Fens Reservoir

Gate two report

November 2022

Contents

Acronyms

Acronyms	Definition
A2AT	Anglian to Affinity Transfer
AA	Appropriate Assessment
AACE	Association for the Advancement of Cost Engineering
ACWG	All Company Working Group
AESI	Adverse Effect on the Site Integrity
AIC	Average Incremental Costs
AMP	Asset Management Plan
ARD	Allowable Revenue Direction
BCIS	Building Cost Information Service - cost and price data for the UK construction industry
BCN	Bedfordshire Cambridgeshire and Northamptonshire
BNG	Biodiversity Net Gain
BSA	Bulk Supply Agreement
CAP	Competitively Appointed Provider
CAPA	Competitively Appointed Provider Agreement
CAPEX	Capital Expenditure
CCW	Consumer Council for Water
CDO	Concept Design Option
CPIH	Consumer Prices Index including owner occupiers' Housing costs
DCO	Development Consent Order
Defra	Department for Environment, Food and Rural Affairs
DO	Deployable Output
DPC	Direct Procurement for Customers
DWI	Drinking Water Inspectorate
dWRMP	Draft Water Resource Management Plan
DWSP	Drinking Water Safety Plan
DYAA	Dry Year Annual Average
DYCP	Dry Year Critical Period
EA	Environment Agency

Acronyms	Definition
EAR	Environmental Assessment Report
EBSD	Economics of Balancing Supply and Demand
EIA	Environmental Impact Assessment
ENCA	Enabling a Natural Capital Approach (Defra)
EPR	Environmental Permitting Regulations
FSR	Flood Storage Reservoir
FWP	Fens Water Partnership
GAC	Granular Activated Carbon
GI	Ground investigation
HH	Household
HMWB	Heavily Modified Waterbody
HOF	Hands-off-Flow
HRA	Habitats Regulations Assessment
HVO	Hydrogenated Vegetable Oil
IDB	Internal Drainage Board
INNS	Invasive Non-Native Species
IP	Infrastructure Provider
ITT	Invitation to Tender
JV	Joint Venture
LA	Local Authority
LSE	Likely Significant Effects
M&E	Mechanical and Electrical
mAOD	Metres above Ordnance Datum
MCDA	Multiple-Criteria Decision Analysis
Mm^3	Million Cubic Metres
Ml/d	Million (mega) litres per day
MORDM	Multi-Objective Decision Making
MOU	Memorandum of Understanding
MW	Megawatt

Acronyms	Definition
NAU	National Appraisal Unit
NC	Natural Capital
NCA	Natural Capital Assessment
NFU	National Farmers Union
NHH	Non Household
NIC	National Infrastructure Commission
NPS	National Policy Statement
NPV	Net Present Value
NSIP	Nationally Significant Infrastructure Project
NYAA	Normal Year Annual Average
OB	Optimism Bias
Ofwat	The Water Services Regulation Authority
OPEX	Operational Expenditure
PACI	Poly Aluminium Chloride
PAS2080	Global standard for managing infrastructure carbon
PEI	Preliminary Environmental Information
PEIR	Preliminary Environmental Information Report
PFAS	Per- and poly-fluoroalkyl substances
PFI	Private Finance Initiative
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
PINS	Planning Inspectorate for England
PMG	Programme Management Group
PQQ	Pre-qualification questionnaire
PR	Price Review
PS	Pumping station
PSS	Property Support Scheme
Pywr	Python Water Resources (model)
RA75	Regulation referring to the Reservoirs Act 1975
RAPID	Regulators' Alliance for Progressing Infrastructure Development

Acronyms	Definition
RCV	Regulatory Capital Value
REGO	Renewable Energy Guarantees of Origin
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SIPR	Specified Infrastructure Project Regulations
SLR	South Lincolnshire Reservoir
SOC	Strategic Outline Case
SOCC	Statement of Community Consultation
SoS	Secretary of State
SPA	Special Protection Area
SRO	Strategic Resource Option
SSSI	Site of Special Scientific Interest
SuDS	Sustainable drainage systems
TTT	Thames Tideway Tunnel
UV	Ultraviolet
VFM	Value For Money
WFD	Water Framework Directive
WFRG	Water Farming Reservoir Group
WQRA	Water Quality Risk Assessment
WRE	Water Resources East
WRMP	Water Resources Management Plan
WTW	Water Treatment Works
ZoI	Zone of Influence

1. Executive summary

The East of England is severely water-stressed. It is also one of the fastest-growing regions in the country which is home to many unique and precious landscapes that rely on water. Anglian Water and Cambridge Water's draft Water Resources Management Plans have identified the need for a reservoir to secure supplies to customers, and to protect the environment from the effects of climate change. This need aligns with the strategy outlined in the draft Water Resources East regional plan. Anglian Water and Cambridge Water are therefore partnering to develop the proposed new reservoir in the Cambridgeshire Fens, and recommending that the Fens Reservoir continues to be progressed through RAPID's SRO programme, together with the proposed new South Lincolnshire Reservoir.

It is anticipated that the new reservoir will deliver benefits beyond just water supply, by enabling a range of wider social, environmental and economic benefits. The new reservoir could be a valuable leisure destination for activities such as walking, cycling, sailing and angling and provide a support system to conserve wildlife and enhance biodiversity, protecting valuable species and creating new habitats. Opportunities are also being explored with partners and stakeholders for the reservoir and transfers to be part of a much bigger system, enabling wider, multi-sector benefits across the region.

This report summarises the extensive work undertaken to date to meet the gate two milestone. A summary of this work is presented below.

Anglian Water and Cambridge Water look forward to continuing to develop the project together with RAPID, stakeholders and communities, towards the next key milestone, gate three. It is therefore proposed that the Fens Reservoir continues through the gated process, to enable an application for a Development Consent Order (DCO) to be submitted in 2025 so that works can start on site in 2029 and water be in supply by 2035 to 2037, in line with the WRE and WRMP programmes. However, the development allowance allocated at PR19 is not sufficient to progress this solution through the remaining gates in AMP7. The ability for Anglian Water and Cambridge Water to continue to develop the solution to the standard required to achieve a successful DCO and to enable water to be brought into supply between 2035 and 2037, is subject to confirmation of adequate funding of the development costs being made available by RAPID and Ofwat.

Background

- Anglian Water and Cambridge Water are facing unprecedented challenges around growth, climate change, and environmental requirements
- The Water Resources East (WRE), Regional Plan and Anglian Water's and Cambridge Water's Water Resources Management Plans (WRMPs) confirm the need for a $50Mm^3$ reservoir in Cambridgeshire by the mid 2030s, to supply Anglian Water and Cambridge Water customers

Programme and planning

- Gate three is proposed for March 2024
- The Fens Reservoir is a Nationally Significant Infrastructure Project (NSIP) and therefore the DCO route for planning is mandatory
- The Development Consent Order (DCO) application is programmed to be submitted in 2025
- A start-of-construction date in 2029 is scheduled
- Fens Reservoir will be in operation between 2035 and 2037
- Procurement options have been analysed: the Fens Reservoir appears to be suitable for delivery via Direct Procurement for Customers (DPC) and potentially suitable for delivery via Specified Infrastructure Project Regulations (SIPR)

Solution design

- A four-stage site-selection process has concluded, identifying a proposed site north of Chatteris
- The gate two concept plan is to be used for public consultation to influence ongoing design
- This presents a 55Mm^3 reservoir (50Mm^3 useable volume) with a maximum embankment height of 20m covering an area of about 5km^3
- The deployable output (DO) is modelled to be 87Ml/d
- Water will be abstracted from the River Great Ouse (300Ml/d) and from the River Delph (400Ml/d), when flows allow

Key risks

The top risks identified are:

- Inflation impacts the cost of delivering the work needed; budget no longer sufficient
- Unfavourable ground conditions or archaeological finds delay programme and increase cost
- Delay to final WRMPs publication or DCO application delays programme
- Information from stakeholder feedback causes programme delays
- Findings from the full Habitats Regulations Assessment (HRA) delay programme
- Unable to obtain and retain abstraction licences
- Supply chain not able to resource earthworks programme

Environmental assessment

- Environmental assessments have been updated and a number of potentially adverse impacts have been identified
- These issues will require further investigation and the potential for mitigation to be assessed
- Several opportunities for environmental enhancement have also been identified

Drinking water quality considerations

- The drinking water quality risk assessments have not highlighted any significant issues
- Outputs from the risk assessment have informed the proposed water treatment requirements
- Consumer acceptability (taste, odour, hardness) remains a key consideration due to a change in water type

Stakeholder engagement

- Stakeholder engagement continues to be at the heart of the development of Fens Reservoir
- A new stakeholder partnership has been created - the Fens Water Partnership (FWP)
- A series of stakeholder workshops have informed the site selection process
- First non-statutory consultation began in October 2022 and ends in December 2022

Cost

- The estimated total scheme Capex (Capital Expenditure) is £1.96 billion (in 2020/21 prices), with an Average Incremental Cost (AIC) of 292p/m^3. This represents an increase on the previous gate one estimate driven by a combination of inflation, additional scope and additional risk allocation Experience has highlighted that CPIH price escalation indices give insufficient inflation provision for major projects and therefore a more appropriate index for estimating forecasts will be required going forward
- The total actual gate two spend is £3.7 million, representing a £390 thousand underspend against allowance (which will be rolled forward into the gate three budget)
- Subject to funding certainty, the forecast estimate for gate three work is £23.8 million, and for gate four work is £31.3 million (in PR19 2017/18 prices) These estimates represent a significant increase to the funding allowances of £9.9 million and £10.9 million for gate three and four respectively

2. Background and objectives

2.1. Background

The Fens Reservoir (FR) featured in the Water Resources Management Plan (WRMP) 2019 as one of the supply-side options that Anglian Water would investigate further as part of their adaptive planning activities to ensure that the scheme would be ready to implement should it emerge as a preferred option in future plans. The option assumed that water would be supplied from a new abstraction point on the River Ely-Ouse at Denver. Additional abstractions from the River Bedford-Ouse at Earith and the Ouse Washes were assessed. High flows would be captured for storage in a new reservoir sited approximately 25km from the intake in Cambridgeshire, subject to further modelling and site investigation.

Anglian Water and Cambridge Water continue to experience unprecedented challenges across their regions. Weather is becoming more extreme, and there is an increasing population which places greater emphasis on the need for water supply resilience during more frequent periods of extreme drought. Water abstraction from environmentally sensitive areas also needs to be reduced to meet the stretching environmental ambitions as set out in the National Framework for Water Resources. The draft Water Resources Management Plans 2024 have set out a best value plan for meeting these challenges, but the scale is such that they cannot be met through demand management solutions alone. In the regional draft water resources plan for Eastern England, Water Resources East (WRE) has identified the need for two new strategic raw water reservoirs in the region to address part of the supply deficit - one of which is the Fens Reservoir. This has been confirmed in Anglian Water's and Cambridge Water's dWRMPs24.

Regional water resources modelling has confirmed that the required reservoir capacity to meet public water supply requirements should be 50 million cubic metres (Mm^3) to provide a supply of up to 87 megalitres per day (Ml/d), with abstractions from the River Great Ouse and the River Delph.

Whilst this reservoir is a fundamental component of the long-term water resource plans in the region, providing a safe, resilient supply of drinking water is not the only benefit the reservoir will provide. The reservoir will also provide environmental, socio-economic, leisure and wellbeing benefits for the communities it serves.

The concept design options (CDO) presented at gate one represented a combination of design features that were being explored with stakeholders to maximise multi-sector benefits, in addition to the public water supply requirements. The multi-sector design features considered during the preliminary feasibility assessment included flood storage, the provision of irrigation and farming reservoirs, wetlands, open water transfer and catchment management to improve water quality. These concepts have been further developed in gate two, through system development work and extensive stakeholder engagement.

Since the gate one submission in July 2021, the four-stage site selection process to identify the best performing site in which the reservoir and embankments will be located has concluded. This has identified and assessed site areas against environmental, technical, economic, planning and community criteria (both constraints and opportunities) and has screened over eighty potential sites to identify the best performing site.

This gate two submission presents a concept plan for the proposed site, including environmental assessments, and has been developed to a standard suitable to meet WRMP and regional planning requirements. The concept plan is being shared as part of a ten-week consultation which will inform the ongoing development of the design ahead of gate three.

2.2. Gate one actions and recommendations

Following the gate one submission, a number of actions and recommendations were made. These are listed in Table 1 with a response next to each.

Table 1: Gate one actions and recommendations

RAPID assessment at gate one	Response at gate two
Actions	
Solution design - A number of candidate locations must be identified, and the implications must be evaluated. The implications that are evaluated should include financial costs (Capex and Opex), carbon cost, flood risk benefit, environmental, and social benefits. A clear table comparing these for the sub-options will be helpful.	The site selection process for Fens Reservoir considered over 80 potential sites. The report includes a tabulated comparison of the final four best-performing sites. These sites were evaluated across several criteria including financial costs (Capex and Opex), carbon cost, flood risk benefit, environmental, and social benefits. The process is summarised in Section 3.3 and the site selection report is presented in Annex A.
Solution design - Ensure utilisation is determined, including uncertainty and sensitivity. Provide detailed explanation of the methodology for defining utilisation from the regional modelling.	Initial anticipated utilisation rates for the Fens Reservoir have been modelled (see Section 4.1). Average utilisation increases over time, from 29Ml/d in 2035 to 84Ml/d by 2050 due to population growth and climate change factors. Maximum utilisation occurs in both the DYAA and NYAA scenarios at the modelled maximum DO output of 87Ml/d.
Solution design - Provide a clear discussion of Fens reservoir's interaction with other sources and state which other water companies will be involved in the conjunctive use of this solution. Provide more detail about the proposed transfer to Cambridge Water.	The Fens Reservoir scheme is being promoted by Anglian Water and Cambridge Water. The scheme is independent of other strategic resource options (see Section 3.7). It is proposed that treated water will be transferred via potable main to both Anglian Water and Cambridge Water resource zones. The Cambridge Water connection will include about 12km 900mm steel pipeline to one take-off point, and then an approximately 22km 700mm steel pipeline spur to a second take-off point (see Section 3.4 and Figure 7).
Environment - Assess carbon impacts and the solutions alignment to net zero for operational emissions by 2030. Explain how the solution is aligned with the ambition of the All Company Working Group on carbon.	A whole-life carbon assessment, covering an 80-year period, has been undertaken along with a review of the opportunities to mitigate emissions across the life of the asset (see Section 6.6). The assessment is aligned with the All Company Working Group (ACWG) guidance, and the scheme design is seeking to minimise carbon impacts whilst maximising water supply and wider environmental benefits within the region.
Solution design - Investigate the integration of flood risk management opportunities and how these will interact with water resource management requirements under appropriate climate change scenarios.	Flood risk was a key consideration throughout the site selection process (see Section 4.4). Modelling has indicated that there is potential to reduce the IDB catchment flow to Bensons Pumping Station, thereby reducing flood risk. Further opportunities were identified with stakeholders including enhancement of flood defences, and use of drawdown and SuDS ponds for temporary storage.
Evaluation of costs and benefits - Develop biodiversity net gain and natural capital assessments as a priority together with amenity and landscape impact reports.	Biodiversity Net Gain, Natural Capital Assessments, amenity and landscape assessments have been completed and are summarised in Section 6 and presented in detail in Annex E.
Environment - The Habitats Regulation Assessment should consider the functionally linked habitats and screening of the Breckland SAC.	The Habitats Regulation Assessment (HRA) is addressing functionally linked habitats with the Appropriate Assessment for gate two. The Breckland SAC predominantly represents European dry heaths of low rainfall and free-draining soils. The river valleys have occasional wet woodland and require high water levels and occasional flooding. Fluctuating meres are a feature, these are aquifer fed and have periods of complete drying. The Breckland SAC is 16km from the proposed Fens Reservoir at its closest point and there is only an indirect hydrological connection. It has therefore been screened out of the assessment.
Evaluation of costs and benefits - Engage third parties who will benefit from the solution to contribute a fair share of the development costs, particularly where this significantly increases solution costs.	As detailed in Section 4.3 a study has been undertaken to understand the wider benefits the reservoir project could enable. This work extended to engagement with investors and identification of funding opportunities for multi-sector benefits, as presented in Annex D.

RAPID assessment at gate one	Response at gate two
Recommendations	
Evaluation of costs and benefits - Ensure wider resilience benefits are fully investigated and quantified as part of the submission for all options.	The opportunity exists for the reservoir and transfers to be part of a much bigger system, enabling wider, multi-sector, benefits across the region. To understand the potential benefits, an initial system concept for the reservoir and the region has been developed with stakeholders (see Section 4.3 and Annex D). A systems framework was created, and benefits were quantified, with economic values assigned to support conversations with stakeholders on value, financing, and risk. This framework provides a platform for the concept to continue to evolve through ongoing dialogue and design, and aligns with the ambition of the Future Fens Adaptation Initiative.
Evaluation of costs and benefits - include which option is considered best value (rather than just least cost) for customers and the environment and the criteria and method used for best value.	The Fens Reservoir solution was identified in WRE's best value plan - it provides environmental value and multi-sector benefits. In the assessment of the best site for this reservoir, a range of criteria, including both impacts and benefits, were considered to identify the best-performing site. See Section 3.3 and Annex A.
Environment - Prioritise the identification of environmental risks, impacts and propose mitigation requirements where necessary. **Environment** - Prioritise the development of environmental modelling, monitoring plans, and approach to in-combination assessment.	The environmental assessment and report (see Section 6 and Annex E) has identified key issues that will inform the next stages of the scheme design, including measures and plans to mitigate and manage predicted impacts. As the scheme progresses, the design concepts will consider recommended mitigation, monitoring and enhancement measures, and the recommendations from further environmental assessments, to optimise the environmental performance. The gate two environmental assessments have not identified any regulatory barriers to the scheme progression.

2.3. Objectives

The National Framework provides the framework for regional water resource planning. It requires that WRMPs are preceded by regional plans to cover the needs of other significant water users in the region across all sectors including agriculture, energy and other industry. The regional water resources plan outlines the strategic case or regional need for water-related infrastructure.

The regional need for reservoirs

As part of the development of the Water Resources East (WRE) draft Regional Plan, an advanced stakeholder decision-making process was followed. The aim of this was to determine which supply-side options would be low regret, robust solutions to meet the challenges faced by water resource planning in the East of England. To achieve this, new supply-side options (such as raw water reservoirs, desalination and water reuse) were tested against differing hydrological and environmental scenarios. Varying levels of water savings associated with demand management were also applied. Stakeholder input was also crucial. As part of this process, it was established that the Fens and South Lincolnshire Reservoirs were low-regret, strategic regional options and pivotal to WRE's Regional Plan. In response, and in accordance with the Water Resource Planning Guideline, Anglian Water and Cambridge Water have incorporated these solutions as 'must do's' in their draft WRMPs and conducted sensitivity testing to ensure the robustness of the decision. An independent national model also identified the need for and value of the Fens Reservoir.

Design parameters

The water resource modelling carried out has confirmed the following parameters for the development of this solution:

- A useable volume of **50Mm³** is an optimal size for the Fens Reservoir
- The proposed sources of water for the Fens Reservoir are the **River Great Ouse (300Ml/d) and the River Delph (400Ml/d)**
- The deployable output (DO) to use for design is modelled at **87Ml/d**
- The reservoir must be in supply by **2035-2037**

3. Solution design, options and sub-options

3.1. Design Principles

A vision and narrative for the Fens Reservoir project has been developed in line with the ACWG design principles, which are based on the National Infrastructure Commission's 'Design Principles for National Infrastructure': People, Places, Climate and Value **[1]**. The Ambition Statement is shown below, with the overarching design principles for the new reservoirs provided in Annex B.

Ambition Statement

In response to climate change and the need to live more sustainably in the 21st and 22nd centuries, a radical transformation is needed in the way water is managed in the East of England. Fens Reservoir and South Lincolnshire Reservoir will play a central role in this transformation, delivering secure, resilient water resources to meet the needs of people and the environment. Integral to this, the projects will also deliver benefits for biodiversity, recreation, health and wellbeing. Subject to funding and support from partners across the region, significant wider benefits can be delivered, including for the economy, agriculture and industry.

The reservoir projects will be exemplars of good design. They will be developed and delivered in collaboration with local people, stakeholders and regulators at all stages to ensure their concerns are addressed, particularly during the long construction period. The projects will deliver a positive legacy for the communities and places they affect, inspiring local and regional pride.

3.2. Options and sub-options

As detailed in Section 2.3, water resource modelling concluded that the Fens Reservoir solution should include a reservoir with useable storage of 50Mm^3 supported by the River Great Ouse and River Delph. Several configurations of the solution were assessed, including changes in reservoir storage capacity up to 100Mm^3 and different transfer rates, with each sub-option tried as part of a regional optimisation.

WRMP modelling validated the cost curves adopted by the regional model, which demonstrated that it would be less cost-effective to construct two 25Mm^3 reservoirs. This resulted in an optimal choice of a 50Mm^3 reservoir.

The site selection process assessed over 80 polygons against a range of criteria in a four-stage selection process, as detailed in Annex A. Four polygons were analysed during stage four of this process, with a range of criteria considered including costs. This cost comparison is presented in Section 8.

At this stage only one option is presented for the concept plan for the proposed site, which will be optioneered and developed before gate three. Options to be considered and investigated during the next stage include:

- the site layout and on-site benefits which will be influenced by consultation response;
- location and routings of abstraction points;
- transfers and treatment works which will be influenced by site screening criteria;
- on-site investigation works and land referencing;
- drawdown facilities which will be informed by further technical studies.

[1] https://nic.org.uk/app/uploads/NIC-Design-Principles.pdf

3.3. Site selection

A four-stage site selection process was undertaken to identify a best performing site in the Cambridgeshire Fens suitable for a strategic reservoir, as summarised in Figure 1, and detailed in the site selection report provided in Annex A. Stakeholders, legal advisors, planning advisors and land agents influenced and informed this process to ensure it was robust and that the best performing site was identified.

Figure 1: Summary of the four-staged site selection process

Stage 1 - Initial screening

- Outlines the regional need and Regional Search Area for the site selection process
- Applies preliminary geological, environmental and infrastructure constraints to the study area
- Assesses surface water availability and proximity to these water sources
- Identifies broad study area suitable for a strategic reservoir **(Cambridgeshire Study Area)**

Stage 2 - Coarse screening

- Defines site areas within the broad study area **(81 polygons)**
- Assesses geotechnical risks in relation to faults and hydraulic uplift as critical constraints to each site area
- Identifies major utilities infrastructure bisecting the sites
- Evaluates the environmental, social and technical constraints for each site area to identify risks using a Red, Amber, Green (RAG) appraisal
- Identifies a longlist of more preferred site areas **(16 polygons)**

Stage 3 - Fine screening

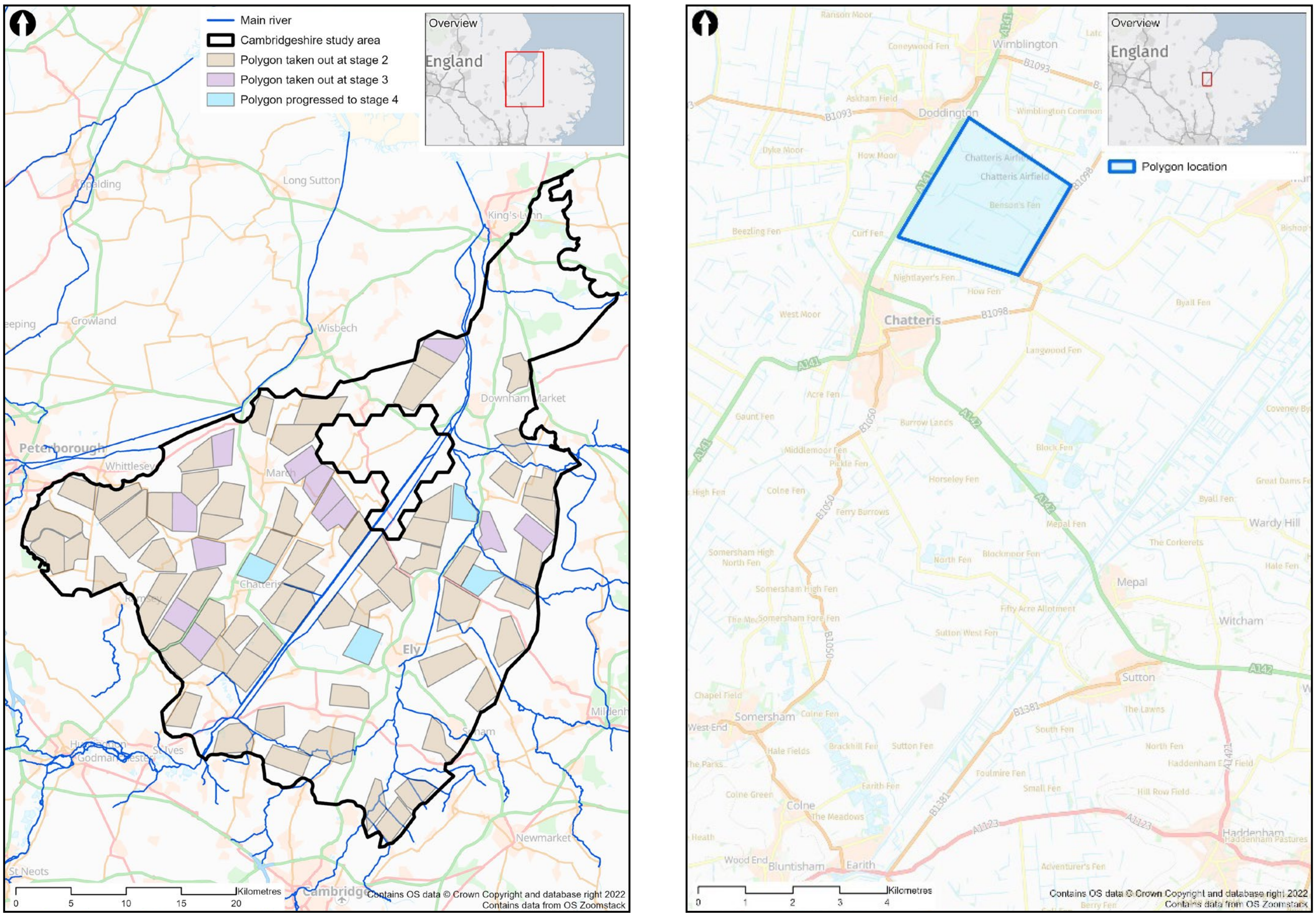
- Assesses earthworks, whole life carbon and cost estimates of the scheme in each site area
- Evaluates the relative constraints and benefits in relation to environmental, planning, social and transport appraisal criteria
- Applies cost threshold (from regional supply demand modelling)
- Considers site alternatives in light of the sequential approach to flood risk
- Identifies shortlist of more preferred site alternatives **(4 polygons)**

Stage 4 - Preferred site selection

- Assesses the remaining site alternatives in greater detail against a range of evaluation criteria
- Identifies the most preferred site area to progress for scheme development **(best performing polygon)**

The Stage 1 process identified the Cambridgeshire study area within which sites were identified and assessed for suitability. Preliminary hydrological assessments confirmed that the River Great Ouse and the River Delph have water available for licensed abstraction during periods of high and medium flows. During site selection, 81 potentially suitable locations (referred to as "polygons") were delineated. These polygons were assessed against a broad range of community, environmental, economic, and other technical criteria covering constraints and opportunities. The reservoir polygons and the best performing polygon location are presented in Figure 2.

Figure 2: Reservoir polygons delineated in the Cambridgeshire study area and the proposed site location



3.4. The proposed site

The proposed site for the Fens Reservoir is located within the Fenland district of Cambridgeshire. The proposed site is between Chatteris and March, near to Doddington, Wimblington and Manea. The Forty Foot Drain, the Sixteen Foot Drain and the A141 surround the site on three sides.

It is situated within an area comprised of arable fields of varying sizes, interspersed with drainage ditches. Except for occasional shelterbelts, there is minimal tree cover within the polygon. Land use includes a mix of residential properties, businesses and agricultural holdings. The analysis conducted during Stage 4 of the site selection process concluded that this was the best performing polygon, as detailed in Annex A, the Site Selection Report.

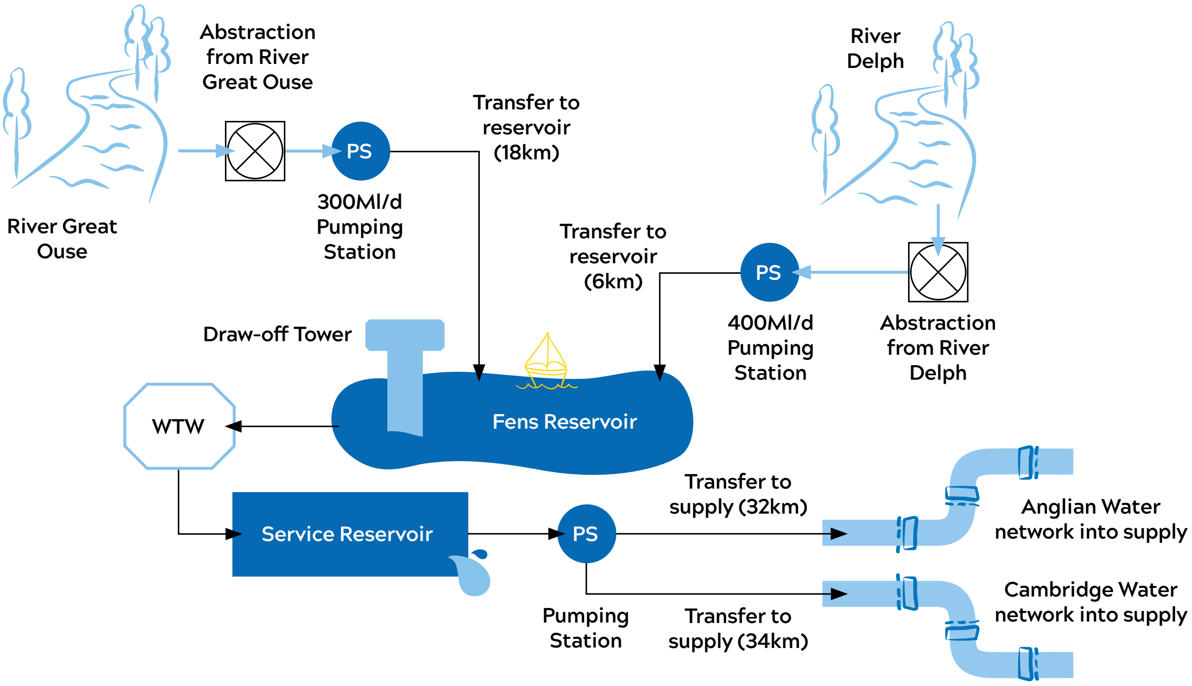
Once the best performing polygon was selected, an initial set of site-specific design principles were developed and reviewed by a Design Review Panel **[2]**, including members from the Design Council **[3]**. The principles cover all aspects of the project design including response to context, landscape design, buildings design, access and connectivity, operational infrastructure, ecology/environmental, and recreation. They will evolve as the design process progresses, taking account of further studies and feedback received during public consultation.

[2] The Design Review Panel is an independent panel of design experts which has been set up to provide design advice to the Fens and South Lincolnshire reservoir projects. Through formal design review sessions, their role is to provide independent advice to support the water companies, their partners and the design team in achieving the best possible design outcomes
[3] The Design Council is an independent Royal Charter charity and the UK's national strategic advisor for design. It was commissioned by Anglian Water and Cambridge Water to establish and administer a Design Review Panel for the two reservoir projects.

3.5. Solution description

The Fens Reservoir includes the development of a new embanked raw water reservoir for water storage for public water supply. It also comprises abstractions from the River Great Ouse and River Delph, raw water transfers, treatment works, and distribution into supply. This is illustrated in Figure 3.

Figure 3: Schematic of the scheme



The following detail explains the indicative plan based on current proposals for the different elements of the project. This detail and design will continue to evolve as the project progresses.

Abstractions and transfers

It is proposed that water will be abstracted from the River Great Ouse at an intake located south of Earith and transferred to the reservoir via approximately 18km of 1500mm diameter steel pipeline. An additional abstraction point is also proposed from the River Delph, with water transferred to the reservoir via about 6km of 1600mm diameter steel pipeline. The proposed abstraction rate from the River Great Ouse is up to 300Ml/d and from the River Delph up to 400Ml/d when flows allow. This is subject to further assessment undertaken in collaboration with the Environment Agency (EA) to develop an abstraction rate which is licensable. The associated abstraction licences are expected to stipulate a minimum flow and water level requirement at the point of abstraction below which it would not be possible to abstract. Abstraction to fill the reservoir will only be possible during high flow periods. The opportunity for these transfers to be open channel is still being investigated and will be confirmed during the next stage of project development.

Further work is planned for the next stage to confirm precise locations for the abstraction points and routes for the transfers involving landowner engagement, environmental surveys, and preliminary ground investigations.

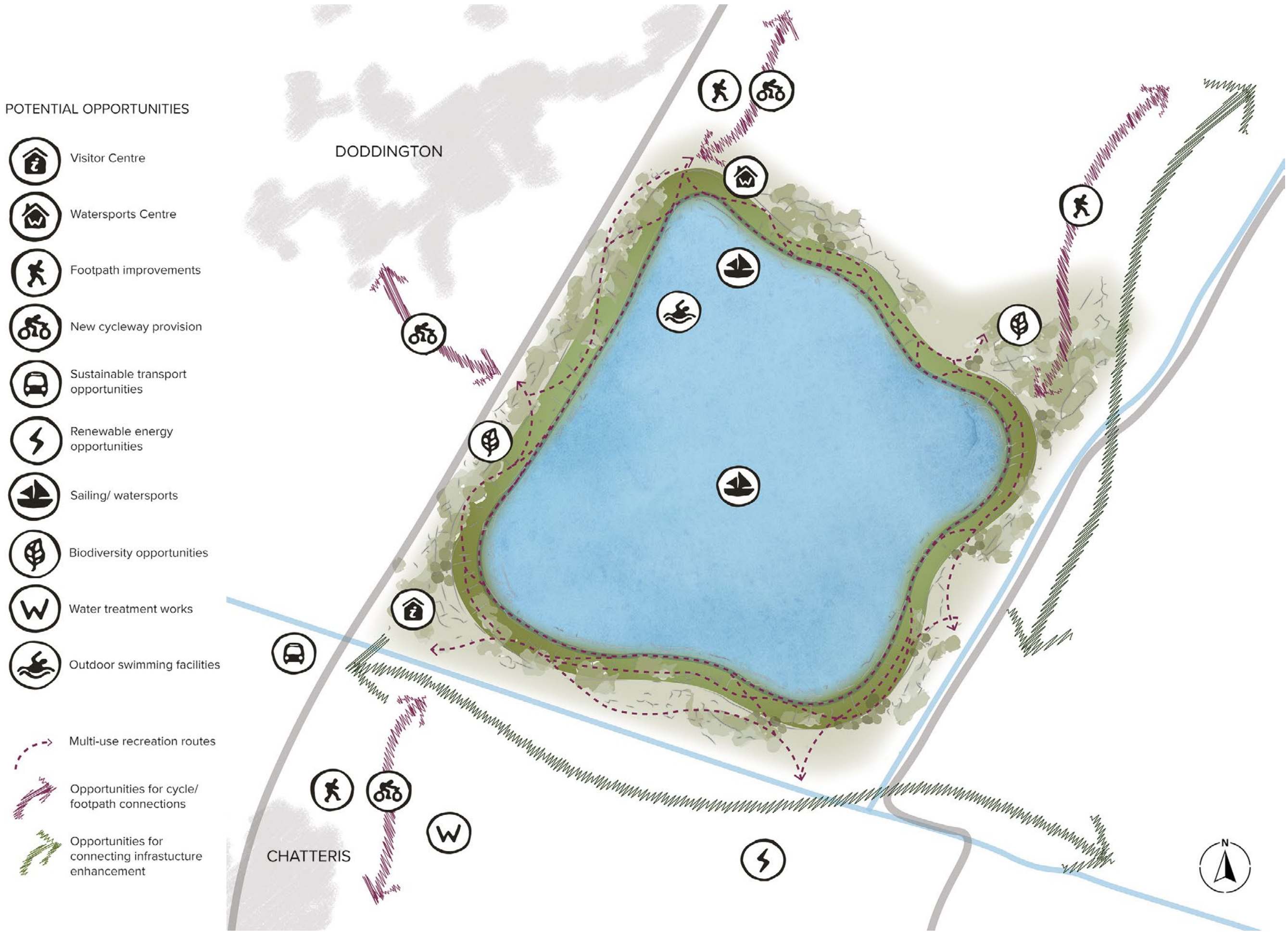
Reservoir

The reservoir will include key infrastructure necessary for its safe operation, including intake and outtake structures; drawdown facilities; a spillway and water sampling facilities. These key elements are listed in Table 2. As highlighted in the ambition statement, the reservoir will also be expected to provide benefits beyond public water supply. Opportunities to incorporate facilities to enable recreation (such as a visitor centre and parking), infrastructure to improve health and wellbeing (such as multi-use footpaths, quiet areas and leisure opportunities) and careful design to enhance and encourage biodiversity are planned and will be further investigated, with the features that will deliver these wider benefits being subject to further assessment and consultation. Landscaping will be carefully designed surrounding the reservoir to minimise the visual impact of the reservoir whilst ensuring it sits within the existing landscape and delivers wider recreational and biodiversity benefits.

An indicative concept plan, shown in Figure 4, has been developed to inform public consultation and provide preliminary information to support this gate two report, the Anglian Water and Cambridge Water draft WRMPs, and the WRE Regional Plan. It is very early in the design process and, as such, the plan is illustrative to highlight that nothing is fixed at this stage. In line with the overarching design principles, understanding community and local needs will underpin ongoing design development. Responses received during the ten-week public consultation which concludes in December 2022 will inform and influence the next stage in which the initial design will be developed.

Figure 4: Illustrative concept plan for the Fens Reservoir

The concept plan shown is indicative at this stage and will develop following more detailed design and in response to consultation



As a minimum, the following key elements of the reservoir design are planned to ensure a safe, operable solution.

Table 2: Key elements of the reservoir

Scheme Element	Description
Borrow pit	The area where the soil will be excavated to build the embankments. Incorporated within the reservoir storage.
Embankment	The earth structure that will impound the water using an internal structural bund overlain by a landscaping bund on the external face.
Inlet headworks	A cascade or submerged pipes with submerged headwall that will control the flow of water into the reservoir.
Reservoir outlet	The main outlet for water leaving the reservoir. A pipe envisaged under the embankment, with an associated maintenance tunnel for access to the pipe and outlet tower, connecting the reservoir to the water treatment works.
Inlet water sampling/control valve compound	A compound housing the water sampling and control valves at the inlet to the reservoir to facilitate monitoring and control of the water being received from the raw water supplies.
Emergency drawdown system	The system for rapid evacuation of water in the event of an emergency requirement. Currently envisaged to be siphons with pipes that run over the embankment and a low-level outlet.
Emergency drawdown control and valve house	A structure set into the embankment that houses the controls to the emergency drawdown valves.
Emergency drawdown pond	A pond used to hold and return water from testing of the emergency drawdown system. This will also allow slow release of water to the watercourse, if required, at a reduced flow rate to not overwhelm the local system.

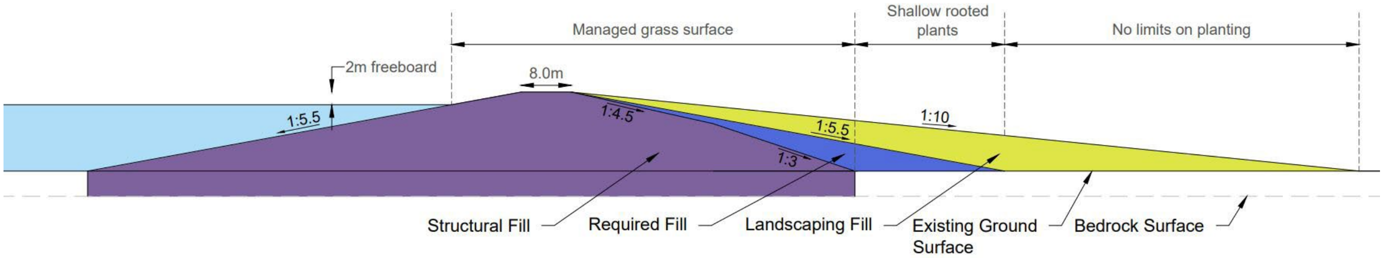
Scheme Element	Description
Emergency drawdown energy dissipation and weir	A structure at the outlet of the emergency drawdown siphons and used to dissipate the energy and regulate the outflow to control erosion.
Emergency drawdown embankment/ ditch widening	An improved section of channel to restore navigation and provide the capacity in the local drain system to convey emergency drawdown flows to suitable receptors. This channel will be shaped to minimise the works required to make it navigable in the future.
Spillway	A grassed spillway to control overtopping and connect the reservoir to the local drain network without other systems needing to be functioning or used.

The reservoir will be constructed by excavating impermeable bedrock from a 'borrow pit' within the reservoir footprint to form the core water retaining bund and using the clay-rich overlying deposits for the remainder of the embankment material. Any less structurally favourable material excavated during construction will be used on the external facing slope of the embankment to reduce the gradient and help blend the structure into the surrounding landscape in line with the site-specific design principles.

The preliminary dimensions of the reservoir design are approximately 2.4km wide and 2.6km long to the embankment toe. The embankment crest is estimated at 12.5mAOD making the embankment an average of 12m above the existing ground level, a maximum of 15m and a minimum of 4m above existing ground levels **[4]**. The crest is proposed to be 8m wide to allow for a multi-user path along the entire reservoir crest. The total perimeter length of the crest is approximately 8.5km and the reservoir surface area is about 4.4km^2. The proposed capacity of the reservoir is 55Mm^3, providing 50Mm^3 of usable volume.

A typical section of the reservoir embankment has been used for the initial reservoir model build, as shown in Figure 5. At this stage it is assumed that the external face of the embankment will be an average slope of 1 vertical in 10 horizontal, utilising less structurally favourable material. As per the site-specific design principles the slope will vary around the embankment to reflect the local topography and reduce the visual impact on the surrounding area. Planting zones on the landscaping bunds have been loosely identified to specify where planting is possible without presenting potential damage to the structural integrity of the embankment.

Figure 5: Typical embankment cross section



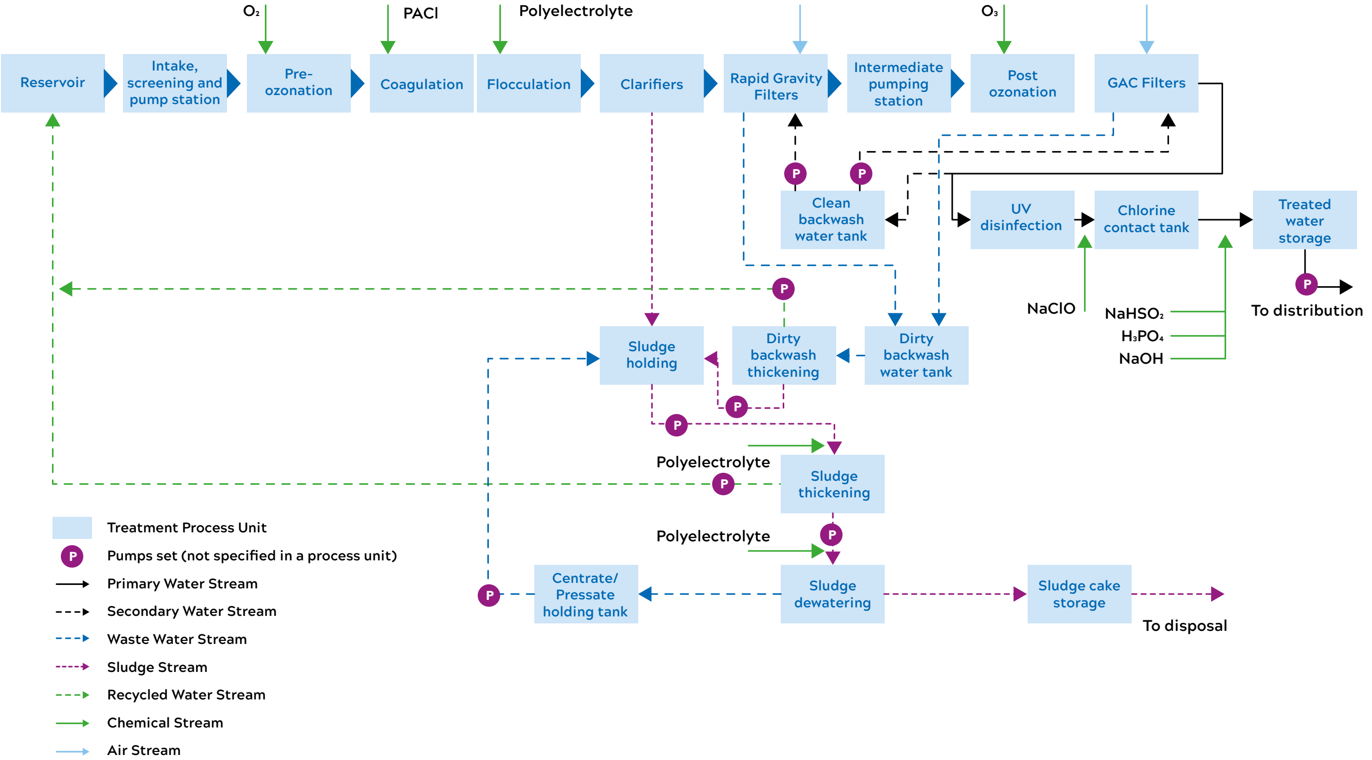
Potable water treatment

Stored water will subsequently be abstracted from the reservoir and treated to a potable quality. It is proposed that a water treatment works (WTW) will be located on land adjacent to the reservoir with a peak throughput capacity of 100Ml/d.

The proposed treatment process is presented in Figure 6. Raw water will be screened using travelling screens for removal of suspended particulates from water, including leaves, debris, and other sizable clogging material. Screened water will then be pumped into the ozonation unit. Pre-ozonation reduces the risk of infection of giardia in drinking water and supports the coagulation of all heavy metals and particulate pollutants, making it easy to filter them out. The ozone generation plant consists of liquid oxygen storage, ozone generator, closed loop water cooling system, off-gas treatment, and ozone detectors. Pre-ozonated raw water will be passed to coagulation and flocculation units by gravity.

[4] The maximum embankment height provided is based on the concept plan shown. If the footprint changes within the proposed site polygon during design development, the embankment height may need to increase to a maximum 20m.

Figure 6: The indicative treatment process for Fens Reservoir



Two trains of coagulation and flocculation are proposed. Poly aluminium chloride (PACl) is proposed as the coagulant as it is effective over a wide range of pH and produces less sludge. Polyelectrolyte solution will be dosed for flocculation. The flocculated water will flow into lamella clarifiers where the suspended solids will settle to form sludge, allowing clear water to overflow to the rapid gravity filters. The rapid gravity filter bed consists of anthracite over the sand media support which will remove suspended solids using filter media. The filtered water will be fed to the post-ozonation unit using an intermediate pumping station equipped with all necessary pumps and equipment.

Post ozonation of drinking water helps to disinfect the water by killing virtually all disease-causing bacteria and viruses. Post-ozonation occurs by passing ozonated water through granular activated carbon (GAC) media filters which removes taste- and odour-causing compounds, pesticides, and other organic contaminants. The water will then be disinfected by ultraviolet (UV) which inactivates cryptosporidium and giardia without any measurable levels of disinfection by-products. Water will then be disinfected by sodium hypochlorite to meet the desired drinking water quality. Sodium hypochlorite will be injected into the chlorine contact tank to provide adequate reaction time, after which sodium bisulphite will be dosed for de-chlorination of the drinking water and phosphoric acid will be dosed to reduce the release of lead in the drinking water.

Potable water transfer

The indicative potable water transfer routes are presented in Figure 7. The treated water will be transferred via an approximately 32km 900mm diameter steel pipeline to an existing Anglian Water service reservoir. The Cambridge Water connection will include about 12km 900mm steel pipeline to one take-off point, and then an approximately 22km 700mm steel pipeline spur to a second take-off point. The reservoir will supply over 250,000 homes in Cambridgeshire.

Further work is planned for the next stage to confirm the routes for the transfers involving landowner engagement, environmental surveys, and preliminary ground investigations. The information provided in this report and accompanying annexes are assumptions based on indicative locations only at this stage.

Figure 7: The indicative transfer routes for Fens Reservoir

The concept plan shown is indicative at this stage and will develop following more detailed design and in response to consultation

Associated infrastructure and features

It is proposed that there will be associated infrastructure and other features such as environmental mitigation to minimise the impacts of the reservoir, as well as enhancement opportunities, as detailed in Table 3.

Table 3: Additional infrastructure and features

Scheme Element	Description
New access roads and infrastructure	The proposed new roads for vehicular/cycle access to the car parks and WTW, will enable access for local villages in addition to separate access for visitors from further afield. This includes bridges, footpaths, and car parks.
Utilities diversion	The new routes for utility diversions are included.
Power Supplies	Connection to the national power grid is included, with options being explored to maximise renewable energy generation, and service the reservoir power demand.
Biodiversity Net Gain (BNG) zones	Areas of land for the purpose of achieving BNG and environmental enhancement (particularly wetland water edge loss) are included.
Landscaping bunds	An area of varying ground profile combined with woodland planting to mitigate visual intrusion during and after construction has been allowed for, as well as providing enhanced woodland corridors.

Opportunities will be explored further to incorporate renewable energy generation as part of a wider energy strategy to support a net-zero operational carbon target, to reduce cost and to ensure resilience. The provisional design incorporates a solar installation (land based and floating) to provide a combined 24MW energy generation capacity to power the associated water treatment and pumping facilities. At certain times this would provide enough energy to meet the full needs of the project. Energy storage and other forms of renewable energy, including wind, will also be considered.

As the design develops further, opportunities for alternative transport routes during construction will assess the option to include water-borne transport options via the Sixteen Foot Drain and Forty Foot Drain. Synergies are being explored to enable the Forty Foot Drain to be used as part of the emergency drawdown system.

Operation and maintenance

Development and operation of the reservoir will be subject to the Reservoirs Act 1975 (as amended by the Floods and Water Management Act 2010). The embankments and associated water retaining elements of the reservoir will need to be maintained and supervised in accordance with the Act to maintain public safety. This will require the appointment of relevant Panel Engineers for regular ongoing supervision, statutory inspections and any intervention works. Regular maintenance activities are to include vegetation management, maintenance of emergency overflow facilities, regular operation of water conveyance equipment and the testing and exercising of the emergency drawdown facilities.

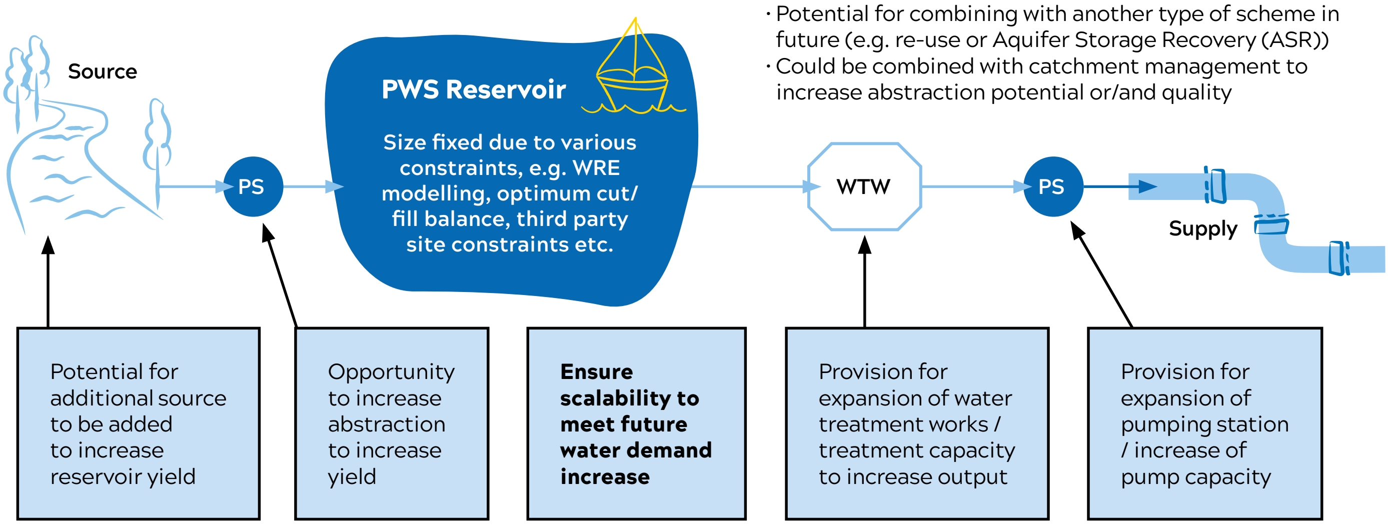
As detailed in section 4.4, an emergency drawdown must be designed in accordance with the Reservoirs Act. The preferred solution at this stage is to discharge to the Forty Foot Drain, but this is to be further modelled and confirmed as part of the next stage of development. Although the risk of needing to fully drawdown the reservoir is very low, there is a need for regular testing and maintenance to confirm functionality. This will involve the opening and testing of relevant valves and gates. Test flows are envisaged to be held in a pond to avoid disruption and to enable water to be returned to the reservoir.

The water treatment works and the distribution water supply system are expected to be in constant regular use according to water supply demand and will require regular operation and maintenance. The water supply components will need regular inspection and maintenance activities in accordance with the requirements of the respectively installed equipment.

3.6. Scalability

The reservoir has been sized optimally based on modelled water availability and predicted water demand. As such the reservoir size will need to be fixed and is not scalable. There are, however, other opportunities to enable scalability in the future by considering the elements of the scheme associated with the throughput of water. It is possible that additional points of abstraction could be considered that would support an increase in deployable output from the reservoir. In WRMP19, the option considered an abstraction from the River Ely Ouse at Denver. This would require a trading arrangement to make use of spare capacity within an existing abstraction licence. The option would include associated pumping and transfer infrastructure from the River Ely Ouse, additional treatment and transfer capacity. In addition, an option to extract water from the Middle Level in winter is being explored. Further opportunities for potential scalability are summarised in Figure 8.

Figure 8: Opportunities for scalability



3.7. Links to other water resource solutions

The Fens Reservoir is independent of other strategic resource options.

The proposed South Lincolnshire Reservoir is a 50Mm^3 reservoir being promoted by Anglian Water. It is currently of a similar design to the Fens Reservoir, with the exception that it relies on different water sources for abstraction to fill the reservoir and supplies a different area of the Anglian Region. The WRMP modelling has confirmed that both reservoirs are required and are independent of each other. Therefore, these solutions are not linked.

The South Lincolnshire Reservoir is currently linked to the A2AT SRO in that up to 100Ml/d of SLR water was originally assumed to be transferred to the Affinity Region. However, Affinity Water is pursuing other options to meet their supply needs and it is proposed that the A2AT ceases at gate two.

4. Water resource assessment

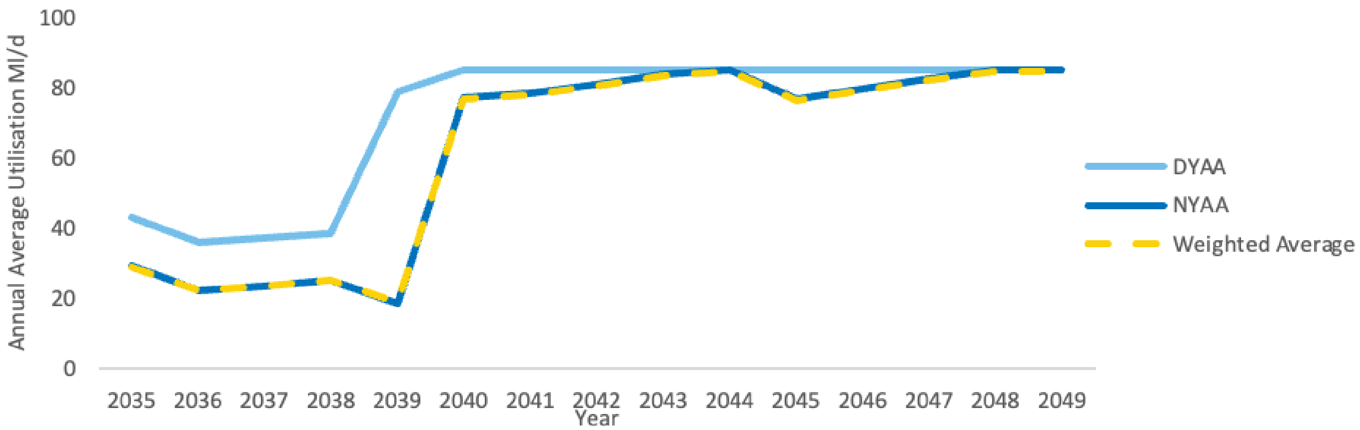
4.1. Utilisation

Initial anticipated utilisation rates for the Fens Reservoir have been developed using Economics of Balancing Supply and Demand (EBSD) modelling. Three scenarios were selected to provide an estimate of utilisation, as follows:

- **Normal Year Annual Average (NYAA):** This scenario was selected to represent the utilisation of the reservoir in average 'business as usual' conditions. Demand was based on the WRMP forecast without a dry year uplift. The supply forecast was the same as the DYAA scenario but adjusted to remove the DO reduction associated with 1:500 drought resilience.
- **Dry Year Annual Average (DYAA):** This scenario is the scenario which the WRMP must meet without residual supply demand deficits. It includes the WRMP24 demand forecast, with dry year uplift. The supply forecast includes reduced DO to account for 1:500 drought resilience and includes climate change and sustainability reductions.
- **Dry Year Critical Period (DYCP):** This scenario represents utilisation of the reservoir during a regional 3-day period of peak demand. Within water resources planning, water resources can output their DO based on daily abstraction licences rather than annual in this scenario. This means more water is available within the system than annual average scenarios, so option utilisation can be lower.

Utilisation under each of these scenarios over time is shown in Figure 9. A weighted average is shown, based on the NYAA scenario occurring 99% of the time, DYAA occurring 0.2% of the time, and DYCP occurring 0.8% of the time.

Figure 9: Average annual utilisation profiles by scenario, from completion (modelled as 2035) to 2050



Average utilisation increases over time, from 29Ml/d in 2035 to 84Ml/d by 2050 due to population growth and climate change factors. Maximum utilisation occurs in both the DYAA and NYAA scenarios at the modelled maximum DO output of 87Ml/d.

This utilisation modelling has been derived from WRMP24 EBSD methodology and represents an initial indicative overview of potential utilisation. Future assessment of potential utilisation is subject to key uncertainties associated with growth, climate change, environmental destination, and other factors.

Third party options to increase utilisation by sharing water for agriculture have been preliminarily explored, as set out in Appendix D. More work will be undertaken in the next gate to establish chances of this conjunctive operation. This would require defining control curves in the reservoir to preserve the public water supply use.

The utilisation assessment will be further refined in gate three to include updated scenarios, as well as the use of more detailed system modelling and simulation techniques such as the WRE Pywr model.

4.2. Water resource benefit

Water resources modelling was undertaken to estimate the conjunctive use water resources benefit of the scheme as Deployable Output (DO) while connected to the existing Ruthamford region of Anglian Water and the Cambridge Water supply area. The Anglian Water region comprises other raw water storage reservoirs: Rutland, Grafham, Pitsford, Ravensthorpe and Hollowell, supported by river intakes and complemented by groundwater sources. The Cambridge Water system does not have any raw water storage and therefore there is no conjunctive benefit to explore at this time. For this reason, the Cambridge Water supply from the proposed reservoir was modelled as a fixed output. The DO of the scheme was estimated as the increase in the DO of the system compared with existing conditions and by using the WRE regional plan's agreed Level of Service.

AQUATOR XV, a water resource simulation software used by many water companies to determine DO, was used for this investigation. An indicative reservoir control curve was included within the model set up to enable a more realistic operation. This allows the model to assign a resource state to the reservoir, which aids prioritisation of sources during the simulation i.e. if the reservoir storage is low, it may look to minimise reservoir output and increase output from elsewhere (e.g. groundwater).

This assessment utilised stochastic flows (a synthetic river flows series) that represent the 1 in 500 year water resource system drought event in the Ruthamford region, including the impact of climate change in the 2050s for a medium range projection of the high emission scenario of the latest Met Office UK Climate Projections. The stochastic trace was selected from a pool of 400 48-year sequences by identifying the one that best matched reservoir drawdown for a 1 in 500 year drought event, as estimated using the 128-year historical sequence.

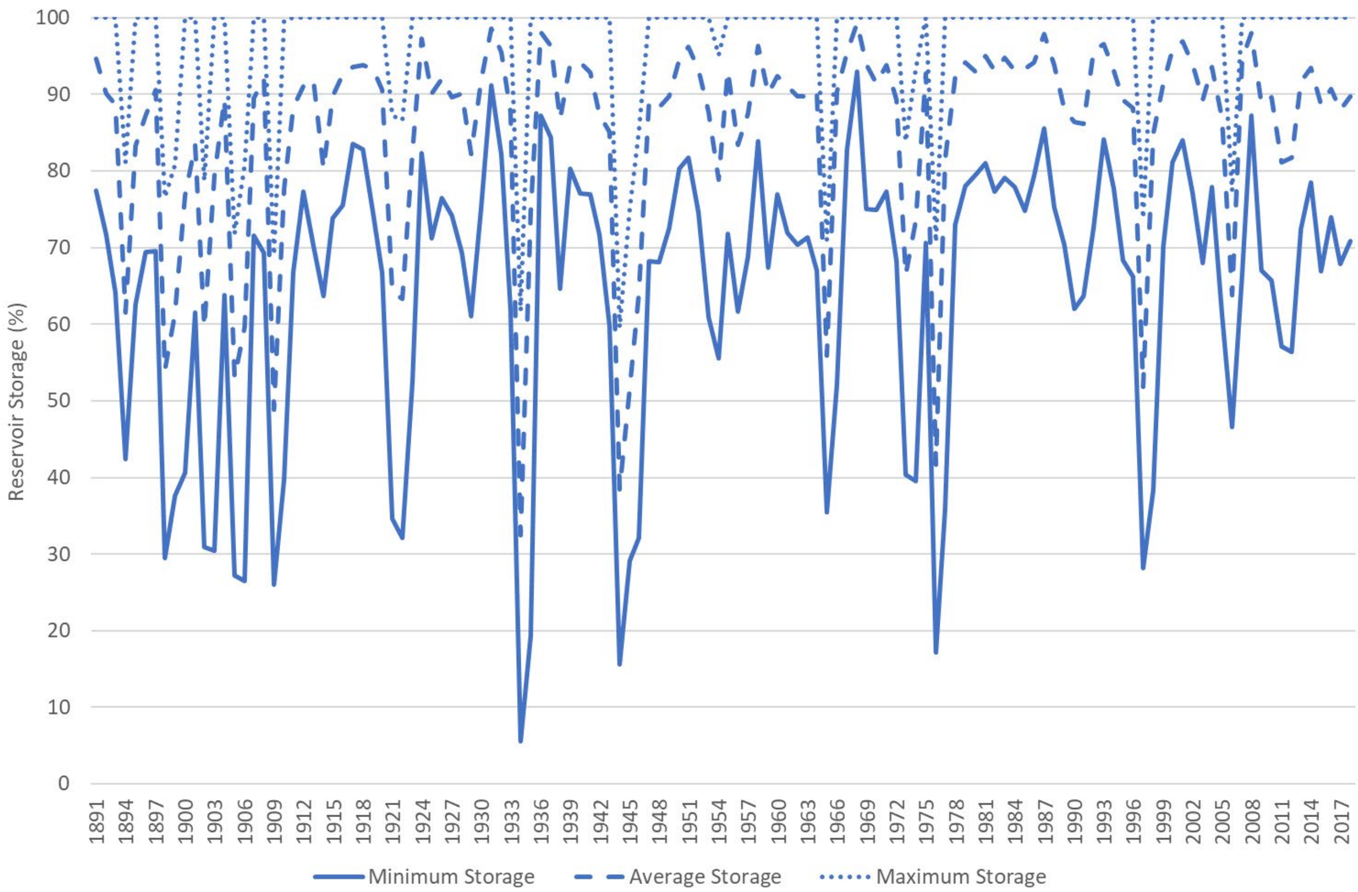
Flows were derived from WRE climate datasets using updated rainfall-runoff models for the region. WRE climate datasets were obtained using a weather generator conditioned by climate drivers that represent key aspects of the climate system. Stochastic rainfall and potential evapotranspiration series were then perturbed to represent future conditions in the 2050s.

Assumptions on abstraction limits and rules, such as hands-off-flow (HoF) conditions, were used based on discussions and information provided by the Environment Agency which are the most updated available at the time of writing. More work will be needed in gate three to confirm these in close collaboration with the Environment Agency and pending more detailed hydro-ecology investigations.

Results from modelling indicate that the conjunctive use DO of the scheme for a 1 in 500 year drought with climate change is 87Ml/d. This is less than the 99Ml/d quoted in gate one, due to changes to the HoF conditions and a better quantification of the impact of the 1 in 500 year drought.

To understand the potential variability of the Fens Reservoir stored volume during operation, a demand of 87Ml/d was placed on the reservoir for the adopted climate change scenario. The resulting simulations, presented in Figure 10, show a range in storage levels depending on the rainfall in any given historical year, and show that <40% could occur in 1 in 10 years. This data is based on maximum demand, and measures could be taken elsewhere in the network to minimise the fluctuation of volumes (and associated levels) within the reservoir to keep it above approximately 70% storage.

Figure 10: Fens Reservoir storage during a historical + mid-climate change simulation



4.3. Long term opportunities and scalability

Opportunity exists for the reservoir and transfers to be part of a much bigger system, enabling wider, multi-sector, benefits across the region. To understand the potential benefits, an initial system concept for the reservoir and the region has been developed with stakeholders and is shown in Figure 11. It illustrates possible interventions which have the potential to deliver social, environmental, and economic value beyond what can be achieved by the reservoir in isolation. The initial system concept is deliberately aspirational, containing interventions that will require further evaluation and external funding if they are to proceed.

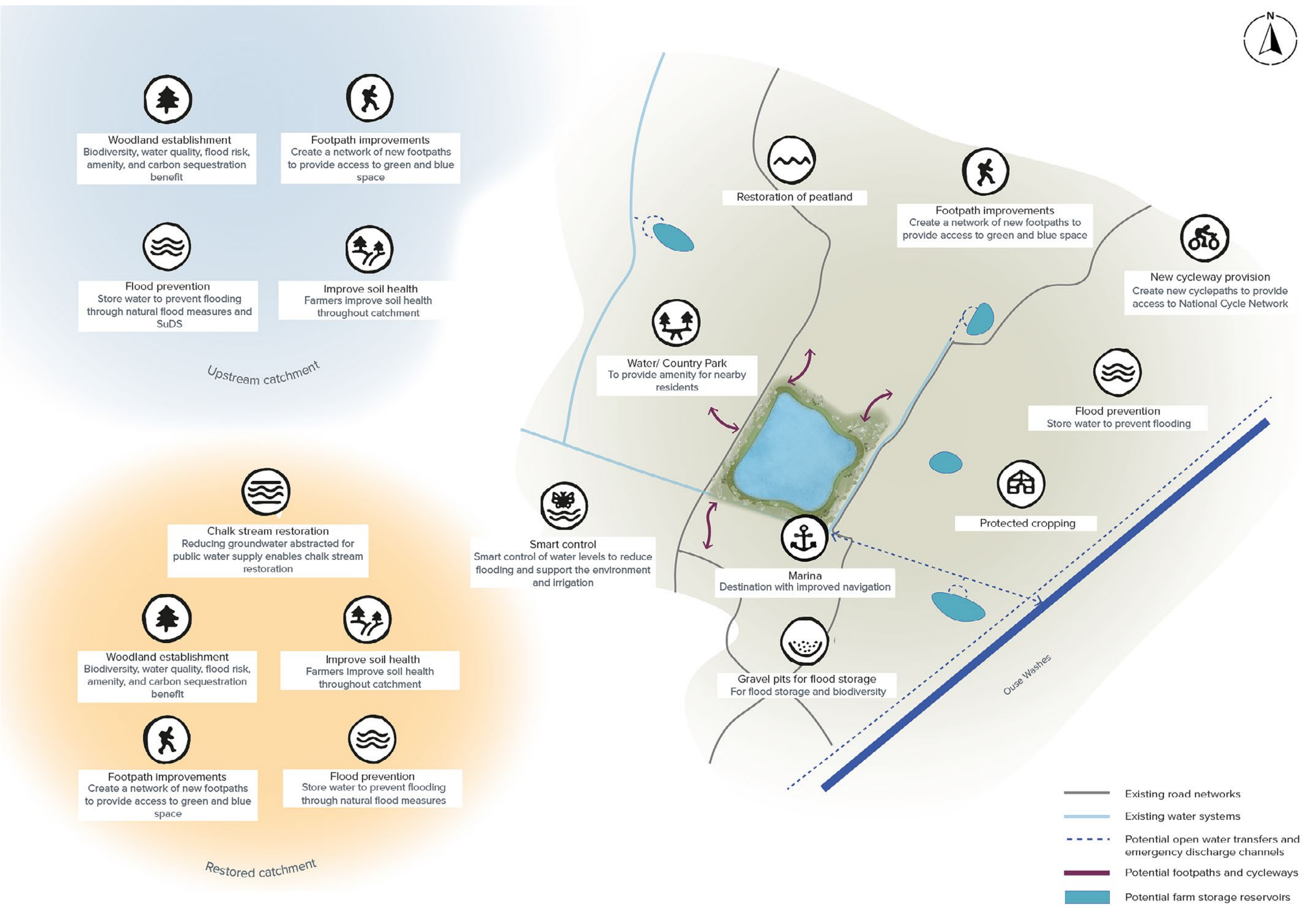
To enable the development of this system concept, a systems framework was created and used to map and understand the relationship between interventions and benefits. The benefits were quantified, and economic values assigned to enable meaningful conversations with stakeholders on value, financing, and risk. This framework provides a platform for the concept to continue to evolve through ongoing dialogue and design.

This initial analysis has shown that some of the most cost-beneficial interventions relate to carbon sequestration. Woodland creation, restoration of fens/peatland and floodplain reconnection are all estimated to deliver a ten-fold return on investment through the creation of carbon offsets alone. Flood plain reconnection is assumed to sequester carbon through a combination of natural afforestation, peatland restoration and some wetland conversion. The business case for these types of habitat restoration becomes even stronger when the carbon benefits are stacked alongside the associated biodiversity, flood risk reduction, cultural and recreational benefits.

Conjunctive use, or sharing of the reservoir's water resource, with the agricultural sector was identified as providing a valuable benefit with a relatively low capital cost. There is also a very strong business case for improving soil health by adopting "regenerative agricultural" measures. This could deliver significant benefits in terms of avoided carbon as well as improved crop margins, improved water quality, improved water retention, and reduced flood risk. Further information on the conjunctive use, agricultural, and other, benefits is available in Annex D.

In terms of benefit to reservoir yield, there is a recognition that the improvement in water quality and natural storage solutions across the catchment (such as derived from the creation of washlands and wetlands) may offer future support to the reservoir yield, subject to the business case for transfer and treatment of such water to improve reservoir resilience and yield. This will be further explored within the ongoing systems work.

Figure 11: Initial system concept



Open water channels are a key enabler of the wider benefits described above. For example, improving the Forty Foot Drain between the reservoir and the Ouse Washes may offer potential to transfer water into the reservoir, as well as out of the reservoir. Stakeholders are particularly interested in the use and development of open channels because they already provide significant benefits for navigation, mitigation of flooding and the environment. Improving the Forty Foot Drain may also deliver navigation benefits and provide the opportunity for synergies with local flood management and biodiversity proposals. Cost efficiencies could be achieved by designing interventions which both meet the transfer needs of the reservoir and increase these wider benefits. Studies have highlighted the risks that will need to be addressed and so further work is underway to confirm which, if any, open water channel opportunities will be pursued during the design of the reservoir.

Many of the interventions which deliver wider benefits are outside the scope of this project and will not be funded by water company customers. A summary of the work, presented in Annex D, provides further detail on how such interventions could be funded. The ability of the reservoir to enable such benefits will be fully considered, with stakeholders and partners, as the project develops.

4.4. Infrastructure resilience to the risk of flooding and coastal erosion

Flood risk has been a key consideration throughout the site selection process. As part of fine screening at Stage 3 of the site selection process, a Strategic Sequential Test study for flood risk was carried out. This is a risk-based approach to development and flood risk and is set out in the National Planning Policy Framework. The aim of the policy is to keep at-risk development out of medium and high flood risk areas (Flood Zones 2 and 3) and other areas at risk from other sources of flooding, wherever possible. None of the Stage 3 polygons passed the Strategic Sequential Test as they are all within Flood Zone 3. Using the Strategic Sequential Test Study approach, it was agreed with the Environment Agency that flood risk from all sources was then to be taken into account to differentiate between the five polygons based on the findings throughout the site selection process. It was agreed that this would not automatically require that the polygon with least flood risk should be preferred; rather that the relative residual flood risk associated with these polygons within Flood Zone 3, would be considered alongside other criteria, in the selection of the best performing site. One site was found to be significantly impacted by flood defences overtopping when climate change was taken into consideration. As this was shown to be a clear differentiator between the polygons, it did not progress to the next stage of assessment. Four selected polygons were considered to have a manageable level of residual flood risk, i.e., that they should be taken forward to Stage 4, preferred site selection, where the residual flood risk would be considered alongside the other impacts and benefits.

During Stage 4, the preferred site screening stage, each site was assessed for historic, fluvial, tidal, surface water, residual, and existing reservoir flood risk as well as initial breach analysis and drawdown feasibility. In line with EA requirements for flood risk assessment, this study included a climate change allowance based on sea level rise guidance (EA, 2022) to the year 2115. A stakeholder workshop was also held to identify potential opportunities for both the site and concept to provide flood risk benefits for the area. This information was used alongside other criteria (e.g. biodiversity, landscape, traffic and transport, carbon etc) to select the best performing polygon for the reservoir.

A Preliminary Flood Risk Assessment was undertaken for the best performing polygon. It demonstrates that the proposed site is at low risk from fluvial, tidal, coastal and groundwater flooding. However, the proposed site is at risk from surface water flooding. It is anticipated that a SuDS (Sustainable Drainage Systems) will be implemented at the site to ensure drainage from impermeable surfaces is appropriately managed, as well as to manage surface water flood risk to the proposed development. Surface water flood risk will be assessed, and the SuDS drainage scheme will ensure surface water flooding is not increased elsewhere.

The proposed site is also at residual flood risk from a breach in the fluvial flood defences and a breach in the Ouse Washes flood storage reservoir (FSR). Emergency planning should be updated to reflect this change in risk. If required further mitigation measures will be considered to manage this risk, however this residual risk is very low. The reason is that

- the Ouse Washes system is regulated under the Reservoirs Act 1975, as amended by the Flood and Water Management Act 2010, and this is enforced by the Environment Agency in England. In line with this Act, high-risk reservoirs are inspected at a specified frequency by an independent qualified civil engineer. However, although reservoirs are regularly inspected, there is still a residual risk in case they fail;
- the existing fluvial flood defences are regulated under the Flood and Water Management Act 2010. This is enforced by the Environment Agency in England and delivered by Risk Assessment Management Authorities (RMAs).

Risk of reservoir breach and drawdown

The risk of dam failure at a non-impounding reservoir is considered very low because the risk is managed by adopting latest industry guidance and standards on reservoir design as well as following the legislation set out in the Reservoirs Act 1975, which also includes requirements for emergency planning. As part of this it is necessary to carry out a dam breach analysis and design for an emergency event to protect vulnerable receptors. In consultation with an All Reservoir Panel Engineer and a Supervising Engineer appointed under the Reservoirs Act 1975, initial modelling has been conducted to understand how to manage the risks during the next stage of project development.

The ability to lower a reservoir's water level quickly in an emergency ('drawdown') is a key factor in ensuring reservoir safety and is a requirement under the Reservoirs Act 1975. It is also important to control the rate of emergency drawdown flows and understand the impact of drawdown on flood risk elsewhere. Initial modelling has confirmed that discharge to the existing river network would be a viable option. Further work is needed to detail this option as part of the next stage of design, yet the results from the preliminary flood risk assessment indicate that the peak modelled water level within the Old Bedford River/River Delph would increase due to the drawdown flows. However, there would be no overtopping of the channel and all flood water could be contained within the Ouse Washes FSR, even during a high tide scenario. Additional infrastructure would be required to convey drawdown flows into the Ouse Washes FSR. Since the Ouse Washes FSR is a statutory large raised reservoir under the Reservoirs Act 1975 modifications to the Ouse Washes FSR will require oversight by an independent All Reservoir Panel Engineer.

Flood risk benefits

Due to the storage of rainwater within the reservoir, the Internal Drainage Board (IDB) catchment flow to Bensons Pumping Station is captured, implying that this IDB pumping station would be no longer required. The proposed development would therefore lead to a reduction in peak modelled water levels within the Sixty Foot Drain and Forty Foot Drain due to the removal of this inflow of water. This has the potential to reduce flood risk.

Further opportunities were also identified during the stakeholder workshop where benefits mapping was undertaken to identify where there are potential opportunities to provide flood risk benefits, such as using drawdown and SuDS ponds for temporary storage which could lead to habitat creation. The reservoir could potentially unlock flood risk opportunities in the area, such as enhancement of flood defences, improved navigability in the Forty Foot Drain and reduction of local flood risk. These align with the ambition that the reservoir has the potential to be part of a bigger system: an exemplar integrated water management system, as detailed in Section 4.3. These opportunities, along with other system benefits, will be investigated in more detail during the next stage of development and separate funding opportunities identified as laid out in Annex D.

5. Drinking water quality considerations

The Water Quality Risk Assessment (WQRA) process is a semi-quantitative water quality risk assessment developed by the ACWG. It determines the impact that a new Strategic Resource Option (SRO) may have on drinking water quality. For the Fens Reservoir SRO the WQRA has been completed to identify any potential water quality deterioration risks in the target Anglian Water and Cambridge Water supply zones. The risk assessment has been based on the indicative treatment design (as described in section 3.5, and will be used to inform ongoing design as the scheme develops. The WQRA is presented in Annex C.

5.1. Methodology

The WQRA assessed hazards across the catchment, abstraction, raw water transfer, treatment, storage, distribution and consumer stages. The stages are analogous to those used within Drinking Water Safety Plans (DWSPs). The WQRA process can be summarised as follows:

- Identification of a limiting hazard,
- Assigning a pre-mitigated risk score (likelihood and consequence),
- Identifying the recommended mitigations,
- Assigning a post-mitigated risk score (likelihood and consequence), and
- Detailing any residual risk considerations.

The hazards were risk ranked across each WQRA stage using a matrix developed for the ACWG, which comprises consequence and likelihood ratings. For consistency, the gate one consequence ratings for parameters were retained, and for a given parameter are consistent across all stages of the WQRA. The likelihood ratings were determined based on water quality data from the Fens Reservoir water quality monitoring programme, information from existing Water DWSPs, and input from the relevant Anglian Water and Cambridge Water water quality experts and process engineers. This likelihood score was then combined with the fixed consequence rating to produce an overall risk score at each WQRA stage. Two strategic WQRA workshops were held with water quality representatives from Anglian Water, Cambridge Water, Mott MacDonald and Jacobs to review and further develop the risk assessment.

5.2. Drinking water quality considerations

The gate two WQRA used water quality monitoring data from the proposed Fens Reservoir abstraction points and information from water quality experts to further develop the understanding of water quality risk. The gate one WQRA included limiting hazards from the following groups aligning with the ACWG Water Quality Risk Framework Report:

- Pathogens
- Acceptability due to change in chemistry
- Acceptability due to taste and odour
- Pesticides
- Nitrate/nitrite
- Change in metal types and form
- Disinfection by-product formation potential

During gate two, further limiting hazards were identified as having potential risks to drinking water quality through the WQRA process. These are shown in Table 4. A full list of limiting hazards alongside the workshop results are detailed in the gate two drinking water quality annex, Annex C.

Table 4: Additional limiting hazards

Limiting Hazard	Reasoning
Aluminium	Choice of coagulant during the concept design is an aluminium coagulant.
Perfluorooctane sulfonate (PFOS)	Emerging hazard of concern. Present in the Fens Reservoir catchment area.
Perfluorooctanoic acid (PFOA)	Emerging hazard of concern. Present in the Fens Reservoir catchment area.
Per- and poly-fluoroalkyl substances (PFAS)	Emerging hazard of concern. Individual PFAS present in the Fens Reservoir catchment area. Parameter represents total PFAS substances.
Dirty discoloured water	Limiting hazard because parameter is likely to drive acceptability of water supply scheme by consumers and therefore requiring treatment.
Radioactivity (Alpha, Beta, Tritium)	Emerging hazard of concern, considered a limiting hazard because parameter can cause a health risk to consumers, and therefore requires removal.

5.3. Proposed mitigations for limiting hazards

Once identified, the limiting hazards were assessed across all stages of the WQRA, including risk ranking and identification of proposed mitigations. Mitigations were identified based on existing controls for the hazards included in the indicative design. Taking coliform bacteria (a limiting hazard) as an example, the main proposed mitigation for this is UV disinfection followed by the addition of a free chlorine residual at Fens Reservoir WTW, which is included in the current treatment design.

By contrast for nitrate (another limiting hazard), it is currently unclear whether nitrate treatment is required at Fens Reservoir WTW, so nitrate treatment is not currently included in the indicative design and is not listed as a mitigation. The key recommendation and action, therefore, is for modelling and further study to be carried out to determine whether nitrate treatment is required, and if so, it should be included in the process design for the Fens Reservoir WTW.

5.4. Details of proposed mitigation for emerging contaminants

The key emerging contaminants identified were PFOS and PFOA, which belong to the group known as per- and poly-fluoroalkyl substances (PFAS). Initial results indicate PFOS and PFOA risk is low, however, sampling is ongoing and due to the current uncertainty, the risk of PFOS, PFOA and PFAS in the WQRA is shown as a medium (amber) risk up until the treatment stage. Granular activated carbon (GAC) is included in the process design for Fens Reservoir WTW, which will mitigate PFOS, PFOA and PFAS risk. If it is found through the water quality monitoring programme that greater PFOS, PFOA and PFAS mitigation is required, this will be included in the process design at future stages of development.

5.5. Continued stakeholder engagement

As the SRO is further progressed, a greater understanding of the water quality risks will be available, and stakeholder engagement will continue throughout the development process to ensure the WQRA is developed based on expert knowledge and includes the latest updates to designs and to water company policies.

5.6. Consumer perception and engagement

Consumer acceptability of the transferred water is a key risk when transferring water. For Fens Reservoir there is a risk to consumers associated with the change in source type from a predominantly groundwater supply to surface water. This risk is applied to taste, odour and other aesthetic limiting hazards, for which an amber risk rating was maintained in the WQRA through to the consumer stage. It is recognised there will be an ongoing need to manage customer acceptability, through customer engagement at later stages and through the ongoing development of the solution. The risk will be reviewed and updated at future gates based on customer engagement.

Detailed information on engagement with the Consumer Council for Water (CCW) and plans for future stakeholder and customer engagement is provided in the stakeholder and customer engagement section.

5.7. Plan for future work to develop drinking water safety plans

Water quality monitoring, modelling and stakeholder engagement will continue through to gate three. The resulting risk assessment is a live document which will progress through RAPID gates, until it is overtaken by the development of a drinking water safety plan (DWSP) in line with the DWI regulation.

6. Environmental assessment

The environmental appraisal work that supports this report builds upon and extends the work done for gate one, which was based around a conceptual scheme without a defined location. A site selection process has identified and assessed potential suitable locations for the new reservoir based upon a broad range of community, economic, environmental, and other technical criteria (constraints and opportunities). The methodology, criteria and findings have been informed by subject matter experts and local stakeholders. The aim of initial coarse screening and subsequent fine screening was to assess potential land parcels using a defined suite of criteria (see Annex E for more detail). The following criteria formed part of the environmental appraisals:

- Carbon emissions
- Socio-Economic
- Historic Environment
- Landscape
- Nature conservation and biodiversity

The short list of selected sites remaining at the end of the coarse and fine screening stages (Stages 2 and 3) went through a further, more detailed environmental appraisal as part of the Stage 4 process to select the best performing polygon. At Stage 4 of the site screening, environmental impacts were assessed in greater detail to incorporate topics such as landscape, historic environment, ecology, noise/air quality, Water Framework Directive (WFD), informal Habitats Regulations Assessment (HRA) and social/community into the decision making. In addition, both Biodiversity Net Gain (BNG) and Natural Capital Assessments were undertaken. The potential for wider environmental benefits relating to flood risk, landscape, heritage and ecology were evaluated.

Following the identification of a proposed reservoir site and indicative abstraction locations and transfer routes, further environmental appraisals were undertaken to support preliminary concept design development. Given that scheme design is still evolving, the scope of the environmental appraisal work was necessarily broad and will be undertaken in progressively more detail in an iterative manner as the scheme design matures.

Stakeholder engagement has been an important element in the environmental appraisals that have supported the gate two submission. Regular meetings were held with both the partnership group and environmental regulators (Environment Agency, Natural England, Historic England), which allowed the opportunity for methodologies and results to be interrogated and challenged. Environmental topic workshops were held to inform Stage 4 of the reservoir site selection for landscape, historic environment, ecology, flood risk and community. This gave stakeholders a forum to share their local knowledge and discuss both constraints and opportunities associated with the prospective locations.

As part of the gate two work, a number of potentially adverse environmental impacts were identified, which will require further investigation at the next stage of scheme development. However, several opportunities were also identified, which have the potential to result in enhancements to the environment and community.

The full Environmental Appraisal Report for the Fens Reservoir scheme is presented in Annex E, and includes detail on the following which are summarised in Sections 6.1 to 6.5:

- Water Framework Directive (WFD) assessment
- Informal Habitats Regulations Assessment (HRA)
- Strategic Environmental Assessment (SEA)
- Environmental appraisal
- Other environmental considerations

6.1. Water Framework Directive (WFD) assessment

The WFD requires all waterbodies (both surface and groundwater) to achieve 'good status or potential', and that waterbodies experience no deterioration. The ACWG has developed a consistent framework for undertaking WFD assessments for SROs, involving two stages of assessment: an initial Level 1 basic screening and a Level 2 detailed impact screening.

The WFD assessment includes an assessment of the reservoir footprint, and the indicative locations for the abstractions, discharges, treatment works and pipelines associated with the potential reservoir. The key findings for those waterbodies that may be affected by construction or operational impacts are presented in Table 5.

Table 5: WFD assessment

Waterbody	Risk score	Cause	Impact	Indicative mitigation / additional work required
GB205033000050 Middle Level	Minor localised, no anticipated risk of deterioration with mitigation.	Approximately 1.1% of catchment lost within reservoir footprint. New pipeline and WTW will be located within this catchment.	Impact on habitat, flow and hydromorphology due to loss of channels and reduction in catchment.	Further hydrological / ecological investigation to inform mitigation options.
GB105033047921 Ouse (Roxton to Earith)	Potential moderate adverse	Surface water abstraction	A potential amber adverse risk to biological quality elements within the River Great Ouse (Roxton to Earith) was identified as a result of the new surface water abstraction. Abstraction rates are expected to reduce the flow volume and velocity which could impede fish migration and cause deterioration to the aquatic habitat.	Further investigation to inform risk assessment and potential mitigation options.
GB205033000060 Old Bedford / River Delph (incl. The Hundred Foot Washes)	Potential moderate adverse	Surface water abstraction	A potential amber adverse risk to flow and therefore biology in the Old Bedford River/River Delph (including The Hundred Foot Washes) was identified as a result of the new surface water abstraction.	Further investigation to inform risk assessment and potential mitigation options.

The risks identified with the above surface waterbodies are due to the loss of open watercourses or reductions in flow from abstraction and associated deterioration of biological status elements and water quality.

Further work to be completed to inform the next stages of scheme development (including those set out in the table above) include:

- Ongoing consultation with the Environment Agency to present and discuss key WFD risks and proposed approach to improving certainty of assessment.
- Consultation with the Environment Agency on Heavily Modified Waterbody (HMWB) status and associated mitigation measures to understand impact of the scheme.
- Update WFD baseline data to include 2019 status (currently based on 2015 status).
- Drainage design to be developed to understand potential for diversion and realignment of watercourses.
- Additional water quality monitoring (both continuous and spot) on the River Great Ouse (Roxton to Earith) and Old Bedford River/River Delph (incl. the Hundred Foot Washes) waterbodies.
- A hydrology study to understand potential impacts (associated with both hydrology and water quality) of reduced flow in the River Great Ouse (Roxton to Earith), the Old Bedford River/River Delph (incl. the Hundred Foot Washes) and Middle Level catchments.
- Development of WFD mitigation options to offset impacts of the scheme as far as reasonably practicable, involving additional modelling as required. If mitigation is not possible, further work will be required to develop an exception submission under Regulation 19 of the WFD Regulations 2017.

6.2. Informal Habitats Regulation Assessment (HRA)

An informal HRA for the scheme has been completed. This includes an in-combination assessment with other identified plans or projects. As further investigations are undertaken and the scheme evolves, the HRA will be revised and updated as part of an iterative process of design and assessment and to inform a future application for development consent.

It should be noted that although an informal HRA was undertaken, the process followed the legislative requirements and is considered a robust assessment given the current level of information available at gate two. It also provides a framework for future investigations. Legislation and guidance require up to four stages to be followed in the assessment process for HRA. A formal HRA will be required for the consenting process(es) for the Scheme.

Stage 1 - HRA Screening

At the first stage (screening) the potential for Likely Significant Effects (LSE) on features of designated sites was considered. The Stage 1 Screening identified six Designated Sites within the Zone of Influence (ZoI) established for the scheme. These are:

- Ouse Washes SAC (UK0013011)
- Ouse Washes Ramsar (UK11051)
- Ouse Washes SPA (UK9008041)
- The Wash SPA (UK9008021))
- The Wash Ramsar (UK11072)
- The Wash and North Norfolk Coast SAC (UK0017075)

The implementation of mitigation cannot be considered at Stage 1 and LSE could not, therefore, be ruled out for any of these designated sites at this stage. Adverse effects on these sites due to abstraction from source rivers and inter-catchment transfers during operation cannot be ruled out. The potential effects of increased sedimentation and changes in water levels, salinity and flows are currently unknown and it is not possible to assess resulting impacts on water quality and biological processes without further investigation.

Where adverse effects cannot be excluded at the screening stage, legislation requires HRA to proceed to Stage 2, where, in the formal process, a report would be produced to inform the competent authority's Appropriate Assessment (AA).

Stage 2 Appropriate Assessment (AA)

The assessment produced to support the informal Stage 2 HRA AA considers whether the proposed development would result in an adverse effect on the site integrity (AESI) of the Designated Sites which were identified at the screening stage as having potential for LSE. At this stage, mitigation measures to prevent adverse effects can be considered. Where AA either concludes that an adverse effect will arise, or that there is insufficient evidence to properly assess the effects, then consent cannot be granted unless a derogation is sought under Stages 3 and 4 of the process.

The informal Stage 2 assessments concluded that, with one exception, and following the adoption of good practice mitigation, no AESI on the Designated Sites would likely arise during the construction phase of the project. However, given the early stage of the development process, and the lack of detailed design of the abstraction facilities at gate two, it would not be possible to fully exclude potential impacts on the Ouse Washes arising from the construction of those facilities within the SPA/SAC, at this stage. Further assessment will be required in respect of these facilities.

The informal assessment also concluded that, given the early stage of the development process and the limited availability of both data and design information, adverse effects on features of the Designated Sites arising from abstraction and transfers during the operation of the project could not currently be ruled out.

An in-combination assessment was undertaken with other plans or projects. The assessment concluded that there was the potential for in-combination effects between the Fens Reservoir and SLR scheme, due to potential effects on The Wash Ramsar and SPA and Wash and North Norfolk Coast SAC. Other existing schemes and developments have been identified including plans to divert an existing Internal Drainage Board (IDB) drain with potential for in-combination effects on the Ouse Washes SAC, Ramsar and SPA. These potential risks will need to be considered in greater detail and addressed as the project evolves as part of the work referenced above.

Conclusion and recommendations

Ultimately, a strong and robust evidence base will be required to conclude that there will be no adverse effects on the integrity of any designated sites as a result of the construction or operation of the scheme. The level of detail available at gate two (which is considered proportionate) means that such effects cannot be ruled out at this stage. As a result, this will need further consideration and assessment as part of the next stages of design development to conclude what level of effects (if any) would arise from the scheme on the designated sites, as required by the HRA process.

A comprehensive programme of survey, data collection, analysis and assessment is therefore required to support the HRA consenting regiment, which will likely include:

- Surveying and data collection in respect of waterbodies on the reservoir site and of abstraction sources to develop a robust water quality and ecological baseline.
- Detailed modelling and assessment of potential operational effects on the Designated Sites, including both the Wash SAC/SPA and the Ouse Washes SAC/SPA.
- Incorporation of climate change scenarios into analysis to account for mid and long-term effects on the Designated Sites
- Comprehensive technical engagement with key stakeholders including the Environment Agency and Natural England on survey and assessment scope including the possible need to agree an HRA evidence plan in accordance with Annex H of PINS Advice Note 11 **[5]**.

6.3. Environmental Appraisal

The preliminary environmental assessments completed at gate one have been developed and expanded during the site selection process. A strategic level appraisal was completed and is presented in Annex E. The appraisal covered all of the topics and proposed objectives used for the WRMP SEA as summarised below, and considered anticipated construction and operational effects, both with and without the application of initial mitigation measures.

The environmental appraisals have highlighted potential environmental effects requiring further consideration and assessment as the scheme progresses. These were mostly associated with changes to the water regime and the associated impacts to biodiversity. There would also be a permanent loss of soils and agricultural land. The SEA review and Environmental Appraisal Report has proposed indicative mitigation measures to reduce any adverse impacts arising from the progression of the scheme. The implementation of detailed mitigation measures would need to be considered as the scheme is developed further, informed by additional environmental appraisals, surveys and modelling.

Consideration was also given to how wider benefits could be assessed and incorporated into scheme development. In summary, the key benefits identified for the scheme include:

- Potential economic impacts deriving from employment and the benefits through the supply chain
- Potential economic benefits from increased tourism related to new recreation assets
- Health and well-being benefits occurring from opportunities to enhance local environment
- Education and opportunities to provide educational resource
- Partnership opportunities to work with local organisations
- New greenspace opportunities including proposed new areas for wetland habitat creation, woodland/scrub planting and wildflower creation. These could incorporate areas to deliver BNG.
- Management of wider areas around the reservoir to promote carbon sequestration.

In addition to the strategic level appraisals, and the outcomes of the WFD and informal HRA, the environmental appraisals have considered the following topics (amongst others not summarised here). Further details of these topics are contained in the Environmental Appraisal Report (Annex E).

Biodiversity

It was concluded that protected species may be affected by the scheme. These include groups such as breeding and overwintering birds and badgers. The presence of ditches across the proposed scheme area may support water vole and otter, and great crested newts are known to be present within the wider area. The proposed scheme is considered to have a low potential impact upon designated statutory sites and other features of conservation and biodiversity importance.

The next phase of work will require detailed field surveys to record whether protected and notable species are present and identify the types and conditions of habitats present. Although, there are anticipated to be both permanent and temporary loss of existing habitats, the scheme offers the opportunity to create new more biodiverse habitats (mainly around the proposed reservoir but also along the transfer routes). The scheme will also seek to secure a positive uplift in BNG.

The scheme is likely to generate the permanent and temporary loss of natural capital stocks during construction. However, some habitat is expected to be reinstated/compensated to pre-construction conditions and will likely have no permanent impact to the provision of associated ecosystem services. The scheme presents an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The scheme covers several Natural England habitat network areas, including Network Enhancement Zones, and would be suitable for the creation of new high value habitats.

[5] https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/an-eleven-annex-h/

Landscape
No designated landscapes would be directly impacted by the scheme development. Due to its scale, the height of the embankments and permanent land use change, the reservoir would fundamentally alter the existing local landscape character and views. However, the embankments would be designed sensitively to reduce visual impacts by reflecting subtle variations in local topography, varying profiles and gradients and introducing planting. The area around the reservoir provides an opportunity to create an attractive greenspace with enhanced biodiversity and public access. The built structures around the reservoir would also require careful consideration to reduce any negative effects.

The majority of the piped transfers are anticipated to be located underground with most landscape effects being temporary in nature during the construction phase. However, there would be some permanent built features along the routes such as water treatment works, intakes and pumping stations that would require mitigation.

Historic Environment
The potential for adverse impact on the historic environment has been identified at the site due to the potential impacts on the setting of four scheduled monuments, which would amount to the middle lower end of "less than substantial harm" to those assets.

6.4. Other Environmental Considerations

Natural Capital Assessment (NCA)
A NCA was completed at scheme level using Defra's Enabling a Natural Capital Approach (ENCA). The results of the change in natural capital stocks informed the assessment against the following ecosystem services:

- Carbon sequestration (climate regulation)
- Natural Hazard management
- Water purification
- Biodiversity and Habitats
- Air pollutant removal
- Recreation and amenity value
- Food production

Five of the ecosystem services were monetised, however, water purification was assessed qualitatively.

The Fens Reservoir will generate a loss of natural capital calculated at approximately -£265,000.

This is due to permanent and temporary loss of natural capital stocks during construction mainly from the loss of agricultural productivity. However, some habitat is expected to be reinstated/compensated to pre-construction conditions and this will likely have no permanent impact to the provision of ecosystem services. The potential post-construction benefits to natural capital stocks (particularly around the proposed reservoir site) have not been factored into the appraisal; this will require an updated assessment once project design is further evolved.

Biodiversity Net Gain (BNG)
Biodiversity net gain (BNG) or net loss has been considered in the scheme development. The scheme will look to secure a positive uplift in biodiversity net gain. A biodiversity baseline has been developed from spatial data sets of habitats inventories and assessed broadly in line with the Defra BNG metric 3.0 which was used to calculate BNG change. The Natural Capital account was used to identify the biodiversity value of the reservoir footprint prior to construction. The post construction land use was used to calculate the post construction biodiversity score. The BNG assessments undertaken for the Fens Reservoir option as part of the WRE regional plan were reviewed and updated as required. The BNG 3.0 calculations for the reservoir and associated infrastructure were updated and are presented in Table 6. This indicates that 31% of river units will be lost and replacement units will need to be sourced accordingly.

It should be noted that BNG calculations at this stage are provisional estimates based on desk studies. They will need revising following detailed field surveys (to evaluate the extent and condition of habitats present) and based on a more progressed scheme design.

Table 6: BNG metric outputs

	Habitat units	River units
On-site baseline	5,243	191
On-site post intervention	5,192	132
Total net change	-51	-59
Total percentage change	-1%	-31%

Invasive Non-Native Species (INNS)
An INNS risk assessment has been undertaken for the scheme considering the transfer of raw water from both the River Great Ouse and River Delph (Ouse Washes) to the reservoir. This has been undertaken using the EA recommended assessment tool to quantify the INNS risk from the respective sources associated with the scheme based on the indicative scheme concept, and to comply with respective national legislation:

- Wildlife and Countryside Act 1981 (as amended),
- Invasive Non-native Species (Amendment etc.) (EU Exit) Regulations 2019,
- Invasive Alien Species (Enforcement and Permitting) Order 2019,
- Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 and related guidance.

INNS were recorded within the proposed abstraction sources and within associated study areas. The assessment concluded that the proposed transfers will not introduce a new hydrological connection between 'isolated' WFD Operational Catchments, as defined in Environment Agency guidance. However, the proposed scheme would result in increased connectivity between waterbodies and will need to be further assessed and appropriately mitigated as the design develops.

6.5. Environmental feasibility

The environmental appraisals have highlighted effects requiring further consideration and assessment. These were mostly associated with changes to the aquatic environment, impacts on biodiversity, landscape and heritage. There would also be a permanent loss of soils and agricultural land on the reservoir site.

Overall, the gate two environmental assessment and report work has identified key issues that will inform the next stages of the scheme design, including measures and plans to mitigate and manage predicted impacts. As the scheme progresses, the design will be subject to an iterative process of environmental assessment, informed by further surveys and modelling, to identify and agree suitable mitigation and enhancement measures. This work will be undertaken in consultation with the relevant stakeholders.

Although further work is required to clarify the nature of WFD and HRA effects, the environmental appraisal work undertaken for the gate two submission has not identified any fundamental regulatory barriers that mean the scheme cannot be progressed to the next stages of development and investigation.

6.6. Carbon

A whole-life carbon assessment, covering an 80-year period, has been undertaken along with a review of the opportunities to mitigate emissions across the life of the asset.

The carbon assessment and emissions mitigation approach has followed PAS2080 **[6]** principles, having focussed on:

- Establishing a baseline assessment to determine carbon hotspots;
- Identifying opportunities through the design, construction and supply chain to further mitigate emissions;
- Prioritising emissions reductions to minimise residual emissions before developing a detailed carbon offsetting strategy; and
- Aligning with targets to achieve and maintain net net zero operational emissions by 2030.

More detail on the assessment can be found in Annex E.

[6] PAS 2080 is a global standard for managing infrastructure carbon and has been authored to meet World Trade Organization requirements. The framework looks at the whole value chain, aiming to reduce carbon and reduce cost through more intelligent design, construction and use.

Assessment of capital carbon

The total scale of capital carbon emissions is estimated to be 247,000tCO_2e and the capital carbon 'hotspots' identified at this stage of the design are summarised in Table 7.

Table 7: Capital carbon hotspot summary

Scheme element	Capital carbon contribution
Reservoir embankment works	Reservoir embankment works account for 32% of total capital carbon emissions for the scheme and approximately 53% of the reservoir emissions. The majority of these emissions are driven by earthworks shift and haulage, including construction of associated haul roads and imported materials.
Transfer pipelines and pumping stations	The transfer pipelines account for 30% of scheme capital carbon emissions, with River Great Ouse to Fens Reservoir accounting for 9%, River Delph to Fens Reservoir 3%, Fens Reservoir to Anglian Water 9%, and Fens Reservoir to Cambridge Water 9%. The scheme accounts for steel pipe material and this contributes the majority of emissions followed by the excavation and reinstatement works required.
Water treatment	The water treatment works accounts for a total of 8% of scheme emissions. The majority of these emissions are associated with civil structures required for process units and associated buildings.
Roads	Reservoir roads account for 8% of scheme emissions, predominantly driven by the large scale perimeter roads and footpaths around the reservoir.
Buildings	Visitor centre buildings account for 2% of scheme capital carbon emissions. These have not been modelled in detail and will be refined as the design is being developed.
Solar Power	The floating and land solar power arrays have been estimated to account for 7% of capital carbon emissions of the scheme but will also provide renewable power to be utilised on site.

Assessment of operational carbon

Operational carbon is dominated by power and chemical consumption. At current day (2022) grid carbon intensity, power emissions account for approximately 87% of annual operational emissions. When the scheme comes into full operation power emissions are estimated to contribute 35% of annual operational emissions, with chemical consumption for water treatment becoming the major operational emissions source at 54%. This highlights the impact of predicted UK grid carbon decarbonisation, without accounting for the significant renewables also included within the Fens Reservoir scheme, which further reduces the emissions associated with power consumption. The assessment does not currently account for future decarbonisation of chemicals as no reliable future forecast is available for the future carbon intensity of the chemicals required for the WTW. This is an area where the scheme and wider sector will need to work closely with the chemicals supply chain to drive decarbonisation across the life of the asset.

Assessment of whole-life carbon

A whole life carbon assessment has been undertaken aligned to the same parameters as the whole life cost assessment and extending over 80 years. The assessment is based on 100% utilisation of the scheme at 87Ml/d and accounts for average utilisation rates for the reservoir filling components to allow maximum deployable output to be achieved by the overall scheme.

Total whole life carbon emissions are estimated at 498,000tCO_2e.

Table 8 summarises the main emissions categories across the whole life of the scheme.

- Capital carbon, all emissions associated with the construction and delivery of the scheme, account for 50% of whole life carbon. This highlights the importance of continuing to explore opportunities with supply chains to decarbonise key construction activities and materials in the build of the scheme delivery.
- Non-power related operational emissions mainly associated with chemical consumption are estimated to contribute 24% of whole life emissions. This highlights the importance of continuing to optimise the design of the WTW to minimise chemical consumption and work with the supply chain to understand the potential to decarbonise the production and supply of these chemicals.
- Power related emissions are estimated to contribute 16% of whole life carbon, the scheme already has ambitious plans to generate renewable power and further work will be explored to maximise the utilisation of the power generated, as well as improve the efficiency of pumping and treatment processes.

Table 8: Summary of whole life carbon emissions and associated carbon costs

Emissions type	tCO_2e	% total emissions	Carbon £M NPV	% carbon costs
Capital Carbon	247,160	50%	51.0	64%
Capital Replacement Carbon	51,820	10%	5.0	6%
Operational Carbon (non-power)	117,630	24%	13.7	17%
Operational Carbon (power)	81,920	16%	10.4	13%
Total	**498,530**		**80.1**	

Table 8 also provides the estimated carbon costs as a net present value for each emissions category; the total Carbon NPV is estimated at £80m. The table highlights that capital carbon emissions account for approximately 64% of carbon costs, followed by non-power related operational carbon at 17%. Capital replacements and power related operational emissions account for 6% and 13% of emissions respectively. These carbon costs can be used to further assess cost efficiency of future mitigation measures as alternatives are tested in more detail at later design stages.

Opportunities for carbon reduction

The key mitigation opportunities to reduce carbon in the scheme design and operation are summarised in Table 9. Further opportunities for carbon reduction to be explored as the scheme evolves are presented in Table 10. Both tables also provide an indication of the areas of supply chain and wider stakeholder engagement required to drive these opportunities through to realised emissions reductions.

Table 9: Carbon mitigations embedded within the existing design

Scheme area	Mitigation measures	Supply chain engagement requirements
Site selection - Cut-fill balance	The site selection process considered a number of factors including whole life carbon emissions. A key driver for both cost and carbon was identifying a site where a cut-fill balance could be achieved thus reducing the need for import and disposal of surplus materials. The best performing polygon was one of the lowest whole life carbon options of those considered.	Not applicable
Renewables	The scheme has made allowances for significant land and floating solar array infrastructure to generate renewable power.	District Network Operators, manufacturers, and suppliers

Table 10: Carbon mitigations opportunities as scheme evolves

Scheme area	Mitigation measures	Supply chain engagement requirements
Low carbon construction plant	The earthworks element of the reservoir construction is the largest hotspot area of the scheme. A significant proportion of this is driven by the fuel used in the construction plant to carry out the earthworks. The current assessment has been undertaken assuming conventional plant using diesel fuel. However, there are significant savings possible through further exploration of use of alternative fuels, such as Hydrogenated Vegetable Oil (HVO), hydrogen or electric for smaller scale excavations. These alternative fuels would also likely have an improved impact on air quality during the construction programme compared to conventional diesel fuel.	· Equipment manufacturers · HVO suppliers · Hydrogen suppliers · Other asset owners: Highways England, Defra, EA · Other water companies delivering similar schemes
Low carbon construction materials	There are significant emissions associated within the embodied carbon of construction materials used. Particularly for substantial civil structures for the WTW and also temporary and permanent road structures. The opportunity to work with the supply chain to identify low carbon alternatives for concrete, steel, pipelines and other construction materials can have a significant impact on the scheme. There is also opportunity to engage with the supply chain to help support them to decarbonise the products and materials they supply.	· Contractors · Concrete suppliers · Structural steel suppliers · Road and temporary road product/material suppliers
Efficient construction approaches	The use of efficient construction approaches that improve fuel and resource efficiency during delivery of the scheme will be explored in more detail as the scheme design detail develops. This includes consideration of automation and opportunities to minimise waste generated though construction.	Contractors
Transport of materials - Opportunity for water transport of materials	Transport of construction materials can contribute significant emissions but also have implications on road congestion and air quality. There is an opportunity for the scheme to develop and utilise water transport for construction materials, which has the potential to then be integrated and utilised for navigation post construction.	Product and material suppliers
Multi-sector (system) opportunities	The Fens Reservoir scheme has further opportunities to integrate with the wider region and potentially support multi-system benefits, including supporting regional decarbonisation efforts. These opportunities continue to be explored with relevant stakeholders across the region.	Regional stakeholders
Maximise land-use benefits	As the scheme progresses there will be greater detail built into maximising the value generated within and beyond the scheme footprint. This will focus on maximising overall value, incorporating water quality, flood defence, biodiversity and carbon sequestration benefits to help offset residual emissions associated with the scheme.	Various technical disciplines and regional stakeholders

Overall, the scheme at its current stage of design has looked to minimise carbon impacts whilst maximising water supply and wider environmental benefits within the region. However, there are still significant opportunities available to further mitigate the whole life emissions associated with the scheme. As the scheme progresses to gate three and beyond, it is expected more mitigation measures will be embedded into the scheme design and costing and a detailed offsetting plan to cover the remaining residual emissions will be developed. The scheme carbon assessments will continue to be updated as the design evolves.

7. Programme and planning

7.1. Project plan

The long-term programme plans are presented in Figure 12 and Figure 13 highlighting the key activities to be undertaken at each stage of the process to design, construct and commission the reservoir, treatment works and transfers. These programmes are indicative only and are subject to further consideration during the next stage of project development. This programme shows that the earliest the Fens Reservoir can be in supply is 2035 to 2037 which is in line with the need date identified in the draft Regional Plan and draft WRMPs.

The construction programme is estimated to be eight years (including time for commissioning and optimisation). The construction of the reservoir and embankment is the longest duration activity and is largely weather dependent - earthworks are most efficient in dry weather. At this stage it has been estimated that it would take five years to construct the main Fens Reservoir embankment, including one season for preparatory works. This assumes that no major delays are caused by adverse weather. This is based on high-level judgement at present and assumes 80% efficiency when constructing the embankment to allow for general delays.

To enable a start on site date in 2029, it is necessary to submit the DCO application by the end of 2025, as shown in the programme. This allows an 18-month period for Secretary of State approval, and 18 months to discharge any conditions and carry out enabling works prior to starting the main works.

There is considerable work to do in the next three years to enable a DCO application to be made by the end of 2025. Three rounds of public consultation are planned: a first non-statutory consultation is underway and two further rounds of consultation are planned for 2024 and 2025. To date, work has been based on publicly available desktop data and therefore a key activity for early in gate three is to undertake on-site surveys. An extensive programme of ground investigations, archaeology investigations and ecology and environmental surveys is planned for the next few years, starting as soon as landowner negotiations allow. It is proposed to move the gates to align with the DCO programme; with gate three planned for March 2024 to allow sufficient time for site investigations to inform design, and gate four planned for the second half of 2025 to align with the DCO application date.

Another significant workstream is the development of the procurement strategy and market engagement, which is discussed in more detail in section 7.5.

The programmes presented are based on the following assumptions and dependencies:

- The project passes through the RAPID gated process as planned
- Land access is obtained to undertake the necessary surveys in line with programme
- The final WRMPs and final Regional Plan confirms the need, timing and project parameters as detailed in the draft plans
- Public inquiry of WRMPs does not delay project proceeding
- The DCO is granted in 2027
- The Abstraction Licences are granted in line with requirements
- There is market appetite for procurement strategy, enabling delivery to be outsourced
- The project is funded
- The supply chain can resource the significant earthworks programme (potentially three large reservoirs to be constructed in the UK at a similar time)
- Water is available to fill the reservoir 2033 - 2036. It is estimated to take three filling cycles to fill the reservoir to provide contingency for a period of drought and low flows.
- The water quality of river sources during commissioning is consistent with what is/will be monitored and designed for.

The project is currently on track to achieve this programme.

Figure 12: Indicative DCO programme

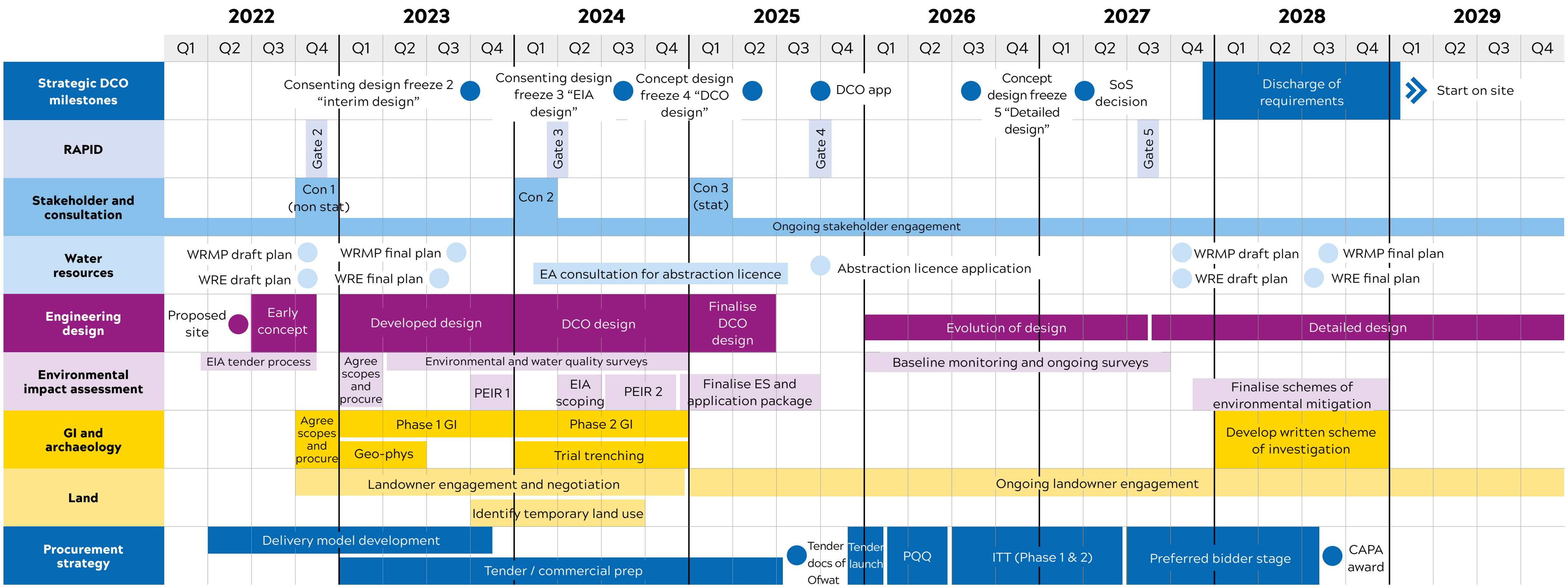
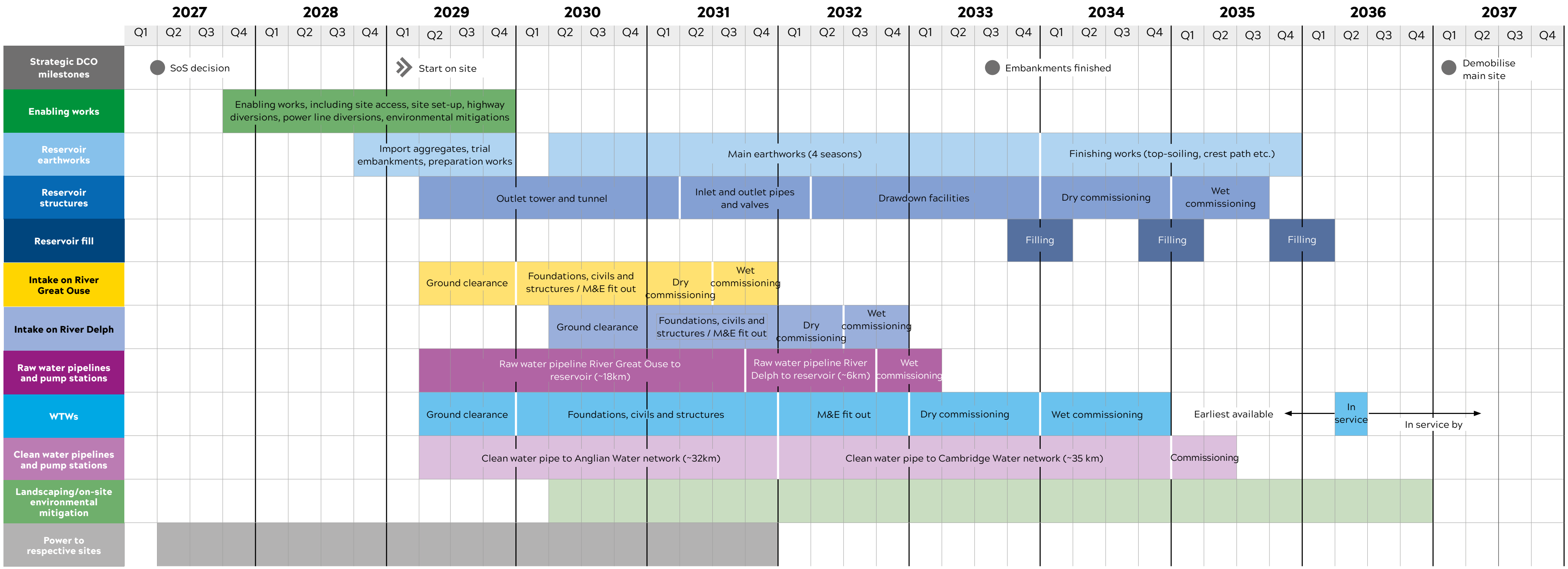


Figure 13: Indicative construction programme



7.2. Planning and consenting route strategy

The preferred planning route for the solution remains the same as that described at gate one, namely obtaining a Development Consent Order (DCO) for a Nationally Significant Infrastructure Project (NSIP) under the Planning Act 2008. The regional modelling has confirmed that the solution's capacity is substantially higher than the thresholds provided for NSIPs and therefore the DCO route is mandatory, and a section 35 direction is not required. Anglian Water has accrued significant experience from its Cambridge Wastewater Relocation Project DCO, which has been applied to the evolution of the SRO's consenting strategy, alongside environmental analysis carried out as part of site selection. The approach has also been informed by preliminary discussions on the project with the Planning Inspectorate.

Key suppliers for the main planning and consenting deliverables, including for consultation, planning, legal, land and environmental impact assessment have been, or are being, contracted. Workshops with environmental consultants have been used to develop scopes of work and identify potential areas of resource shortages. Governance structures to ensure that the different planning and consenting workstreams are aligned with each other, and with the engineering and procurement functions, have been put in place to ensure that customer value for money is maintained by an integrated programme management approach, aligned with principles such as those set out in the Institution of Civil Engineers partnership initiative known as "Project 13" **[7]**.

As referred to in section 7.1 above, an outline plan of the survey and data collection work required to inform the Environmental Impact Assessment (EIA) process has been developed. Survey scopes will be agreed with statutory consultees in Q1 of 2023 including in respect of hydrology and hydrogeology, archaeology, ecology, baseline conditions for noise, air quality and agricultural soils assessments. The implementation of these surveys will be informed by early-stage ground investigations which will aid the project's siting and design evolution. This sequential and iterative approach is intended to balance the need to advance the programme against the risk of unnecessary expenditure on surveys. The challenges of the Habitats Regulation Assessment (HRA) and Water Framework Directive (WFD) processes, discussed in section 6 above, are likely to require extensive survey and modelling effort, which has been taken into account in developing the project's programme and budget. Extensive and ongoing engagement with statutory consultees will be required throughout the EIA process, including as part of EIA Scoping. The advice of the Planning Inspectorate in respect of scoping and EIA set out in Advice Note Seven **[8]** has been followed, resulting in the proposed submission of a scoping report in 2024, once the project design is sufficiently mature. Obtaining access to land to carry out these survey activities will be an important objective, discussed further below.

The DCO will incorporate the main additional consents required for construction, including the right to work in streets, crossings of water courses along the transfer routes and interference with other utilities, subject to the agreement of relevant protective provisions. Discussions have not yet taken place with the Environment Agency on the extent to which operational permits, most notably the abstraction licence, will be incorporated into the DCO but it is thought likely that this will be applied for separately. Discussions and negotiations will commence next year, and it is proposed that a Memorandum of Understanding be agreed with the Environment Agency regarding the water required from both the River Great Ouse and River Delph. The permit application would be aligned with the DCO application, and the two applications would draw upon the same environmental information, particularly in respect of Habitats Regulation Assessment (HRA). This approach is intended to align the issue of a draft licence by the Environment Agency with the back end of the DCO examination, consistent with the process envisaged in the Planning Inspectorate's Advice Note Eleven **[9]**. Separate planning permission from the local planning authority may be required for some survey activity, particularly where longer-term activities, such as the retention of boreholes for hydrological surveys, will be required up to gate three and beyond.

Significant additional work on land has been carried out since gate one, including the appointment of land agents and the development of a land acquisition strategy. Initial, desktop, land referencing has been completed on the reservoir site and activities targeted towards satisfying the "diligent inquiry" provisions of s.44 Planning Act 2008 commenced in September 2021, with preliminary landowner engagement. The land acquisition strategy is focussed on managing compulsory acquisition risk by seeking to secure options over land through voluntary agreement. Customer value is delivered through this approach by reducing consenting and design risk, an approach consistent with other NSIPs. It is thought that the procurement model for the project (described at section 7.5 below) will be dependent on the need for a freehold interest in all the relevant land as a means of providing security for finance providers, and therefore the intention will be to secure options for freehold land in the majority of cases. Access to land for engineering and environmental services will also be sought by agreement in the first instance, either through the negotiated options agreements or side agreements, however the project has also considered the need to obtain specific access powers from Defra where agreement is not forthcoming.

[7] https://www.project13.info
[8] https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/advice-note-seven-environmental-impact-assessment-process-preliminary-environmental-information-and-environmental-statements/
[9] https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/advice-note-eleven-working-with-public-bodies-in-the-infrastructure-planning-process/

As discussed in the Site Selection report provided in Annex A, there is a need to acquire residential properties to make way for the reservoir development. The dialogue with affected families will be managed sensitively and a property support scheme (PSS) will be put in place to provide a level of certainty to those owning residential property on the project footprint.

Anglian Water and Cambridge Water together believe that the customer journey for all those who will be affected by the project can be eased by effective and clear consultation, including the provision of concise and accurate information about the consenting process and the likely environmental impacts of the project. The Statement of Community Consultation (SOCC) required under the NSIP process will be discussed with the local authorities and outline how community consultation will take place. Preliminary Environmental Information (PEI) for the formal consultation rounds will be provided in a simple, graphical form, to aid understanding of what can be complex issues. Anglian Water adopted this "light" approach to PEI on the Cambridge Wastewater DCO, where it was well received and proved to be an effective tool for community engagement.

In addition to the general risks outlined above, and those set out in section 7.3 below, there are likely to be a number of challenges in specific topic areas which need to be managed, for example in respect of HRA and WFD as discussed in Section 6 and flood issues as described in Section 4.4 above. These risks have been identified through a comprehensive site selection methodology, which considered relevant environmental and consenting risks at each stage of the process. Stakeholder engagement through the Fens Water Partnership during the site selection process has significantly mitigated these risks by allowing different stakeholder interest groups to explore the trade-offs between different environmental and social constraints. Early consideration of how the solution will comply with the National Policy Statement (NPS) for Water Resources (currently in draft form) has also informed the management of consenting risk. Additional work, identified through the EIA and consultation processes will be required to further mitigate these risks.

7.3. Key risks and mitigation measures

For gate two, a qualitative risk register has been used to manage project risk. The top risks are summarised in Table 11, alongside the mitigation measures with a pre- and post-mitigation score using the probability versus impact matrix shown below the table. Risks associated with the commercial agreement specifically are provided in more detail in Section 7.5.

Table 11: Top project risks

Risk Theme	Details	Risk Pre-Mitigation			Proposed Mitigation	Risk Post-Mitigation		
		Probability	Impact	Risk		Probability	Impact	Risk
Procurement and Commercial	Economic inflation means gate one to gate five budget is insufficient. Economic inflation post gate five means market pricing exceeds current forecasts resulting in project funding being outside of governance.	5	4	Very High	· Ongoing engagement with RAPID to ensure budget is sufficient · Budget to include contingency for additional cost due to price increases, informed by expert market intelligence · Consider establishing longer term relationships with contractors/delivery entities, possibly through careful design of the early contractor involvement mechanism	4	4	High
Programme	Unable to attain or retain abstraction licences from the Environment Agency.	4	5	Very High	· Early liaison with Environment Agency and DEFRA regarding abstraction licences and obtain memorandum of understanding. · Robust engagement with Environmental Permitting Regulations (EPR) licensing requirements during consultation period to ensure proportionate outcomes.	3	5	High
Programme	Information from stakeholder feedback causes programme delays.	4	4	High	· Continue to actively engage and work closely with stakeholder partnerships and specialist groups post public consultation. · Several rounds of public consultation to be held. · Consult affected landowners to understand and if possible, accommodate individual needs.	3	4	High
Programme	Need to meet requirements of Habitats Regulations Assessment in respect of DCO and Environmental Permit applications	4	4	High	· Effective use of available ecological survey periods · Agreement of Evidence Plan with Natural England · Early communication of findings to statutory parties	3	4	High
Programme and Commercial	Unfavourable ground conditions during construction causing programme delays and increased costs.	4	4	High	· Undertake appropriate level of ground investigation work as part of gate three design · Experts to take account of local knowledge when developing designs · Allow contingency for additional cost due to delay and redesign	3	4	High
Programme and Commercial	Archaeological find during construction causes programme delays and increased costs.	4	4	High	· Design to avoid known archaeologically rich zones where possible. · Ensure robust written scheme of investigation is compiled and agreed with all stakeholders and diligently followed. · Allow contingency for additional cost due to delay and redesign	3	4	High

Risk Theme	Details	Risk Pre-Mitigation			Proposed Mitigation	Risk Post-Mitigation		
		Probability	Impact	Risk		Probability	Impact	Risk
Programme	Delays to signing off other Water Company WRMPs causing programme delays to the SRO.	4	4	High	· Close liaison with other water companies via the Regional Coordination Group of the National Framework for Water Resources · Ensure alignment and collaboration of WRMPs programmes between water companies and regional groups	4	4	High
Construction	Limitation of available plant and equipment, particularly earth moving vehicles, and workforce during construction period due the parallel timing of multiple NSIPs/SROs.	4	4	High	· Engage with the supply chain as early as possible. · Engage with other NSIPs/SROs to create a strategy around ensuring sufficient number of plant, equipment and staff available when needed. · Develop early understanding of constructability requirements / Early Contractor Input assessment.	3	4	High
Programme	Legal challenge or public inquiry on Anglian Water or Cambridge Water WRMPs24 or DCO application causing programme delays.	5	3	High	· Legal and planning advice sought at early stage to ensure process robust and less opportunity for challenge · Early and continued stakeholder engagement to mitigate risk of significant opposition group forming	4	3	Medium
Construction	Non-reservoir infrastructure concept design is less mature with locations/ routes still to be confirmed. This process could delay programme.	4	3	Medium	· Development of non-reservoir infrastructure to confirmed concept definition progressing in parallel with gate three submission. · Develop collaborative culture for overall SRO scheme development · Ensure messaging is clear during RAPID gates and throughout consultation to highlight the need for non-reservoir infrastructure and the process for their development. · Apply robust site selection process to the non-reservoir infrastructure.	3	3	Medium

Probability		Impact				
		1	2	3	4	5
	5	Medium	Medium	High	Very High	Very High
	4	Low	Medium	Medium	High	Very High
	3	Low	Low	Medium	High	High
	2	Low	Low	Medium	Medium	Medium
	1	Low	Low	Low	Low	Medium

7.4. Proposed gate three activities and timelines

Gate three of the RAPID programme falls within the pre-application period for the DCO, at a point where pre-application activities are being progressed and have a clear programme through to completion and application. Based on this, it is proposed to move the gate three date to March 2024 to provide sufficient time to carry out the following activities:

- **On-site investigations** - a key activity post gate two is to carry out environmental and ecology surveys, ground investigations and preliminary archaeology investigations (geo-physical). To date, it has only been possible to use publicly available desktop data to inform decisions and design and therefore it is hoped to commence this work as soon as landowner negotiations make it possible.
- **Confirmation of the need** - before gate three, it is anticipated that the final WRMPs and WRE will be published (autumn 2023) which will confirm the need and design parameters on which to base the design on.
- **Environmental impacts** - preliminary environmental information reports (PEIR) to inform public consultation will be developed prior to gate three utilising data gathered from early site investigations.
- **Transfers and treatment** - further work is required to confirm the routing of the transfers and the exact locations of the abstraction points and treatment works. Once this is done, land referencing and landowner engagement will progress, and further design work developed for these aspects of the scheme.
- **Associated infrastructure and features** - further work is required to confirm access, utility diversions, power, Biodiversity Net Gain and landscaping requirements.
- **Ongoing monitoring** - water quality and flow monitoring will continue, and further work will be done to understand the potential impacts on local watercourses.
- **Strategies** - to be developed for renewable energy; sustainable transport; and economic and social benefits.
- **Engagement and consultation** - On completion of the first public consultation phase, post consultation analysis will be carried out and the feedback incorporated into the ongoing design. Prior to gate three the second round of public consultation is planned; This will include engagement with all consultees who will need to be consulted under s.42 and 47 of the Planning Act 2008. Information to be presented as part of this consultation will include the interim design, details of the associated development including preferred transfer infrastructure routes, and identification of significant environmental impacts with the PEI included.
- **Master planning and design development** - a key activity for gate three is to progress with the solution design, to be aligned with the site-specific design principles.

7.5. Procurement, ownership and operation

This section sets out the eligibility for competitive delivery of Fens Reservoir, the commercial strategy and the procurement strategy. It provides a summary of the option development and analysis undertaken as part of gate two. This work has focused on the ownership, commercial, regulatory, procurement and legal arrangements and activities for the delivery of Fens Reservoir.

7.5.1. Eligibility for Competitive delivery

This sub-section sets out an assessment of the suitability of Fens Reservoir for delivery under Direct Procurement for Customers (DPC) and Specified Infrastructure Project Regulations (SIPR).

1. Direct Procurement for Customers (DPC) eligibility framework and assessment

At PR19 Ofwat set out three tests (size, discreteness, and Value for Money (VfM)) for eligibility for DPC and the initial methodology for PR24 proposed updates to those tests.

Overall, Fens Reservoir appears to be suitable for delivery via DPC. Fens Reservoir as an entire solution meets the size threshold, is broadly discrete (different components are varying degrees of discrete) and offers benefits for customers when Ofwat's standard assumptions are used. Four factors require further consideration:

- Limitations of Drinking Water Inspectorate (DWI) enforcement powers as noted by Ofwat; **[10]**
- Liabilities under RA75 and the extent to which these could be passed down to the Competitive Appointed Provider (CAP);
- Potential financial implications (including the credit rating impact) of Fens Reservoir for the project promoters (exacerbated if combined with SLR) if delivered via DPC; and
- The potential bespoke trading arrangements required for project promoters.

[10] https://www.ofwat.gov.uk/publication/competition-in-strategic-investment-a-high-level-stocktake/

2. Specified Infrastructure Project Regulations (SIPR) conditions and assessment

SIPR was introduced in 2013 to deliver Thames Tideway Tunnel (TTT). Projects which meet the two SIPR conditions (size and complexity, and VfM) are eligible for competitive delivery. There is no formal threshold or further guidance regarding the size or complexity of a project which would threaten an undertaker's ability to provide services for its customers. **[11]**

TTT is the only designated project under SIPR **[12]** and was used as a benchmark to establish an indicative threshold as to whether Fens Reservoir is suitable. A summary of the detailed assessment of the project characteristics is presented below:

- **Size and complexity**
  - Scale risk - Fens Reservoir relative to both the project promoters' Regulatory Capital Value (RCV) represents a significant concentration of risk and is comparable with TTT
  - Construction risk - ground risk has not been managed on this scale in the industry for decades, although not as complex as TTT
  - Management risk - it will be a significant challenge to deliver Fens Reservoir alongside the rest of the project promoters' business activities
  - Regulatory risk - similarly to TTT, Fens Reservoir would require bespoke regulatory delivery arrangements.
- **VfM** - potential savings to customers, based on TTT decision analysis, is likely to apply in the context of Fens Reservoir

Fens Reservoir appears to be sufficiently large and complex to threaten the project promoters' ability to serve their customers and meets the VfM condition. This is exacerbated when considered against the scale of the project promoters and alongside SLR which will be delivered on a similar timescale. For these reasons, the Fens Reservoir appears to be potentially suitable for delivery via SIPR.

7.5.2. Commercial strategy

This section summarises the detailed work done to date on the emerging commercial strategy covering the assumed operating arrangements, commercial considerations and stakeholders, delivery model options and evaluation, tender model and contractual risk identification and allocation.

Operating arrangements

The high-level operating arrangements used to develop the emerging commercial strategy are based on the current arrangements under WRMP24. The raw water component of the asset will be utilised when the river levels allow for abstraction and transfer to the reservoir. Treated water, from the reservoir output will contribute to baseload and to resilience. The contribution to baseload is expected to increase over time driven by caps on abstraction and growth in demand. There is also the potential for scalability of the treated water capacity either through increasing the capacity of the WTW or the construction of a new WTW. Responsibilities of the parties for the operating arrangements are set out in the delivery model and tender model sections below.

Commercial considerations and stakeholders

The emerging commercial strategy takes account of: (1) regulatory expectations of competitive delivery; (2) the potential for system opportunities; (3) the various stakeholders involved in agreeing the arrangements. The project promoters are considering various multi-sector opportunities including agricultural irrigation, tourism & leisure and power generation.
Given this complexity a bespoke commercial strategy and delivery model is required.

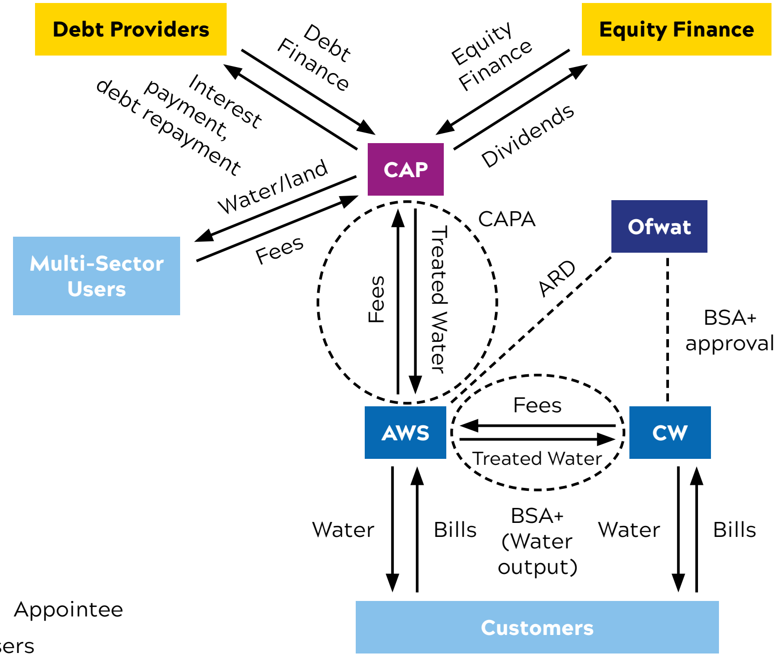
Delivery model

As part of the detailed work to develop the delivery model for Fens Reservoir, nine key commercial dimensions, and options within each dimension, were identified based on regulatory and procurement precedents. For the purpose of gate two analysis, six potential delivery model options were developed for FR. Two examples of delivery model options, 3 and 6, are presented below in Figure 14 and Figure 15 for illustrative purposes.

[11] Note that Ofwat recently recommended the size and complexity condition is removed under SIPR. https://www.ofwat.gov.uk/publication/competition-in-strategic-investment-a-high-level-stocktake/
[12] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/317558/TTTP-reason-notice-ldmsig.pdf

Figure 14: Delivery model option 3

Model dimension	Selected option
Packaging	All assets packaged in single tender
Applicable regulations	DPC
Contracting arrangements	· CAPA between AWS and CAP for treated water outtake from CAP to AWS · BSA+ between AWS and CW for treated water export from AWS to CW
Finance raising party	CAP
Financing recovery model	Tender Revenue Stream
Regulatory allowance	ARD (Allowable Revenue Direction) to AWS BSA+ approval to CW

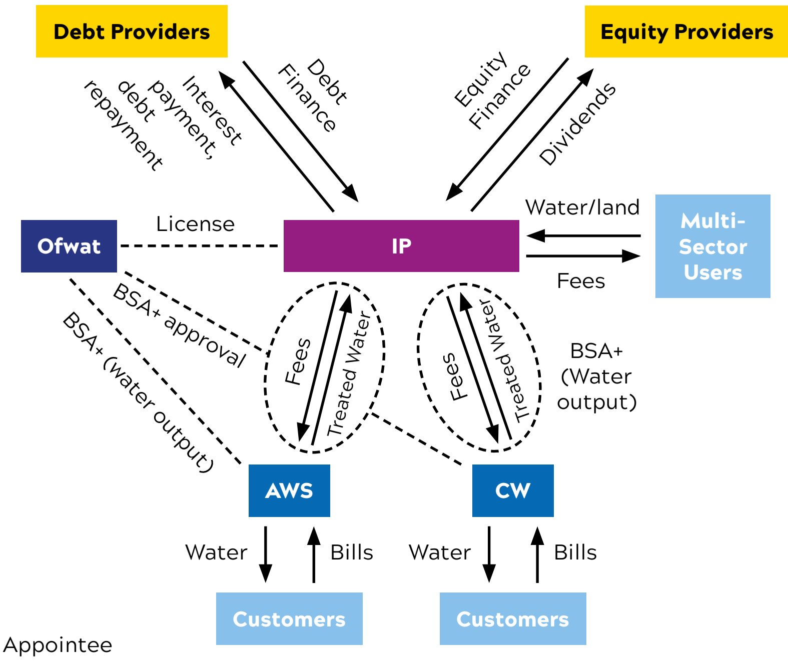


Finance providers | Project owner | Appointee
Regulator | Customers/multi-sector users

Under delivery model 3, the reservoir, WTW and all transfers will be delivered by a competitively appointed provider (CAP). A Bulk Supply Agreement (BSA) will be agreed between the project promoters which will include a bespoke price control to guarantee long-term revenue streams. All delivery risk will be passed to the CAP. The project promoters will agree the contractual arrangements with Ofwat as part of the gated process.

Figure 15: Delivery model option 6

Model dimension	Selected option
Packaging	All assets packaged in single tender
Applicable regulations	Specified Infrastructure Project Regulations (SIPR)
Contracting arrangements	· Project Licence from Ofwat to Infrastructure Provider (IP) · BSA+ between IP AWS/CW for treated water outtake from IP to AWS/CW
Finance raising party	IP
Financing recovery model	Bid RCV and bid WACC
Regulatory allowance	Regulatory allowance awarded to IP via license; Pass-through allowance awarded to AWS/CW



Finance providers | Project owner | Appointee
Regulator | Customers/multi-sector users

Delivery model 6 is comparable to option 3 with the exception that the CAP would be awarded a Project Licence instead of a DPC contract. SIPR provides a higher level of separation between the project promoters and the project risks than DPC does as the licensed entity takes on that risk. The project promoters would both require a Bulk Supply Agreement (BSA) with the Infrastructure Provider (IP) and the IP would take on revenue risk.

Risk identification and allocation

A detailed bottom-up assessment has been undertaken of all relevant risks for Fens Reservoir which will require allocation under the contractual arrangements. 110 risks were identified and tested with internal experts across five stages - feasibility and design, procurement, construction, operations and termination - and quantified (impact and likelihood). Initial views of risk mitigation strategies were then developed based on construction and operational experience and these were then allocated between stakeholders. This analysis will support the development of the commercial model such as pain/gain sharing, which costs can be fixed, efficient risk allocation and incentivisation. Annex F sets out an example of the output from the analysis for the construction stage.

7.5.3. Procurement strategy

This section summarises the work to date on the procurement strategy for Fens Reservoir assuming delivery under either SIPR or DPC. It covers the tender model, pre-tender activities, the tender process stages (including the procurement route), alignment with the procurement of the SLR and market engagement.

Tender model

The tender model refers to the handover point in the competitive process from the appointee to the CAP.

The very early and early models were discounted as they do not align with the funding and activity timeline for RAPID. Implementing either could create scope for design innovation but would add significant delays to the overall programme. The very late model was discounted on the basis that it would still result in significant financing, regulatory and managerial risks to sit with the project promoters. The late model is the current preferred tender model for Fens Reservoir.

A split model (a variation of the late model), where the construction and finance contracts are tendered separately, could be employed to manage risk or maintain competitive pressure and has not been discounted.

Pre-tender

Pre-tender activities for Fens Reservoir sit across four key workstreams:

- **Regulatory submissions** - RAPID gates and Ofwat control points;
- **Commercial** - the full development of the contracting arrangements, contractual mechanisms, trading arrangements, negotiation with stakeholders, BSA development and negotiation and development of a shadow bid financial model;
- **Tender** - the development of bid evaluation criteria, governance and process design, scenario testing and bidder guidance; and
- **Stakeholder** - engagement with regulators, key public bodies, internal stakeholder engagement (e.g. water resource and regulatory teams) and the market to test and shape the commercial and tender arrangements.

Annex F presents the initial detailed assessment of activities required to prepare for a DPC or SIPR tender of Fens Reservoir.

Tender process

The initial tender process for Fens Reservoir was developed in alignment to the RAPID programme. This assumes either a late DPC or SIPR tender and does not draw out the differences between those two delivery models. It builds on comparable tenders including Middlegate DPC, Haweswater Aqueduct Resilience Programme (HAR) DPC, Private Finance Initiative (PFI), the Early Competition Plan in electricity onshore transmission, Offshore Transmission Owners and TTT as precedents.

It also assumes that a similar gated process to the DPC control point process would be in place for SIPR. The key interdependency in the process with the RAPID programme is the DCO award, discharge of requirements and the preferred bidder stage.

Assessment of the different procurement procedures available under the Utilities Contract Regulations 2016 has also been assessed. All options have benefits and limitations and are suitable to different commercial and tender approaches. These will be explored in more detail and a preferred option selected as part of gate three.

Annex F presents the initial detailed assessment of activities required to run a DPC or SIPR tender for Fens Reservoir.

Alignment of Fens Reservoir and SLR

Different approaches to managing the tenders for both SLR and Fens Reservoir have been analysed. The current assumption is that both projects will be delivered under similar arrangements and at similar times, although there are synergy benefits of sequential tendering as lessons can be learnt and applied. WRMPs24, the DCO process and capacity of the project promoters, Ofwat and the market will need to be considered as the procurement strategy develops. Four options are considered at this stage:

- **Combined tender process** - all tender stages are combined for both SLR and Fens Reservoir. One successful bidder/consortium would deliver both projects;
- **Combined PQQ and sequential ITT** - a single PQQ stage for SLR and Fens Reservoir that shortlists the same bidder for both tenders, but Fens Reservoir tender process will be completed/nearing award before the SLR tender process commences;
- **Sequential tendering of SROs (tender overlap)** - Fens Reservoir tender process is at the preferred bidder stage when the SLR tender process commences; and
- **Sequential tendering of SROs (no tender overlap)** - One tender process is completed before the other tender process commences, spreading the effort level required over time.

Market engagement

As part of the early market engagement, 14 construction contractors who operate in the GB market or are considering entering were engaged. The aim was to discuss the capacity and competition in the market, how recent macro-events (e.g. COVID, Brexit and inflation) have impacted their attitude to risk and the application of cost plus, lump sum and target cost contracts. Further formal and informal market engagement is planned to continue as the project progresses.

8. Solution costs and benefits

8.1. Solution cost estimates

Option Selection

The dWRMPs24 have established the need for this strategic reservoir within the 'best value plan', and in preference to alternative options. This is aligned with WRE's draft regional plan, which promotes this Solution.

The site selection process then compares the potential reservoir options, as described in detail in Annex A, where Whole Life Cost was one of 19 criteria assessed. Table 12 is taken from this comparison and includes the NPV of shortlisted options compared in Stage 4. Polygon C represents the location of the proposed site that performed best through the site selection process, as set out in Section 3.3, and for which detailed costings are provided in the remainder of this section.

Table 12: Comparison of Option NPVs at Stage 4 of the Site Selection Process

Criterion	Polygon A	Polygon B	Polygon C	Polygon D
Whole Life Cost	Lowest whole life cost at an estimated £1,230 million Net Present Value (NPV) (based on core scope before risk and early development phase contingency are applied)	Second highest whole life cost at an estimated £1,360 million NPV (based on core scope before risk and early development phase contingency are applied)	Second lowest whole life cost at an estimated £1,250 million NPV (based on core scope risk and early development phase contingency are applied)	Highest whole life cost at an estimated £1,559 million NPV (based on core scope before risk and early development phase contingency are applied)

[13]

Once the proposed site had been identified, the solution cost estimates were developed for this site based on:

- Core reservoir elements: semi-detailed unit rate approach using expert judgement and available industry data.
- Treatment and transfer elements: unit rates in Anglian Water cost models and industry bench marked where appropriate.
- Operational costs: assessed based on design team inputs for consumables (electricity and chemicals) and estimated maintenance costs.

In addition to the construction capital costing, the estimating teams have considered additional project costs (land, power, planning, legal and environmental), indirect costs, qualitative risk analysis and optimism bias, associated with a scheme of this size and complex nature. It should be noted that although a cost plan has been produced, this should not infer a high level of cost confidence as the design definition remains at a very early stage. In order to address this, an order of magnitude range has been applied from the Association for the Advancement of Cost Engineering (AACE) **[14]** guidance as a category 4 estimate (+50% / -20% accuracy range).

The capital expenditure (Capex) and operational costs (Opex) use 2020/2021 cost base data and are summarised in Table 13 (note that there are no comparable Opex figures available for gate one). A comparison between gate one and gate two costs is shown in Table 14.

Table 13: Capex and Opex for each element (2020/21 base date)

	Units
CAPEX	
Base Capex	£729m
Indirect Costs	£522m
Costed Risk	£246m
Optimism Bias	£468m
Total gate two Capex	**£1,965m**
Total gate one Capex	£1,103m
Change gate one to gate two	+78%
OPEX	
Gate two Fixed	£1.8m/ annum
Gate two Variable	£417/Ml

[13] It should be noted that the NPV figures presented in Table 12 are before the costed risk, inflation, optimism bias, and updated unit rate data reflected in Table 14 have been applied.
[14] Association for the Advancement of Cost Engineering (AACE) cost estimate classification system as applied in international engineering, procurement and construction projects.

Table 14: Comparison against gate one cost estimate

Fens	Value Increase (£m)	% of overall increase	Comments
Scope additions	271	31%	Designs refined based on proposed site, requiring additional asset components across both treatment and transfer. Increase allows for significant increase in price of steel, and new unit cost data available from large diameter installations.
DCO and DPC/ SIPR delivery	70	8%	Review of the parametric model has identified specific shortfalls in unit rates if applied to a DCO + DPC/SIPR procurement scheme as these costs are absent/significantly less on a normal Capex scheme.
Inflation	208	24%	Inflated using BCIS as this more closely aligns to industry cost increases and deflated to common point using CPIH, as per agreed ACWG approach.
Risk	189	22%	Costed risk has been developed during gate two and now represents 20% of overall scheme. This is in line with the agreed ACWG approach and understood to be at the lower end of risk allowances on comparable SROs.
OB	124	14%	The calculated OB is 37% (reduction in percentage against gate one estimate), is comparable to other SROs and considered proportionate to level of scheme maturity.
TOTAL Capex £m	862	100%	

Detail of capital expenditure

The capital expenditure estimates have been assessed from several perspectives depending on the level of definition currently available. The transfer elements which cover abstraction, pipelines, pumping stations and water treatment works have been costed utilising Anglian Water's cost modelling system. This process involves the analysis of parametric cost data from historical costs collated by Anglian Water and, due to the complexity of the project, reviewed and updated where necessary when the source data is limited.

The reservoir elements which include the profiling of the reservoir, access roads, visitor centres, emergency drawdown facilities, ancillary power systems (e.g. solar) along with the reprofiling of watercourses such as the Forty Foot Drain (for emergency drawdown requirements) and environmental planting / habitat creation have been costed using first principals estimating where volumes are known (earthworks), expert judgement based on volumetric costs for roadways and buildings and provisional sums with limited input from market data for power systems.

Additional project costs have been produced where possible in alignment with appointed subject matter experts to provide an order of magnitude cost which until the option definition and route to market has been commenced remains indicative.

Detail of operating expenditure

Opex was estimated for the overall Fens Reservoir scheme and broken into each of the main sections of the scheme. Opex was based on provided estimates of annual power and chemical consumption required for each of the scheme elements, as well as maintenance costs. The Opex categories for the transfer and WTW included:

- Labour costs
- Replacement parts
- Chemical
- Power
- Contract Services

The above categories were allocated as fixed or variable Opex costs, with variable costs being linked to the level of utilisation of the scheme and fixed costs being constant regardless of utilisation. Chemical and Power considered as variable costs, and all other activities being fixed costs.

Additionally, annual operational maintenance costs have been estimated based on a percentage of the initial capital costs at the option level. These percentages are based on common assumptions used across the water industry for such infrastructure. Civil maintenance was calculated as 0.30% of the infra and non-infra civil costs whilst mechanical and electrical (M&E) maintenance was calculated as 1.5% of infra and non-infra M&E costs. These percentages were applied to qualifying civil and M&E Capex costs, which excluded civil costs associated with developing the internal embankment face as this would not require annual maintenance activities.

Design life of the asset and any significant maintenance liabilities during operational life.

The main reservoir embankment is expected to have a design life of 250 years; associated reservoir structures of 100 years; and operational structures of 60 years. These align to both best practice and guidance from the ACWG. Costs for this as well as the depreciating asset values have been calculated as part of the overall Opex calculations.

Net Present Value

The Net Present Value of the selected option has been updated using the capital and operational cost data presented above and is provided in Table 15

Table 15: NPV and AIC costs for each element (2020/2021 base date)

Item	Value
Total planning period indicative capital cost of option (Capex NPV £m)	£1,733m
Total planning period financing cost (NPV £m)	£1,497m
Total planning period indicative operating cost of option (Opex NPV £m)	£290m
Total planning period indicative option cost (NPV £m)	£1,787m
Average Incremental Cost (AIC)	292 p/m^3

Optimism bias

Optimism Bias has been calculated in accordance with the UK Treasury Green Book Guidance and is applied in conjunction with costed risk. It is essential to ensure that Optimism Bias is used to calculate the overall level of confidence that exists at this stage of scheme design once base Capex and known threats have been addressed to ensure that double counting does not take place.

The gate two optimism bias allowance has been assessed as 37% this was reviewed through stakeholder workshops. This has reduced from a gate one value of 44% accounting for the improved design information and costed risk assessment.

Assumptions and exclusions

The key opportunities, threats and assumptions to the current estimate are summarised as:

- A significant threat to the scheme is that the cut and fill balance and availability of site won material is more onerous than estimated, resulting in additional costs and vehicle movements.
- Threat that inflation significantly outstrips the Anglian Water cost models causing affordability challenges in the future. Current construction section inflation tracks higher than CPIH and therefore is a significant and likely risk.
- Opportunity to utilise alternative water transport options to alleviate road transport cost and disruption.

In addition, the following apply:

- The estimate is priced based upon current market values in Q3 - 2022. The estimate does not infer any forward indexation or potential outturn cost. The cost estimate presented for gate two is deflated to a price base dated as September 2020 (20/21) to allow comparison of costs across all SROs.
- There has been no engagement to date with the market for project specific data.
- The estimate does not include any element of costs realised to date.
- Relevant methodologies and green book guidance.

Cost scalability

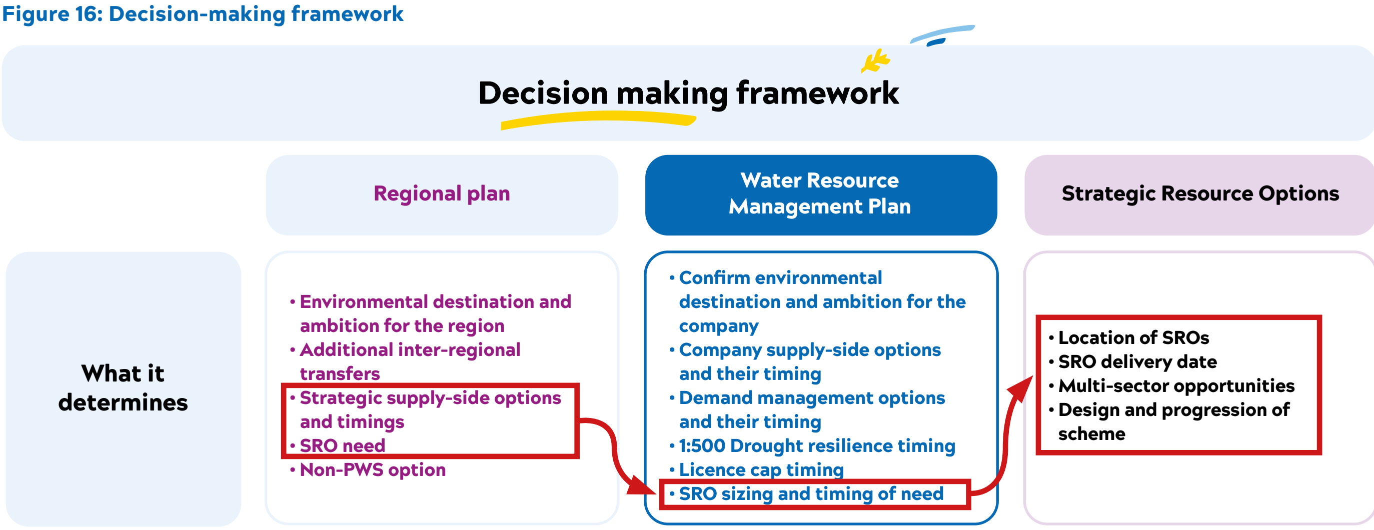
Scalability is discussed in Section 3.6. Costs presented in this report are based on the indicative concept design, which will be refined during the next stage, including further analysis on scalability options (such as multiple pipeline crossings and future treatment streams).

8.2. Best value and solution benefits

Strategic reservoirs within the WRE and WRMP best value planning process

The need for the strategic resource options is defined by the water resource management planning process and solutions promoted where they feature in the WRMP best value plan. The scope of decision making between the regional plan, WRMP and RAPID gated process is summarised in Anglian Water's draft WRMP and referenced in Figure 16.

Figure 16: Decision-making framework



The different aspects of decision-making, setting out the best value and solution benefits relating to the strategic resource options, across the various plans are summarised below. Both the Fens Reservoir and South Lincolnshire Reservoir have been identified as integral to the WRE regional plan and Anglian Water's and Cambridge Water's (Fens only) dWRMP24 best value plans. These plans have been developed following the WRMP24 best value guidance and in summary:

1. The strategic reservoirs are identified as low regret options as part of WRE Multi-Objective Robust Decision-Making process (MORDM) and the regional modelling has informed the size of the reservoirs.
2. The strategic reservoirs are incorporated as 'must-do' options in WRMP24 company plans, reflecting the regional plan.
3. Metrics associated with the strategic reservoirs are included in the WRMP24 best value assessment, which evaluates the strategic resource options alongside other water resources options to form overall plans for analysis and comparison (including sensitivity testing and adaptive planning). This sensitivity testing included confirmation that the reservoir options would be selected independently in WRMP modelling.
4. The final WRMP24 'best value plan' has established the need for the strategic reservoirs and defined the timing for the options. The strategic reservoirs provide multi-sector benefits, contribute to addressing supply demand deficits and increase drought resilience.

Summary of the WRE recommendations

Regional modelling concluded that the following strategic supply-side options would meet 316Ml/d of the 454Ml/d shortfall: two major new reservoirs located in South Lincolnshire and the Cambridgeshire Fens, effluent reuse projects and, in the longer-term, aquifer storage and recovery and desalination.

The regional simulator tested combinations of feasible options and operating regimes over a wide range of potential scenarios for 2050, reflecting uncertainty in demand forecasts, climate change, weather patterns, and also different environmental destination scenarios. The strategic reservoir options appear in every or almost every portfolio (90% or more) for each environmental destination scenario.

The regional best value plan also concluded that the new reservoir options will lead to a net increase in habitat units across the region, whereas other supply options led to a loss of habitat units.

WRMP response to the regional plan

The Anglian Water dWRMP24 confirms that the plan includes two new raw water storage reservoirs as 'least regret' options. This decision has been informed, and proven robust, by three independent modelling processes. Fens Reservoir (and the associated transfer) is central to the Cambridge Water dWRMP24 best value plan.

As part of the iterative modelling process between the WRE Regional Plan and the WRMP, the timing of the reservoir need was confirmed as being required into supply by 2035-2037 to support delivery of abstraction licence caps reductions.
The best value metrics used in the planning processes are summarised in Table 16.

Table 16: Option level best value metrics associated with Strategic Reservoir Options within WRE and dWRMPs24 company plans

Objective	Value Criteria	Metric
A plan that is affordable and sustainable over the long term	Programme cost	Capex, Opex and Totex (£)
Deliver long-term environmental improvement	Strategic Environmental Assessment (SEA)	SEA score (positive and negative construction, positive and negative operation)
	Natural capital	Natural capital ecosystem services (£)
	Biodiversity	Habitat units requiring restoration
	Carbon	Capital carbon and operational carbon (tCO_2e) and operational energy use (kw/h)
A plan that supports the views of regional stakeholders and customers and is not detrimental to social wellbeing	Recreation benefit	Recreation benefit (£/ year)

Metrics, weighting and scoring

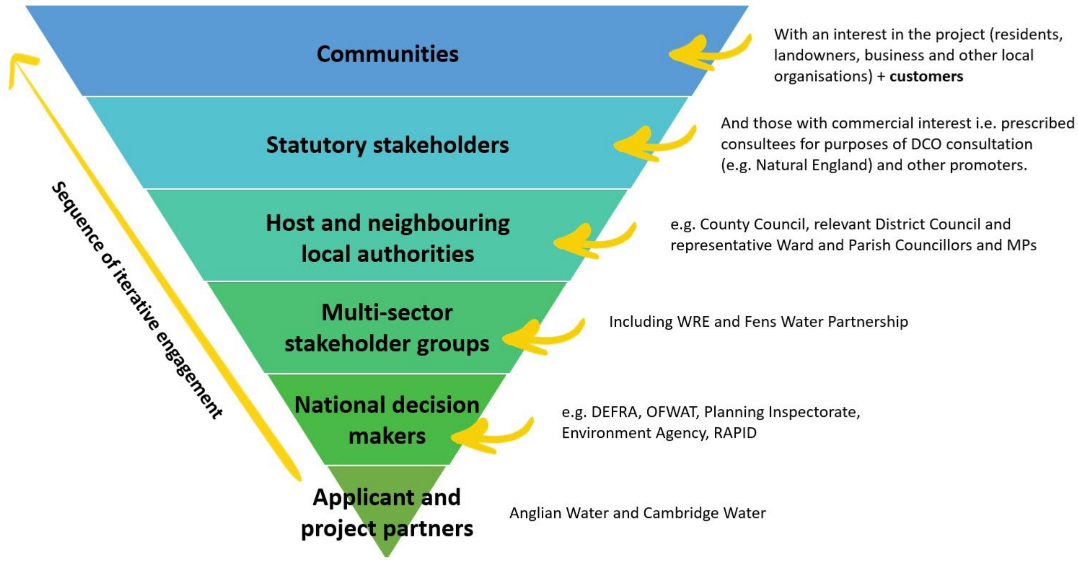
Having incorporated Fens Reservoir within the best value plan described within the companies' dWRMPs, this has been further assessed as part of gate two. During site selection the sites were assessed on a range of criteria as set out in the Site Selection Report in Annex A and the rationale and metrics for the proposed site set out in detail.

Full details of the decision-making process can be found within WRE regional planning documents and the companies' draft WRMP24 reports. The Anglian Water Decision Making document confirms how the SROs are considered in the round of best value planning and sets out how the strategic reservoir options are central to the Best Value Plan, and which through the regional plan have been identified as the most robust and low regret options.

9. Stakeholder and customer engagement

Stakeholder and customer engagement has been at the heart of the development of the Fens Reservoir. Anglian Water and Cambridge Water have adopted an iterative approach as presented in Figure 19, which has enabled stakeholder and customer voices to influence the development of the project, ensuring consultation and engagement is meaningful.

Figure 19: Iterative approach to stakeholder engagement



Working in partnership with stakeholders

In order to ensure conversations with stakeholders were meaningful and able to genuinely influence the development of the proposals, a Memorandum of Understanding (MoU) has been in place since November 2021. The MoU includes confidentiality clauses that have allowed the water companies to share details on potential locations as the site selection process has passed through initial, coarse, fine and preferred site screening.

Signatories to the MoU include the Angling Trust, Borough Council of Kings Lynn and West Norfolk, Cambridgeshire ACRE, Cambridgeshire County Council, Downham Market Group of IDBs, East Cambridgeshire District Council, Ely Group of IDBs, the Environment Agency, Fenland District Council, the Inland Waterways Association, Middle Level Commissioners, National Farmers Union (NFU), Natural Cambridgeshire, Norfolk County Council, North Level IDB, RSPB, Wildlife Trust Bedfordshire, Cambridgeshire and Northamptonshire (BCN), the Water Management Alliance, Water Resources East, Wildfowl and Wetlands Trust, Historic England and Huntingdonshire District Council. Whilst not signatories to the MoU, Natural England were also engaged under a pre-existing confidentiality agreement.

Anglian Water and Cambridge Water have held monthly meetings with these stakeholders through the Fens Water Partnership (FWP) and have used these meetings to engage stakeholders throughout the site selection process.

Anglian Water and Cambridge Water have also been consulting with representatives of the landowner community since gate one, both with the NFU, and also the Water Farming Reservoir Group (WFRG). The WFRG consists of representatives from the farming and landowner community and was established to provide advice and guidance on how the reservoir could deliver benefits for agriculture, and provide support in developing the water companies' approach to engaging with landowners and occupiers.

This process of iterative engagement has enabled stakeholders to provide input, challenge and review to the site selection process, concept design and developing the broader systems thinking which can deliver multi-sector benefits. Anglian Water and Cambridge Water have hosted stakeholder workshops on biodiversity and ecology, landscape and heritage, flood risk, and community opportunities, all of which were well attended and well received. The outputs from these workshops were fed into the site evaluation process.

This engagement has helped Anglian Water and Cambridge Water develop a vision for the project that goes beyond just building a reservoir. The aim is to build a place where water, people and nature come together. That means creating space for wildlife such as wetlands, alongside enabling new recreational and educational activities and natural places for people to explore. It also means creating new jobs and providing opportunities for local businesses and tourism.

Engagement with affected communities

To inform customers directly impacted by the solution Anglian Water and Cambridge Water began issuing communications regarding investment in the reservoir in August 2022. This was geographically targeted at the communities most impacted by the reservoirs and included social media, digital and print media advertising, customer email and new webpages on water company websites.

Landowner engagement commenced in September 2022, with a letter to all those with an interest in land within the polygon and the wider area for associated permanent and temporary infrastructure. This letter also offered face-to-face meetings with the land agents working on behalf of the water companies.

In October 2022 Anglian Water and Cambridge Water launched a non-statutory consultation. This ten-week consultation is currently ongoing and will close on the 21st of December. All consultation information and materials can be found at; www.fensreservoir.co.uk. The Approach to Consultation document in Annex G was consulted on with the local authorities and sets out the details of where, when and how the water companies are consulting the communities affected by the proposals.

The aim of consultation is to gather feedback from the public on the proposals for a new reservoir in the Fens and encourage input in the early design proposals. The water companies are engaging the public through a range of means, supporting widespread participation and encouraging people of all ages and backgrounds to have their say.

Anglian Water and Cambridge Water identified a consultation zone based on the potential effects of the proposed reservoir. The consultation zone is where the majority of the consultation activities are focused, such as community events, information displays and on-the-ground publicity. This zone is intended to help focus the consultation activities, however, anyone is welcome to take part in the consultation regardless of whether they are inside or outside this zone. To build wider awareness and encourage participation, Anglian Water and Cambridge Water are also carrying out additional activities for a broader audience, such as media advertising and publicity.

A consultation postcard (Figure 20) was sent to every residential and business address within the consultation zone. Over 8,500 addressees were contacted and encouraged to visit the website, find out more about the proposals and share their feedback.

Figure 20: Fens Reservoir consultation postcard

Customer Engagement

Anglian Water and Cambridge Water's approach to customer engagement has been developed to ensure a clear line of sight between preferences and the decisions made in the plans and to be in line with RAPID's gate two guidance. The water companies have also built on the customer engagement undertaken from gate one, as well as the Regional Plans and the company draft WRMPs24. This has ensured consistency, as well as with the company Price Reviews, ensuring insights that can also feed into supporting Business-as-Usual action plans.

Specifically, Anglian Water and Cambridge Water have both undertaken research studies, following best practice guidelines, into customers' preferences for supply and demand options for water resource planning. These robust qualitative and quantitative research studies, undertaken at both a local and regional level since gate one, highlight that reservoirs are the preferred supply side option of the options tested. This view on why reservoirs are preferred as a supply side option is predominately driven by:

- Feeling reservoirs are a familiar, tried and tested option
- Ability to hold large volumes of water in an efficient way to meet future demand challenges
- Being seen as environmentally friendly, including helping reduce the amount of water taken from rivers, streams and underground aquifers in dry periods
- They can help reduce flood risks if planned correctly
- Delivering an attractive community asset.

Examples of this support include a number of independently run studies commissioned by Anglian Water and Cambridge Water among household (HH) (including future customers and those in vulnerable situations) and non-household (NHH) customers:

- A multi-stage qualitative WRE water company club research study into the optimal regional approach to delivering a 'best value' plan found that reservoirs were the third highest ranked option when customers were asked to pick their top three (37%) and gained the most votes of the supply option listed. Only 15% selected it in their bottom three.
- A Cambridge Water quantitative study highlighted that from nine demand and supply side options presented, building a new regional storage reservoir was ranked 3rd, behind leakage and universal water metering.
- Cambridge Water has run a year-long deliberative customer Forum (Water Resources Advisory Panel). The overall preference among this engaged audience was that reservoirs were the most popular supply side option and an in-depth focus group found that a shared reservoir asset with a transfer to Cambridge Water customers was the preferred option. It was viewed as providing sufficient security and control, whilst being lower cost than others.
- An Anglian Water quantitative study showed that from twelve demand and supply side options presented to customers, a new raw water storage reservoir was ranked 5th, behind demand management measures such as leakage reduction. Reservoirs were the second most preferred supply-side option, behind water reuse. Further engagement has confirmed Anglian Water customers' preference for reservoirs as a supply-side option.

Alongside these studies, collaboration with other SROs has also been a key feature of our customer engagement, maximising the expertise across the companies and building our knowledge of what our customers think is important. It also shares the costs and prevents duplication across companies, which ultimately benefits customers. Two customer research studies were undertaken during 2022 as part of 'club' projects with other SROs to provide robust evidence of our customers' priorities, one on Change of Water Source and another on Public Value. Outputs of these studies are summarised below.

Change of Water Source: summary of key insights

The findings from this research conducted by "BritainThinks" from February to May 2022, highlight the key communication points for the scheme going forward, as presented in Table 17. This communications framework was developed based on three stages of research, focused on understanding customer attitudes towards water source changes and the implications of these for communications. Phase one was an evidence review, phase two consisted of qualitative research involving 96 HH customers across six water companies and 36 NHH customers. Phase three involved quantitative research via a fifteen minute online survey with 1,762 HH customers and 198 NHH customers.

The insights have provided the foundation for the development of a communications framework that water companies can use to ensure they deliver timely and effective communication to customers around the impacts of the change in their water supply when the reservoir comes online.

Table 17: Key communication points for the project

Who	Water companies are seen as a logical key messenger on this topic and should lead the communications to customers.
What	Reference the familiarity and common use of reservoirs to reinforce perceptions that it is a 'tried and tested' solution.
How	High level information is likely to be sufficient due to high familiarity with reservoirs as a way of supplying water.
Where	Long term communications plans are likely to be helpful, as presumed level of disruption mean customers expect comms via many channels over a long period of time, including various ways to voice their own concerns. Quantitative data shows customers like information on next steps within comms.
When	Consistent and clear communications will be necessary to manage concerns about local area disruption; transparent comms on when different stages are being implemented are important, including an overview of planning processes.

Views on Public Value: summary of key insights

The key public value insights to feed into the plans for the scheme going forward are presented in Figure 21. This research was conducted by Accent and involved a desk review, qualitative and quantitative research. The qualitative survey consisted of twenty four Zoom groups with Household (HH), Non Household (NHH) and Future Customers across six water companies. The quantitative study sampled 5,902 HH participants and 553 NHH participants. In both the qualitative and quantitative work, environmental project additions were valued highly. In the quantitative willingness to pay element of the study, the top-three most highly valued project additions by household customers when asked in the context of a reservoir scheme were:

- **'New wetland area' (£3.06 annually, on average)**
- **"A quarter of employees at the site from local area" (£2.79 annually, on average)**
- **'Specialist habitats created for wildlife' (£2.56 annually, on average)**

Figure 21: Key public value insights

Reflecting on customer preference studies

The findings of the customer preference studies have been reflected in the approach to stakeholder engagement and consultation, and how the water companies have communicated about the project. In line with the change of water source research, the consultation provides an early opportunity for communities to share their views, voice any concerns and access high level information about the project.

In line with the public value research, messaging about the project sets out the value of the reservoir as a supply side option, meeting the challenges of a changing climate and growing population, but is also clear about the significant social, economic and environmental opportunities the reservoir can bring. Through the consultation, communities and stakeholders can provide their views on the wider features they would like to see included as the design for the reservoir is developed.

The feedback form part of the non-statutory consultation launched in October 2022, lists potential features communities may wish to see, this includes some of those features valued by customers in our public value and wider research studies.

- Wildlife enhancements and conservation (such as for birds and other species)
- Recreational water sports (such as sailing, angling and windsurfing)
- Ecological enhancements (such as wetland areas and woodlands)
- Education facilities (such as nature trails, visitor centres)
- Social and recreational facilities (such as picnic areas, playgrounds)
- Landscape enhancements (such as tree planting)
- Green infrastructure (including cycle paths, electrical vehicle charging and renewable energy generation)
- Creating a recognised visitor destination for local people and tourists
- Local enterprise and economic opportunities
- Water for wider sector uses (such as agriculture and commercial use)

Challenge process
Throughout the customer engagement programme, the Consumer CCW has been actively involved in developing the club research projects, reviewing and inputting into the research methodologies used and stimulus materials design, with reports shared at the end of projects. Anglian Water and Cambridge Water have also held regular meetings with their respective CCW representatives to discuss their customer engagement programmes to enable effective challenge.

Addressing stakeholder concerns raised at gate one
The water companies have had regard to the representations published by stakeholders at gate one and ensured that these are addressed through aligning the approach with guidance published for gate two. In particular, representations regarding deployable output and stochastic river flow data are addressed in Section 4.2, Water Resource Benefit.

Work to be undertaken prior to gate three
Following the closure of the non-statutory consultation in December, Anglian Water and Cambridge Water will be carrying out post consultation analysis and factoring consultee feedback into the development of the reservoir concept design. Once the design has developed in line with feedback received at the first consultation, the water companies currently anticipate holding a further statutory consultation ahead of gate three. Anglian Water and Cambridge Water will also assess whether any follow up customer research is required to explore any areas of specific and consistent challenge further.

10. Board statement and assurance

WSP UK Ltd undertook assurance of the development of Fens Reservoir for the gate one submission based on a comprehensive assurance plan, and has continued to provide assurance of the scheme development between gate one and gate two. Assurance has been focussed on studies and findings which present high risk to the safe development of the scheme or are otherwise critical to decision making in respect of scheme development.

In addition to this, further assurance has been undertaken of key activities and findings, including legal assurance and detailed cost assurance exercises for different stages of the process. Separate assurance has also been undertaken for both the draft WRMPs and the draft WRE regional plan.

Both Anglian Water and Cambridge Water Boards support this submission and have signed off the Board statement in accordance with the RAPID guidance, based on the above controls and assurance.

11. Efficiency of expenditure for gate two and forecast

This section outlines the procurement approach and governance process that Anglian Water and Cambridge Water have taken to procure services required to efficiently deliver the gate two work for Fens Reservoir. The governance process and structure between both companies was established at the start of the SRO programme and includes a Programme Management Group (PMG), whose responsibilities include ensuring that all activity is aligned with RAPID's requirements to minimise and to ensure efficient spend. The procurement approach used for gate one has continued for gate two, with a new framework established especially for the development of the SROs to provide more competition and efficiency across the programme. This caters for:

- Mini-competition between framework suppliers
- Direct selection of framework suppliers when required for consistency or a particular skillset
- Tender for services outside of existing frameworks
- Direct award to specialist suppliers outside of existing frameworks where appropriate

In addition, the PMG continues to be responsible for the approval of all procurement decisions. A standard proforma is used to facilitate this and is signed by the PMG prior to procuring any work. This documents the rationale for selecting a particular supplier or contractor, as well as detailing the scope, requirements, costs and expected outputs of each work package. Many work packages have been procured jointly with the other SROs (SLR, A2AT, Fens Reservoir and Minworth) to bring efficiencies to the programme and, where possible, costs have been benchmarked against other similar work packages. Work has been carried out internally where there is the capability, such as the water quality monitoring programme which has been carried out by the Anglian Water laboratory at a circa £150k efficiency when compared to the mini-bid with consultants. The efficiency of spend has also been confirmed through external, third-party assurance of the gate two costs.

11.1. The breakdown of costs for gate two

The breakdown of costs for gate two activities is presented below in Table 19 in 2017-18 prices. The total actual spend is £3.7 million, representing a £390 thousand underspend against allowance (which will be rolled forward into the gate three budget, as agreed).

In addition to these costs, some early gate three spend has been incurred. This includes the costs associated with scoping workshops with the supply chain and hydroecology and is detailed in Table 18.

Table 18: Breakdown of gate three spend incurred to date

Activity	Cost	Cost in 2017/18 prices
Scoping workshops (Fens contribution)	£24,684	£21,260
Hydroecology for gate three	£31,325	£26,979

Table 19: Breakdown of costs for gate two activities

Category	Activity	Expenditure (£, 2017-2018 prices)	% of Total Expenditure	Description of Activity
Programme and Project Management	Project management	£0.19m	5.19%	Project Management and support, including staff and consultancy support
	Assurance	£0.10m	2.69%	Includes third line assurance activities, cost assurance activities, and advisory support roles to assure process throughout.
Feasibility Assessment and Concept Design	Site selection - Stage 3	£0.17m	4.59%	Costs associated with fine screening process - including technical appraisal studies and the development of decision making tools
	Site selection - Stage 4	£0.39m	10.45%	Costs associated with preferred site screening - technical studies and a series of workshops to analyse information and make decisions.
	Concept design - reservoir	£0.27m	7.40%	Development of initial concept plan for use in consultation and gate two
	Concept design - transfers and treatment	£0.03m	0.85%	Early development of transfers and treatment design.

Category	Activity	Expenditure (£, 2017-2018 prices)	(£, 2017-2018 prices)	Description of Activity
Option benefits development and appraisal	Option benefit assessments	£0.02m	0.51%	Includes studies to understand option benefits, including wetlands and open channel transfers.
	System benefits assessments	£0.09m	2.50%	Costs associated with developing system concept and funding strategy for wider multi-sector benefits
Environmental Assessment	Environmental assessments	£0.35m	9.39%	Includes detailed environmental assessment work carried out during site selection, and initial assessments of preferred site.
	Ecology assessments	£0.11m	3.02%	Studies to understand the impact to ecology.
	Hydroecology assessments	£0.09m	2.32%	A study to understand the impacts to hydroecology.
	Flood risk assessment	£0.06m	1.54%	Studies to assess flood risk throughout site selection and on the preferred site.
	EA and Natural England contribution	£0.31m	8.47%	EA NAU and local office costs, and a contribution to Natural England
Data Collection, Sampling, and Pilot Trials	Water quality assessments	£0.28m	7.67%	12 months of water quality sampling of the main water courses, and water quality modelling to inform design.
	Site surveys	£0.16m	4.41%	Includes regional ground investigation works and scoping for future surveys.
	Hydrology assessments	£0.08m	2.23%	Costs associated with flow modelling and DO estimation
Procurement Strategy	Procurement strategy	£0.23m	6.23%	Costs associated with developing procurement strategy for gate two.
Planning Strategy	Planning and consenting strategy	£0.05m	1.36%	Ongoing support costs from Planning Advisor and production of consenting strategy.
	Site selection - narrative	£0.11m	2.98%	Write up of site selection process.
	Land referencing	£0.19m	5.12%	Land referencing for reservoir and surrounding area; development of land rights strategy, and landowner engagement
Stakeholder Engagement	Stakeholder engagement	£0.07m	1.81%	Costs associated with engagement strategy, consultant support and stakeholder workshops.
	Customer research	£0.03m	0.91%	Contribution to joint company research projects.
	WRE contribution	£0.10m	2.81%	Contribution to Water Resources East modelling.
	Consultation	£0.13m	3.52%	Costs associated with first public consultation.
Legal	Legal Support	£0.07m	2.03%	Legal advisory costs to support project development.
Total		**£3.70m**	**100%**	
Gate 2 Allowance		£4.09m		
Gate Under/ Overspend		-£0.39m		

*Expenditure (2017-2018 prices) has been rounded to 2 decimal places.

11.2. Forecast of expenditure for following gates

A detailed build-up of forecast to gate four has been developed. This forecast has involved significant forecast development work with the supply chain, whereby Anglian Water and Cambridge Water have undertaken an integrated collaborative framework scoping exercise - bringing delivery consultants into the team to help develop scopes and estimates. These scopes and estimates have then been benchmarked, and then rationalised from a top-down perspective against other major schemes within Anglian Water's delivery portfolio (building on lessons learned from the Cambridge Waste Water Treatment Plant Relocation DCO project, and also from the delivery of Anglian Water's Strategic Pipeline Alliance). Data from other comparative schemes across the water sector has been further used to sense check and rationalise the forecasts.

The forecast development costs represent less than 4% of the total scheme value including costs to date, when compared in the same price base. As such they are deemed to represent good value to the scheme, and considerably lower than the notional 6% cost that such schemes might be expected to attract in development. That said, the costs significantly exceed the RAPID allowance: The cost for gate three is forecast to be £23.8million (circa £14 million over the allowance) and the forecast for gate four is estimated to be £31.3million (circa £20 million over the allowance), all in 2017/2018 price base. There are a number of reasons for this, notably that the extent of environmental work, design development, DCO preparedness, DPC/SIPR procurement, intrusive investigation, risk allowance, and longer development programme allowance, are all deemed to be significantly greater than the initial allowance for this scheme. These changes have, in part, come as a result of the DCO process maturing and lessons learned from other projects being available. Further clarity on costs has also come from the reservoir site selection process concluding, and as cost data becomes available from adjacent major projects. The key factors are:

- As part of the Development Consent Order process, an EIA process is required and will involve a number of stages, including requesting an EIA scoping opinion, producing Preliminary Environmental Information (PEI) for statutory consultation and, ultimately, producing an Environmental Statement for the consenting process. The Cambridge Waste Water Treatment Plant Relocation DCO project has recently been through this process, and is a useful benchmark to validate the current forecast for Fens Reservoir EIA of circa £15million. This Environmental work needs to be complete prior to the DCO application, and therefore prior to gate four.
- The design progression required over gate three and four will be significantly influenced by the stakeholder engagement and environmental assessment. It will seek to balance the need for flexibility (in order to allow the CAP/SIPR to further develop this design) whilst being sufficiently detailed to assess and mitigate any potential impact upon the environment. It will also need to be developed to a level which allows for a meaningful tender process for the DPC/SIPR delivery route. As a result the design forecast up to gate four is circa £14 million, and reflects the inputs required to deliver the significant and varying scope associated with the reservoir, treatment, and transfer assets.
- The Procurement Strategy and process requirements as part of the SOC is significant due to the necessary and extensive engagement with the market, management of contract liabilities, and development of assurances needed to engage CAP providers and satisfy relevant legislation. The current forecast of £3 million is comparative to similar schemes.
- Ground Investigation requirements for a reservoir are significant, given the need to de-risk the project from a delivery and procurement perspective, recognising that this is a significant earthworks job. Similarly, given the extent of earthworks required, the archaeological requirements should not be underestimated, to ensure that the project complies with good practice from an archaeological investigation perspective. The forecast of circa £7 million is comparable to other schemes going through this process.
- The risk profile included allows for the early stage of the process and a consenting strategy that maintains a high level of design flexibility. There are also significant risks associated with the procurement requirements and the ground investigation works.
- The proposed gates are later than the initial dates laid out in the final determination - gate three is planned for March 2024 compared to summer 2023, and the gate four is planned for autumn 2025 rather than summer 2024. This additional duration impacts ongoing costs.

Whilst options could be considered to delay certain activities to reduce the funding gap, all of these will have a commensurate impact on the development schedule, the construction schedule, and also the market appetite to fund and deliver the scheme. Options considered include delaying certain activities such as the intrusive archaeological scope and delaying ground investigation works. These are not considered feasible, in part given their role in design development and environmental assessment, but also given the need to de-risk the design assumptions sufficiently for successful DPC/SIPR market engagement. In this respect the DPC/SIPR procurement activity could be postponed until after gate four, but this would again affect the RAPID milestone outputs, and most significantly the construction start and completion dates. The ability for Anglian Water and Cambridge Water to continue to develop the solution to the standard required to achieve a successful DCO and to enable water to be brought into supply between 2035 and 2037 is subject to confirmation of adequate funding of the development costs being made available by RAPID and Ofwat.

Synergies and Efficiencies

Within the current forecast, efficiencies have been assessed to deliver the Fens Reservoir in parallel to the South Lincolnshire Reservoir SRO. It is estimated that by delivering both SROs together, an efficiency of up to 20% can be realised. These efficiencies are a result of shared project prelims, such as project management and systems, in addition to a common approach to design, EIA and market engagement, and are reflected in the expenditure forecast below.

Table 20: Forecast of expenditure for following gates in 2017/18 prices

	G3 (based on March 24)		G4 (based on October 25)		
FR RAPID Forecast- to G4 - (Indicative costs)	**FR Forecast (£m)***	**% of Total Project**	**FR Forecast (£m)***	**% of Total Project**	**FR G3+4 TOTAL (£m)***
Design - Engineering	6.95	29%	6.93	22%	**13.87**
EIA, water quality studies, hydrological assessments and environmental assessments	7.46	31%	7.65	24%	**15.10**
Ground investigation and archaeology	2.06	9%	4.63	15%	**6.68**
Development Consent Order Works inclusive of Legal Support, Stakeholder Engagement and Planning and Land obligations	3.10	13%	6.80	22%	**9.90**
Project management and commercial	1.37	6%	0.99	3%	**2.36**
Procurement strategy including legal support	1.06	4%	1.97	6%	**3.04**
Risk	1.82	8%	2.38	8%	**4.20**
Total forecast cost to complete	**23.82**		**31.34**		**55.16**
FR RAPID allowance	9.54		10.91		**20.45**
Underspend from previous gate	0.39				**0.39**
Total RAPID allowance	9.93				**20.84**
Variance	**13.89**		**20.43**		**34.23**

*Expenditure (2017-2018 prices) has been rounded to 2 decimal places.

12. Conclusions and recommendations

The Fens Reservoir solution has continued to progress well since gate one and the programme has delivered against key objectives, including the identification of a proposed site for the reservoir north of Chatteris in Cambridgeshire and the development of a preliminary concept plan.

Stakeholder engagement continues to be at the heart of the Fens Reservoir development with a new stakeholder partnership established - the FWP. A series of stakeholder workshops have taken place to input into the site selection process, and regular engagement with councils and statutory authorities has taken place.

There has been close alignment to the WRE Regional Planning process and Anglian Water's and Cambridge Water's WRMP teams to understand the need and design parameters required. Regional modelling has confirmed that the Fens Reservoir is integral to securing both Anglian and Cambridge Water's future water supply. The scheme continues to be jointly delivered by both water companies.

Gate two spend is considered to be efficient and well within budget. The forecasts for gates three and four are over allowance and further funding is required to develop the solution in line with programme. The solution cost is £1.96billion, an increase since gate one costs due to inflation, greater clarity on risks, and additional scope.

It is recommended that this solution proceeds to gate three within the RAPID standard gated process. Anglian Water and Cambridge Water look forward to continuing to work in partnership with RAPID, WRE and stakeholders to progress an innovative solution that will bring multiple benefits to the region, customers, and the environment.

13. Supporting documentation

A. Site selection report
B. Overarching design principles
C. Drinking Water Risk Assessment
D. Reservoir and landscape system summary report
E. Environmental Appraisal Report (EAR), including:
- Water Framework Directive (WFD) assessment
- Informal Habitats Regulations Assessment (HRA)
- Strategic Environmental Assessment (SEA)
- Carbon assessment

F. Detailed assessment of procurement strategy
G. Approach to consultation
H. WRMP cost tables 5a and 5b