Gate 2 EAR Carbon Appendix

Fens Reservoir

November 2022

This page left intentionally blank for pagination.

Mott MacDonald
22 Station Road
Cambridge CB1 2JD
United Kingdom

T +44 (0)1223 463500
mottmac.com

Gate 2 EAR Carbon Appendix

Fens Reservoir

November 2022

Mott MacDonald Limited. Registered in
England and Wales no. 1243967.
Registered office: Mott MacDonald House,
8-10 Sydenham Road, Croydon CR0 2EE,
United Kingdom

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
01	03/11/22	AA	PD	NW	First issue for assurance
02	08/11/22	AA	PD	NW	Second issue following comments

Document reference: 421065059-GT2-MMD-XX-XX-RP-Z-0020 | 02 | A | Click or tap here to enter text.

Information class: Standard

Contents

Tables

Figures

Click or tap here to enter text.

1 Introduction

1.1 Scheme Overview

The Fens Reservoir scheme 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 includes transfer elements and reservoir elements, summarised as follows:

- Intake and abstraction assets at each river,
- Raw water transfer pumping and conveyance pipelines,
- Water storage reservoir and associated components, amenity, and environmental measures,
- Water treatment works for potable water,
- Potable water transfer pumping stations, pipelines, and water storage and brake pressure tanks
- Connection to existing potable water supply systems for both Anglian Water and Cambridge Water.

Following on from the gate one submission and subsequent site selection exercise, the project promoters have undertaken additional work to both rationalise and refine existing and additional options in order to ensure that feasible solutions resilience criteria has been explored in more detail for the Fens Reservoir programme of works.

Design maturity remains at an early stage of concept planning and thus the carbon estimate produced in this report while further developed from those derived at the gate one still presents a representative scale of expected emissions with further detail to be developed as the design progresses.

The basis of the gate two carbon assessment is based on:

- Raw water intake to reservoir of up to 400 Ml/d.
- Potable water distribution output of 150 Ml/d[1].

1.2 Carbon assessment overview

The Fens Reservoir scheme has the potential to deliver significant water security benefits but could also be a significant source of carbon emissions through its construction and operation. This report estimates the scale of expected carbon emissions and key emissions sources to help inform focus areas for decarbonisation.

To align with the latest RAPID gate two guidance the carbon assessment is required to consider:

- Assessment of whole life carbon cost of the solution.
- Consideration and discussion of whole life carbon reduction including how carbon has been considered in the best value planning approaches, metrics and decision making with due consideration to the six main greenhouse gasses. (This is covered by the regional planning approach delivered through Water Resources East)

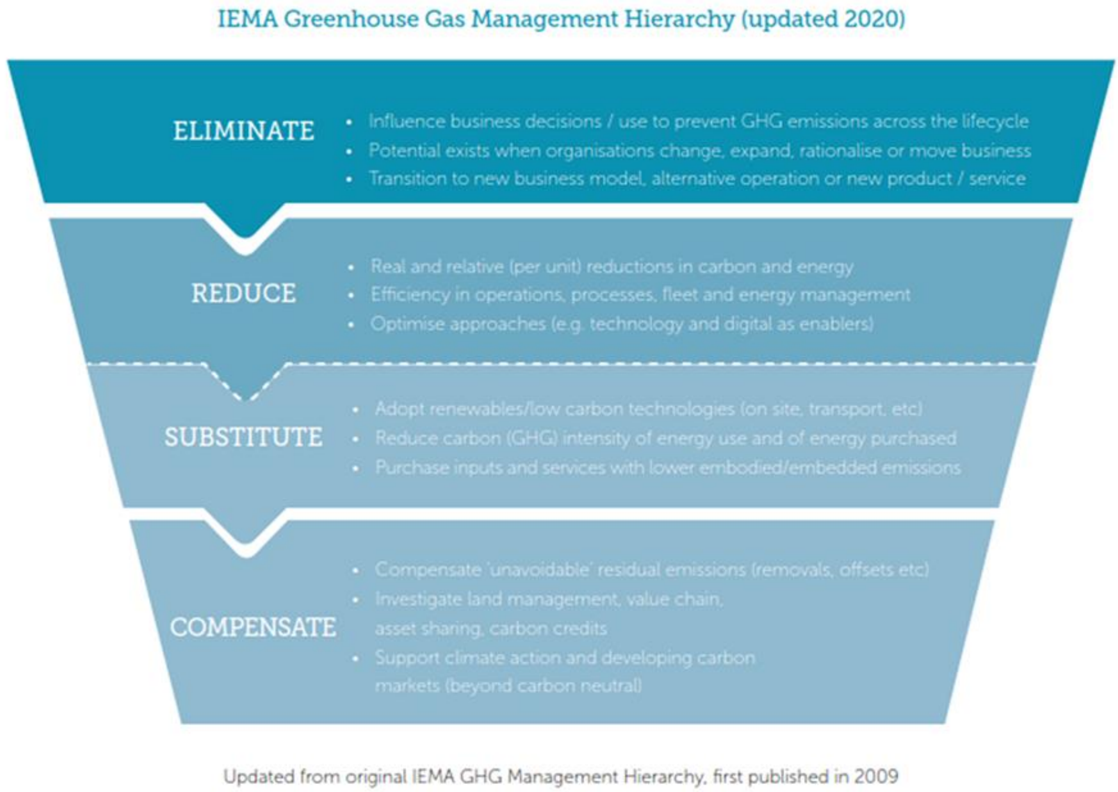
[1] The proposed capacity of the water treatment works and transfer pipelines has been updated since this assessment was completed. The figures quoted in the gate two report include a scheme deployable output of 87Ml/d and works capacity up to 100Ml/d. These changes will be incorporated into future carbon assessments.

- Demonstration of use of relevant policy, frameworks, and approaches to drive down carbon emissions.
- Assessment of key emission areas (scope 1, 2 and 3), considerations for reduction and inclusions of material selection choice (including explanation of where low carbon materials have been discounted).
- Consideration of the impact between cost and carbon reduction.

To respond to the above requirements, this report provides an overview of the current estimate for capital carbon (Section 2) and operational carbon (Section 3). These have subsequently been used to assess the whole-life carbon emissions of the scheme (Section 4). Aspects on which to focus mitigation measures as the scheme moves forward into the next stages of design have been considered in Section 5 and Section 6.

The carbon assessment for Fens Reservoir has followed the IEMA emissions reduction hierarchy shown in Figure 1.1 to identify opportunities to reduce and mitigate carbon emissions from the scheme. This aligns well with the carbon reduction hierarchy from PAS2080 and helps focus initial efforts on reducing emissions rather than offsetting them.

Figure 1.1: IEMA Greenhouse Gas Management Hierarchy



It is acknowledged that a significant proportion of capital and operational carbon emissions associated with the scheme are considered to be Scope 3 emissions and outside of the direct control of the water companies and project team. However, it is also acknowledged that there are significant opportunities to work with the supply chain (prior to scheme delivery) to support accelerated decarbonisation of external systems and supply chains to help reduce the carbon impact. For, example the availability, at sufficient scale, of alternative fuels and construction plant for the earthworks and haulage activities associated with reservoir construction are a key area for engagement to enable decarbonisation of the Fens Reservoir scheme.

The carbon emissions mitigation efforts have been split into two areas:

- Opportunities directly under the control of the project team, including areas which can reduce emissions through design decisions that can be embedded and costed into the scheme.
- Longer term opportunities where the scheme and sector can influence external systems and supply chains to decarbonise major components of the scheme. These longer-term mitigation opportunities have been covered by a collaborative project commissioned by the All Company Working Group (ACWG) which has identified a consistent view across SROs of how these external systems may decarbonise in the future to inform future decarbonisation potential and engagement priorities for individual SROs.

The report then presents priority focus areas of a carbon management strategy for the Fens Reservoir to take forward onto the next stages of design and planning.

Whilst no specific emissions reduction target has been put in place for the Fens Reservoir scheme, the aim of the carbon assessment and strategy is to continue to drive emissions down from the scheme as much as possible whilst continuing to provide the substantial water supply and security value the scheme delivers.

1.3 Uncertainty within carbon estimates and assessment

There is inherent uncertainty in carbon estimating due to the developing maturity of carbon accounting practices and associated data. There is also additional uncertainty driven by scope uncertainty associated with level of design information available at given stages within the project lifecycle.

There is currently no standardised or established guidance to assess uncertainty in carbon estimates in a consistent way and directly applying the range of uncertainty associated with cost estimates and optimism bias would likely overstate the level of uncertainty associated with the gate two carbon estimate.

Whilst further ongoing work is required at a carbon estimating and accounting discipline level and within the infrastructure sector to establish a more formalised approach to assessing carbon uncertainty, a range of +/-30% has been applied based on expert judgement for the gate two estimate. This uncertainty range accounts for:

- Uncertainty in carbon factors related to the quality and representativeness of industry level emissions factors to the specific activities undertaken and materials used on the Fens Reservoir scheme.
- Scope uncertainty associated with ensuring the carbon estimate has captured all scope requirements to fully deliver the scheme.

These uncertainty estimates will be reviewed and refined at future stages of Fens Reservoir design development to build on any further industry wide efforts to assess uncertainty in carbon estimating.

2 Capital Carbon

Under the Greenhouse Gas Protocol, capital carbon emissions from construction are typically categorised as Scope 3 emissions of the sector/organisation. The main Scope 3 categories of relevance for the construction of the Fens Reservoir scheme are:

- Category 1 and 2 – Covering purchased goods and services and capital goods. This will cradle-to-gate embodied carbon emissions associated with construction materials.
- Category 4 – Covering upstream transport of products and materials to the Fens Reservoir location
- Category 5 – Covering waste generated in operations, this could include removal of surplus excavated materials for the reservoir and removal and disposal of site clearance or surplus construction materials.

Capital carbon emissions from construction and maintenance activities are the result of materials (extraction and processing), manufacturing effort, transportation, and any disposal of construction waste. The capital carbon assessments within this section cover lifecycle modules A1-A5 (as per PAS2080:2016) and are only associated with the embodied carbon of materials used and associated construction activities to get the reservoir up to commissioning stage. The assessments also considered a cradle-to-built asset boundary (as per UKWIR, 2012).

Asset construction will be a significant emissions source for most SROs and quantification of these emissions is a key element to identifying efficient mitigation opportunities. This section provides an overview of the capital carbon emissions estimate undertaken for Fens Reservoir and describes some of the key carbon hotspots.

2.1 Capital Carbon Components and Emissions Factors

A capital carbon assessment has been carried out using current design information alongside the breakdown of asset scope inputs used for the gate two cost estimate. The asset information used for costing was aligned to carbon models based on industry standard data to enable an estimate of capital carbon.

The assessment for the reservoir construction activities has predominantly used emissions factor rates from Civil Engineering Standard Method of Measurement (CESMM4), these cover activities such as topsoil stripping, excavation, stockpiling and placing of excavated materials.

Additionally, carbon models have been used to determine capital carbon emissions for other types of assets that would be constructed as part of Fens Reservoir, such as models for site service roads and temporary fencing. These models have been developed using typical industry generic designs and supplier information for products and materials, alongside emissions factor data from the Inventory of Carbon and Energy (ICE).

Typically, CESMM4 factors have been applied to construction activities and ICE database factors have been used for construction material carbon intensities. Over time, as more detail is built into material specifications and specific locations of supply, it is expected that more supplier specific emissions data could be utilised in place of industry generic emissions inventories.

2.2 Summary of Capital Carbon Estimate

The capital carbon assessment has been presented in Table 2.1 and under the standard asset life classes for water resources as proposed in the Cost Consistency Methodology[2].

The capital carbon associated with the construction of the Fens Reservoir is shown in Table 2.1. The breakdown into the ACWG asset life categories helps to identify the aspects which contribute more significantly to higher emissions. The largest capital carbon contributor for the Fens Reservoir is the reservoir, with pipelines and WTW categorised as the other divisions. A full breakdown of the FR capital carbon estimate is shown in Figure 2.2, with the most significant divisions of the reservoir discussed further as capital carbon hotspots.

Table 2.1: Summary of emission sources by water resource planning asset class

Asset types	Scheme area	Capital Carbon tCO_2e	% of scheme capital carbon
Embankment Works	Reservoirs	94,765	38%
Roads and Car Parks	Reservoirs	20,807	8%
Power Supply, Including Renewables	Reservoirs	17,507	7%
Buildings	Reservoirs	5,745	2%
Pipework (within reservoir footprint)	Reservoirs	4,913	2%
Landscaping/Environmental Works	Reservoirs	2,318	1%
Tunnels Sections	Reservoirs	2,034	1%
Planning and Development (Non depreciating)	Reservoirs	1,663	1%
Mechanical and Electrical Equipment	Reservoirs	621	0%
Other Non-Depreciating Assets (Non depreciating)	Reservoirs	469	0%
Fencing	Reservoirs	353	0%
Reinforced Concrete Tanks / Service Reservoirs (80)	Reservoirs	542	0%
Bridges	Reservoirs	286	0%
Water Towers	Reservoirs	129	0%
Ouse to FR (Pipeline)	Transfer pipeline and pump stations	21,884	9%
Ouse Washes Abstraction to FR	Transfer pipeline and pump stations	8,461	3%
FR to Bexwell	Transfer pipeline and pump stations	21,777	9%
FR to Cambridge	Transfer pipeline and pump stations	22,082	9%
Fens WTW	Treatment	20,801	8%
Total		**247,160**	**100%**

[2] Table 4-3 Cost Consistency Methodology Rev E (Feb 2022)

Figure 2.1: Capital Carbon Estimate break down by scheme area

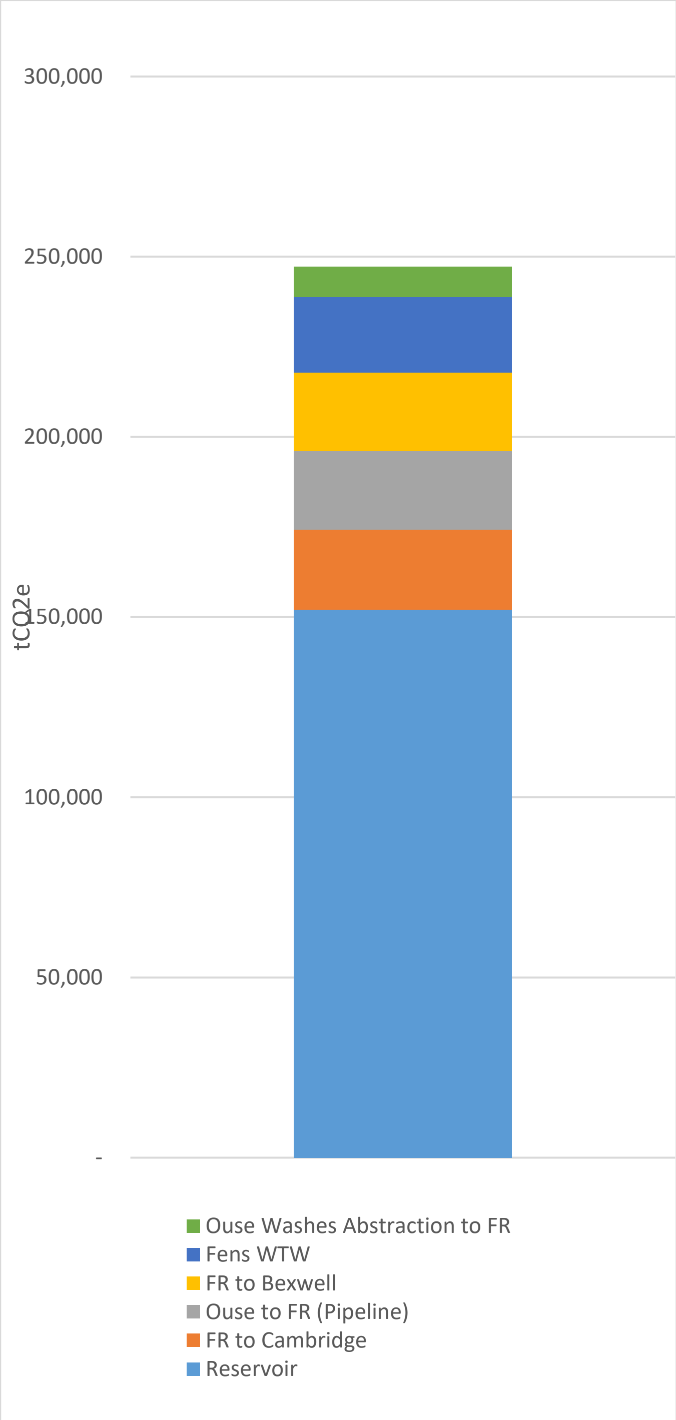


Figure 2.1 highlights the main scheme areas and their contribution to capital carbon. It highlights that the reservoir construction has the most significant capital carbon impact, accounting for 62% (152,150tCO_2e) of capital carbon.

The transfer pipelines are then the next largest contributors, accounting for 30% of scheme capital carbon emissions. This is split between 3 sections of the abstraction and transfer infrastructure, covering:

- Ouse to Fens Reservoir – 9% of capital carbon emissions emission (21,880tCO_2e)
- Ouse Washes Abstraction to Fens Reservoir – 3% (8,460tCO_2e) of capital carbon emissions
- Fens Reservoir to Anglian Water supply – 9%% (21,780 tCO_2e)
- Fens Reservoir to Cambridge Water supply 9% (22,080tCO_2e)

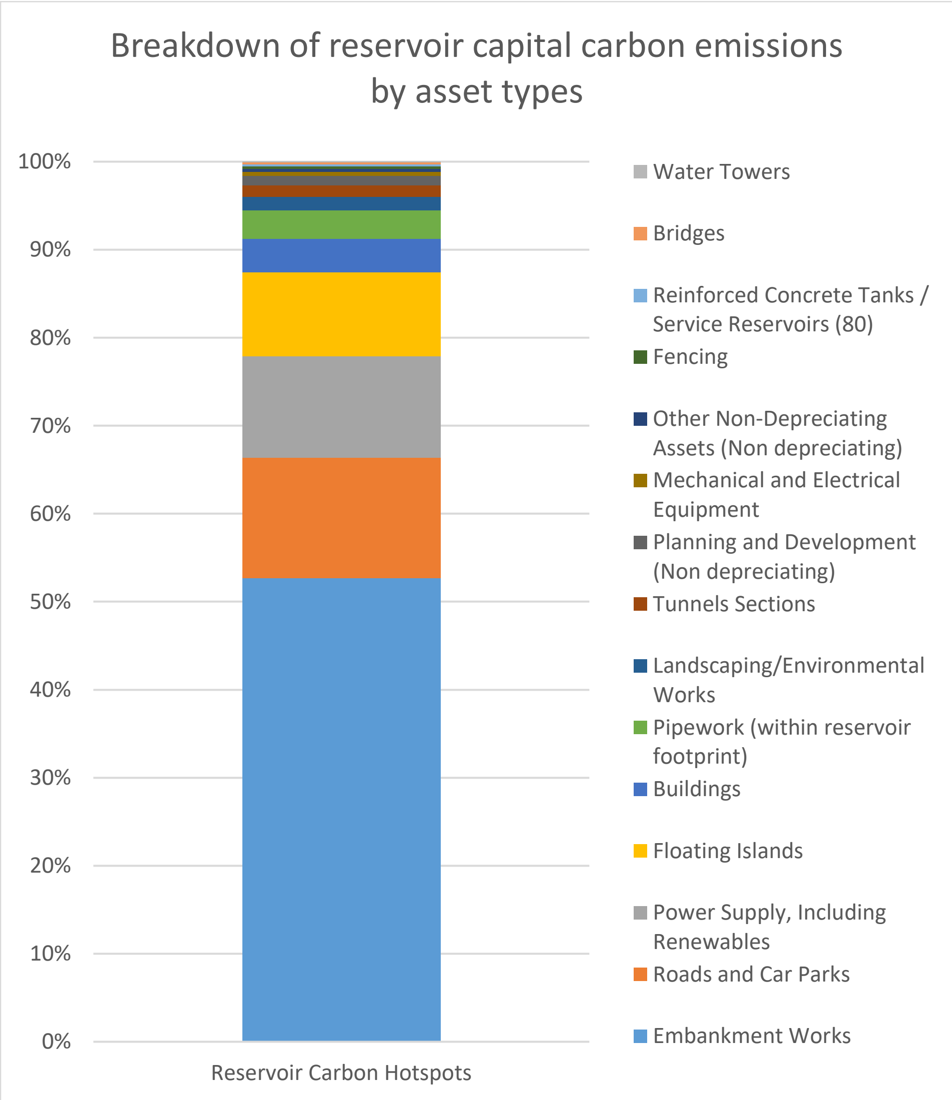
The potable Water Treatment Works (WTW) account for 8% (20,800tCO_2e).

The reservoir construction clearly is the largest emissions contributor but there is still significant scale of emissions and associated decarbonisation opportunities within the transfer pipelines and treatment infrastructure to drive through the scheme development.

2.3 Capital Carbon Hotspots

Figure 2.2 presents a breakdown of the reservoir capital emissions by asset class category. The sub sections below provide an overview of the major hotspots associated with the construction of the Fens Reservoir.

Figure 2.2: Capital carbon breakdown of reservoir construction element of Fens Reservoir scheme



2.3.1 Reservoir Embankment Works

Across all the Fens Reservoir options shown in Figure 2.2, the reservoir embankment works category is the largest carbon hotspot, accounting for 32%% of the total capital carbon. The aspects that are grouped into this category relate primarily to the construction of the reservoir borrow pit and the reservoir embankments; this includes:

- Excavation of the borrow pit;

- Placement of the excavated material from the borrow pit to form the reservoir embankment;
- Importing and placing sand and gravel to create drainage layers within the reservoir embankment; and
- Importing and placing sand, gravel and riprap on the inner face of the reservoir embankment for protection against wave erosion.

The current design for the reservoir is based on achieving a balance between the volume of suitable material that would be excavated from the borrow pit and the volume of material that is required to form the main reservoir embankment. It is also important to ensure that any other material excavated from the borrow pit can be used on the site, so as to remove the need for export and disposal off-site and associated emissions, and the gate two concept design achieves this aim.

2.3.2 Reservoir Roads and Car Parks

The Roads and Car parks are another significant carbon hotspot for the scheme, accounting for 8% of the total capital carbon for the reservoir. The roads and car park category includes:

- Paved routes for cyclists & pedestrians (e.g., from site to March, access from Doddington, access from Chatteris);
- Car parks for visitors to reservoir/surrounding benefits of the scheme; and
- Bridges (associated with the new roads and for various watercourse crossings)

The current roads capital carbon emissions assume a type 1 road construction of paved and unpaved haul roads.

2.3.3 Power Supply (Including Renewables)

The power supply category accounts for 7% of the total capital carbon for the scheme. This category includes the material and construction efforts for:

- Floating & land-based solar arrays to provide power to the scheme
- 2 No. 2MW wind turbines

2.3.4 Transfer pipelines

The various transfer pipelines are also a major emissions source. The majority of the emissions from these is associated with the large diameter steel pipelines currently assumed for the majority of the transfers. There is also a smaller but still significant carbon contribution associated with the excavation, reinstatement and transport elements required to install these pipelines.

2.3.5 WTW

The WTW components are also significant emissions areas. There are a number of hotspots within these components but are dominated by materials associated with process tanks currently assumed to be a mix or reinforced concrete and steel process units within the models used.

2.4 Replacement Capital Carbon

The whole life carbon assessment also provided an estimate of the likely carbon associated with replacing components of the scheme. Table 2.2 provides the asset life category that the capital carbon estimate was broken down into and the expected asset life of each category. These asset life categories have been aligned to those defined in the ACWG Cost Consistency Report[3]. The modelling assumes assets are replaced like for like at the end of their asset life and the initial modelled capital carbon for construction of that asset are repeated at that time. The same asset life categories have been used in the whole life cost modelling to derive the NPV and AIC values.

Table 2.2: Summary of Asset Life categories used in Fens Reservoir whole life carbon assessment

ACWG Asset Life Category	Asset Life (years)
Embankment Works	250
Other Non-Depreciating Assets (Non depreciating)	n/a
Roads and Car Parks	60
Tunnels	100
Treatment and Pumping Station Civils (incl. Intakes)	60
Reinforced Concrete Tanks / Service Reservoirs	80
Landscaping/Environmental Works	30
Pipelines	100
Brick/Concrete Office Structures	50
M&E (Mechanical and Electrical) Works on Pumping Stations and Treatment Works	20
Bridges	40
Underwater Assets	60
Water Towers	60
Fencing	10
Land (Non depreciating)	-

[3] ACWG Cost Consistency Methodology Rev E (February 2022)

3 Operational Carbon

An operational carbon assessment has been undertaken for the Fens Reservoir scheme. These emissions would be considered as Scope 1 and 2 emissions of an organisation under the GHG Protocol, which cover direct and indirect emissions, respectively. Direct emissions in the water sector result from treatment process emissions, fossil fuel use and owned or leased transport emissions. Indirect energy emissions are the product of purchase and use of grid electricity by water company assets notably for water and wastewater pumping and treatment as well as use in buildings. Under the PAS2080:2016 life cycle modules, the current assessment covers use stages B1-B6 modules.

For Fens, the major operational emissions source is through maintenance activities and indirect emissions associated with grid power consumption.

3.1 Summary of Operational Carbon Estimate

Figure 3.1 shows the annual operational carbon emissions for the Fens Reservoir and has been compared at three different timeframes using the BEIS grid carbon intensity forecast:

- 2022 using BEIS grid carbon intensity forecasts 0.139 $kgCO_2e/kWh$
- 2040 using BEIS grid carbon intensity forecasts 0.015 $kgCO_2e/kWh$
- 2080 using BEIS grid carbon intensity forecasts 0.007 $kgCO_2e/kWh$

Figure 3.1: Effect of Grid Decarbonisation on Whole Life Operational Carbon Emission

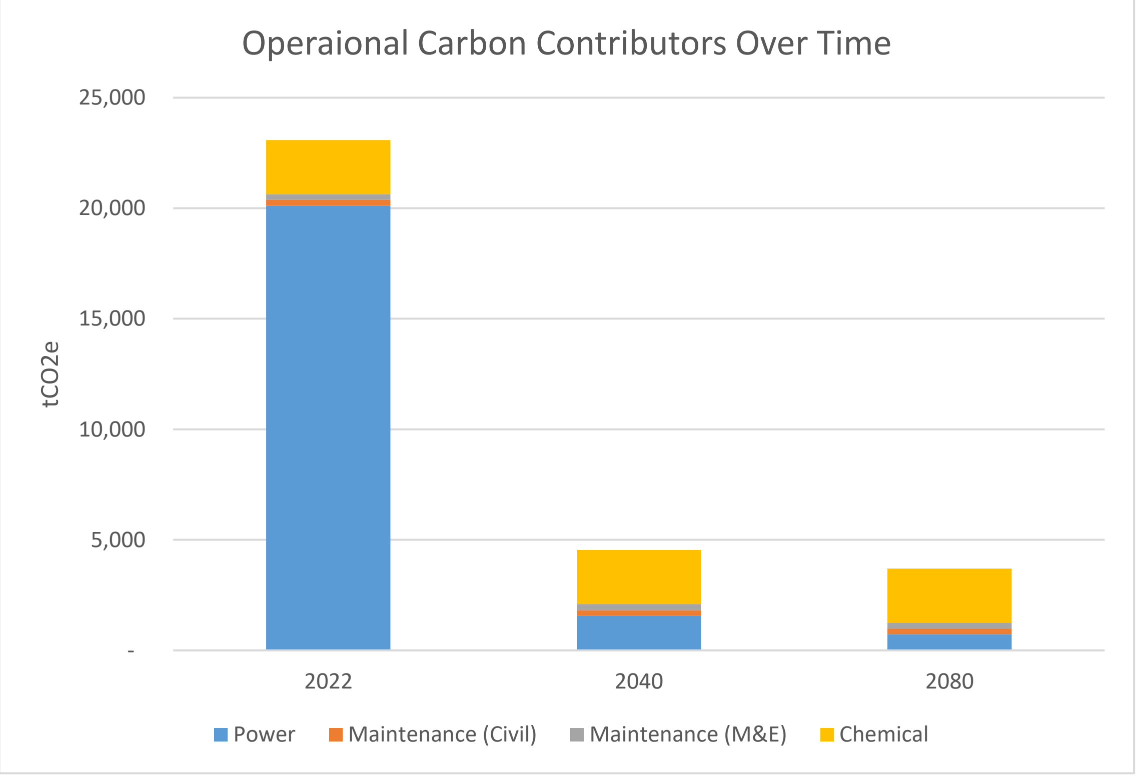


Figure 3.1 demonstrates the impact of the predicted grid decarbonisation on the carbon intensity of the scheme's anticipated power consumption. There is expected to be an 92% decrease in annual power carbon emissions between now (2022) and 2040 and it is predicted that the grid will have largely decarbonised by around 2050.

If the scheme were to move forward, it would only be completed by the late 2030s at the earliest, meaning that the 2040 carbon intensity of power consumption would be more representative of Fens' initial operational carbon.

3.2 Operational Carbon Hotspots

3.2.1 Grid Power Consumption

As noted in Figure 3.1, over time, the significance of power related carbon emissions is expected to decrease as grid decarbonisation projects take effect. With the scheme's earliest first year of operation being in the late 2030s, it is expected that carbon emission intensity should be approximately 13% of its current level. Furthermore, by 2050 the forecast indicates a reduction to 5% of current levels.

3.2.2 Chemicals

The WTW elements have requirement for chemicals and media replacement or reactivation. Post-2040 when the scheme is currently expected to be required to be in operation chemical use is expected to be responsible for 54% of operational emissions in 2040, and 66% by 2060. Unlike power there are no established national or international trajectories for expected levels of decarbonisation of chemicals.

3.2.3 Maintenance (M&E and Civils)

Maintenance associated with the scheme is estimated to account for 12% (6% civils-related, 6% M&E related) of gross operational carbon emissions in 2040.

Annual maintenance carbon estimates have been estimated based on a similar approach to annual operational costs. Annual maintenance costs are based on 0.25% of the initial construction cost of the civil works components (excluding internal embankment works) and 1.5% of the initial cost of the E&M works. Consideration of the typical maintenance activities for reservoirs however indicates that the carbon intensity of these activities would be less than their cost intensity, as they would require relatively limited additional products, materials, and operational consumables. Some examples of the regular maintenance activities that would be required include:

- Valves (Greasing of spindles, ensure regular operation, Replacement of gland packing (occasional), Painting (occasional)
- Pro-active maintenance of M&E equipment, such as, pumps, blowers, generators, water mixing plant and Instrumentation (Check power connections, check for leakage/damage, greasing/oil)
- Turbines (inspection of electrical cabinet and gearbox, oil/lubrication, rotor blade servicing, alignment)
- Maintaining roads (e.g. resurfacing access roads as required)
- Landscape management
- Security fencing inspections

The activities above, while potentially labour / cost intensive, would have relatively limited consumables that would have a direct carbon impact. Furthermore, many of the products or consumables required would have already been accounted for in the replacement capital carbon. The additional operational maintenance carbon emissions are likely to be associated with:

- Transport fuel consumption for the maintenance visits.
- Embodied carbon associated with the limited amounts of grease and M&E replacement parts required.
- Fuel use for landscaping e.g. maintaining grass / vegetation on embankments

Therefore, to estimate carbon emissions associated with maintenance activities an additional factor of 0.1 was applied to account for the reduced carbon intensity of labour-intensive activities. This assessment will be refined at future stages of design development with a bottom-up estimate to account for transport fuel as well as typical products and materials required for operational maintenance.

4 Whole-Life Carbon

4.1 Whole-Life Carbon Estimate Components

The outputs from the capital and operational carbon assessments outlined above have been used to inform a whole-life carbon assessment.

In order to align with whole-life cost estimates, whole-life carbon for Fens Reservoir has been assessed over 80 years (from 2022/23 to 2101/02) with the following assumptions based on initial outputs from WRE Emerging Regional Plan:

- A 4-year planning and development period (2025/26 – 2028/29) during which carbon emissions are assumed to be negligible.
- An 6-year construction period (2029/30 – 2035/36) during which the capital carbon emissions as described in Section 2 are applied.
- A 65-year operation period (2036/37 – 2101/02) during which the replacement capital carbon emissions as outlined in Section 2.3 are applied alongside the annual operational carbon emissions as described in Section 3.

Whilst capital carbon associated with replacements have been considered (see Section 2.3) the quantified assessment does not include for estimating the potential impact of decommissioning the scheme. The operational life is expected to be over 100 years and it is anticipated that the systems in place to re-use, recycle or dispose of assets would be substantially different to present day.

4.2 Summary of Whole-Life Carbon Estimate

A summary of estimated whole-life carbon emissions is presented annually in Figure 4.1. A summary of estimated cumulative whole-life carbon emissions is presented annually in Figure 4.2.

Table 4.1 provides a summary of the estimated whole life carbon results, with Table 4.2 showing a breakdown of how these are split across different carbon categories. The capital carbon emissions account for around 54.7% of emissions across the whole-life carbon estimate, with a further 12.3% associated with capital replacements of the assets across the 80-year period.

The operational carbon emissions are split into those associated with chemicals and maintenance (non-power) and power consumption (power related); these account for 27.9% and 5.1% of the whole-life carbon emissions respectively.

The large capital replacement emissions in 2096-98 are associated with the replacement of large civil components, such as roads, the river intake / outfall structure, and the pumping station. These, as shown in Table 2.2, are assumed to have an asset life of 60 years.

Figure 4.1: Fens Reservoir – Whole-Life Emissions by Category (Annual)

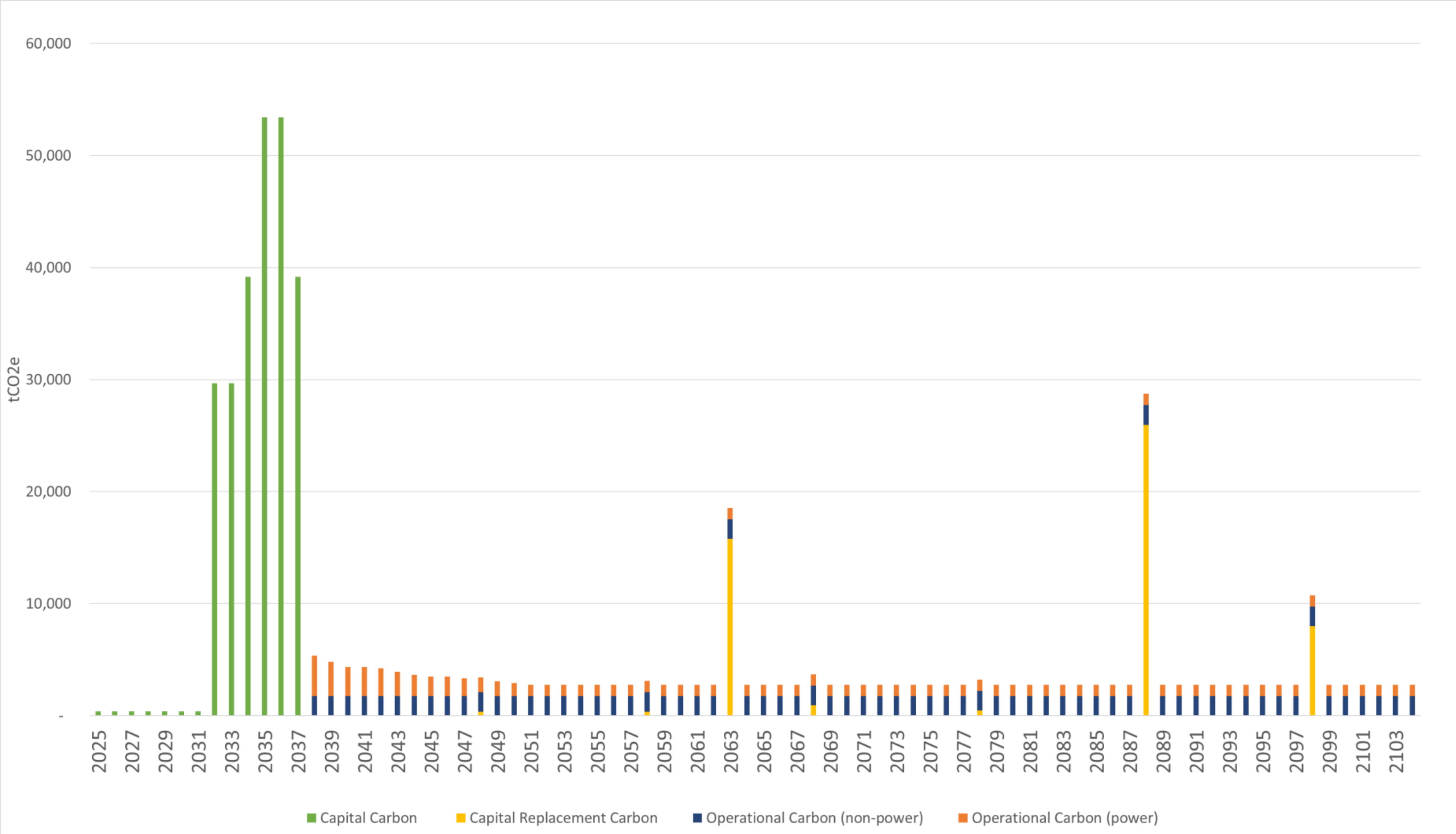


Figure 4.2: Fens Reservoir – Whole-Life Emissions by Category (Cumulative)

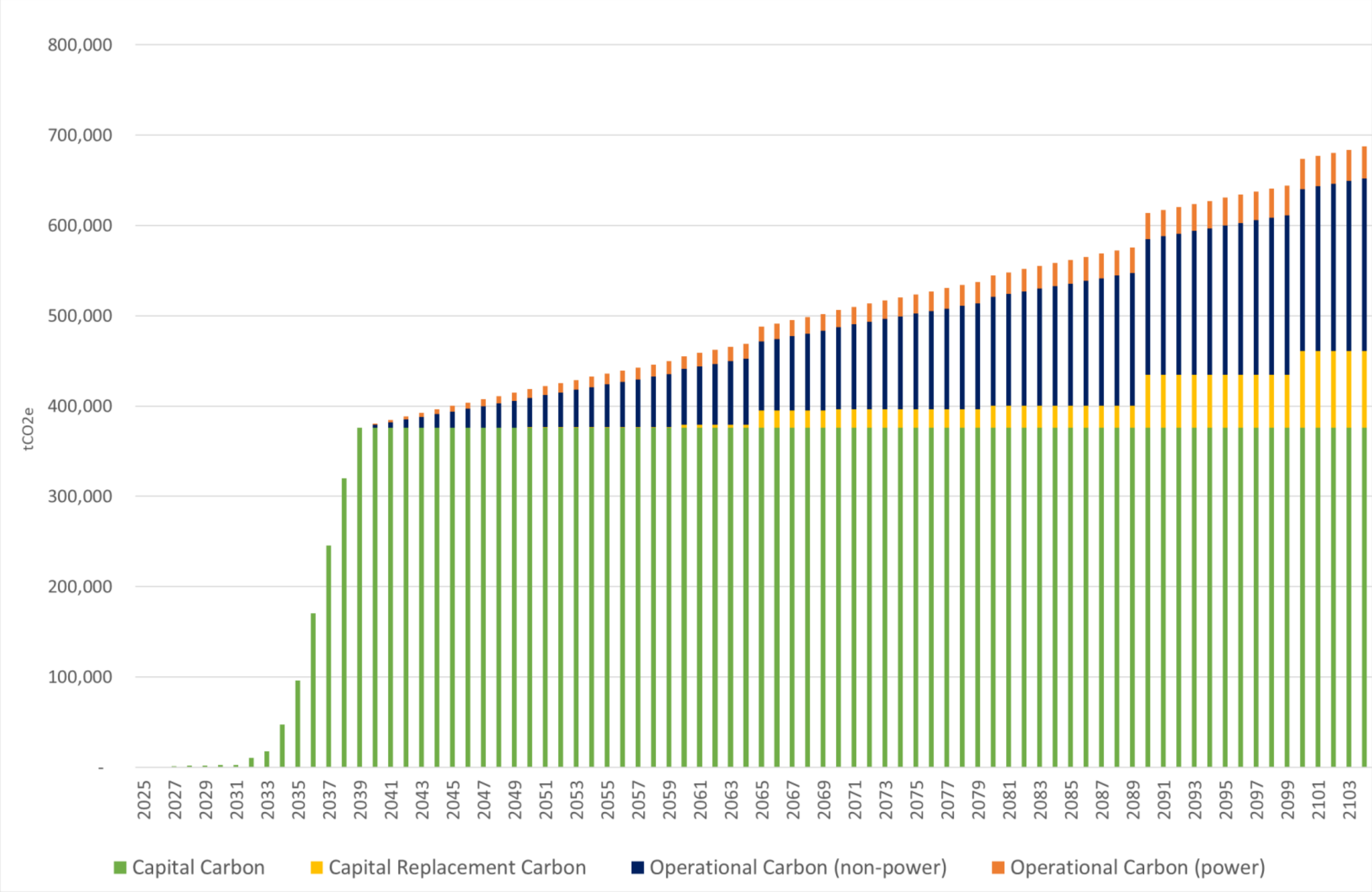


Table 4.1: Summary of whole life carbon emissions and associated carbon NPV

Emissions type	tCO2e	% 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	**498,250**		**84.5**	

5 ACWG Carbon Mitigation Reservoir Assessment

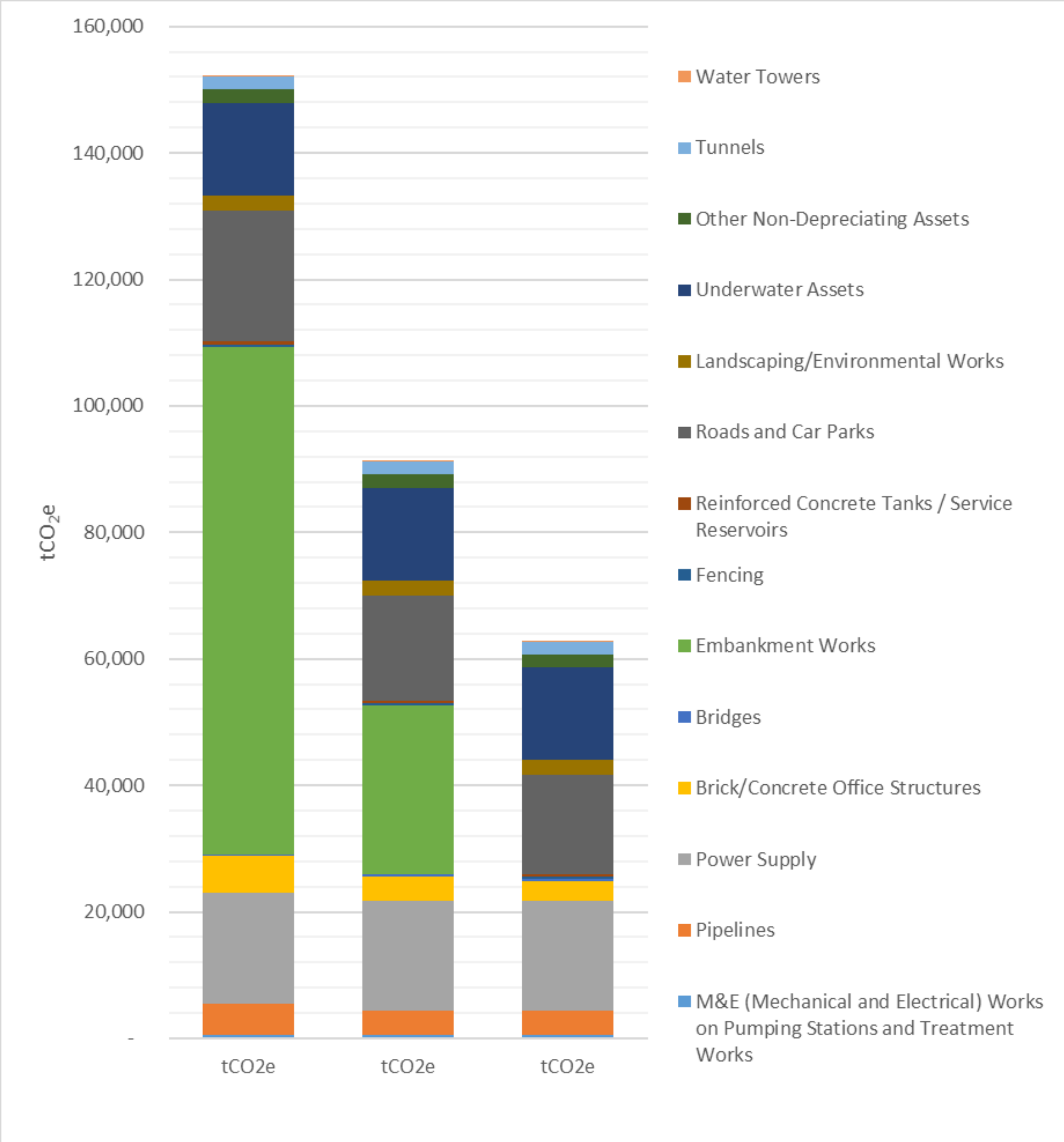
The All Company Working Group (ACWG) commissioned a study to identify potential decarbonisation opportunities for the different types of SROs with a focus on 'build clever' and 'build efficiently' measures. 'Build-nothing' and 'build less' measures in the PAS 2080 carbon reduction hierarchy (or 'eliminate' and 'reduce' measures as noted in the IEMA framework shown in Figure 1.1) are site specific and will have been considered through regional planning and earlier design development stages.

The ACWG - Low capital carbon alternatives for SROs study identified that, for reservoirs, the majority of carbon emissions would be associated with on-site excavation, production of quarried material off-site, transporting materials to and from site, and the construction plant on site. This aligns with the assessment for Fens Reservoir outlined in the previous sections of this report. The ACWG report also found that for large diameter transfer pipelines, the majority of carbon emissions are associated with the chosen pipe material.

The majority of carbon emissions, as highlighted in the capital and whole life carbon assessment, arising from the Fens Reservoir are associated with initial construction with earthworks activities, including importing material to site; excavating material from the borrow pit; and moving / placing material on site. The Fens Reservoir concept design has already mitigated some of the associated emissions by, for example, the site selection exercise that identified a site where a cut fill balance could be achieved reducing the need for imported materials or disposal of surplus materials. Whilst these have been considered in the development of the scheme to date this section focusses on the potential decarbonisation opportunities possible linked to external system decarbonisation through collaboration with the supply chain and provides some indicative estimates of the scale of carbon reductions that may be possible based on the scenarios produced in the ACWG report.

Figure 5.1 presents an interpretation of the mid and best-case scenarios from the ACWG report, which has been used to derive % reductions against each of the tCO_2e values for each asset class, as presented in Table 5.1. The ACWG report looked at three different time horizons to estimate how decarbonisation opportunities may change over time. The results presented in Figure 5.1 represent the time period between 2025 and 2040, which aligns with the expected programme of the FR scheme. This timeframe is governed by the water resources modelling of when the additional water resource will be required, hence alternative timeframes have not been reviewed at this time. These reduction opportunities currently only focus on the major hotspots of the reservoir construction but will be further reviewed in regard to the transfer pipelines and treatment components at the next gate stages.

Figure 5.1: Possible reductions in capital carbon emissions through review of ACWG Low capital carbon alternatives for SROs (for 2025-2040 construction period)



The application of the possible reductions available through the ACWG study show potential reductions in capital carbon between 40% in the mid-case and 59% in the best case. These are purely indicative scales of emissions reduction possibilities based on the high-level study undertaken by the ACWG and extrapolated through the Fens Reservoir scheme. A continued in-depth review of decarbonisation opportunities will continue as part of the scheme development and priority areas of focus are presented within Section 6.

Table 5.1: Summary of asset classes and % capital carbon emissions reductions applied under ACWG mid and best-case scenarios

	Base case	ACWG Mid-case		ACWG best-case	
	tCO2e	% Reduction	tCO2e	% Reduction	**tCO2e**
M&E (Mechanical and Electrical) Works on Pumping Stations and Treatment Works	620		620		620
Pipelines	4,910	25%	3,680	25%	3,690
Power Supply	17,510		17,510		17,510
Brick/Concrete Office Structures	5,750	33%	3,830	46%	3,100
Bridges	290		290		290
Embankment Works	80,180	67%	26,730	100%	-
Fencing	350		350		350
Reinforced Concrete Tanks / Service Reservoirs	540	20%	430	24%	410
Roads and Car Parks	20,810	20%	16,650	24%	15,750
Landscaping/Environmental Works	2,320		2,320		2,320
Underwater Assets	14,580		14,580		14,580
Other Non-Depreciating Assets	2,130		2,130		2,130
Tunnels	2,030		2,030		2,030
Water Towers	130	20%	100	24%	100
	152,150	40%	91,250	59%	62,880

Note: blank values represent asset classes where the ACWG did not review potential reduction opportunities as they were not significant hotspot areas within the reference designs reviewed in their study. The carbon reduction potential of these asset classes can be reviewed by each individual scheme further as the design develops.

6 Fens Reservoir Carbon Mitigation Strategy Recommendations

The carbon assessment and analysis presented above has been used to inform focus areas for carbon mitigation efforts. Some of these have already been implemented as part of the development of the gate two design, while others are identified as future strategic priorities. If the scheme is to continue to the next stage of design development, the carbon mitigation strategy will also need to advance. This would involve acting on recommendations from the ACWG study (discussed in Section 5) including engagement with relevant external stakeholders.

Section 6.1 below summarises capital carbon mitigation measures already considered as well as those identified for consideration and the next stage of design development. An initial list of stakeholders for engagement is also provided in Tables 6.1 and 6.2, which could help broaden the dialogue and promote early collaboration to maximise opportunities and accelerate the pace emissions reductions.

6.1 Capital Carbon

6.1.1 Capital Carbon Mitigation Incorporated into Current Design

Table 6.1 highlights the areas of carbon mitigation that have already been embedded into the scheme design to help reduce whole life carbo impacts.

Table 6.1: 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 site 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 and other power users to maximise value of renewables in the region.

6.2 Capital Carbon Mitigation Opportunities

Carbon mitigation opportunities have been identified during gate one and gate two for ‘build clever’ and ‘build efficiently’ stages in the carbon reduction hierarchy, these range in potential impact and feasibility with some being relatively easy to implement, and others requiring further work to understand their feasibility. The following areas shown in Table 6.2 will continue to be explored as part of the carbon mitigation strategy for Fens Reservoir:

Table 6.2: 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

As Table 6.2 shows there is significant need for a collaborative approach with a range of regional stakeholders and the supply chain to maximise the decarbonisation opportunities presented above. This engagement will form an important part of the scheme development going forward from the next design stages and through to delivery.

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 Table 6.2 shows there is significant need for a collaborative approach with a range of regional stakeholders and the supply chain to maximise the decarbonisation opportunities presented above. The nature of this engagement needs to be planned further taking into account potential barriers of meaningful and detailed engagement with the supply chain until an established procurement process is in place. This may also mean that some of this engagement activity will need to be managed by a future Competitively Appointed Provider (CAP), and consideration will need to be made on how the appointment of a CAP and associated contracts can effectively integrate carbon mitigation requirements.

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.

mottmac.com