South East Strategic Reservoir Option (SESRO)

Supporting Document A3

Cost Report

J696-DN-A01A-ZZZZ-RP-ZD-100023

Version: 1.0

Standard Gate three submission for SESRO SRO

Notice – Position Statement

- This document has been produced as the part of the process set out by RAPID for the development of the Strategic Resource Options (SROs). This is a regulatory gated process allowing there to be control and appropriate scrutiny on the activities that are undertaken by the water companies to investigate and develop efficient solutions on behalf of customers to meet future drought resilience challenges.
- This report forms part of the suite of documents that make up the 'Gate 3 submission.' Gate 3 of the RAPID programme represents a checkpoint on the way to solutions being prepared for consent applications. The intention at this stage is to provide RAPID with an update on activities being undertaken in preparation for consent application submission; activities' progress including programme through to completion; and consideration of specific activities to address particular risks or issues associated with a solution. The regulatory gated process does not form part of the consenting process and will not determine whether an SRO is granted planning consent.
- Given the stage of the SROs in the planning process, the information presented in the Gate 3 submission includes material or data which is still in the course of completion, pending further engagement, consultation, design development and technical / environmental assessment. Final proposals will be presented as part of consent applications in due course.
- The project information captured in this document reflects a design freeze in October 2024 following the non-statutory consultation, to meet the requirements of RAPID's gated process. Since then, the design has continued to evolve which includes further work with Affinity Water and Southern Water partners to form agreed requirements for the development consent application, such as the incorporation of Southern Water's proposed water treatment works into the SESRO consent. You can find the latest information about the design and development of the project at https://thames-sro.co.uk/projects/sesro/.

Disclaimer

This document has been written in line with the requirements of the RAPID Gate 3 Guidance (v3, January 2024) and to comply with the regulatory process pursuant to Thames Water's, Southern Water's and Affinity Water's statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, the co-sponsors will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.

Revision history

Version	Date	Submitted at
1.0	21-07-2025	RAPID submission

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Glossary

Terms and acronyms	Definition
ACWG	All Company Working Group (water companies involved in Strategic Resource Option projects)
AIC	Average Incremental Cost
base capex	Direct capex, indirects and client costs (land and indirect costs). Does not include Optimism Bias and costed risk.
BGL	Below Ground Level
BNG	Biodiversity Net Gain
BOQ	Bill of quantities
capex	Capital expenditure
CARES	Certification Authority for Reinforcing Steels
CESMM4	Civil Engineering Standard Method of Measurement
CUBOB	Combined Upper Bound Optimism bias
DCO	Development Control Order
D&PG	Design and Procurement General
direct capex	BOQ priced elements which form part of the permanent solution. Does not include indirects, client costs, Optimism Bias and costed risk.
DWI	Drinking Water Inspectorate
EIA	Environmental Impact Assessment
EU	Estimating Uncertainty
GI	Ground Investigation
MEICA	Mechanical, Electrical, Instrumentation, Controls and Automation
NPS	National Policy Statement (in this report this refers to the NPS for Water Resources)
NPV	Net Present Value
OB	Optimism Bias
opex	Operational expenditure
PV	Photovoltaic solar panels or plant
QCRA	Quantitative Cost Risk Assessment
RAIDO	Risk, Assumptions, Issues, Dependencies, and Opportunities

Terms and acronyms	Definition
RAPID	Regulators' Alliance for Progressing Infrastructure Development
Reservoir Tunnel	Tunnel between the SESRO pumping station and the main tower
River Tunnel	Tunnel between the SESRO pumping station and the inlet/outfall
SESRO	South East Strategic Reservoir Option
SiPR	Water Industry (Specified Infrastructure Projects) (English Undertakers) Regulations 2013
SRO	Strategic Resource Option
STT	Severn Thames Transfer
SWOX	Swindon and Oxfordshire WRZ
T2AT	Thames to Affinity Transfer SRO
T2ST	Thames to Southern Transfer SRO
TBM	Tunnel Boring Machine
total capex	The total costs including direct costs, indirect costs, Optimism Bias and costed risk.
WEEE	Waste Electrical and Electronic Equipment
WRMP24	Water Resources Management Plan 2024
WRSE	Water Resources South East
WRZ	Water Resources Zone
WTW	Water Treatment Works

1 Introduction and Context

1.1 Introduction and Context

1.1.1 Under the Water Industry Act 1991, every water company must prepare and maintain a Water Resources Management Plan (WRMP). This plan is updated every five years and sets out how companies are required to produce WRMPs every five years. The water-stressed status of south-east England was recognised by Ofwat (the Water Services Regulation Authority) following submission of the WRMP 2019 (Various Water Companies, 2019), and subsequently, funding was provided for water companies to investigate, then develop SROs that will benefit customers and the wider society and help protect and enhance the environment. Thames Water's WRMP 2024 was published on 18 October 2024, following a direction to publish from the Secretary of State in August 2024. The WRMP24 aligns with the revised draft Water Resources South East (WRSE) regional plan and establishes the need for a new 150Mm^3 reservoir (the South East Strategic Reservoir Option, or SESRO) that will primarily supply Thames Water, Southern Water and Affinity Water customers.

1.2 SESRO

1.2.1 In 2019, Ofwat provided funding for water companies to investigate and develop new large scale Strategic Resource Options (SROs) which are expected to play a crucial role in meeting long-term water needs, particularly in the south east which is described as "seriously water stressed". SESRO is a strategically important SRO which requires development by multiple partners for wider regional benefit beyond one company's supply boundaries. This type of scheme is lengthy and complex to consent and develop. In accordance with Thames Water's WRMP, SESRO is required to be operational by 2040.

1.3 RAPID

1.3.1 RAPID, a joint team made up of the three water regulators: Ofwat, the Environment Agency (EA) and the Drinking Water Inspectorate (DWI), was set up to support and oversee the progress of SROs. At PR19, Ofwat introduced a new gated process for which RAPID provides advisory oversight. At each gate, RAPID assesses the progress made in the development of each solution and provides recommendations to Ofwat on whether to release the next tranche of funding to continue scheme development. This process allows comparison of the solutions at regular intervals, and has clear checkpoints, or 'gates', to assess progress and determine which solutions should be taken forward for further work.

1.3.2 Each scheme passes through a series of governance 'gates', enabling key information to be presented and an assessment made on whether the scheme should continue for further development. The gates, for a standard SRO, set out by Ofwat in PR19 are as follows

- Gate one – Initial feasibility, design and multi-solution decision making.
- Gate two – detailed feasibility, design and multi-solution decision making.
- Gate three – finalised feasibility, pre-planning investigations and planning applications
- Gate four – Planning application, procurement strategy and land purchase.

1.4 Structure of Report

1.4.1 This report has been prepared to provide cost supporting information for the SESRO SRO gate three submission to RAPID. This report is Supporting Document A3, Cost. An overview of the SESRO project is provided in the gate three main report to RAPID.

1.4.2 The structure of this supporting document is as follows:

- Section 1 – describes background and context
- Section 2 – describes the gate three solution costs
- Section 3 – describes the gate three costed risk
- Section 4 – describes the gate three optimism bias
- Section 5 – describes the gate three while life cost assessment
- Section 6 – is a summary which also details the comparison between gate two and gate three cost estimates

1.5 Estimating Introduction and Methodology

1.5.1 The direct capex estimate for the 150Mm^3 SESRO solution has been developed as outlined in Section 2.1. Quantities from the gate three design documentation were extracted and exported to a Bill of Quantities (BOQ). The BOQ enabled the costing teams, with support from the technical teams, to estimate the gate three design scope using the BOQ as the basis. Once a final BOQ was achieved the costing team then applied suitable costed rates to each relevant quantity to form the direct capex estimate. Prelims and client costs are added to the direct capex to form the base capex estimate. Design and Procurement General cost (D&PG), optimism bias and risk are then applied to form the total capex.

1.5.2 Section 3 provides a summary of the quantitative costed risk assessment (QCRA) carried out for SESRO, while Section 4 outlines the process followed for estimating an allowance for optimism bias (OB). The approach adopted for QCRA and OB aligns with the approach developed for SROs on behalf of the ACWG. Estimating uncertainty has been reviewed and included as part of the QCRA.

1.5.3 The assumptions used to develop the operating expenditure estimate for SESRO are outlined in Section 2.3. These include annual energy estimates as well as assumptions for annual maintenance costs, abstraction licence costs and employees. Operating expenditure has been estimated using a 2022/2023 price base.

1.5.4 The capex estimate has been divided into the asset life categories defined by the All Company Working Group (ACWG - the water companies involved in the SRO programme). This allows for replacement capex to be estimated based on expected asset life and replacement over the modelled assessment period (80 years overall, including a 65 year operating period). Solution costs are in line with the relevant ACWG Guidelines and HM Treasury Green Book guidance.

1.5.5 Total capex (which includes QCRA and OB), replacement capex and opex estimates have then been used to generate Net Present Value (NPV) and Average Incremental Cost (AIC) estimates for SESRO, as described in Section 5. This has been carried out using the discount rates provided in the HM Treasury Green Book guidance and an 80 year assessment period.

1.5.6 Environmental and Water quality mitigation costs have been included with in the Total Capex cost. Where the mitigations are not considered in the base cost they have been costed through Risk.

2 Solution Costs

2.1 Details of Capital Expenditure (capex)

2.1.1 The current capital cost (capex) and operational cost (opex) estimates for SESRO are based on a reservoir with a storage capacity of 150Mm^3. The cost estimate is based on the gate three design, which is outlined in supporting document A1, Basis of Design[1].

2.1.2 The total capex estimate is comprised of direct costs (items which form part of the permanent solution / priced BOQ), indirect costs (items such as client and contractor costs which facilitate the creation of the permanent solution) as well as costed risks and optimism bias (OB).

2.2 Basis of Estimate

2.2.1 The estimated costs have been derived using items and quantities from the gate three information, reviewed alongside drawings and models where possible to understand the project scope and inform the costing exercise. During the estimating phase the level of detail available for the different elements of the design was reviewed to determine the most appropriate method for cost estimation. The cost basis of estimate has been priced based on Q3 2024 cost base then de-inflated to 2022/2023 rates. The estimating methodologies include first principles (bottom up), historical benchmarking (top down), quotations and provisional sums.

2.2.2 The direct capex is defined as the supply, site installation and construction cost which is directly attributable to the provision of the new capital asset. In addition to the direct capex the cost estimate allows for the indirect costs associated with developing and delivering the Project and Thames Water costs, as follows:

- In the development phase, indirect costs include the initial design of the scheme, obtaining consent, carrying out surveys, consulting with stakeholders and procurement of suppliers to carry out the works. The development indirect costs include actual development costs incurred up to gate three and resource-based forecasts for the remainder of the development phase.
- The land & property cost estimate allows for the costs of acquiring land and property required for the construction and/or operation of SESRO. It includes temporary and permanent acquisitions, and their associated fees, compensation and taxes.
- In the delivery phase, the indirect costs cover both client and contractor indirect costs. The client indirect costs include Thames Water sponsor roles and Specified

[1] *SESRO Gate 3, A1, Basis of Design Report, J696-DN-A01A-ZZZZ-RP-ZD-100021, 2025*

Infrastructure Projects (SiPR) Infrastructure Provider (IP) costs and are predominantly resource based forecasts benchmarked against comparable UK major civils projects. The contractor indirect costs cover contractor design, preliminaries and fee. These are benchmarked against comparable UK major civils project percentages.

2.2.3 Given the levels of risk and uncertainty inherent in the scheme at this stage of development, the capex estimate reported should be considered as a point within a range of potential cost outcomes. The reporting of early stage cost estimates as a range is proposed in the RAPID and OFWAT publication "Approaches for estimating and benchmarking costs for large scale water infrastructure projects"[2] published in June 2022.

2.2.4 A recognised construction industry approach to assessing the range of a cost estimate has been defined by the American Association of Cost Engineers (AACE). The AACE Cost Estimate Classification System approach requires:

- selection of an appropriate industry or recommended practice
- review of the maturity of the estimate input information to establish estimate class
- application of the wider expected accuracy ranges within the estimate class unless the narrower ranges can be justified

2.2.5 Following this approach, the SESRO project has been considered as Hydro Power Industry and assessed as a Class 4 Estimate with an evaluation of accuracy range within this class being -20% to +40%.

Quantities

2.2.6 For this gate three submission, quantities for SESRO have been estimated based on the gate three design (which is described in supporting document A1, Basis of Design).

2.2.7 A model of the reservoir embankment and borrow pit was developed and used to estimate the volume of earth moving required to deliver this major element of the project. This was combined with assumptions relating to construction vehicles and the rate at which earthworks can be undertaken to develop the cost estimate. Workshops were held utilising expertise from the project design and client team to check and review the approach and assumptions.

2.2.8 The calculations developed for the design of reservoir embankment inner face erosion protection and reservoir embankment internal drainage system were used

[2] Approaches for estimating and benchmarking costs for large scale water infrastructure projects - a report for Ofwat and RAPID by CEPA - Ofwat

to provide the required quantities of sand, gravel and riprap.

2.2.9 Models of the pumping station, intake / outfall structure, reservoir towers, tunnels and roads were developed. Construction material quantities for the civil works were extracted from the models to provide information for the BOQ. The main associated mechanical, electrical and controls (MEICA) equipment for each structure were itemised for inclusion in the BOQ. The quantities extracted were checked either through an alternative method of measurement, spot checks using separate calculations, or review by the appropriate specialists.

2.2.10 Where the design was developed to a lower level of detail for gate three, and for non-engineered items (such as environmental enabling works) quantities and provisional sums were included in the BOQ. These were informed by available gate three information.

Rates

2.2.11 Rates were applied to items in the BOQ to develop an estimate of contractor direct costs (exclusive of client and principal contractor indirect costs).

2.3 Details of Operating Expenditure (opex)

2.3.1 The opex assessment for SESRO includes the following components:

- Power consumed (for pumping water to the reservoir, the air diffuser system and miscellaneous ancillary assets)
- Power generated – by the hydro turbine during periods when the reservoir releases water to the River Thames
- Staff – for operation of the water supply assets
- Abstraction licence costs
- Maintenance – annual/regular routine operational maintenance activities for civil and MEICA assets

2.3.2 The opex associated with the potential facilities (i.e. café, visitor centre, education centre, recreational facility and water sports centre) is excluded at this stage as they are not fully defined and may be delivered on a commercial basis.

2.3.3 Year 1 of operation for SESRO is assumed to occur in 2040 and the analysis models opex over a 65-year period.

2.3.4 Grid electricity requirements for pumping water (to fill the reservoir and to transfer water to other uses) are modelled using a theoretical “high utilisation” (conservative) scenario, defined in the gate three supporting document A1, Basis of Design[3]. This scenario is different to the "Maximum Utilisation (100%)" scenario used for the gate two assessment and the change in approach was needed due to the inclusion of the flows for the Thames to Southern Transfer (T2ST) and Farmoor transfer. The revised approach still gives a deployable output of 271 Ml/d over a theoretical single year cycle, which is then used to estimate an annual opex. The gate three modelling assumptions are as follows:

- Required pumping of 1000Ml/d to refill the reservoir from the River Thames for 99 days in a year.
- Required pumping (where gravity discharge is not possible) of 74Ml/d to T2ST for 365 days in a year.
- Required pumping of 24Ml/d for raw water transfer to Farmoor for 365 days in a year.
- Release of 237Ml/d to the River Thames for 266 days in a year.

Fixed Operational Costs

2.3.5 The fixed opex components include operational maintenance, operating staff, abstraction fees as well as the power used for aeration and miscellaneous ancillary assets.

2.3.6 Annual maintenance costs for civil works and MEICA assets have been derived based on percentages of the capex associated with civil works and MEICA components, respectively. At gate three, only a high-level assessment has been undertaken with a separate value derived for all civil works and one for MEICA works (covering all types of operational maintenance). This is not based on a maintenance schedule or other detailed build-up of specific activities at this stage, but is based upon industry-wide cost intelligence from previous projects. The percentage value for civil works is 0.25% and for MEICA assets 1.5%. As the estimate is based upon a percentage uplift, based upon previous projects, it is considered representative of required significant maintenance activity without needing recourse to an activity-specific build-up. In addition to the maintenance work estimates, salary costs to cover five full time employees (operators) is included.

2.3.7 The cost for the abstraction licence has been estimated based on Statutory Guidance: Environmental Permits and Abstraction Licences: tables of charges[4]. It has been assumed that the licence would cover a full refill of the reservoir. It has been assumed that the full abstraction licence cost would be incurred each year.

2.3.8 Fixed power requirements for the scheme have been allowed for the following uses

[3] *SESRO Gate 3, A1, Basis of Design Report, J696-DN-A01A-ZZZZ-RP-ZD-100021, 2025*
[4] *Environmental permits and abstraction licences: tables of charges - GOV.UK (www.gov.uk) (Environment Agency, 2022)*

(the annual energy requirements for these uses are stated in the gate three supporting document A1, Basis of Design):

- Operation of an air diffuser network to maintain reservoir water quality.
- Energy requirements for miscellaneous ancillary assets (e.g. lighting, ventilation and control systems in operational facilities).

2.3.9 Unit electricity rates for imported electricity have been adjusted to a 2022/2023 cost base and assumed to be fixed over the length of the operating period.

Variable Operational Costs

2.3.10 The amount of energy required to pump water into the reservoir, and the amount of energy that could be generated through the hydropower turbines, would vary from year to year based on utilisation of the scheme.

2.3.11 In a year with high scheme utilisation the reservoir would be drawn down from top water level to a low reservoir water level. While this will generate energy as the water discharges through the energy recovery turbines, there would be a larger amount of energy required for the subsequent pumping to refill the reservoir. The variable opex impacts of power use and generation have been assessed using the energy estimates outlined in the gate three supporting document A1, Basis of Design Report. The estimates have been based on fixed rates for imported and exported electricity, adjusted to a 2022/2023 cost base.

Opex Summary

2.3.12 A summary of the estimated fixed and variable annual opex is provided in Table 1. The variable cost estimates are provided as cost per megalitre (Ml) as well as cost per year based upon an assessment of a theoretical “High Utilisation”.

Table 1 – Summary of Operating Expenditure Estimate (2022/2023 price base)

Opex component	Total	SESRO	SWOX/T2ST
Fixed Operational Annual Costs (£M/year)	4.18	3.90	0.28
Variable Operational Costs (£/Ml)	22.9	13.6	39.3
Variable Cost/year (£M/year) at “Theoretical High Utilisation”	2.26	0.86	1.41

2.4 Estimating Uncertainty

2.4.1 Following development of base capex (direct and indirect) estimate, the uncertainty associated with the cost elements (with respect to pricing, design and supporting assumptions) has been considered. The uncertainty was reflected in the costed risk assessment through the inclusion of estimating uncertainties. The estimating uncertainties were provided by cost estimation specialists and captured as percentage ranges around the component costs and productivity rates of the defined project scope. The resulting estimating uncertainties have been captured as part of the quantitative costed risk assessment (QCRA) (further details provided in Section 3).

2.4.2 Where cost components were identified to require an estimating uncertainty, uncertainty ranges were applied. The estimating uncertainty methodology has been undertaken by reviewing key rates, taking into account: normal market fluctuations on key materials, estimating expert judgement, how recent the rates are and confidence in the applied rate (e.g. depending on whether it is derived by first principles, historical benchmarks or provisional sums). Care has been taken to ensure that these are separate from the external threats and opportunities included within the costed risk register.

2.4.3 Indirect estimating uncertainties were considered to reflect the level of variability with the percentage uplifts currently applied, using benchmarking data and professional judgement on the potential for variance.

2.4.4 Estimating uncertainty applicable to client delivery indirect costs whereby assumptions made on headcount were considered together with rates assumption taking account of, for example, potential specialist consultant support requirements, and design development team size.

2.4.5 Estimating uncertainty applicable to contractor indirect costs related to the Prelims, Design and Fee uplifts; Thames Water benchmark data was used to support the ranges.

2.4.6 Estimating uncertainty applicable to land and property was also considered based on the assumptions and exclusions developed for the property cost estimate.

2.4.7 The assessment resulted in a risk profile of estimating uncertainty which has been reflected in the QCRA and provides a provision as part of the costed risk for the project.

2.5 Key Assumptions and Exclusions

2.5.1 Table 2 outlines the key assumptions and exclusions that have been made for estimating the total capex.

Table 2 – Key Assumptions and Exclusions for Solution Cost Estimate

Assumption	Description
Exceptional Market Conditions	Due to current circumstances, this estimate does not consider any potential short- or long-term impacts due to Covid 19 or the on-going conflicts in Ukraine, Middle East/Red Sea, or other latent conflicts.
Pre-Mitigation	Cost and risk information remains at pre-mitigation stage due to the current level of design maturity.
Reservoir excavated material	It is assumed that no excavated material within the footprint of the reservoir excavation will be disposed off site.
BNG	It is assumed all BNG requirements can be achieved within the gate three site boundary
Other project opportunities	This work is assumed to be required as a standalone operation and not part of any wider scheme. No opportunity or cost savings has been assumed from other projects running before, during or after construction.
Plant Hire	It is assumed that all construction plant (excluding Tunnel Boring Machine) are hire only and no allowance for purchasing of plant has been included.
Earthworks Seasons	It is assumed that the earthworks construction is during summer working hours only. During the winter season the plant would remain on site and be charged at a reduced rate.
Indirect Costs	The indirect costs associated to the delivery phase assumes the project will be delivered via SIPR procurement approach requiring an Infrastructure Provider (IP) Organisation

3 Risk

3.1 Risk Identification and Scoring

3.1.1 Since gate two, with an increased understanding of the design and detail of the programme, risk management has become more mature. Risk is managed using a project level RAIDO (Risks, Assumptions, Issues, Dependencies and Opportunities) Log, which is focused on the quantification and mitigation of strategic risk across the project lifecycle covering development, delivery of early works, main works and commissioning and asset operation.

3.1.2 The RAIDO Log enables the development of coherent and holistic mitigation strategies to address the primary consenting risks, which remain a priority at this stage in the project. These risks are generally hard to quantify in cost and programme terms but can be categorised and prioritised relative to each other. This register forms the basis of the quarterly reporting that the SRO issues to RAPID and the monthly risk review undertaken by the Programme Management Board.

3.1.3 As part of the cost estimation process, the risk register has been analysed and quantified to include the financial implications of the critical cost and schedule risks. This analysis forms the basis of the Monte Carlo simulation used to derive the costed risk element of the updated cost estimate. To facilitate the updates to the Quantified Costed Risk Assessment (QCRA), a more comprehensive approach to risk identification, assessment and management has been adopted at gate three with key areas of development including:

- Risk Identification: the quantity of risks identified in the QCRA has increased from 75 at gate two to more than 270 at gate three.
- Risk workshops have been expanded to include input from more technical disciplines (up to 12) and an evaluation of risks to account for the uncertainty of key technical/schedule/pricing assumptions undertaken.
- Risk Impact Assessment: a higher proportion of risk impacts have been costed with alignment between the capex estimate and the schedule, including detailed impact estimates for critical delay items.

3.2 Approach to QCRA

3.2.1 The risk register and QCRA has been reviewed at gate one, gate two and again for gate three to take account of design development. Risks are described in the RAIDO log; a probability of occurrence is estimated and an estimated cost range for the potential minimum and maximum cost impact of the risk is assigned.

3.2.2 The probability distributions and associated cost impacts for the different risks are input to a Monte Carlo simulation using the @Risk Excel add-in. Monte Carlo is a recognised technique for considering uncertainty that simulates thousands of possible future outcomes, and the likelihood that they will occur. The 50th percentile (P50) total risk value is then identified for reporting and to be used in whole-life cost assessments. P50 means there is a 50% probability that the risk value will not be exceeded,

3.2.3 The QCRA has considered the following items:

- Specific risk (threats) events
- Estimating Uncertainties (EU)
- Time related cost risk allowance provision

3.2.4 The QCRA has considered time risk allowance related to Development Activities, DCO Process, Enabling Works, Main Delivery Works and Testing & Commissioning/Filling. The costed time risk allowance is intended to account for uncertainty and risk associated with the programme timescales and the many risks which have the potential to impact the critical path. Given the status of the reported unmitigated position, an allowance has been assessed to accommodate a variety of responses including mitigation, acceleration, parallel running and/or prolongation related costs. These will be further investigated and reviewed during gate four. The project team will conduct more detailed schedule risk analysis to provide confidence in the overall delivery programme, with mitigation measures embedded in the programme and cost estimate, where applicable.

3.2.5 The key drivers for potential delays have been identified as follows:

- Development activities carry potential for impact to the schedule critical path and negatively affect the timely submission of the DCO. These activities include finalising a gate four design, production of the Environmental Statement, stakeholder engagement / statutory consultation, consideration of commercial arrangements and procurement of an Infrastructure Partner.
- DCO is a multiple stage consecutive process where each stage may be faced with possible delays which could directly impact the following stage; the main risk resides with the potential for Judicial Review of the DCO decision. The current programme assumes standard durations which, based on current experience of major infrastructure projects, are seldom achieved.
- Enabling Works are currently assumed to comprise the following key activities: site clearance (including solar farms decommissioning and removal), habitat creation and species translocation, utilities / service diversions, road access and railhead construction. These may attract delays due to the extent of the works, seasonality and dependency on third parties.
- Main Works construction will be driven mainly by earthworks and tunnelling activities, scope that carries inherent critical path risks, including but not limited to seasonality, unforeseen ground conditions, productivity, site access and logistical challenges. All of these may impact the critical path and require specific mitigation for recovery to avoid overrun.

- Testing, Commissioning and Filling activities may take longer than anticipated due to issues encountered when wet commissioning is undertaken. The primary cause for delay is likely to be linked to seasonality and water availability: delays will be experienced in the event of lack of sufficient flow in the River Thames, adverse weather impacting water levels and therefore rate at which reservoir can be filled, other water companies drawing greater volumes of water, or for a longer period than anticipated to conduct their testing (i.e. interface with T2ST commissioning taking place as the reservoir fills, T2ST pipelines and Farmoor transfer asset testing). Constraints may also be imposed by the Construction Engineer who may issue a series of Certificates controlling the extent of filling (to the intermediate levels) and/or the rate of filling.
- The model includes a total of 274 risks plus 13 EU items, as documented in the RAIDO log.

3.2.6 The gate three analysis was performed from a pre-mitigation perspective, not considering any potential mitigation measures. This approach provides a current view of the risks and their potential impacts on the project.

3.2.7 The key risks that contribute most significantly to the costed risk estimate are listed in Table 3.

Table 3 – Key Risks from Monte-Carlo Simulation

No.	Description
1	Enhanced renewable energy generation may be required (above that provided by the hydropower turbines) to achieve potential carbon commitments.
2	Unexpected overburden (e.g. solifluction clay) may be encountered during foundation excavation for the reservoir embankment.
3	Wetter foundation clay than predicted for the reservoir embankment may be encountered, complicating compaction efforts.
4	10% Biodiversity Net Gain (BNG) requirements may not be able to be achieved within currently assumed Order Limits.
5	Foundation of the perimeter embankment may be weaker than expected requiring a modification to the section and increased cut and fill volumes.
6	High plasticity, very stiff bedrock clay may be found within the borrow pit which impacts compatibility for use in reservoir embankment construction.
7	At a later stage in design development it may be necessary to introduce a surface water channel into the design for auxiliary emergency drawdown of the reservoir.

8	Utility Statutory Undertakers may not be able to deliver utility works within the currently assumed programme.
9	At a later stage in design development it may be determined that additional works are required to make provision for the potential Wilts & Berks Canal.
10	Main Works Contractor insolvency.

3.3 Summary of P50 Costed Risk Estimate

3.3.1 The analysis identified significant risks that could impact the project's budget. The P50 value is estimated at £1.212 billion (2022/2023 price base), while the P80 value is £1.433 billion and the P95 value is £1.680 billion. P50 means there is a 50% probability that the cost of the risks will not exceed £1.212 billion.

3.3.2 A summary of the QCRA results is shown in Table 4.

Table 4 – Summary of QCRA Results (2022/2023 price base)

	50th Percentile (P50)	80th Percentile (P80)	95th Percentile (P95)
Risk (threats) only	£1.058b	£1.229b	£1.447b
Risk + Estimating Uncertainty	£1.212b	£1.433b	£1.680b
Base Capex	£4.168b	£4.168b	£4.168b
Risk + EU (% of Base Capex)	29.1%	34.4%	40.3%

4 Optimism Bias

4.1.1 The assessment of optimism bias has followed an approach developed for the ACWG.

4.1.2 First Stage: Determine whether the option is a 'standard civil engineering' project or a 'non-standard civil engineering' project to set the 'Upper Bound Optimism Bias'. SESRO is considered to be a mix of standard and non-standard civil engineering with a split of 57% standard civil engineering and 43% 'non-standard civil engineering' and therefore the 'Upper Bound Optimism Bias' is set at 53.5%.

4.1.3 Second Stage: Determine whether any of the contributory factors for optimism bias can be scaled back to account for risks that have been identified, understood and managed.

4.1.4 Third Stage: Reassess the scaling back of optimism bias carried out in the Second Stage each time the Quantitative Cost Risk Assessment (QCRA) is updated.

4.1.5 Following the assessment of the QCRA outlined in Section 3, the Adjusted Optimism Bias for the SESRO gate three cost estimate is 26.8%.

5 Whole Life Cost Assessment

5.1 Spend Profiles

5.1.1 To assess the whole life cost for SESRO the cost estimates outlined in the above sections have been spread over an 80-year investment period. This has required spend profiles to be developed for the following phases:

- Pre-construction Phase (assumed to be completed by December 2028)
- Construction and Commissioning Phase (assumed January 2029 to March 2040)
- Operation and Asset Replacement Phase (assumed to be 65 years)

5.1.2 Assumptions made to develop the spend profiles are provided in the following sub-sections.

Spend profile during pre-construction and construction

5.1.3 Historic pre- construction costs were assigned to the year when they occurred. Remaining pre-construction costs were spread evenly across the remaining years of the pre- construction phase.

5.1.4 Construction and commissioning costs were spread evenly across the Construction and commissioning phase.

Spend profile during operation and asset replacement phase

5.1.5 The fixed operational cost and the variable operational cost have been applied for each year of operation, assuming the theoretical “High Utilisation” (conservative) scenario (see Section 2.3).

5.1.6 To estimate the scale of replacement capex throughout the modelled 65 year asset replacement phase each of the proposed asset types have been assigned to one of the ACWG asset life categories presented in Table 5. The total capex by ACWG asset life category have then been calculated.

5.1.7 Each category has an associated asset life in years. It has been assumed that at the end of an item’s asset life, the item would be completely replaced and the initial construction cost for that item would be incurred again. The resulting asset replacement costs, over the 65 year modelled asset replacement phase, are provided in Table 5b in Appendix A.

Table 5 – ACWG Asset Life Categorise used for SESRO

ACWG Asset Life Category	Asset Life (years)
Fencing	10
Building services	10
ICA (Instrumentation, Control & Automation)	10
Plant and machinery	15
M&E (Mechanical and Electrical) Works on Pumping Stations and Treatment Works	20
Power supply	25
Steel/Timber/GRP Structures	30
Landscaping/Environmental Works	30
Brick/Concrete Office Structures	50
Roads and Car Parks	60
Treatment and Pumping Station Civils (incl. Intakes)	60
Headworks/valves	60
Reinforced Concrete Tanks / Service Reservoirs	80
Tunnels	100
Pipelines	100
Weirs	100
Embankment Works	250
Other Non-Depreciating Assets (Non depreciating)	N/A
Land (Non depreciating)	N/A

5.2 Net Present Value (NPV) and Average Incremental Cost (AIC) Estimates

5.2.1 NPV and AIC have been estimated using the spend profiles discussed above. The assessment has been carried out using ACWG templates and the Environment Agency Table 5a and 5b (with outputs presented in Appendix A). The template uses HM Treasury Green book with a declining schedule of discount rates (HMT Green Book: Annex 6, Table 8) and an 80-year assessment period.

5.2.2 Estimates for the NPV and AIC are provided in Table 6 and show a gate three AIC of 268.4p/m^3.

Table 6 – NPV and AIC Esimates (2022/2023 prices)

	Units	Quantity
Option benefit	Mld	271
Capex NPV	£m	5,193.1
Opex NPV	£m	103.4
Total NPV	£m	5,296.5
AIC	p/m³	268.4

6 Gate Three Cost Estimate Changes from Gate Two

6.1.1 The following sub-sections provide a comparison between gate two and three cost estimate to a 2022/23 price base.

6.1 Summary Comparison

Table 7 – Summary of Gate Two to Gate Three Comparison (2022/2023 price base)

Items	Gate Three (£M)	Gate Two (£M)	Change (£M)	% Increase
Enabling works	£636	£222	£414	187%
Land costs	£247	£205	£42	20%
Rail sidings	£105	£50	£55	111%
Reservoir	£1,939	£907	£1,032	114%
Road diversion	£98	£35	£64	183%
Access road	£112	£84	£27	33%
Shaft / Tunnel	£283	£157	£126	80%
Siphons	£23	£5	£18	353%
Intake/outfall	£63	£25	£38	153%
Intake pumping station	£279	£115	£164	143%
Landscaping	£331	£46	£286	624%
Public facilities	£92	£39	£53	135%
TW Other items	£22	£0	£22	100%
Pipework	£63	£0	£63	100%
Costed risk (total)	£1,212	£386	£826	214%
Optimism bias	£1,098	£468	£630	134%
Total (base capex, costed risk and optimism bias)	**£6,604**	**£2,745**	**£3,859**	**141%**

6.2 Capital Expenditure

6.2.1 As SESRO has developed from gate two to gate three a number of factors have driven capex increases, the most significant of these are summarised in Table 8. The five items listed are the highest cost items in Table 7 (accounting for approximately 84% of capex before costed risk and OB) and have also increased notably in cost since gate two. Table 2-1 of document A1, Basis of Design Report forms a summary of the key design changes since gate two. Although there is a direct correlation between design change and capex change there are separate influencers to the significant capex change other than design that drive costs as detailed in Table 8.

Table 8 – Significant influencers to increased capex

Description	% increase since gate two
Reservoir Construction: The construction methodology and production rates have been reviewed in further detail leading to an increase in the cost estimate. There has been some increase in the earthworks volume due to the inclusion of a 'dig and replace' trench within the dam foundation (see supporting document A1 for reasons).	114%
Enabling Works: Review of the length of haul roads required and update to their design. Review of the estimated rate for utility diversions, and separate cost for abandoning / removing existing utilities.	187%
Landscaping costs: The floating islands significantly increased in area. The following items have also been added to this part of the estimate: maintenance of habitats during construction, topsoil treatment, and noise bunds.	624%
Intake Pumping Station: The pumping station civil structure increased significantly in size and the design / construction methodology was significantly changed alongside a review of concrete and reinforcement requirements (see supporting document A1 for reasons). A more detailed MEICA scope was developed.	143%
Shafts /Tunnels: The diameter of the tunnels and shafts increased to facilitate changes to the proposed operation of the conveyance system (see supporting document A1 for reasons).	80%

6.3 Risk

6.3.1 The costed risk at gate two was £386m (2022/23 price base). As the project has matured, a more detailed understanding of risks has developed. The risk value at gate three is £1.212 billion (2022/23 price base), the most significant factors for the increase are summarised in Table 9.

Table 9 – Significant influencers to increased risk value

Contributory Factor	Description
Capex and number of risks increased	Risk impacts are proportional to the base cost, as this has increased, the risk value has increased too. At gate two, the risk value was 23% of the total capex, this has increased to 29.1% at gate three. The number of risks identified in the QCRA has increased from 75 at gate two to 274 at gate three. These two factors have contributed to a risk value increase.
Estimating Uncertainty added to the risk value	EU has been included in the QCRA as part of the gate three development. The 13 EU items in the QCRA have an expected value of £174m, approximately 14% of the total risk value.
Time related costs added to the risk value	Time related risks have been identified during gate three and incorporated into the QCRA, as described in Section 3. The five time-related risks included in the QCRA have an expected value of £278m, approximately 23% of the total risk value.

6.4 Optimism Bias

6.4.1 The project is considered to be 43% non-standard civil engineering project, rather than 100% non-standard at gate two. Therefore the 'Upper Bound Optimism Bias' has reduced to 53.5% (from 66% at gate two).

6.4.2 Between gate two and gate three the level of design detail has increased and there is a greater understanding of the likely delivery route (through SiPR). However, further technical analysis and liaison with stakeholders is still needed to increase confidence in some elements of the design and land access has limited the progress of environmental and engineering data collection. There remains opposition to the project and this drives uncertainty in the consenting of the scheme.

6.4.3 In the gate three assessment OB has reduced from the gate two value of 27.9% to 26.8%. The cost of OB is relative to base capex; therefore as base capex has increased the cost related to OB has also increased.

6.4.4 Overall, optimism bias has increased as the design of the project has developed and complexity has increased, but the supporting collection of field data has continued to be lag behind the design progression. This has increased uncertainty overall and hence OB.

6.5 Operating Expenditure

6.5.1 The annual fixed opex estimate for gate three is similar to that at gate two. Although the overall capex estimate has increased significantly the components that contribute to fixed operating costs have seen less movement. The fixed opex components include operational maintenance, operating staff, abstraction fees as well as the power used for aeration and miscellaneous ancillary assets.

6.5.2 There has been a significant increase in the variable opex (102% increase from gate two to gate three), predominantly driven by changes in expected water utilisation (increased pumping to the reservoir and other users (T2ST and the Farmoor transfer), combined with a resulting reduction in flows available for generating power using the hydropower turbines). However, the overall impact on the total opex NPV (including fixed and variable opex, over a 65-year period) is a 19% increase from gate two to gate three.

6.5.3 Table 10 compares the gate two and gate three opex estimates (along with NPV and AIC values). Note that gate two costs have been converted to a 2022/23 cost base to aid comparisons.

Table 10 – Comparison of gate two and gate three opex estimates (2022/23 cost base)

Cost types	Units	Gate three	Gate two	Change
Option benefit	Mld	271	271	
Fixed opex	£m/annum	4.18	4.75	-12%
Variable opex	£/ML	22.9	12.6	82%
Capex NPV	£m	5,193.1	1,747.9	197%
Opex NPV (over 65-year period)	£m	103.4	96.2	8%
Total NPV	£m	5,296.5	1,844.1	187%
AIC	p/m³	268.4	116.3	131%

6.6 Average Incremental Cost

6.6.1 Table 10 shows the increases in NPV and AIC from gate two to gate three. The significant increase in total NPV and AIC from gate two to gate three is predominantly driven by the increase in capex.

Appendix A – Tables 5a and 5b

See separate supporting document: A3: Cost Report Appendix A

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