Hampshire Water Transfer and Water Recycling Project

Environmental Statement – Appendix 10.1 Carbon assessment methodology

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1 Carbon assessment methodology

1.1 Introduction

1.1.1 This appendix presents the methodology for the carbon assessment, specifically the activity data, emission factors and assumptions used for calculating emissions arising from the Hampshire Water Transfer and Water Recycling Project (hereafter referred to as the 'Proposed Development'). The carbon assessment for the Proposed Development for the Environmental Statement (ES) is derived from carbon modelling that is being undertaken as part of the Regulator's Alliance for Progressing Infrastructure Development (RAPID) gated process, which aims to accelerate the development of new water infrastructure [1].

1.1.2 This report is a technical appendix to ES Chapter 10 Carbon and climate change, Volume I (Document reference 6.1, DCO Volume 6).

1.2 Overview of approach

Approach

1.2.1 The methodology for the carbon assessment has been developed in accordance with the following guidance:

1. Institute of Sustainability and Environmental Professionals (ISEP) (formerly the Institute of Environmental Management and Assessment) Assessing Greenhouse Gas Emissions and Evaluating their Significance (2022) [2]
2. The National Policy Statement for Water Resource Infrastructure (NPSWRI) [3]
3. The British Standards Institution (BSI), PAS 2080:2023 Carbon management in building and infrastructure (2023) [4]
4. UK Water Industry Research (UKWIR), a framework for accounting for embodied carbon in water industry assets (2012) [5]
5. UKWIR (2022) Calculating whole life/TOTEX Carbon [6]
6. European Standard (2019) EN15804 [7]
7. The Department for Business, Environment, and Industrial Strategy (BEIS) (2023) Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions appraisal [8]

1.2.2 As outlined in ES Chapter 10 Carbon and climate change, Volume I (Document reference 6.1, DCO Volume 6), the term 'carbon' used in this appendix refers to all greenhouse gases (GHGs) referenced in the Kyoto Protocol.

1.2.3 Whole life carbon emissions associated with the Proposed Development have been calculated in accordance with the PAS 2080:2023 framework. The boundary of the assessment includes activities required to construct, operate and decommission the following principal components of the Proposed Development:

1. Water Recycling Plant (WRP) site
2. Pipelines between Budds Farm Wastewater Treatment Works (WTW) and the WRP site

3. Pipelines between the WRP site and Bedhampton Springs
4. Pipelines between the WRP site and Otterbourne Water Supply Works (WSW)
5. Above Ground Plant (AGP)

1.2.4 Emissions from the proposed works at the Invasive Non-Native Species Treatment at Otterbourne WSW and utility connections at the WRP site and AGP, outlined in ES Chapter 3 Description of the Proposed Development, Volume I (Document reference 6.1, DCO Volume 6) are covered risk and contingency allowances as discussed in section 1.7.

1.3 Construction carbon

Scope of construction emissions

1.3.1 The carbon assessment of construction phase emissions considered a cradle-to-built asset boundary as per the UKWIR [5] framework as detailed in Graphic 1-1. The cradle-to-built asset boundary includes emissions from the extraction, transportation and processing of raw materials used to create a product or material, the delivery of materials from the factory to site, on-site construction activities and the off-site disposal of any waste.

Graphic 1-1 Cradle-to-built asset coverage of carbon assessments

1.3.2 A breakdown of the asset groups and construction activities included in the assessment to quantify carbon emissions from the construction of the Proposed Development are listed below:

1. Civil works such as excavation, earthworks, foundation construction and tunnelling
2. Pipeline installation (e.g. open-cut trenching)
3. Structural components, including process plants/buildings/pumping stations

4. Materials and products with available emissions data from industry-standard sources (e.g. Inventory of Carbon and Energy (ICE) database [9])
5. Temporary works where emissions are significant and quantifiable

Data sources

1.3.3 Several data sources were used to predict carbon emissions from the construction of the Proposed Development. These are listed in Table 1-1.

Table 1-1 Construction carbon modelling data sources

Source of Data	Description
Mott MacDonald's library of industry-standard carbon models	Mott MacDonald's carbon models are based on typical industry design in the Water Sector, and supplier information for products and materials.
ICE Standard Method of Measurement (CESMM4) [9] - Carbon and Cost Price Book	The ICE database provides an inventory of embodied carbon emissions data for construction materials based on statistical analysis of a range of data sources from lifecycle assessments. The data sources vary in quality for different construction materials, dependent on what level of analysis has been undertaken within those sectors, e.g. concrete and steel factors have a larger and more comprehensive set of lifecycle assessment datasets. This dataset also provides carbon unit rates for typical construction activities, such as excavation, backfilling, and reinstatement. It should be acknowledged that the dataset was last updated in 2013, and there has been a decarbonisation of many sectors and efficiency improvements over the last ten years. The emission factors used from the CESMM are therefore considered to be conservative.

Methodology

1.3.4 The carbon assessment for the construction phase was undertaken using the latest design information and the asset scope breakdown used in the RAPID Gate 3+ cost estimates for the Proposed Development. The asset data informing the Proposed Development's cost estimates were used with the Mott MacDonald carbon model, developed with industry-standard datasets, to extract material quantities. Embodied carbon emissions were then estimated using ICE emission factors [9].

1.3.5 Carbon emissions from on-site construction activities such as fuel consumption by plant and equipment were estimated using emission factors from CESMM4 for activities such as topsoil stripping, excavation stockpiling, and placing of excavated materials [9].

1.3.6 Additionally, carbon models have been used to determine the carbon emissions for specific types of assets in the Proposed Development such as open-cut pipeline installation. These models have been developed using industry-standard generic designs and supplier information for products and materials, alongside ICE emission factors [9].

1.3.7 Emissions were calculated over the anticipated five year construction period. It was assumed that there was no decrease in the carbon intensity of construction related activities during this period to present a conservative assessment.

1.3.8 Carbon emissions from waste arisings during the construction phase of the Proposed Development were calculated based on the following assumptions:

1. In-trench pipework:
   a. Excavated materials:
      i Round trip transport distances based on CESMM4 emission factors and applicable vehicle types [9]
      ii 250mm topsoil layer assumed to be stored on-site for reuse with stockpiles 100m away from the excavation
      iii 20% of the surplus excavated materials are disposed off-site at a site 15km away, an assumption accessed from CESMM4 [9], which was a conservative approach compared to other waste disposal options in the model
   b. Materials – it was assumed that 2% of the total pipe materials would be wasted through the construction process to present a conservative approach.
2. Tunnels/shafts:
   a. Excavated materials:
      i Round trip transport distances are as per the assumption for In-trench pipework
      ii Tunnels: 100% of excavated material disposed off-site at a site 15km away, which is a conservative assumption from CESMM4 [9]
      iii Shafts: 100% of excavated material disposed off-site at a site 15km away, which is a conservative assumption from CESMM4 [9]
   b. Material:
      i Tunnels: 2% of precast material used is assumed to be disposed of during the construction process
      ii Shafts: 2% of precast segments, concrete for slab/platforms/plug, manhole cover and brickwork and manhole handrail and rope material are assumed to be disposed of during the construction process
3. Most major civil assets buildings/tanks
   a. 5% of materials prefabricated off-site will be disposed of during the construction process (e.g. piling, blinding, base slabs/rebar).

1.4 Operational carbon

Scope of the operational emissions

1.4.1 The operational carbon assessment includes emissions from the operation and maintenance of the Proposed Development over an anticipated 100-year operational lifespan.

1.4.2 The scope of operational carbon assessment encompasses activities which would be classified as Scope 1, 2 and 3 emissions within the GHG Protocol [16]. The emissions within each scope include:

1. Scope 1 emissions, which are direct emissions from the Applicant's controlled assets
2. Scope 2 emissions, which are indirect, resulting from the purchase and use of grid electricity
3. Scope 3 emissions, which are associated with activities undertaken within the Applicant's value chain (e.g. chemicals purchased from a supplier)

1.4.3 The emission sources considered in the assessment are:

1. Emissions from grid power consumption (e.g. pumping)
2. Emissions from regular transport activities (e.g. treatment chemical deliveries)
3. Emissions from operational material use (e.g. chemical use in water treatment)
4. Emissions from operational maintenance, including annual/routine operational maintenance activities for civil works and Mechanical, Electrical, Instrumentation, Controls and Automation assets
5. Emissions from the replacement of assets and infrastructure

1.4.4 The operational carbon assessment has been undertaken based on the flow regimes provided by the Applicant, which are summarised in Table 1-2.

1.4.5 The timescale and flow regime are based on the mean 'Full Period' flows. This includes both flows under both normal and drought conditions, and the use of mean flows is considered a reasonable likely worst case for the carbon assessment. These assumptions directly affect the volume of water transferred, the consumption of electricity and chemicals, and the frequency of maintenance activities.

Table 1-2 Flow regimes used in the operational carbon analysis

Flows (mean)	For 2034-2039 (Ml/d)	For 2040-2049 (Ml/d)	For 2050+ (Ml/d)
WRP site to Bedhampton Springs Transfer	20.1	51.0	60.0
Bedhampton Springs to Otterbourne WSW Transfer	26.3	43.6	46.9

1.4.6 The corresponding estimated annual operational power consumption for the Proposed Development, under the mean 'Full Period' flows presented in Table 1-2, are shown in Table 1-3.

Table 1-3 Annual operational power consumption

Annual Power Consumption	For 2034-2039 (kWh/year)	For 2040-2049 (kWh/year)	For 2050+ (kWh/year)
WRP site to Bedhampton Springs Transfer	21,488,296	24,439,252	37,822,578
Bedhampton Springs to Otterbourne WSW Transfer	18,870,537	11,486,079	24,243,725

Data sources

1.4.7 The data sources used in the operational carbon emission carbon assessment are detailed in Table 1-4.

Table 1-4 Operational carbon modelling data sources

Emission sources	Data sources
Power consumption from grid	The quantity of power consumed is based on the flow regime described in Table 1-5, accessed from the operational cost estimates provided by the Applicant. Emission factors for grid electricity were accessed from the Department for Energy Security and Net Zero (DESNZ) Green Book supplementary guidance data tables [12]. This dataset includes future projections of the emissions intensity of the grid (in $kgCO_2e/kWh$), taking account of projected grid de-carbonisation from 2029-2100. It was assumed that emission factor for consumption of electricity from the grid would be constant after 2100. The current UK grid carbon intensity from the DESNZ Green Book supplementary guidance data tables [12] accounts for transmission and distribution losses, including those resulting from inefficiencies across the grid system.
Transport	Estimated transport requirements have been taken from the operational cost estimates provided by the Applicant. Where available, emission factors have been accessed from the UKWIR Carbon Accounting Workbook (CAW, which provides data in units of tCO_2e/km travelled. It is assumed that standard operational journeys are completed by van whilst heavy goods vehicles (HGVs) are used for transporting chemicals.
Operational material use (chemical use)	Chemical consumption data have been accessed from the operational cost estimates provided by the Applicant. Where available, emissions factors for chemical use were taken from the UKWIR CAW. Where not accessible from the CAW, an emissions factor for carbon dioxide equivalent (CO_2e) was found from industry data specific to the water sector.
Operational maintenance activities	Carbon emissions associated with operational maintenance activities include emissions resulting from civil works and mechanical and electrical works. These are assumed to be 0.025% and 1.5% of the construction carbon emissions, respectively.

Replacement carbon

1.4.8 The requirement to replace components of the Proposed Development would result in the release of carbon emissions over the lifetime of the Proposed Development. Where possible, assets of the Proposed Development were assigned an Asset Life Category, as detailed in Table 1-5. This aligns with the All Company Working Group (ACWG) [12], which provides guidance aligned with the RAPID process to calculate replacement carbon emissions. To provide a precautionary assessment, it has been assumed that when an asset is replaced, the entire carbon emissions from its installation during the construction phase would be repeated. The asset life presented in Table 1-5 differs from the expected design life of assets presented in ES Chapter 3 Description of the Proposed Development, Volume I (Document reference 6.1, DCO Volume 6) due to the use

of the ACWG asset categories as part of the RAPID process. However, the asset lives listed in Table 1-5 were used in the carbon assessment to provide a precautionary assessment.

Table 1-5 All company working group asset life categories

ACWG Asset Life Category	Asset Life (years)
Embankment Works	250
Pipelines	100
Tunnels	100
Weirs	100
Reinforced Concrete Tanks/Service Reservoirs	80
Roads and Car Parks	60
Treatment and Pumping Station Civils (incl. Intakes)	60
Bridges	40
Landscaping/Environmental Works	30
Steel/Timber/Glass Reinforced Plastic Structures	30
Mechanical and Electrical Works on Pumping Stations and Treatment Works	20
Building services	10
Fencing	10

1.5 Decommissioning

1.5.1 As detailed information regarding the potential decommissioning activities and downstream end-of-life processes are not yet available at the time of assessment, a high-level emissions estimate was included in the carbon model. Assessment of the decommissioning emissions includes a high degree of uncertainty, as information regarding the carbon intensity of activities in over 100-years time is not known, and end-of-life strategies are likely to emerge and evolve over the same timescale.

1.5.2 Emissions during decommissioning were quantified in the carbon model based on the activities, assumptions and data presented in Table 1-6.

Table 1-6 Activities included within the high-level decommissioning carbon estimate

Activity	Assumption	Source of the Emissions factor
Capping the main pipeline route	Assumes the main 900mm pipeline (Sections E-M) is capped at both ends, with concrete being injected to fill 5m of the length	ICE database: Concrete RC40/50 with CEM I cement [9]
General demolition of the WRP site and AGP	General demolition activities over within the Order Limits of the WRP site and all AGPs	CESMM4 [9]

Activity	Assumption	Source of the Emissions factor
Backfilling the demolished areas within the Order Limits; this includes backfilling any voids with granular materials to produce a consistent level surface. The backfilled area would then be topsoiled and seeded to restore original landscape level and surface.	Filling the demolished areas within the Order Limits with imported topsoil	CESMM4 [9]

1.6 Other emissions areas

Direct emissions sources from land use change

1.6.1 Potential carbon emissions associated with land use change have been considered as part of the carbon assessment. It is acknowledged that the proposed location of the WRP site is situated above an existing landfill site. However, upon review of ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume 6) it was found that the risk of methane emissions from landfill is very low and is not expected to be influenced by the construction or operation of the Proposed Development. Therefore, no fugitive emissions from landfill have been included in the carbon assessment.

Carbon sequestration

1.6.2 As part of the design of the Proposed Development, carbon is likely to be sequestered (or removed) due to changes in land use associated with the landscaping activities within the Order Limits of the Proposed Development. The most notable opportunities for sequestration are likely to be at the AGPs along the main pipeline route.

1.6.3 However, the scale of these sequestration benefits is assumed to be negligible in comparison to the whole life carbon emissions associated with the construction and operation of the Proposed Development. Therefore, the potential sequestration emissions were not included in the carbon assessment.

1.7 Uncertainty in the carbon emissions modelling

1.7.1 There is inherent uncertainty in carbon estimation due to the evolving nature of carbon accounting practices, the variability and limitation of emissions factor data and the developing scientific understanding of emissions sources, such as emissions associated with land use change (direct emission and sequestration opportunities).

1.7.2 There is additional uncertainty driven by the scope and level of detail available at different stages of a project lifecycle. The following sources have been used to guide the estimation of the uncertainty associated with the carbon assessments:

1. The Royal Institution of Chartered Surveyors (RICS) has issued standard guidance on managing uncertainties in Whole Life Carbon Assessment for the built environment [13].

2. The cost estimating risk review process, undertaken to identify potentially unforeseen project costs produced in parallel with the carbon assessment.

1.7.3 The following key components were used to estimate the total carbon uncertainty factor following the RICS guidance and the cost estimating process:

1. Contingency Factor (14%): Estimated on an element-by-element basis using the RAPID Gate 3 cost risk register. Only cost items with material quantity implications were included. The resulting carbon risk exposure was found to be consistent with RICS default values for early design stages.
2. Carbon Data Uncertainty Factor (7%): Due to limited data at this stage of the design process, the maximum RICS uncertainty value was applied as a conservative estimate, reflecting potential variability in emission factors.
3. Quantities Uncertainty Factor (4%): Similarly, the highest RICS uncertainty value was assumed, given the early stage of quantity definition.

1.7.4 These components were combined to produce a total carbon uncertainty factor of 24.7%, which has been applied to the construction carbon and replacement carbon emissions estimate. This uncertainty factor was considered to also include emission activities from minor connection works to existing infrastructure and any required utility connections required for the Proposed Development.

References

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