters				✓	
	Ancillaries (chemical dosing, waste stream, etc.)				✓	
Conveyance	Abstraction (effluent/sewage)	✓	✓	✓	✓	Annual inspection of all pumping station equipment and valves, and inspection of abstraction and discharge structures. Annual walkover and exercising of pipeline/tunnel valves and inspection of shafts. Continual maintenance for all M&E equipment.
	Tunnel	✓			✓	
	Pipelines	✓	✓	✓		
Abstraction (raw water)	Abstraction pumped system				✓	Annual inspection of all pumping station equipment and valves, and inspection of abstraction structures.

Area	Element	BEC	MOG	MSS	TED	Maintenance
						Continual maintenance for all M&E equipment.

Design Life

4.15 The design life of any civil structures, such as buildings and tanks in the AWRP/Tertiary Treatment Plant, is generally 60 years, and for the tunnels and alternative pipeline for recycled water transfer the design life would be 100 years. The lifetime of mechanical and electrical and control equipment varies, however for consistency asset life expectancies / Opex considerations have been selected to be as per the WRSE Cost Consistency Methodology Technical Note[2]. The determination of lifetime of each asset will require further design assessment at Gate 2.

4.16 These asset life expectancies assume that assets are maintained following a maintenance profile that helps them to stay operational for the expected asset duration. Since the reuse treatment facilities are intended to be operated intermittently, the maintenance regime of the mechanical equipment needs to be considered carefully. Periods out of use can affect the asset life of equipment such as pumps/membranes.

Initial Costing and Estimating

4.17 The costs associated with the elements of the project detailed in this SRO are detailed in the Cost and Carbon Report for each scheme. A summary of the Net Present Value (NPV) costs is in Section 10 in Table 10-2 and Table 10-3.

Initial Water Resource Benefit Assessment

4.18 Refer to Table 2-1 in Section 2 for Deployable Outputs for each sub-option in the 1 in 500-year drought scenarios. DO's were calculated by WARMSII modelling for both the Dry Year Annual Average and the Dry Year Critical Period in accordance with Annex I of the TWUL Final WRMP19. The London Effluent Reuse SRO will benefit the London WRZ.

4.19 TWUL is a Partner in the regional water resource modelling and planning through WRSE, in line with the National Framework requirements to ensure that the water reuse options optimise hydrology across the region. WRSE is an alliance of the six South East of England water companies to develop long-term plans for securing regional water supplies. Noting the likelihood of future water supply resilience requirements, the London Effluent Reuse SRO options have been intentionally configured with multiple phased stages and could include redundancy to allow further expansion capacity. Refer to paragraph 2.10.

Initial Data Provided to Regional Groups

4.20 The initial configurations of the sub-options and costing information in this SRO were provided to WRSE in March 2021 for inclusion in the Regional Plan investment modelling to evaluate a series of Regional Plans for the whole WRSE region.

4.21 The London Effluent Reuse SRO (schemes and sub-options) has been identified as being on the WRMP24 Unconstrained List. The design of each option (and sub-options) has been developed to an equivalent level to ensure unbiased comparison. TWUL provided metrics including cost estimates, environmental impacts and resilience metrics to WRSE to be included in the WRSE Options Database for investment modelling in March 2021.

4.22 The design elements reported to WRSE through the Options Database are Capex, Opex, carbon, DO, lead time, optimism bias, dependencies and Geographic Information System (GIS) data for each sub-option. The WRSE investment modelling will determine which

[2] Cost Consistency Methodology – Technical Note & Methodology (August 2020).

scheme option, or combination of options, could best meet the supply deficit from 50 Ml/d up to a maximum of 200 Ml/d in West London and up to 300 Ml/d in East London or a combination of both up to 500 Ml/d. As stated in paragraph 2.9, the volume of reuse waste streams that can be accommodated in the Thames Tideway without causing environmental deterioration is likely to be significantly less than the combined maximum DO (500 Ml/d) of the schemes.

4.23 The WRSE investment model will also be able to select, in direct competition to the London Effluent Reuse SRO, other non-strategic resource schemes including Beckton Desalination plant, Crossness Desalination plant, Crossness Reuse and against the already selected Deephams Reuse (WRMP19 preferred reuse option).

5 Environmental and Drinking Water Quality Considerations

Introduction

5.1 This section summarises the environmental and drinking water regulatory assessments completed for Gate 1. The environmental assessment has been undertaken in accordance with the methodology set out in the ACWG and WRMP environmental guidance and was undertaken to inform both Gate 1 and the WRSE environmental metrics, to ensure consistency across the two processes.

5.2 To ensure a robust and proportionate approach at Gate 1, we have extensively engaged with multiple stakeholders to develop an agreed evidence base and shape environmental assessments and plans for future work through Gate 2. In this way it also ensures we provide best value outcomes and opportunities for social and environmental benefits.

High-level Environmental Appraisal

5.3 A full suite of hydro-ecological assessments was completed based on existing and bespoke data collection and modelling, to a level of detail commensurate with the development of the London Effluent Reuse SRO initial conceptual design. A summary of the pre-mitigation assessment is presented below.

5.4 The Mogden South Sewer scheme (50 Ml/d) was assessed to have the potential to cause: negligible change to flow, wetted habitat, tidal level and intertidal-exposure; a minor increase in water temperature local to an outfall in Reach A or B (refer to Glossary for definition); localised changes to freshwater fish community structure and migration patterns in Reach A or B; alteration of life-cycle and WFD quality criteria of macroinvertebrates in Reach A or B.

5.5 The Mogden Effluent Reuse scheme (50 - 200 Ml/d) was assessed to have the potential to cause: negligible to moderate flow change in Reach C; minor to moderate water temperature change in Reach A or B and minor salinity change in Reach D; changes to freshwater and estuarine fish community structure and migration patterns in Reaches A to E; alteration of life-cycle and WFD quality criteria of macroinvertebrates in Reach A to C.

5.6 The Teddington DRA scheme (50 - 150 Ml/d) was assessed to have the potential to cause: negligible to minor flow change within Reaches A-C; minor to moderate water temperature change in local to the outfall in Reach C and minor salinity change in Reach D; changes to freshwater and estuarine fish community structure and migration patterns in Reach C to E; alteration of life-cycle and WFD quality criteria of macroinvertebrates in Reach C.

5.7 The Beckton Effluent Reuse scheme (100 - 300 Ml/d) was assessed to have the potential to cause: major flow change within Reach G; moderate water temperature change in Reach

G; changes to freshwater fish community structure and migration patterns in Reach G; alteration of life-cycle and WFD quality criteria of macroinvertebrates in Reach G.

5.8 The Invasive Non-Native Species (INNS) assessment concluded that the changes summarised above would not adversely influence preference conditions for INNS and so distribution should not be affected, but that the potential for additional volume of water to be transferred through the existing TLT could increase the risk of transfer between catchments from this pathway, prior to mitigation being considered.

5.9 The estuarine ecology assessment concluded that the London Effluent Reuse SROs would not impact macroalgae, benthic marine invertebrates, seagrass and salt marsh receptors within the tideway.

Initial Option-level Environmental Regulatory Assessments

5.10 Regulatory assessments have been completed in accordance with the ACWG methodology for environment assessments[3], consisting of Habitats Regulations Assessment (HRA) Appropriate Assessment, WFD assessment and Strategic Environmental Assessment (SEA).

5.11 The HRA concluded that with the implementation of key mitigation measures, no adverse effects from London Effluent Reuse SROs were anticipated on European sites. However, additional surveys during Gate 2 have been recommended to confirm the assessment outcomes. Mitigation measures included timing restrictions to avoid construction works during the bird wintering season and ensuring compliance with water quality attributes and targets associated with the European sites. The in-combination assessment concluded that there were no in-combination effects between potential west and east London Effluent Reuse SRO sub-options, and that in-combination effects with other regional plans and major infrastructure developments were also unlikely.

5.12 The WFD assessment concluded that the Mogden South Sewer scheme, the 50 Ml/d and 100 Ml/d Mogden Effluent Reuse schemes, the 50 Ml/d Teddington DRA scheme and the 100 Ml/d and 200 Ml/d Beckton Effluent Reuse schemes would be compliant with WFD objectives. The 150 Ml/d and 200 Ml/d Mogden Effluent Reuse schemes were assessed to have the potential to not comply with the macroinvertebrate objective in the Thames (Egham to Teddington) (GB106039023232) water body and chemical status in the Thames Upper (GB530603911403) water body. The 75 Ml/d Teddington DRA scheme was assessed to have the potential to not comply with the angiosperm and phytoplankton objectives in the Thames Upper (GB530603911403) water body, with the 150 Ml/d variant also having the potential to not comply with the chemical status objective of the water body. The 300 Ml/d Beckton Effluent Reuse scheme was assessed to have the potential to not comply with the chemical status of the Thames Middle (GB530603911402) water body. Through the consideration of the construction good practice and mitigation measures that the ACWG methodology includes, the conveyance components of all schemes are assessed to be WFD compliant.

5.13 All WFD assessments were considered to have low confidence due to limitations in design information and baseline data availability at this early stage. These assessments require further investigation of effects and mitigation measures through Gate 2 to increase the level of confidence. At this stage, it is not envisaged there would be a risk of WFD non-compliance as further work is carried out.

5.14 The SEA concluded that, during construction and with further identified mitigation measures applied, Mogden South Sewer, Mogden Effluent Reuse and Teddington DRA schemes could result in a temporary moderate negative effect to local air quality, with

[3] Mott MacDonald Limited (2020). All Company Working Group WRMP environmental assessment guidance and applicability with SROs. Published October 2020

other negative effects being mitigated to negligible or minor effects. During operation and with further identified mitigation measures applied, the schemes would deliver major positive effects in relation to resilient water supply, reduction in drought risks and support economic and population growth. However, during operation the schemes (at their large sizes) could also result in a moderate negative effect to aquatic ecology receptors, potentially caused by increased water temperature, which requires further investigation in Gate 2 into the effect on WFD quality. All other negative effects would be mitigated to negligible or minor effects. The Beckton Effluent Reuse scheme was assessed to have similar negative construction effects and similar positive operational effects as the West London Effluent Reuse schemes, with the addition that the large scheme size (300 Ml/d) could cause additional WFD issues around dilution of effluent which needs to be assessed further in Gate 2. The SEA concluded that there could be in-combination effects from a Mogden Effluent Reuse scheme and a Teddington DRA scheme during construction on air quality and human health and during operation on the water environment, but that further assessment was required in Gate 2.

Initial Environmental, Social and Economic Valuations

5.15 For Gate 1, Environmental, Social and Economic valuation was undertaken based on a Natural Capital (NC) assessment following the methodology provided by ACWG[3]. The assessment concluded that all options and components could result in a net-loss to NC assets and corresponding ecosystem services. However, enhancement measures to support delivery of Biodiversity Net Gain (BNG) will be further developed at Gate 2 and these will provide an opportunity to create wider NC benefits, e.g. by improving carbon sequestration or flood regulation through habitat creation or improvement.

Environmental Net Gain

5.16 Environmental Net Gain has been assessed through both the NC assessment and the BNG assessment. The results of the BNG assessment show a loss in Biodiversity Units[4] of 1,125 for Mogden Effluent Reuse, 1,074 for Mogden South Sewer, 670 for Beckton Effluent Reuse and 0.4 for Teddington DRA. Further assessment of habitat impacts will be required as the scheme designs evolve. For Gate 2 this will include Phase 1 habitat surveys to ground truth the BNG assessment.

5.17 As a core principle, the London Effluent Reuse SRO is committed to not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall BNG. The latter will be achieved by identifying local sites of ecological interest and proposing measures which enhance these features as part of the Gate 2 assessments. Habitat enhancement measures also have the potential to provide wider social benefits.

Carbon Commitments

5.18 An assessment of the carbon impacts of the SRO has been completed and includes measures to decarbonise, in line with Thames Water's commitment to go beyond net zero by 2040. This includes undertaking a detailed capital and whole-life carbon baseline assessment, holding a low-carbon workshop to review hotspots and priorities, adopting design principles and a management process to support decarbonisation, and considering a regional systems approach to develop a more integrated regional plan for renewables and offsetting schemes. These ideas need to be developed further and emissions sources interrogated in more detail through Gate 2 to help provide further insights into the specific sources of emissions in the different options and who needs to be engaged to start to decarbonise these.

[4] Biodiversity Units measured using the Defra Metric 2.0.

Social and Environmental Benefits, Resilience and Best Value Outcome for Customers and the Environment

5.19 The potential wider benefits and adverse effects on the environment and society are summarised below in Table 5-1. The best value for customer outcomes of these schemes shall be defined through WRSE Investment Modelling. The Natural Capital assessment shows Teddington DRA as the "least adverse".

Table 5-1 Summary of environmental and social benefits and adverse effects

Benefit	Adverse
Common to All Schemes	
• Potential for offsite habitat enhancement and resulting increase in NC and ecosystem service provision. • Reduced vulnerability to risks (drought) associated with climate change effects. • Creation of local jobs during construction and operation and provides resilient, high-quality and affordable water supply	• Potential loss or degradation of priority habitats and designated sites as detailed in SEA/HRA. • Potentially energy intensive project • Potential impact on navigation from reduced water depth in Thames Tideway.
Mogden South Sewer	
• TWUL own land around Kempton WTW to accommodate a reuse treatment works. Sufficient space for future expansion if required. Opportunity for integrated planning between water / wastewater	• New or modified access required to the site from the A308. • The length of new conveyance is around 10 km.
Mogden Effluent Reuse	
• TWUL own land around Kempton WTW to accommodate an AWRP. Sufficient space for future expansion if required. Opportunity for integrated planning between water / wastewater. • Supply of water would become more resilient and sustainable and provides an alternative to increased freshwater abstraction. • Potential for improved dissolved oxygen concentration in the upper tideway through reduced Mogden STW input when scheme running.	• Potential adverse impacts to ecological communities in the freshwater River Thames as a result of changes in flow and water quality. • New or modified access required to the site from the A308. • The length of new conveyance is around 15 km. • Potential environmental and navigational impacts on Thames Tideway from reduced volume of effluent discharge from existing Mogden STW outfalls.
Teddington DRA	
• The treatment location is on TWUL's Mogden STW site. The abstraction discharges into the existing TWUL TLT. The use of effluent is allowing abstraction of water without impacting the volume of water reaching Teddington Weir	• Potential adverse impacts to ecological communities in the freshwater River Thames as a result of changes in flow and water quality. • Approx. 1,020 residential buildings likely to be affected in some capacity during construction. There is a strong residents' group near Mogden STW who challenge operational practices at the works currently. • Land around abstraction location is located within the North Riverside conservation area, with a number of designated sites within 1 km. • Potential impact on navigation from reduced water depth in Thames Tideway.
Beckton Effluent Reuse	
• Limited construction traffic impacts as good connectivity. • Site benefits from existing flood defence assets.	• Potential adverse impacts to ecological communities in the River Lee as a result of changes in flow and water quality. • <100 residential buildings likely to be affected by construction activities to varying degrees. • Potential for construction works within more than one Air Quality Management Area.

Benefit	Adverse
	• Lengths of the conveyance route and shafts are within the London Area Greenbelt. Recreational Public Right of Way Route (13) may be affected.

Initial Drinking Water Quality Considerations and Risk Assessments

5.20 A Strategic Water Quality Risk Assessment (WQRA) was undertaken using the ACWG methodology[5] to assess the treated water quality risks associated with each scheme. The SRO team worked with the TWUL Drinking Water Quality team throughout the assessment, culminating in a workshop to review and agree the draft WQRA spreadsheets on 1 March 2021. Consultation was held with the Drinking Water Inspectorate (DWI) to outline the approach to the assessment on 27 January 2021 and to present draft assessment findings on 18 March 2021. Based on available water quality data, the WQRA identified a set of water quality parameters that pose a risk to drinking water quality (termed Limiting Hazards) for each of the reuse options. The WQRA identified that for Mogden Effluent Reuse, Mogden South Sewer and Teddington DRA all Limiting Hazards would be dealt with at the catchment stage and not pose an additional risk to drinking water quality. The WQRA of Beckton Effluent Reuse identified that the larger scheme had the potential to change the corrosivity, hardness/alkalinity and source of water. This might pose a low risk to the distribution network and be noticeable to the consumer, which requires further consideration in relation to the scheme's operating pattern in Gate 2. The current Gate 1 water quality monitoring programme will be used to validate the Limiting Hazards identified in the Gate 2 assessment.

6 Initial Outline of Procurement and Operation Strategy

Development and appraisal of Procurement Options

6.1 This section outlines the procurement considerations for the London Effluent Reuse SRO. Due to the early stage of scheme development, the strategy does not provide a definitive recommendation for a single procurement option but does set out a preferred 'direction-of-travel' to take forward to Gate 2 for further development.

6.2 The London Effluent Reuse SRO was assessed against the HM Treasury Green Book risk criteria through the means of a series of workshops. The outputs of the two expert review workshops were used to develop an understanding of the overall risks, challenges and uncertainties. This has enabled an understanding of the size of the scheme, the complexity, options and component parts of the scheme, and the risks associated with its delivery and operation.

6.3 The procurement strategy examines the various models for delivery and operation grouped under four broad categories, covering:

- Typical current procurement models;
- DPC models;
- DBOM models; and
- Infrastructure Provider (IP) models.

[5] All Company Working Group (ACWG) (2021) Strategic WQ Risk Framework – FINAL Report, B19589BJ-DOC-001|06, 19/01/2021, Jacobs.

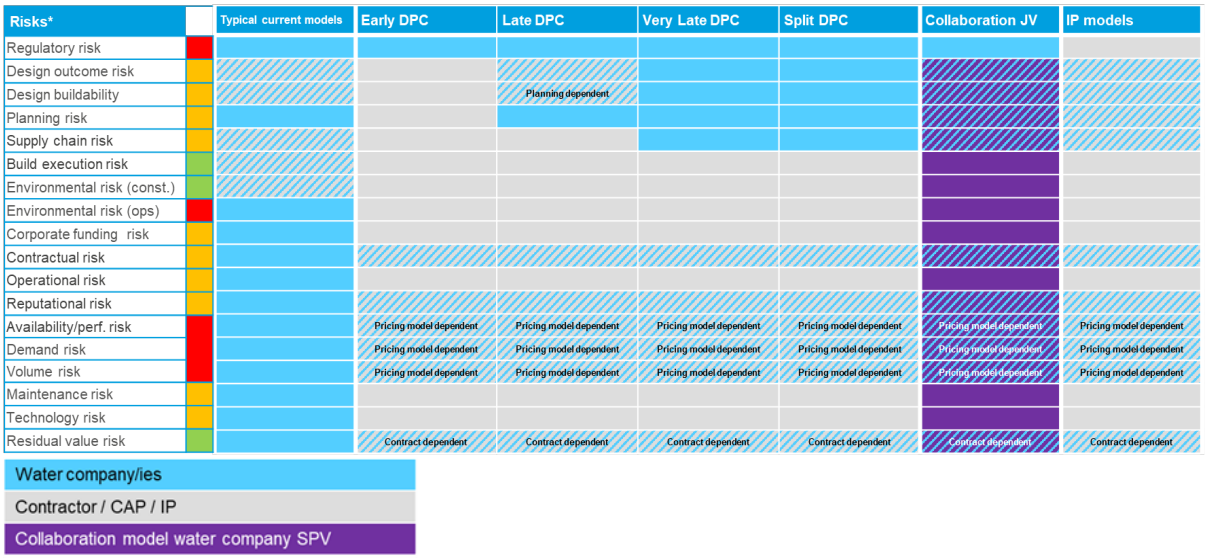

Figure 6-1 Alignment of the risk assessment outputs to the procurement model of options

6.4 To assess the suitability of different procurement models, we have used the criteria set out by Ofwat for the assessment of DPC suitability (size, 'discreteness' and value-for-money), and adapted this for the other models considered. To provide some insight into the value-for-money of different models, we have used a high-level risk and pricing assessment, based on the risk assessment in Figure 6-1. For DPC models, we have used insight from the assessment for the Deephams reuse scheme undertaken by TWUL in its PR19 document CSD011-Direct Procurement for Customers.

Table 6-1 Procurement Model Qualitative Assessment

Procurement Models	Assessment of Procurement Models for London Reuse	Rating
Typical current models	There is limited water company expertise in the operation and maintenance of water recycling technology; therefore, it is likely that the supply chain is better able to manage operational risks. This is likely to decrease the relative value-for-money of traditional procurement models.	
DPC models	Potential for more DPC options as it is expected that the supply chain may be better placed to manage the design, build, operation and maintenance of the plant. Previous TWUL value-for-money analysis indicates that DPC could offer value-for-money benefits over typical current models. It is recognised that the incumbent water company would still need some involvement in the early planning phase. Note: This aspect of the model could become more complex if more water companies are supplied.	
DBOM models	These models enable TWUL to procure the capabilities of the supply chain throughout the DBOM life-cycle, offering some of the advantages of DPC, but without requiring third-party finance.	
IP models	This would require a licensed service provider which, through the size of the scheme, would need regulatory endorsement. At this stage, there is no existing legal framework for the SRO schemes to be individually licensed. Therefore, this model is not considered feasible.	

6.5 The procurement model assessment indicates that DPC or DBOM models would be more preferable to typical current models, as the supply chain is likely to have greater capability in the design, construction and operation of water recycling facilities than TWUL. Both DPC and DBOM models will have similar programme durations. IP models are not currently considered feasible, as there is no current legal framework for SRO schemes to be individually licensed.

Scheme Ownership

6.6 For both DPC and DBOM procurement models, ultimate accountability resides with TWUL. Day-to-day control could reside with different parties under different options within most models, and further work through Gate 2 will define the preferred procurement and operational regime. Furthermore, it is expected that further discussion with Ofwat would be required to determine the extent of day-to-day control aspects in confirming the preferred approach.

Scheme Operation and Utilisation

6.7 At this stage of design development, a high-level operating philosophy (utilisation) has been established for the London Effluent Reuse SRO options based upon the WRMP19 period hydrological modelling through WARMSII modelling[6]. The preferred scheme size, phased development and utilisation will be determined taking cognisance of the WRSE regional modelling initial investment plan outputs in June 2021.

6.8 The WARMSII modelling shall be finalised post-Gate 1 for a preferred scheme or combination of schemes to provide sufficient data for a detailed defined operating philosophy. The types of operating modes considered are as follows:

- Normal Operation – Treatment plant or other element is operating in normal automatic control (typically 25-100% of maximum output) and delivering water.
- Hot Standby – Where an element runs at a proportion of total flow, with a 'duty' stream under Normal Operation and with parts of the plant in standby and is able to return into Normal Operation mode between 1 day and up to 2 to 4 weeks. The timescale is dependent upon the type and number of process units and subject to more detailed evaluation of ramp up sequences during Gate 2. Typically used in summer months.
- Cold Standby - Operating mode where process units are available to return to full Normal Operation in a matter of a few days or a few weeks. Water is not being produced, but it may involve a minimum or 'sweetening' flow being run-to-waste.
- Care and Maintenance – Operating mode under which the asset is not producing and delivering any water (e.g. drained down, RO membranes in preservative state), but maintenance is carried out in order to keep the plant serviceable and able to return into full operation in a number of weeks or a few months. Typically, non-summer months.
- Non-operational – Treatment plant or other element is out of service and there is minimal ongoing expenditure.

6.9 Table 6-2 details the as-expected asset availability for non-Normal Operation of the options, in terms of preferred base operating regime when not called to be in Normal Operation mode. Note that these values are developed from the WRMP19 Options Operating Philosophy report and assessment. The time listed to "Ramp Up" / "Ramp Down" is the duration needed to meet the Normal Operation mode when a scheme is called to provide water resource to the WRZ.

6.10 In the event of a quality failure, each scheme will "fail safe", via a run-to-waste back to the relevant source STWs. The treatment facilities are monitored at Critical Control Points for the required water quality parameters and will initiate an auto-shutdown/diversion of flow in the event of registering out of bound ("critical limit") quality parameters or catastrophic failure of the plant.

[6] Options Operating Philosophy Feb 2018, Mott MacDonald

Table 6-2 Summary of Base Operating Mode Proposed and Estimated Start-up Duration to Normal Operation Mode

Option	Sub-option/Option-Element	Hot Standby Mode			Care & Maintenance Mode		
		Operating Time / Year	Ramp Down	Ramp Up	Operating Time / Year	Ramp Down	Ramp Up
Beckton Effluent Reuse	AWRP	3 months	Between 1 day and 2-4 weeks		9 months	5 weeks	8.5 weeks
	Conveyance (All Streams)	3 months			9 months	<1 week	< 1 week
Mogden Effluent Reuse	AWRP	3 months	Between 1 day and 2-4 weeks		9 months	5 weeks	8.5 weeks
	Conveyance (All Streams)	3 months			9 months	<1 week	< 1 week
Mogden South Sewer	Sewage Treatment & AWRP	12 months	Between 1 day and 2-4 weeks		N/A	N/A	N/A
	Conveyance (All Streams)	12 months			N/A	N/A	N/A
Teddington DRA	Tertiary Treatment Plant	3 months	Between 1 day and 2-4 weeks		9 months	5 weeks	8.5 weeks
	MOG-TED tunnel	3 months			9 months	<1 week	< 1 week
	Raw Water Abstraction & TLT Connection	N/A	N/A	N/A	12 months	<1 day	< 1 day

6.11 TWUL would utilise a real-time control system to analyse demand patterns for calling sources to run as required. This will ensure advanced warning for ramp-up of a system for Production operations and enable optimised control of the network.

7 Planning Considerations

Initial Considerations of Planning Application Route

7.1 This section summarises the use of a Development Consent Order (DCO) under the Planning Act 2008 and conventional planning permission under the Town and County Planning Act 1990 as routes for planning consent for the London Effluent Reuse SRO.

7.2 A number of schemes and size options do not automatically qualify under the Planning Act as a Nationally Significant Infrastructure Project (NSIP) as they do not meet the criteria set out in Section 28 of the Act. At this stage, a number of the larger size options do appear to satisfy the criteria of a NSIP and would automatically qualify however, there is uncertainty around the definition of what constitutes the transfer of water between river basins within the Act. Where a project automatically qualifies it must progress under the Act. When a project does not automatically qualify, there are two options for the project to still progress under the Act. Firstly, a change can be made to the Act via a Section 14(3) Order to change the categories of development that are captured; such an approach must be led by a Government department. Secondly, TWUL could apply for a Section 35 Direction for each scheme on a case-by-case basis.

7.3 An alternative and viable route for consenting would be through a conventional planning application under the Town and Country Planning Act. This would involve an application being made to each local planning authority in whose authority area an option is located, and each would need to approve their application. A local planning application would not grant powers to acquire land or rights in land, which would have to be sought separately under the Water Industry Act 1991, and other consents would also likely be required.

7.4 With both planning routes it is assumed that, overall, there would be a similar timeframe to consent being granted, although the time to obtain planning permission through the Town and Country Planning Act can vary significantly and carries greater uncertainty.

Preferred Planning Route and Key Steps

7.5 The preferred planning route for the London Effluent Reuse SRO is through the Planning Act 2008. There are a number of strategic advantages in using this planning route, including:

- Single decision maker;
- Enables a number of separate consents to be incorporated into one application;
- Includes compulsory acquisition powers;
- More straightforward when in the administrative area of more than one local authority; and
- Greater certainty of timescale for consent.

7.6 Where schemes do not automatically qualify under the Planning Act, the preferred planning route would be to seek a Section 35 Direction for each specific scheme. Should a direction not be secured from the Secretary of State, then an application for planning permission would instead need to be made to each local planning authority in whose authority area an option is located.

7.7 Figure 7-1 illustrates the planning steps and timelines for progressing a scheme under the Planning Act.

7.8 The overall programme for a DCO application is governed by establishing the 'need' of the scheme, which as defined in the draft Water Resources National Policy Statement would be within a WRMP publication. WRMP24 is expected to be published sometime between late 2023 and early 2025. Based on a worst-case assumption of making a DCO application in mid-2025, 3-6 months after publication of WRMP24, it is expected a DCO grant or planning permission can be achieved by late 2026 allowing a scheme to be construction ready within AMP8.

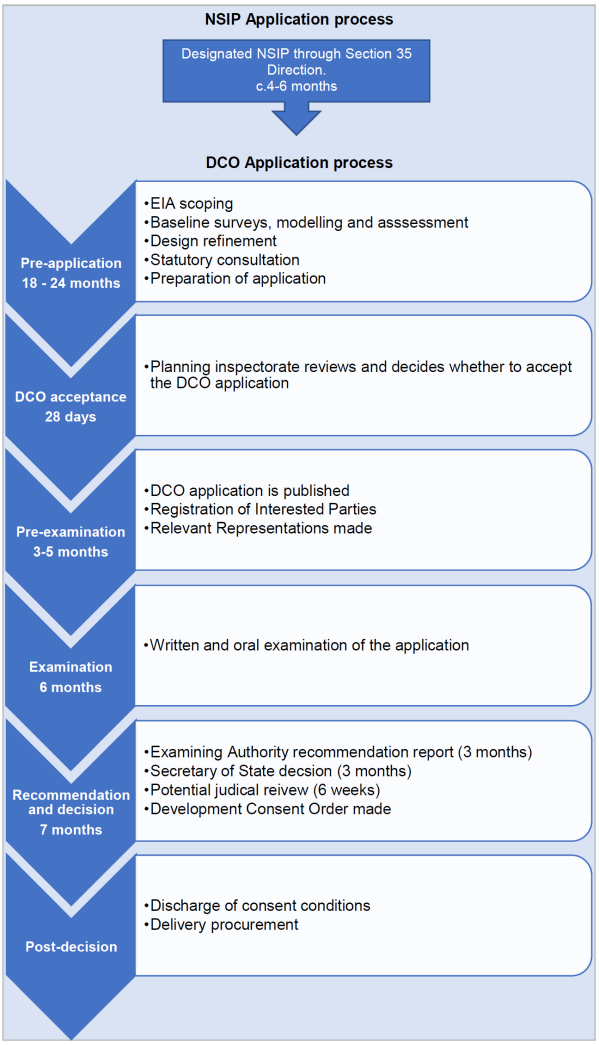

Figure 7-1: Timeline of Planning Steps under Planning Act 2008

Key Planning Risks

7.9 It is considered that there are no showstoppers to gaining a DCO grant or planning consent for any scheme under investigation at Gate 1. A number of risks exists that at this stage are capable of being mitigated through ongoing technical and environmental assessment, design and mitigation refinement, and engagement activities.

7.10 A summary of the key planning risks include:

- Establishing the 'need case' for a scheme via a WRMP. While reuse schemes are included in the current WRMP, this is as part of TWUL's adaptive Alternative Plan. Basing a 'need case' on WRMP24 would de-risk scheme planning.
- Revised policy tests within a published Water Resources National Policy Statement. The lack of an adopted National Policy Statement represents a continuing risk as publication may introduce new or materially different policy tests needing to be met by an application.
- Insufficient land to implement a scheme or risks associated with other developments being permitted on key sites/conveyance route corridors. This is being managed through collaborative working with engineering and environmental teams and the use of safeguarding directions at the appropriate time.
- Risk of objections is being managed through open and transparent engagement with key stakeholders set out in an engagement plan and a forward action plan.

8 Stakeholder Engagement

Stakeholder Engagement - Overview

8.1 The engagement plan for the SRO was developed building on previous engagement. Stakeholder engagement consisted of two parts: firstly, to inform the development of the South East regional plan to ensure stakeholders understood how effluent reuse, and other SROs, fit within the strategic planning framework; and secondly, targeted discussions on effluent reuse.

8.2 The targeted engagement focused on regulators, strategic stakeholders and water company representatives to ensure issues which could potentially prevent, or substantially change the development of the scheme, were considered. An overview is presented in Table 8-1.

Table 8-1: Overview of Engagement on London Effluent Reuse SRO to Gate 1

Stakeholder	Summary of the Main Points of Interest	Summary of Activity
Environment Agency (EA) incorporating the NAU	Water quality, environmental and hydrological assessments including the requirements of, and compliance with, the WFD. Delivery of wider environmental, social and economic benefits including BNG and NC assessments in line with the 25-year Environment Plan.	Monthly progress meetings to facilitate collaborative working and ensure timely discussions. Topics discussed include the specific London Effluent Reuse options (4), environmental and water quality monitoring plans, environmental appraisal, and enhancement opportunities. Draft outputs have been shared to ensure the expectations are satisfied.
Natural England (NE)	Legal and regulatory requirements with respect to the natural environment plus opportunities for landscape and environmental enhancement.	
Drinking Water Inspectorate (DWI)	Compliance with drinking water quality legislation and ensuring water quality risks are properly assessed and evaluated.	Meetings have been held to discuss the drinking water quality risk assessment methodology, monitoring programme, and potential risks to drinking water quality and supply issues. There have also been discussions on the monitoring required to Gate 2.
Port of London Authority	Changes to the water level, and potential ecological and navigation impacts.	Monthly meetings held to review the programme of work and facilitate timely discussions on points of interest. Topics discussed have included the operation of the schemes, environmental and water quality monitoring plans and potential navigation impacts.
Historic England	Protection of the historic environment with specific interest in scheduled monuments and archaeology	An introductory meeting has been held to present the reuse options (4), alongside other SROs, and discuss the scope and timing of future engagement.
RAPID	Responsible for overseeing the work to examine the SROs and administering regulatory process.	Discussions on the regulatory process, requirements and outputs to ensure "no surprises" at Gate 1.

Stakeholder	Summary of the Main Points of Interest	Summary of Activity
Regional Customer Challenge Group & CCW	Protection of customer interests ensuring plans and schemes are developed with customer engagement and input.	WRSE Regional Customer Challenge Group, with representation from the Consumer Council for Water, has been actively engaged in the WRSE customer research programme, including SRO engagement, to ensure the activity is well designed and executed.
TWUL – waste water teams	Coordinated planning to identify risks and synergies.	Bi-monthly meetings to share programme, information and identify risks and opportunities.
Other water companies	Various reuse schemes are being investigated – this engagement has focused on shared learning.	Active engagement to share knowledge and information and identify differences in approach.
Affinity Water	Investigating a range of potential solutions for future water supply.	Engagement on the opportunities to provide potential water resource.
Wider stakeholder community	Wide interest in long-term water resource planning from a range of perspectives, to ensure resilience of supply, opportunities to protect and improve the environment as well as interest in specific schemes.	TWUL hosts a quarterly Water Resource Forum, jointly with Affinity Water, to provide information and an opportunity to provide input on the development of the regional water resources plan and company activity.

8.3 Overall, stakeholders are comfortable with the promotion of effluent reuse options to Gate 2. They have been engaged in shaping the further monitoring, modelling and assessments that are required to Gate 2 which will help to determine the sites and sizes of reuse options that should be progressed.

Stakeholder Engagement - Next Steps

8.4 TWUL plans continued engagement in collaboration with WRSE and through the Water Resources Forum to ensure discussions on schemes are anchored in the context of national and regional strategic planning. Engagement with regulators and key stakeholders will continue to ensure legal and regulatory issues are identified and addressed together with actions set out through Gate 1.

8.5 TWUL plans to extend engagement through Gate 2 and seek input and views from a number of local authorities and non-governmental organisations.

Customer Engagement - Overview

8.6 London Effluent Reuse SRO participated in a research programme coordinated by WRSE to examine customers' views on resilience planning, supply and demand options, sharing resources and the SROs.

8.7 A summary of the main findings, specific to effluent reuse are:

- Reuse schemes tend to draw mixed views from customers. There is a low level of customer understanding and a lack of familiarity with reuse. Often it is not recognised that "unplanned" reuse is widely used in the UK.
- "Effluent" and even "reuse" can have negative associations, and therefore terminology and framing are important for engaging customers. Framing reuse schemes as "water recycling" has been observed to result in a more favourable view.
- For some customers it is difficult to get past the "yuck factor" to weigh up wider pros and cons of schemes, even when provided with assurances on water quality or when informed that treatment processes are identical for more familiar sources of water.
- Concerns mainly focused on safety and hygiene, the use of chemicals, and water quality. Other issues were around the potential environmental impact with customers wanting to understand about the possible effect on rivers, and the energy intensity and carbon emissions. Cost was also raised due to the need for new treatment works.

- Positive comments focused on reuse as an efficient and logical approach, resilient to drought and a proven concept outside the UK.
- Overall support for reuse tends to be finely balanced. There is some evidence that the more informed customers become, the more they recognise the benefits. The challenge is therefore to improve communication about water reuse to lessen the perceived concerns of customers.

Customer Engagement - Next Steps

8.8 Further customer research to Gate 2 is planned to address issues and concerns raised by customers. The proposed activity has three components:

- In-depth engagement on the acceptability of effluent reuse in general, considering how reuse schemes work; process and treatment information; public health and drinking water quality concerns.
- Focus on the specific schemes to examine in detail the options, construction and local impacts, and potential opportunities.
- Test the acceptability of the proposed drinking water in terms of the aesthetics, taste and odour with customers.

9 Key Risks and Mitigation Measures

Assessment of Key Risks

9.1 The risk register for the programme consists of two specific elements managed through the programme risk management process:

- The overarching programme risk register, as reported to RAPID through the quarterly reporting process. This provides a register of programme level risks to the overall delivery of the schemes or to the achievement of the required strategic outcomes required by the programme.
- The costed risk register gives a detailed breakdown of delivery phase risks likely to have a material impact on the costs of the scheme (summary of key risks shown in Table 9-1).

9.2 This costed risk register is the Quantitative Costed Risk Assessments (QCRA) which have been developed for each scheme, including the water reuse and conveyance solution components as part of the costing assessment (Section 10). This achieves a consistent and levelled approach in assessing risks associated with each of the four London Effluent Reuse SRO schemes. The approach built upon the WRMP19 work, reviewing scheme development under the SRO work and revising and adding risks to the risk registers.

9.3 The Quantitative Costed Risk Assessments process aims are to produce a costed risk for each option. The risk assessment methodology followed was TWUL's adaptation of the HM Treasury Green Book (scaling back using Solution and Delivery Confidence Grades and further adjustment for risk already included in cost models). Risks and risk costs were identified, and the optimism bias allowance included at the outset of the appraisal was reduced. Optimism bias is the demonstrated systematic tendency for appraisers to be over-optimistic about key project parameters, including capital costs, operating costs, project duration and benefits delivery.

Risk Assessment Output

9.4 Costs associated with identified risks for the London Effluent Reuse SRO schemes were used to adjust the optimism bias associated with each element. The consistent approach reduces the risk of double counting risks and allows the costs presented in Section 10 for

each of the four schemes and various configurations to be compared and ranked in terms of best value for customers.

9.5 Key dependencies are defined as those which may result in a significant change to the proposed London Effluent Reuse SRO delivery programme. Two key dependencies noted are the following:

- There remains a high level of uncertainty with regards to the timing of the publication of the WRMP24 and hence the timing of an application for planning consent. In the expected 'best case' scenario, publication may be instructed by the Secretary of State in autumn 2023. However, the risk of the need for a formal Hearing or Inquiry into the WRMP24 would push this timetable back by up to 15 months – see Section 3. Gate 1 construction programmes have assumed the later date to be conservative.
- The DPC procurement route. This process requires the formal appointment of a third-party entity, a CAP, who will then deliver the detailed design, construction, commissioning and operation of the scheme for a specified period of time. The exact scope of a DPC is yet to be finalised and needs to be resolved with Ofwat as part of the activities between Gate 1 and Gate 2.

9.6 The key assumptions made at this stage were as follows:

- A published WRMP24 is required before an application for a DCO can be made.
- A licence variation will be granted by the Environment Agency (EA) to allow water to be diverted from Beckton/Mogden STW to the relevant SRO scheme.
- A discharge consent will be granted by the EA for discharge of recycled water to either the River Thames (West London options) or River Lee Diversion (East London options).
- The proposed sites are available for development for the reuse treatment facilities and that sufficient land is available for purchase for conveyance scope (tunnel shafts, etc.).

9.7 Risks were categorised with current and residual scores after mitigation on a 5 x 5 matrix basis (Probability vs Impacts) in accordance with the WRMP option risk scoring matrix. Key risks are defined as risks with an initial score of 12 of higher. The key risks and opportunities are detailed within Table 9-1.

Table 9-1 London Effluent Reuse System Key Risks

ID	SRO Scheme(s)	Risk Description	Risk Score	Mitigation	Mitigated Risk Score
R-001	Beckton Effluent Reuse; Mogden Effluent Reuse; Mogden South Sewer; Teddington DRA	There is a risk that there will be a delay with obtaining, or inability to obtain, an abstraction licence (at STW, sewer or direct from river). There is a risk that there will be a delay with obtaining a discharge licence for the River Thames for recycled water/waste streams.	15	Early discussions between water authorities, EA and other stakeholders are included in programme. Receipt of further water quality modelling would be required. WRSE modelling and feasibility screening studies have been completed to confirm any showstopper items.	12
R-002	Mogden Effluent Reuse; Mogden South Sewer; Teddington DRA	There is a risk that additional ecological works are required or cannot be undertaken/finalised within the target season. Additional Capex cost and time delay to overall project programme.	15	Ecology surveys to be undertaken and all recommendations followed. Advanced works contract is an option.	12
R-003	Beckton Effluent Reuse; Mogden Effluent Reuse; Mogden South Sewer; Teddington DRA	There is a risk that the discharge consent for the Beckton Gateway desalination plant will need to be amended due to the decrease in Final Effluent flow. For all SRO schemes, RO concentrate produced is proposed to be disposed to STW outfall. There is a risk that EA licence to discharge concentrate will not be granted for permeate disposal. Additional cost and delay to the programme.	16	Engagement with EA and other interested partners prior to project start. Water quality sampling and environmental water quality modelling.	15
R-004	Beckton Effluent Reuse; Teddington DRA	There is a risk that the unit cost of the large diameter tunnel conveyance options does not include all realised project risk. There is limited local experience and cost estimates vary. Risk that project estimated cost is under-valued leading to a resource issue.	18	Scoped costs and costed risk have been benchmarked with other projects and using British Tunnelling Society/Infrastructure UK data before Gate 1 submission. Further cost evaluation to be completed to Gate 2.	15
R-005	Beckton Effluent Reuse; Mogden Effluent Reuse; Mogden South Sewer; Teddington DRA	Current local power supply capacity may not be sufficient to support the proposed high-power treatment systems. Risk that reinforcement of power supply will be required by Distribution Network Operator, requiring increased scope of the work for additional power supply required.	18	Adequate project preparation and confirmation with local Distribution Network Operator supplier.	15

ID	SRO Scheme(s)	Risk Description	Risk Score	Mitigation	Mitigated Risk Score
R-006	Beckton Effluent Reuse; Mogden Effluent Reuse; Mogden South Sewer; Teddington DRA	Various generic scheme risks, for example proposed land may be safeguarded for another scheme, there may be restrictions to secure land (programme not feasible) and there could be lack of clarity on land ownership. Specific locations that have been noted as having a higher probability of land risk include space on Mogden STW for Teddington DRA Tertiary Treatment Plant and insufficient available land for Lockwood reception shaft / pumping station (Beckton Effluent Reuse conveyance).	15	Searches to be done as early as possible and findings to be reported. Compulsory acquisition powers may be required in the DCO or a separate compulsory purchase order may be required if a planning application is made under the Town and Country Planning Act.	12
R-007	Mogden Effluent Reuse; Mogden South Sewer	Risk that ground conditions differ to what was expected, e.g. survey results, ground investigation. Specifically, higher potential likelihood of encountering contaminated land at brownfield sites based on desktop studies. Requirement for specialist storage and removal of contaminated spoil. Delay to construction programme and additional construction cost.	15	Site-specific ground investigation – this would lead to new methodology/specification based on findings. Trial holes and surveys to be carried out. Landscaping bund being used where possible to store waste.	12
R-008	Beckton Effluent Reuse; Mogden Effluent Reuse; Mogden South Sewer; Teddington DRA	Risk that changes to pipeline/tunnel route will be required during Planning and Development stage. Pipe jacking or additional length of pipeline would be required.	20	Optioneering and desktop studies carried out to assess feasible routes, with lowest risk of requiring major change. Early engagement with local landowners, utility providers, etc.	18
R-009	Beckton Effluent Reuse; Mogden Effluent Reuse; Mogden South Sewer; Teddington DRA	Planning approvals may require longer than time allowed for in the programme, leading to construction being delayed and increased costs.	20	Adequate project preparation and planning consultation. Consultants to have significant DCO experience.	18

10 Option Cost/Benefits Comparison

Qualitative Assessment of Options

10.1 The four London Effluent Reuse SRO schemes have a number of sub-options with varying DO sizes for each to enable selection as scalable and phased schemes. Many configurations are possible; however a base case or preferred configuration is not being proposed at this stage until the WRSE investment modelling is completed. As there are multiple criteria that govern the 'best value for customers', detailed evaluation of the resource benefits post-Gate 1 is required to decide which schemes (and sub-options) are progressed.

10.2 At this early stage, the scheme options have been evaluated and compared to provide a baseline assessment to be input into the WRSE modelling. The assessment of all configurations in this way represents prudent risk management and business planning, to ensure that, should it be required, there is an alternative available to meet the TWUL supply obligation if it is not possible to implement the preferred configuration.

10.3 A qualitative high-level benefit and impact assessment has been carried out for the four schemes (at maximum size) based on unit cost for treatment, with a quantitative assessment to be done at Gate 2. The benefits criteria for each option have been assessed qualitatively on a 'high', 'medium' and 'low' basis, as detailed below:

 = Net benefit expected, i.e. the benefits are expected to exceed the costs.

 = Negligible net benefit expected, i.e. the magnitude of costs and benefits are expected to be similar to one other and 'offset' each other in calculating the cost benefit ratio.

 = Net disbenefit expected, i.e. costs are expected to exceed benefits.

Table 10-1 Qualitative Benefit and Impact Assessment – London Effluent Reuse SRO

	Benefit	Beckton Effluent Reuse scheme (BEC)	Mogden Effluent Reuse scheme (MOG)	Mogden South Sewer scheme (MSS)	Teddington DRA scheme (TED)
1	**Resilience:** Assessment based on reliability, evolvability and adaptability compared to other SRO types	All options provide a water resource benefit to the London WRZ; however, based on WRSE resilience metric scoring, all options score poorly for resilience in comparison to other SROs. Reuse options have highly complex treatment systems, low adaptability to infrequent use, and long planning and lead times for the large conveyance elements.			
2	**Water Resources:** Provides additional resources of water supply to the Greater London region, and utilises water resources sustainably	Aligns with national policy requirements, where TWUL considers the efficient use of water resources at a regional level. BEC – 300 Ml/d DO maximum; MOG – 200 Ml/d max; TED – 150 Ml/d max; MSS – 50 Ml/d max.			
3	**Environmental:** Enhanced provision for biodiversity, flora and fauna	Water reuse is a highly energy-intensive process (although less than desalination and comparable with other SROs), causing high carbon emissions. TED option has the lowest electricity, chemical and carbon footprint. All options and components would result in a net loss of NC assets and corresponding ecosystem services.			
4	**Amenity Value:** Increased amenity provision for the local communities	Potential adverse impacts to ecology in the River Thames/Lee as a result of changes in flow and water quality. Some residential buildings likely to be affected by construction activities (largest number for TED option). Higher creation of jobs for BEC/MOG schemes due to larger construction works.			
5	**Futureproof/scalability:** Option capacity can be expanded and scaled in phases to suit demand/supply	BEC option has the highest DO based on STW effluent availability; MOG/BEC have phased scalability options; MSS and TED have limited or no scalability options, and TED has environmental constraints limiting the maximum DO. TED requires existing assets (storm tanks) to be demolished before construction of new assets.			

	Benefit	Beckton Effluent Reuse scheme (BEC)	Mogden Effluent Reuse scheme (MOG)	Mogden South Sewer scheme (MSS)	Teddington DRA scheme (TED)
6	**Water Quality:** Enhanced water quality for customers				
		AWRP plants produce exceptionally clean water. The use of environmental buffers is required by the DWI; therefore, options BEC, MOG and MSS are green. TED option introduces treated sewage effluent to the River Thames.			
7	**Carbon Emissions:** Offsets emissions and has potential for carbon net zero without external initiatives				
		All water reuse options will require external initiatives to offset the high carbon emissions. However, these are lower than all desalination options. TED option has much smaller carbon footprint due to simpler treatment.			
8	**Deliverable & Operable:** TWUL has experience delivering and operating the required technology and systems				
		Water reuse would be effectively a new technology for TWUL. BEC and TED have complex interactions with TLT, and MSS has both sewage treatment and AWRP processes, which is not a combination with a proven track record in the UK.			
9	**Affordability:** Average Incremental Cost and best value for customers, compared to other SROs.				
		Water reuse options have comparable costs with the TWUL Options considered in WRMP19, with TED and BEC having the lowest costs – refer to Table 10-2 below.			

10.4 The hierarchy that has been produced is intended to reflect best value for customers, to the extent possible at this early design stage, for the sole purpose of satisfying the requirement for such a hierarchy at Gate 1 by RAPID. Through this qualitative assessment, the Beckton Effluent Reuse and Teddington DRA schemes score a slightly positive net benefit overall and the Mogden Effluent Reuse and Mogden South Sewer schemes have a negligible net benefit overall.

Solution Costs

10.5 The cost methodology adopted for Gate 1 is aligned to ACWG methodology for the WRMP24 (March 21 WRSE upload) and is consistent across SROs and non-SRO options. It is based on the stage three assessment adopted under WRMP19, with an additional stage to calculate the Net Present Value (NPV) and Average Incremental Cost (AIC) which is believed to best quantify value to customers from a purely cost perspective. An assessment of Capex, Opex, costed risk and optimism bias (OB) costs for the four schemes was completed.

10.6 The scope of work updated the WRMP19 stage three assessment to reflect the schemes as developed to the same level of conceptual design for Gate 1. This has ensured stakeholder comments were addressed whilst minimising Gate 1 cost. To develop the Capex/Opex cost estimates, the following activities have been undertaken:

- Review of the feasibility design information currently available, updates of cost algorithms selected and yardsticks using TWUL costing tools (generates Capex and Opex), including for optimism bias adjustments (based on Green Book).
- Qualitative Costed Risk Assessment with mitigated risk scoring and Monte Carlo simulations to develop associated costs for project risks.
- Development of OB taking cognisance of the updated scope and costed risk and scaling back where appropriate in line with the ACWG cost consistency methodology.

10.7 Due to the lack of comparable effluent reuse schemes, unit rate benchmarking has been carried out for bottom-up estimates of the base capital costs of the schemes. Benchmarking of the Capex costs associated with the various elements of the schemes has been undertaken via the built-in benchmarking in the TWUL Engineering Estimating System (EES) cost curves, where cost curves have been used. Where unit costs have been input outside of these curves, quotations and supplier costs have been compared for accuracy with unit costs developed at WRMP19. The percentage difference between the Estimated Costs and Benchmark Costs for all scheme sub-options is no greater than 10%.

10.8 Opex costs are estimated based on the proposed operating modes of each scheme (e.g. expected utilisation percentage) – refer to paragraph 6.9. Opex NPV costs for minimum and maximum scheme utilisation are shown in Table 10-2 and Table 10-3.

10.9 Construction Capex and Opex costs from TWUL's costing tools have been used to generate the NPV values for the elements using the Treasury Green book with a declining schedule of discount rates (refer to the Cost and Carbon Report for each scheme) and an 80-year period. All costs have been adjusted for deflation to 2017/18 cost base for accurate comparison with the Final Determination allowance, using Thames Water's Internal Business Plan (IBP) deflationary factors, based upon the CPIH (November 2019 dataset) index. Carbon values at min and max utilisation have been calculated in a similar method with conversion to tCo2e units but without discount factors or inflation adjustment. The estimated NPV and Average Incremental Cost (AIC) for each of the options is shown in Table 10-2 and Table 10-3.

10.10 The costs for the maximum size of each of the four schemes has been assessed in Table 10-2 to demonstrate the best value for money configuration of each scheme. The NPV and AIC costs are combined for the sub-options required for the maximum scheme capacity:

- Beckton Effluent Reuse – 300 Ml/d yield: 2 phases of 150 Ml/d treatment stages and the Beckton to Lockwood tunnel and Lockwood to KGV TLT tunnel extension sub-options.
- Mogden Effluent Reuse – 200 Ml/d yield: 2 phases of 100 Ml/d treatment stages and the conveyance (all streams) sub-option.
- Mogden South Sewer – 50 Ml/d yield: 1 phase of 50 Ml/d treatment stage and the conveyance (all streams) sub-option.
- Teddington DRA – 150 Ml/d yield: 2 phases of 75 Ml/d treatment stages and the Mogden to Teddington tunnel and Lockwood to KGV TLT connection sub-options.

10.11 The solution costs detailed have been developed in line with relevant HM Treasury Green Book guidance. These AIC costs are similar to those determined in WRMP19 (where the schemes can be compared like-for-like), with slight decreases in cost for the Beckton Effluent Reuse and Mogden South Sewer schemes.

Table 10-2 NPV and AIC for each scheme at maximum phase size

Option name	Units	Beckton Effluent Reuse (300 Ml/d)	Mogden Effluent Reuse (200 Ml/d)	Mogden South Sewer (50 Ml/d) *	Teddington DRA (150 Ml/d)
Option benefit / DO	Ml/d	252	169	46	134
Total planning period option benefit (NPV)	Ml	1,951,370	1,320,927	357,993	1,042,849
Total planning period indicative capital cost of option (Capex NPV)	£m	£1,524.06	£1,070.11	£343.10	£366.52
Minimum Flow – 20% utilisation for 3 months of the year (*12 months for Mogden South Sewer)					
Total planning period indicative operating cost of option (Opex NPV)	£m	£182.08	£136.47	£75.25	£48.49
Total planning period indicative option cost (NPV)	£m	£1,706.14	£1,206.58	£418.35	£415.01
Average Incremental Cost (AIC)	p/m³	87.43	91.34	116.86	39.80
Maximum Flow – 100% utilisation for 12 months of the year					
Total planning period indicative operating cost of option (Opex NPV)	£m	£857.67	£645.83	£192.90	£101.20
Total planning period indicative option cost (NPV)	£m	£2,381.73	£1,715.94	£536.00	£467.72
Average Incremental Cost (AIC)	p/m³	122.05	129.90	149.72	44.85

Total Carbon (including electricity) over 80 year period and no discount rate					
Embodied Carbon	tCO2e	215,812	144,245	70,263	85,098
Operational Carbon – Min Flow	tCO2e	276,594	198,043	172,595	14,626
Operational Carbon – Max Flow	tCO2e	3,226,862	2,348,366	745,924	167,315

10.12 To demonstrate an assessment of each scheme for the same water resource benefit (50 Ml/d yield), the costs for the minimum size of each of the four schemes including the relevant conveyancing sub-option has been assessed in Table 10-3.

Table 10-3 NPV and AIC for each scheme at smallest phase size (50 Ml/d capacity for each scheme)

Option name	Units	Beckton Effluent Reuse (50 Ml/d)	Mogden Effluent Reuse (50 Ml/d)	Mogden South Sewer (50 Ml/d) *	Teddington DRA (50 Ml/d)
Option benefit	Ml/d	46	46	46	46
Total planning period option benefit (NPV)	Ml	345,242	345,242	357,993	357,993
Total planning period indicative capital cost of option (Capex NPV)	£m	£463.70	£461.98	£343.10	£225.43
Minimum Flow – 20% utilisation for 3 months of the year (*12 months for Mogden South Sewer)					
Total planning period indicative operating cost of option (Opex NPV)	£m	£44.43	£47.26	£75.25	£35.16
Total planning period indicative option cost (NPV)	£m	£508.13	£509.23	£418.35	£260.60
Average Incremental Cost (AIC)	p/m³	147.18	147.50	116.86	72.79
Maximum Flow – 100% utilisation for 12 months of the year					
Total planning period indicative operating cost of option (Opex NPV)	£m	£150.43	£166.47	£192.90	£50.11
Total planning period indicative option cost (NPV)	£m	£614.12	£628.45	£536.00	£275.54
Average Incremental Cost (AIC)	p/m³	177.88	182.03	149.72	76.97
Total Carbon (including electricity) over 80 year period and no discount rate					
Embodied Carbon	tCO2e	79,387	86,799	70,263	45,581
Operational Carbon – Min Flow	tCO2e	41,859	49,492	172,595	5,455
Operational Carbon – Max Flow	tCO2e	492,061	527,526	745,924	47,224

10.13 There are multiple variables to consider for effective utilisation of the schemes for selection of the preferred configuration in addition to purely the scheme NPV and AIC costs as shown above. These include TWUL legal obligations; assessment of alternatives from the environmental perspective of SEA, HRA or WFD; or wider issues relating to deliverability and risk. The WRSE programmes will indicate effective utilisation and overall rating on Resilience and Environmental criteria of the programmes from which through Gate 2 it will be feasible to undertake a Multiple Criteria Decision Analysis (MCDA) approach to selecting scheme(s) that offer the best value to customer.

10.14 Based upon the qualitative assessment summarised in Table 10-1 and the quantitative summaries in Table 10-2 and Table 10-3, the Teddington DRA and Beckton Effluent Reuse schemes provide the best value for customers for this SRO.

Programme for Delivery

10.15 The initial programmes developed (refer to Section 3) show that any of the configurations can be "construction ready" early in AMP8, to meet RAPID requirements. The plan

indicates an earliest construction phase start, which will be subsequent to the CAP award (or equivalent), in 2027, with WAFU ranging from 2031-2032 depending on the scheme, but up to 12 months earlier based on the earliest Final WRMP24 date.

11 Impacts on Current Plan

11.1 TWUL's final WRMP19 was developed on the basis of achieving resilience to a 1 in 200-year drought and concluded that demand management on its own will not be enough to resolve all supply demand deficits in the future within the London WRZ. Modelling indicated that leading SROs best able to address deficits were captured within either the preferred plan or an alternative adaptive plan should options under the preferred plan subsequently prove to be unfeasible.

11.2 Beckton Effluent Reuse and/or the West London effluent reuse options were included in the alternative plan as the best value alternative options that could be constructed in time to meet the need to improve drought resilience by 2030 or by 2037 driven by the regional need for additional water resources. It was also stated that, should the supply-demand situation turn out to be worse than forecast through further investigations, a London effluent reuse scheme could be implemented alongside other preferred options.

11.3 In the absence of any new WRSE best value analysis being available for Gate 1, the WRMP19 provides a case for London effluent reuse schemes. The WRMP is supported by regulators and customers, confirming a clear acceptance for the need to develop new long-term strategic resource solutions of this type.

11.4 No changes to date have occurred as a result of any analysis or investigations since the publishing of TWUL's WRMP19. Analysis of the initial work supporting the development of WRSE regional plan has not changed the conclusions reached at WRMP19. These conclusions will be kept under review as the WRSE regional plan is finalised during Gate 2 and while TWUL develops work for WRMP24 and finalises decisions around which schemes to progress. The draft WRSE regional plan is expected to be published for consultation in January 2022.

11.5 Since publication of WRMP19, it has been confirmed that a requirement to plan for resilience to a 1 in 500-year drought is required, and hence the Gate 1 assessments for deployable output have been calculated on this scenario.

11.6 It should be noted that in the final WRMP19, a Teddington DRA option at 300 Ml/d did not pass through a feasibility assessment owing to uncertainty and concerns from the Environment Agency over effects on the River Thames and in the Thames Tideway. WRMP19 sets out an approach to investigate a smaller sized scheme through AMP7; following work through Gate 1, TWUL is planning to provide an updated WRMP19 options feasibility report capturing any changes since the publication of WRMP19.

12 Board Statement and Assurance

Assurance Approach

12.1 TWUL board statement for this Gate 1 submission is provided in the associated covering letter.

12.2 The assurance framework used for this submission has been developed by TWUL and is an extension of the approach that was adopted for PR19.The risk-based assurance approach is consistent with that documented in the "Statements of reporting risks, strengths, and

weaknesses"[7] and "Final Assurance plans for 2020-21" (published 31 March 2021) and is based on the three lines of assurance model shown in Figure 12-1. It is also consistent with the assurance requirements laid out in Ofwat's Company Monitoring Framework[8] and meets the assessment criteria defined by RAPID.

12.3 This approach provides an effective programme of assurance which considers areas that are known to be of prime importance to customers and regulators; or may have a significant financial value, alongside the likelihood or reporting issues. Areas of higher risk receive three lines of assurance while other areas, where the risk is lower, may be targeted with first and second lines only.

12.4 A detailed risk assessment was completed and the components requiring third-party (independent external) assurance. Following procurement AECOM were appointed as the external assurers.

12.5 TWUL's approach was augmented by experience the company gained through the PR19 assurance process and the further development of existing assurance processes (e.g. the use of TWUL's standard Independent Information Declaration forms to verify sign-off).

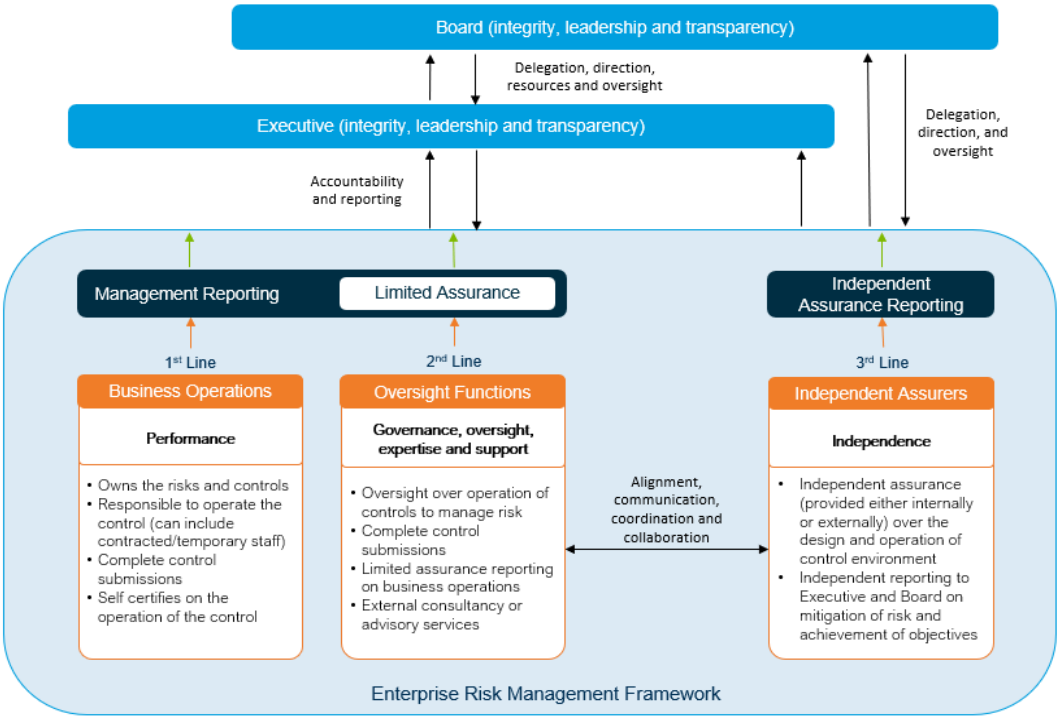

Figure 12-1 Risk Assessment and Assurance Approach

12.6 We confirm that this submission has been prepared in accordance with the following RAPID assessment criteria:

- Robustness: all planned Gate 1 activities have been completed and reported on in this Gate 1 submission with appropriate evidence provided, where required. Clear activities and outcomes for Gate 2 have been set out (Section 15) and key risks and mitigation measures have been reported (Section 9).

[7] https://www.thameswater.co.uk/media-library/home/about-us/investors/our-results/current-reports/statement-of-reporting-risks-strengths-and-weaknesses.pdf
[8] The latest iteration of Ofwat's Company Monitoring Framework can be found on their website through the following link: http://www.ofwat.gov.uk/publication/company-monitoring-framework-final-position/

- Consistency: all work has been undertaken following national policy, guidance and agreed methodologies and is consistent with other plans and SROs. This has included ACWG and WRSE methodologies to ensure consistency across the SROs. This has been ensured through a robust assurance approach.
- Uncertainty: Assumptions, key risks and mitigation measures have been reported on for delivery of the scheme (Sections 3 and 9) and our costing methodology has included for optimism bias and costed risk, appropriate to the stage of the scheme's development (Section 10).

Items to Highlight and any Points for Future Gates

12.7 AECOM has challenged and independently assured this Gate 1 submission. At the completion of the assurance work, AECOM have been able to confirm that:

- the Gate 1 report is consistent and aligned with the regulatory requirements as set out in RAPID Gate 1 submission guidance;
- the Gate 1 work has been of sufficient scope, details and quality which is expected for a large infrastructure project in the early design phase and supports the recommendations that this SRO should progress through to Gate 2;
- the scope, detail and quality of the Gate 1 Expenditure reporting meets the objectives of RAPID's submission template in that the costs incurred are broken-down per activity and are appropriately evidenced as being benchmarked;
- the Gate 1 work follows the methodologies set out by ACWG and WRSE where relevant, and meets the expectations set by RAPID;
- the scheme costs have been generated using consistent methodologies and appropriate costing mechanisms, benchmarked where defined appropriate;
- the scheme delivery programme presented in the submission aligns with being construction ready in AMP8; and
- evidence of regular engagement with key regulators and stakeholders ensures the Gate 1 submission provides trust and confidence in the viable development of the schemes.

12.8 It is acknowledged further work is required and planned through Gate 2. TWUL constantly looks to improve its assurance approach and will conduct a "lessons learnt" exercise before the assurance approach for Gate 2 is finalised.

13 Solution or Partner Changes

Solution Changes

13.1 There are currently no proposals for a solution substitution.

13.2 The Beckton Effluent Reuse scheme has an alternative solution for the conveyancing scope, which was not included in WRMP19. Due to the multiple configurations of DO for the Beckton Effluent Reuse scheme (DO from 50 Ml/d up to 300 Ml/d), the tunnel conveyancing option may not be cost viable for 100 Ml/d total conveyance or less. An alternative pipeline option has been costed and scoped at this stage for a maximum treatment phase DO of 100 Ml/d. During Gate 2, the conveyance solution will be decided following an assessment of configurations and resource benefits for the preferred SRO scheme(s).

Figure 13-1 Beckton Effluent Reuse Scheme – Sub-components for Base Case with DO > 100 Ml/d

Figure 13-2 Beckton Effluent Reuse Scheme – Sub-components for Alternative Solution with DO ≤100 Ml/d

Partner Changes

13.3 There are currently no proposed changes to the London Effluent Reuse SRO solution partner organisations, with TWUL, RAPID and WRSE all proposing to continue to work together to progress the scheme development through the gated stages. The London Effluent Reuse SRO schemes are standalone, in that they do not rely on, or require the direct involvement from, partners or other water companies to deliver.

13.4 The potential for raw water transfers from TWUL to Affinity Water (T2A SRO) is being investigated through WRSE regional investment modelling, which could affect the London Effluent Reuse SRO schemes through increased demand (e.g. higher DO required).

14 Efficient Spend of Gate Allowance

Gate 1 Expenditure

14.1 The Final Determination maximum cost allowance for the London Effluent Reuse SRO totals £62.9m through the gated process, with £6.29m (10%) allocated through Gate 1. The anticipated expenditure through Gate 1 totals £2.78m based on a 2017/18 price base[9] and represents expenditure of 44% of the Gate 1 allowance, representing a saving of £3.51m to customers. The breakdown of expenditure against the Work Breakdown Structure (WBS) is shown in Table 14-1.

14.2 All activities planned through Gate 1 have been completed and results used to inform the conceptual design, modelling and assessments. The work has built on work undertaken for WRMP19 and has not included any WRMP24 business as usual activities. A number of activities within the water quality and in-river investigations WBS will continue seamlessly through to Gate 2 and be reported in full at that point.

14.3 Two workstream activities through Gate 1 exceeded spend of £0.5m, and in-line with RAPID's expectation, the values of these are broken down further in Table 14-1.

Table 14-1: Breakdown of costs against a WBS aligned to expectations and tasks

WBS	Total Value (£)	% of Spend	Description of tasks aligned to Gate 1 criteria
Programme management	£201,157	7%	Programme manager plus ad-hoc support to coordinate, manage and technically advise on the delivery of all Gate 1 activities.
TWUL activity	£109,599	4%	TWUL day-to-day input, overview and governance through Gate 1.
Engineering	£736,078	26%	Technical lead for engineering services and WRSE regional submission including lead author of Gate 1 report (£120k) Preliminary solution feasibility and data collection for four schemes, including sub-options, using comparable methodologies and consistent assumptions (£400k) Environmental modelling to support Gate 1 assessments (£60k) Analysis of effluent reuse technology (£30k) Development of a programme plan for progression of SRO including cost methodology (£25k) Secondment of engineering technical staff to support SRO (£100k)

[9] Actual costs were deflated back to a 2017/18 cost base using Thames Water's Internal Business Plan (IBP) deflationary factors, based upon the CPIH (November 2019 dataset) index.

WBS	Total Value (£)	% of Spend	Description of tasks aligned to Gate 1 criteria
Environment	£464,291	17%	Environmental lead to provide environmental information and prepare environmental assessments for each scheme taking into account feedback from WRMP19. Lead author for regulatory assessments and drinking water quality considerations using ACWG methodology.
Water quality and in-river investigations	£688,356	25%	Provide an ecological, chemical and physical evidence base upon which modelling, and assessments can be based through the gated process. 1) Invertebrate and INNS monitoring in the River Thames and Lee (£60k). 2) Macrophytes and general fisheries (£30k). 3) Targeted smelt surveys (£110k) 4) Water quality and algae surveys including in-situ sampling (£465k). 5) Algae analysis and flow cytometry (£10k) 6) Environmental data gap analysis (£15k)
Planning	£3,500	<1%	Initial considerations of planning application route and timelines
Procurement	£185,317	7%	Initial outline of the solution procurement strategy
Stakeholder	£36,301	1%	Undertake regional stakeholder engagement including customer preferences to identify any issues that need further investigation
Assurance	£62,477	2%	External assurance to support Board statement and RAPID assessment criteria.
Regulator costs	£289,777	10%	Funding to regulators (as agreed with RAPID) to support the SRO.
WRSE modelling	£0	0%	Funding for regional support and consistency across SROs
Legal	£2,655	<1%	
Total	£2,779,509	100%	
Note: (i) All figures have been deflated to a 17/18 cost base. (ii) TWUL capital overhead has been calculated and allocated to each activity in proportion to the value of spend. (iii) where spend per WBS is over £500k we have provided further details of the cost breakdown.			

Evidence of Efficient Spend

14.4 In delivering the Gate 1 submission, TWUL has adhered to the criteria provided by RAPID for efficient expenditure, namely that activities should be relevant, timely, complete and of high quality, and that this should be backed by benchmarking and assurance.

14.5 This efficiency includes:

- Ensuring alignment between the RAPID Gate 1 requirements, the WBS and the work packages and scope initiated.
- Engaging early and continuously through Gate 1 with key stakeholders to agree survey methods and approaches.
- Agreement of a standardised procurement process across SROs and clearly scoped work packages using consistent methodologies.
- Application of competitive procurement approaches, wherever possible, and procurement across SROs, for aligned work packages.
- Robust project management, change control processes, and delivery to estimated budgets.
- Benchmarking through competitive tender and a cost comparison exercise within and across other TWUL SROs.
- External assurance of TWUL approach.

Forecast Spend to Gate 2

14.6 We have developed a Gate 2 budget estimate by engaging with our Gate 1 delivery teams and external stakeholders including the NAU, DWI and Port of London Authority to define an outline task list as summarised in Chapter 15. An overall budget estimate of £6.63m is expected through Gate 2, which represents 70% of the maximum allocated allowance from

the Final Determination by Ofwat for Gate 2 with an estimated £2.8m to be returned to customers.

14.7 At this stage, the estimated costs for Gates 3 and 4 indicate spend will be within the Final Determination cost allowance of £22m and £25m respectively for the SRO.

15 Proposed Gate 2 Activities and Outcomes

Penalty Assessment Criteria, Incentives and Solution Delay Impacts

15.1 In the context that Gate 1 is a key step in developing the schemes to an equivalent level of detail towards Gate 2, then maintaining the same penalty criteria for both gates would be logical. This would provide continuity with RAPID comments on areas requiring further work at Gate 1, and then providing useful direction towards achieving the required criteria for Gate 2. No changes to the proposed penalty assessment criteria are proposed for Gate 2. TWUL, where reasonably practicable, will maintain the Regulatory Milestone Dates, in line with the penalty/reward scales and assessment noted above.

15.2 The project is currently running to programme and on track to be construction ready in AMP8 and to deliver the preferred option(s) by the required dates. Progress is dependent on the WRSE regional modelling outputs through 2021 and 2022 which will identify the best value programmes for appraisal with the preferred and next best scheme(s) identified for WRMP24. There are a number of assumptions and dependencies which might impact upon the successful commissioning of a scheme by the required date as presented in Section 3. These programme issues and risks will be explored further up to Gate 2 to provide further clarity and allow more detailed mitigation to be defined for each. We do not anticipate any solution delay impacts for Gate 2.

15.3 If selected to proceed to planning and beyond, any subsequent delays could have a significant impact on drought resilience in Greater London and the South East.

Gate 2 Activities

15.4 TWUL recommend all London Effluent Reuse schemes progress through to Gate 2 and work would focus on refining current design and assessments with the following outcomes:

- Confirm the technical engineering and environmental scheme feasibility including providing a robust evidence base and endorsement from key regulatory stakeholders.
- Undertake further options appraisal of the treatment and conveyance options to define a preferred solution, investigate solution enhancements, mitigation and opportunities.
- Refine and update data for WRSE regional modelling with updated costs, metrics and benefits ahead of the WRSE January 2022 update. Progress and advance the environmental understanding of schemes aligned to stakeholder expectations.
- Undertake key activities to mitigate risks, maintain or improve programme and to be ready for Gate 3 if the London Effluent Reuse SRO is selected to proceed.

15.5 The key tasks which form the WBS for Gate 2 that will enable the key outcomes to be achieved are summarised below.

Engineering studies WBS

- Update conceptual designs and confirm treatment options, including preferred options for site selection, conveyance routing and other supporting infrastructure.
- Further cost estimating, risk assessment and quantitative analysis, developing mitigation for key risks noted.
- Further detailed hydraulic modelling and development of scheme operational scenarios.

- Identify third-party assets with interfaces to the schemes and include potential impacts and consents required within the design considerations.
- Development of GIS platform and supply/demand balance delivery plans.
- Constructability review to determine the feasibility, assess the complexity and inform construction sequencing.

Environmental/EIA Studies WBS

- Update environmental assessments, including regulatory, NC and carbon assessments.
- Consider scheme permitting and operating requirements.
- Development of mitigation, social and economic valuations.
- Support stakeholder engagement.

Environmental Monitoring WBS

- Continuation of aquatic and terrestrial based monitoring covering identified receptors.
- Development of more detailed environmental modelling.

Planning, Legal, Procurement and Stakeholder WBSs

- Development and implementation of a planning strategy.
- Prepare licensing strategy of scheme construction and operation.
- Develop preferred scheme commercial and procurement strategy.
- Continue and expand technical engagement with stakeholders and customers.

16 Conclusions and Recommendations

Conclusions

16.1 The initial configuration of this SRO (i.e. the optimum combination of the four schemes and sub-options) has not been determined at this stage. The WRSE investment model Regional Plan outcomes will be used to determine what combinations, sizes and phasing is required to deliver the need and best value to the customer in combination with an MCDA analysis at Gate 2.

16.2 No showstoppers have been identified in the progression of schemes through Gate 1, and each conceptual design has been developed to an equal level which has enabled technical and environmental appraisal and water quality assessments. From the Gate 1 qualitative and NPV/AIC quantitative analyses, the “best value for customer” options are Teddington DRA and Beckton Effluent Reuse schemes. This statement is based solely on individual schemes at maximum yield and not in-combination configurations.

16.3 The London Effluent Reuse SRO would provide significant additional raw water sources (up to 300 Ml/d total yield from East London scheme and/or 200 Ml/d total yield from West London schemes) to supplement the London WRZ by recycling treated sewage effluent/sewage for indirect use, which provides the resource benefit to the region.

16.4 The scheme capacity of 50 to 300 Ml/d equates to a Dry Year Annual Average DO benefit of 46 to 252 Ml/d to the London WRZ. The regional planning process will determine the volume, timing, and utilisation of water to be recycled.

16.5 At this stage, based on the high-level programme developed for Gate 1, the latest WAFU dates for all four schemes are between mid-2031 and mid-2032 (based on latest planned publication dates for Final WRMP24), noting that early publication of the Final WRMP24

may allow acceleration of these dates by up to 12 months. All schemes align with the RAPID requirement to be “construction ready” within early AMP8.

16.6 Water reuse has a degree of scalability, which is offered via phased DO configurations for the effluent reuse schemes; however, the sizes and phasing need to be developed for Gate 2. Each of the four schemes have interdependencies with the other London Effluent Reuse SRO schemes, and other non-SROs (e.g. Crossness Desalination and Deephams Reuse) which constrain the DO and project scope.

16.7 ACWG costing methodology has been applied in our Gate 1 submission demonstrating that the costs at Gate 1 have been refined but remain comparable with those presented at WRMP19.

16.8 Overall, key stakeholders are comfortable with the promotion of effluent reuse subject to compliance with water quality, environmental and navigation requirements. A number of actions have been set for Gate 2 with NAU to advance the understanding of each scheme.

Recommendations

16.9 This proposal and its options should be developed for Gate 2 to provide further information about how this solution will meet the National Framework and WRSE requirements and explore the wider resilience benefits this solution could bring. At this stage, it is recommended that all four schemes and sub-options progress to Gate 2 for further development and appraisal.