OXFORDSHIRE
STRATEGIC RAIL FREIGHT INTERCHANGE

Environmental Statement

Chapter 15: Climate Change
Appendix 15.2: Greenhouse Gas Technical Appendix

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On behalf of
Oxfordshire Railfreight Limited

Prepared by RPS Ltd.
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Oxfordshire Strategic Rail Freight Interchange

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1.1 Overview

1.1.1 This appendix to Chapter 15: Climate Change sets out the methodology, calculations and magnitude of the greenhouse gas (GHG) emissions associated with Proposed Development. These calculations and resultant magnitudes of GHG emissions inform the assessment of climate change impacts in Chapter 15. This appendix should be read in conjunction with the chapter, as supporting information.

1.1.2 For ease of reading, the headings match those in Chapter 15: Climate Change, where sections are relevant to the GHG emissions assessment.

1.2 GHG Emissions Assessment Methodology

1.2.1 The GHGs considered in this assessment are those in the 'Kyoto basket' of global warming gases expressed as their CO_2-equivalent (CO_2e) global warming potential (GWP). This is denoted by CO_2e units in emissions factors and calculation results. GWPs used are typically the 100-year factors in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC, 2013) or as otherwise defined for national reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

1.2.2 GHG emissions caused by an activity are often categorised into 'scope 1', 'scope 2' or 'scope 3' emissions, following the guidance of the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol suite of guidance documents (WRI and WBCSD, 2004):

- Scope 1 emissions: direct GHG emissions from sources owned or controlled by the company, e.g. from combustion of fuel at an installation.
- Scope 2 emissions: caused indirectly by consumption of purchased energy, e.g. from generating electricity supplied through the national grid to an installation.
- Scope 3 emissions: all other indirect emissions occurring as a consequence of the activities of the company, e.g. in the upstream extraction, processing and transport of materials consumed or the use of sold products or services.

1.2.3 This appendix has sought to include emissions from all three scopes, where this is material and reasonably possible from the information and emissions factors available, to capture the impacts attributable most completely to the Proposed Development. These emissions shall not be separated out by defined scopes (scopes 1, 2 or 3) in the assessment.

1.2.4 GHG emissions from all relevant life cycle stages of the Proposed Development have been calculated in a life cycle assessment. A life cycle assessment comprises an evaluation of the inputs, outputs and potential environmental impacts that occur throughout the lifecycle of a particular project, encompassing either a cradle-to-gate (project site) or a cradle-to-grave (accounting for in use and decommissioning) approach. This can be further broken down into the following Lifecycle Carbon Assessment (LCA) phases of development, in line with RICS (2023):

- Materials and construction (A1-A5)[1].

[1] Carbon life-cycle stages A1-A3 refer to the 'product' stage embodied emissions (i.e. the emissions associated with the extraction, processing and manufacturing of building materials). Carbon life-cycle stages A4 and A5 refer to the 'construction' stage embodied emissions (i.e. the emissions associated with the transport of building materials to the construction site and all construction processes on-site) (RICS, 2024).

- Operations and maintenance (B1-B8)[2].
- Decommissioning (C1-C4).

1.2.5 GHG emissions have been estimated by applying published emissions factors to activities in the baseline and to those required for the Proposed Development. The emissions factors relate to a given level of activity, or amount of fuel, energy or materials used, to the mass of GHGs released as a consequence. The sources of GHG emissions considered in this assessment, and an overview of the methodologies to calculate these emissions, are set out in Table 1.1, in accordance with the Design Manual for Roads and Bridges (DMRB) LA 114: Climate (Highways England, 2021). Methodology specific to each item assessed is detailed in this report (see Sections 2 and 3).

Table 1.1: Sources of GHG emissions and overview of calculation methodology

Project Stage	Part of Scheme	Activity	Sources of GHG Emissions	Overview of Calculation Methodology
Construction	**Rail Freight Interchange buildings**	Manufacturing of the buildings.	Embodied GHG emissions associated with the raw materials.	Application of published benchmark carbon intensities and LCA literature.
	Main Site warehousing	Manufacturing of the buildings.	Embodied GHG emissions associated with the raw materials.	Application of published benchmark carbon intensities and LCA literature, analysis of comparable developments' whole-life carbon (WLC) assessments (comprising the Applicant's recent projects), and the application of material emission intensities to material quantities.
	Rail Terminal and Main Site infrastructure	Manufacturing of the rail materials and associated infrastructure. Manufacturing of the warehousing associated infrastructure (including HGV loading areas, internal and external roads, landscaping, active travel links, retaining walls and drainage).	Embodied GHG emissions associated with the raw materials.	Application of material emission intensities to material quantities. Use of LCA analysis.
	Main Site	Construction processes, including earthworks and site preparation activities, transport of materials.	Traffic movements to site and fuel and energy use on site.	Application of fuel emission intensities informed by construction traffic flows and plant schedules across the construction period.

[2] Carbon life-cycle stages B1-B5 refer to in-use embodied emissions (i.e. emissions associated with the maintenance, repair, replacement and refurbishment of a development, including the embodied emissions of the required materials). Carbon life-cycle stages B6-B7 refer to the 'operational carbon' arising from operational energy and water use. Carbon life-cycle stage B8 refers to other 'user carbon' not included in operational energy and water use, which includes road user emissions (RICS, 2024).

Project Stage	Part of Scheme	Activity	Sources of GHG Emissions	Overview of Calculation Methodology
		to site and construction activities on site.		
		Land use change.	GHG emissions from disturbance of land.	Application of published literature carbon intensities to the type and area of land subject to change.
	Highways Works	Manufacturing of the Highways Works materials.	Embodied GHG emissions associated with the raw materials.	Application of material emission intensities to material quantities. Use of LCA analysis.
		Construction processes, including earthworks and site preparation activities, transport of materials to site and construction activities on site.	Traffic movements to the Highways Works and fuel and energy use on site.	Application of fuel emission intensities informed by construction traffic flows and plant schedules across the construction period.
		Land use change.	GHG emissions from disturbance of land.	Application of published literature carbon intensities to the type and area of land subject to change.
Operation	**Main Site**	Use of buildings and infrastructure by tenants and other users. Use of the Rail Freight Interchange.	Operational energy use, including electricity and fuel use, alongside vehicle and rail movements to/from the Main Site.	Application of fuel and energy emission intensities to energy use and operational traffic flows/rail movements.
	Highways Works	Use of roads by end users.	Vehicles using the highways infrastructure.	Application of fuel and energy emission intensities to operational traffic flows.
	Proposed Development	Operation and maintenance activities.	Energy and material consumption for maintenance and refurbishment activities.	Application of published benchmark carbon intensities and LCA literature, and the application of material or fuel emission intensities to material or fuel quantities.
		Land use change.	Net GHG flux changes as a result of proposed landscape planting.	Application of published literature carbon intensities and modelled carbon sequestration rates to the type and area of land subject to change.

1.2.6 Key sources relied upon for the assessment are as follows:

- Carbon Heroes Benchmark (OneClick LCA, 2023);
- OneClick LCA Materials Database (OneClick LCA, 2025);
- Royal Institute for Chartered Surveyors (RICS) Professional Standard: Whole life carbon assessment for the built environment (2nd Edition, Version 3) (RICS, 2024);

- UK Government GHG Conversion Factors for Company Reporting (Department for Energy Security and Net Zero (DESNZ) and Department for Environment, Food and Rural Affairs (Defra), 2025);
- Emissions Factor Toolkit (Defra, 2025);
- Carbon Storage and Sequestration by Habitat (Natural England, 2021); and
- Woodland Carbon Code (WCC) Carbon Calculation Guidance version 3.0 (WCC, 2025).

1.3 Assumptions and Limitations of the Assessment

1.3.1 Some of the construction-stage GHG emissions associated with the manufacturing of components may occur outside the territorial boundary of the UK and hence outside the scope of the UK's national carbon budget, policy and governance. However, in recognition of the climate change effect of GHG emissions (wherever occurring), and the need to avoid 'carbon leakage' overseas when reducing UK emissions, emissions associated with the construction stage have been presented within the assessment and quantification of GHG emissions as part of the Proposed Development.

1.3.2 As the Proposed Development is currently in the early stages of design, data relating to specific metrics for site specific design details, including specific warehouse design etc, are currently unavailable. Therefore, data has been extracted from industry benchmarks, previous developments' WLC assessments completed by the Applicant, and indicative material quantities provided by the design team to provide estimated emissions for the construction and operation phases. Thus, there is a degree of uncertainty regarding the emissions resulting from the manufacturing and construction, and ongoing maintenance of the Proposed Development.

1.3.3 The assessment has sought to limit the impact this may have by assessing a maximum design scenario (which will result in a conservative or worst-case assessment). The maximum design scenario is based on the design set out in Chapter 2: Description of Development and Alternatives. The following items comprise the main assumptions made for the maximum design scenario for the Proposed Development:

- An estimated bill of materials for the Main Site warehousing and office space (excluding the rail terminal buildings) was developed based on WLC information collected from recently constructed comparable developments by the Applicant. Though exact material specifications may be subject to change (i.e. due to the availability of materials in proximity to the Proposed Development), the Applicant is committed to a comparable level of low carbon design, as a minimum, for the Proposed Development. The information provided is therefore deemed to suitably capture the material types and quantities to be used within the Proposed Development. Actions to be implemented throughout the Proposed Development's lifetime to reduce emissions associated with materials are detailed in the Carbon Management Plan (Appendix 15.5).
- The WLC assessments used to calculate the estimated bill of materials for the Main Site buildings (excluding the Rail Freight Interchange buildings) include the foundations, ground floor structure, frame, floors, roofs, stairs and ramps, external walls, internal walls and partitions, windows and doors and internal finishes.
- An estimated bill of materials for the Main Site infrastructure (i.e. HGV and car parking areas and internal roads) was provided by the project team. The information provided was approximated by a rough pavement build up and the indicative paved areas have been informed by the illustrative masterplan (Document No. 2.6). In addition, an estimated bill of materials has been provided by the project team since the submission of the draft ES for drainage and retaining walls associated with the Main Site. The

information provides estimates of materials and the associated quantities that represent a worst case scenario. Emissions have been calculated using OneClick LCA Materials Database (2026). The life expectancy of the drainage materials is 100 years and therefore operational emissions associated with maintenance, repair and replacement are not applicable for the assessment period (see paragraph 1.3.11).

- An estimated bill of materials for the Highways Works and rail terminal infrastructure (i.e. track, sleepers, ballast, concrete apron) was provided by the project team. The information provided was deemed to suitably capture the material types and quantities to be used for these elements.
- Carbon Heroes benchmarks (2023) have been used to inform an emissions estimate for the rail terminal buildings as site specific design details are currently unavailable.
- Following the submission of the draft ES, detailed project-specific information for the construction stage emissions associated with transport of material and personnel to the Main Site and Highway Works have become available. The methodology to calculate the emissions considers total heavy goods vehicles (HGVs) and light goods vehicle (LGVs) movements for the construction period, an average distance of travel (RICS, 2024) and appropriate emissions factors (DESNZ and Defra, 2025).
- In the absence of project-specific detailed information with regards to on-site construction activity for the Main Site and Highway Works, OneClick LCA (2025) construction site scenarios and published benchmarks (OneClick LCA, 2023) have been applied. The use of such benchmarks are considered to appropriately represent site construction activity emissions for the purpose of the assessment.
- Emissions associated with operational Main Site traffic movements have been informed by detailed traffic modelling. The assumptions underlying this modelling can be found in Chapter 3: Traffic and Transport, Technical Note 4: HGV Trip Distribution, and are summarised below:
    - It should be noted that not all the HGV traffic associated with the Proposed Development would be new traffic to the road network, as container movements associated with existing end users would already by taking place on both the strategic and local road network. By way of example, instead of goods destined for a local area, arriving by HGV, the containers may be transferred to the region by rail, arriving at the Proposed Development to then be distributed from the site to the local area by HGV. The Proposed Development would therefore alter the assignment of HGV trips, particularly around the Main Site itself, as the development will result in a modal shift to rail and provide a distribution hub.
    - HGV trips associated with the warehousing at the Main Site would have anywhere from a local to a national catchment. The actual catchment will be dictated by end users and their requirements. As a result, it is not possible at this stage to identify which HGV trips would be transferred from one route to another. Therefore, an approximate distance travelled has been applied to all HGV movements, which may present a conservative assessment.
- Emissions associated with building energy demand has included both regulated and unregulated energy consumption[3], to ensure all material downstream impacts of the Proposed Development's buildings have been accounted for. However, unregulated energy demand has been calculated without knowledge of occupier activities (including whether warehouses will be predominantly refrigerated or unrefrigerated). As such, it should be noted that true energy consumption (and resultant emissions) will vary

[3] Regulated energy arises from controlled fixed building services and fittings, such as space heating and cooling, lighting, hot water and ventilation. Unregulated energy arises from other tenant installations and non-fixed appliances.

depending on how the end user utilises the building, the values presented are for use to inform the assessment on climate change only.

- The emissions arising from land-use change and the amount of carbon sequestered were estimated from an indicative planting schedule. The results are preliminary and sensitive to design parameters (species, planting density, and timing). The annual sequestration rate is the average of total sequestration over a century; however, this does not reflect the actual carbon uptake over time, which is lower in early growth and increases as the trees mature.

1.3.4 The following emissions sources have been investigated and have been scoped out of the assessment of emissions. For the reasons described below, each are anticipated to result in negligible and immaterial emissions across the lifetime of the Proposed Development, and therefore are not considered further.

1.3.5 The Central Hub area which includes Ashgrove Farm and the existing Grade II listed Threshing Barn is proposed to be retained within the scheme, along with the surrounding courtyard, and developed for ancillary uses relating to the Proposed Development. Emissions associated with the refurbishment works are considered unlikely to make a material contribution to construction emissions in the context of the wider construction of the Proposed Development, and as such have been scoped out of the assessment.

1.3.6 Emissions arising from vehicle movements in the locality of the Proposed Development which may be affected by the Highway Works, i.e. from changes to traffic within the wider network as a result of the new or changed highways infrastructure associated with the Proposed Development (excluding those arising from the Main Site, as these are assessed separately), have been investigated to understand whether such emissions are likely to increase or decrease. Link-based data was output from the Bicester Transport Model (BTM) and used to analyse Annual Average Daily Traffic (AADT) movements across each identified link. Further details on the AADT calculation can be found in Appendix 3.1 of the ES. This modelling was completed for two scenarios: the 2034 reference case (i.e. future baseline), and 2034 with OxSRFI scenario (i.e. accounting for the inclusion of the Highway Works). The with-development scenario had all movements associated with activity at the Main Site removed, given such emissions are assessed separately (see Sections 2.3 and 3.3). The process generates outputs such as 24-hour total flow, Speed, HGV %, and link length for all links in the network, which were input for each scenario into Defra's Emissions Factor Toolkit (EFT) (Defra, 2025).

1.3.7 The output of the EFT are total annual vehicle emissions arising from each scenario. Total emissions arising from the with-development scenario are 0.5% greater than those associated with the baseline scenario, indicating a negligible increase in vehicle emissions associated with the Highway Works. Such an increase may be due to the rerouting of traffic across the network (e.g. vehicles using the new proposed link roads which may result in slightly increased journey distances) and increased journey speeds. The increased average journey speeds are indicative of reduced congestion across the network. Reduced congestion in reality is likely to result in reduced emissions (as idling and stop-go movements result in low vehicle efficiency). However, the EFT is not capable of accounting for this nuance. As it can be seen that emissions arising from operational vehicle movements affected by the Highway Works are negligible (0.5% change from future baseline), such emissions have not been considered further within the assessment of operational emissions.

1.3.8 As detailed in Chapter 13: Materials and Waste of the ES, operational waste arising from the Main Site has been approximated to total 32,970 tonnes per annum. It is expected that a high proportion of the material generated will be recyclable (with a target recycling rate of 65%). It is reasonable to assume that remaining waste is likely to be diverted from landfill, given Oxfordshire County Council's (OCC) waste management targets for commercial / industrial waste requires non-hazardous waste sent to landfill to be reduced to no more than 5% of arisings by 2026 (OCC, 2017). As stated within Chapter 13: Materials and Waste of

the ES, waste management for the Proposed Development would aim to match or exceed such targets. Emissions factors for waste management currently only account for emissions arising from the transport of waste to the management facility. Such emissions are accounted for within the assessment of operational vehicle movements arising from the Main Site, and as such no further assessment is considered appropriate.

1.3.9 Operational water consumption is considered to be negligible, given it is likely that it will be limited welfare facilities within the office spaces across the Main Site. Such uses will be required to adhere to efficiency improvements in line with BREEAM requirements, and with emissions factors for water consumption and water treatment being limited (0.191 $kgCO_2e/m^3$ and 0.171 $kgCO_2e/m^3$, respectively), emissions associated with water consumption are considered to be negligible and immaterial within the context of wider emissions arising from the Proposed Development.

1.3.10 With regards to refrigerant use within the Proposed Development buildings, standard assumed annual leakage rates from commercial air conditioning are 1-5% (WRI and WBCSD, 2004); with the global warming potential (GWP) of refrigerants limited through adherence of the Proposed Development to relevant BREEAM credits (Pol 01: Impact of Refrigerants) and the inclusion of leak detection on R32 gases for the Variable Refrigerant Flow (VRF) System, emissions arising from refrigerant use are likely to be immaterial and as such are not considered further.

1.3.11 With regards to assessment lifetimes, the Proposed Development is expected to be operational indefinitely, subject to viability and market conditions. However, while the Proposed Development has no end date, the operational assessment lifetime has been assumed to be 60 years, in line with National Highways (2021) and RICS (2023) guidance, to inform the assessment of operational and whole lifetime emissions.

1.3.12 The decommissioning stage of the assessment has been scoped out of the assessment. Considering associated emissions qualitatively, it is considered that there would be negligible end-of-life emissions associated with plant use on site, disassembly activities and material transport, given anticipated decarbonisation of the construction industry in line with UK net zero goals. Further, materials used to construct the Proposed Development will be recycled at the end of their lifetime wherever possible, through the specification of recyclable and recycled materials for the buildings and infrastructure. As such, when disposing of materials, recycling is the preferred solution. This not only prevents materials from being sent to landfill, but also reduces the need for extraction of primary materials. Material which cannot be recycled might be incinerated or used to produce energy from waste. Emissions associated with the disposal of materials at the end of the lifetime is considered to be negligible and may even result in future avoided emissions. Emissions associated with decommissioning are therefore not assessed further.

2 Potential Impacts

2.1 Embedded Mitigation

2.1.1 As part of the Proposed Development's design process, a number of embedded mitigation measures have been proposed to reduce the potential for impacts on climate change. They are considered at every stage of the Proposed Development through design and best practice and, as there is a commitment to implementing these measures, these have been considered in the calculation of GHG emissions. The embedded mitigation is set out in Chapter 15 and summarised below.

Construction Stage

2.1.2 Good working practices during the construction of the Proposed Development are being defined through a Construction Environmental Management Plan (CEMP) (Appendix 2.3 of the ES), a future Site Waste Management Plan and Carbon Management Plan (Appendix 15.5). In terms of climate change, the CEMP and Site Waste Management Plan in accordance with the Carbon Management Plan, will ensure that, where possible, construction activities generating GHG emissions are undertaken efficiently in order to minimise emissions in the following ways:

- The Proposed Development design will minimise the need for slope stabilisation by designing shallow (1 in 3 or shallower) slopes where practicable. Where required, retaining walls will be constructed, using rock sourced from the site where feasible and practicable.
- A cut/fill balance will be achieved to minimise the volume of material moved on or off-site.
- Off-site construction solutions or products will be explored where feasible, which will reduce on-site construction waste and reduce vehicle movements as part of the construction process.
- Construction materials should be sourced locally where practicable, to minimise the impact of transportation.
- Vehicles used in road deliveries of materials, equipment and waste arisings on- and off-site would be loaded to full capacity to minimise the number of journeys associated with the transport of these items.
- All machinery and plant would be procured to adhere with emissions standards prevailing at the time and should be maintained in good repair to remain fuel efficient.
- Fuel procurement for onsite vehicles and plant will be reviewed, with biodiesel/hydrotreated vegetable oil (HVO)/electricity used preferentially where feasible. Where HVO is procured, sustainable procurement practices will apply to ensure fuel obtained is not derived from virgin oil food crops, and is instead from waste feedstocks. Appropriate certification will be provided by contractors to confirm the use of sustainably sourced HVO (i.e. sourcing from Renewable Fuel Assurance Scheme (RFAS) approved suppliers, and obtaining Renewable Fuel Declarations (RFD)).
- When not in use, vehicles and plant machinery involved in site operations would be switched off to further reduce fuel consumption.
- Where possible, local waste management facilities would be used to dispose of all waste arisings, to reduce distance travelled and associated emissions.
- The volume of waste generated would be minimised, and resource efficiency maximised, by applying the principles of the waste hierarchy throughout the

construction period. Waste storage should be employed, with on- and off-site segregation to maximise recycling potential for materials.

- Equipment and machinery requiring electricity would only be switched on when required for use. Procedures should be implemented to ensure that staff adhere to good energy management practices, e.g. through turning off lights, computers and heating/air conditioning units when leaving buildings.
- Plant efficiency measures such as the use of telematics and/or real-time operator feedback, alongside automatic control for idling, acceleration, and braking; hybrid excavators with energy recovery on the swing system; and GPS precision control for areas/levels/slopes during earth movement to reduce idling time while marking out areas, and to avoid reworking areas, should be considered.
- The number of materials used to construct the Proposed Development will be reduced to enable a reduction in different waste types (to be detailed within a Site Waste Management Plan (SWMP) that will be prepared as part of the construction stage).
- Materials will be specified which are durable and able to withstand storage, handling and installation, thereby reducing associated waste (to be detailed within the SWMP).
- The design of the Proposed Development will allow for standard manufactured material dimensions, to reduce variables and off-cuts (to be detailed within the SWMP).
- Accurate estimates of materials required will be produced prior to construction, in order to reduce the percentage of material ordered and reduce associated waste (to be detailed within the SWMP).

Operational Stage

2.1.3 The Energy Strategy (Appendix 15.4) and Carbon Management Plan (Appendix 15.5) detail the means by which emissions associated with the operational energy demand of the Main Site buildings will be reduced. The strategy follows the energy hierarchy: be lean (reduce building energy consumption), be clean (supply the energy required in an efficient manner), and be green (supply remaining energy from low carbon and renewable energy sources). Such embedded design measures include the following:

- Building fabric elements and glazing specifications improved beyond the Building Regulation requirements.
- Reduced air permeability compared to maximum required standards.
- Specification of efficient heating, ventilation and cooling (HVAC) services and control systems which includes the installation of localised Air Source Heat Pumps for each Main Site warehouse and building unit (warehouse spaces will be untreated).
- No gas will be used for space heating within office spaces. Air source heat pumps, or most appropriate alternative heat source, have been specified to deliver space heating and hot water (the warehouse areas will be untreated).
- Energy efficient LED lighting specified throughout the development, where practicable these will be controlled via Passive Infrared (PIR) sensors. Lighting specifications are set out in the Applicant's Developer's Specification.
- Installation of Photovoltaic (PV) Panels on available roof space of warehouse units. In addition to the PV installed from the outset, the structural design of the warehouse units allows for 100% of usable roof areas to be covered by solar PV to enable the buildings to be 'future proofed' should there be additional demand for renewable energy on-site, and where there is capacity within the grid to accommodate such additional generated renewable electricity.

- Buildings will target Energy Performance Certificate (EPC) 'A+' rating.
- Leak detection on R32 gases will be installed on the Variable Refrigerant Flow (VRF) system.

2.1.4 GHG emissions from road-users (i.e. vehicular traffic) lie outside the Applicant's control. These emissions are instead covered by Government policy (including the Transport Decarbonisation Plan (DfT, 2021). However, it is proposed to target 25% of car parking spaces to be Electric Vehicle (EV) charging spaces, with all remaining car parking spaces to be fitted with passive EV charging infrastructure in line with local OCC policy requirements. This would support road-user decarbonisation by facilitating the use of EVs. Given it cannot be predicted to what extent the EV charging facility would be used and encourage increased EV ownership during the operational phase of the Proposed Development, the inclusion of such provision has been accounted for qualitatively within the assessment of significance. The quantification of emissions associated with operational traffic has assumed the use of EVs in line with current ownership patterns (see paragraph 2.3.12).

2.1.5 As part of the landscaping design, areas of new woodland planting within the Proposed Development are proposed. The landscape planting proposed would sequester carbon over the Proposed Development's lifetime as the woodland matures.

2.2 Construction Stage Emissions

2.2.1 The construction stage emissions cover the LCA stages A1-A5. This includes embodied carbon emissions from materials, emissions associated with the transport of materials and workers to site, and the energy and fuel use on site during the construction process.

Main Site

Rail Terminal and Associated Infrastructure

2.2.2 The rail terminal and associated infrastructure comprises the rail corridor, management building, rail reception sidings, container storage area and associated container transfer equipment, and refuelling facility.

2.2.3 The methodologies used to calculate construction stage emissions associated with the rail terminal and associated infrastructure can be divided into that applied to the rail corridor and associated infrastructure ('Rail Infrastructure Elements') and that applied to the management buildings ('Rail Building Elements'). Each methodology is further detailed within the sections below.

Rail Infrastructure Elements

2.2.4 LCA stages A1-A3 emissions associated with the Rail Infrastructure Elements have been calculated using material quantities (informed by the project design team) and relevant material emissions factors (sourced from the OneClick LCA Materials Database, 2025).

2.2.5 Table 2.1 summarises the material quantities associated with the Rail Infrastructure Elements, and the associated A1-A3 emissions calculated within OneClick LCA.

Table 2.1: Rail infrastructure elements - A1 to A3 construction emissions

LCA Stage	Item	Material Quantity (tonnes)	Emissions Factor (OneClick LCA, 2025)	Emissions Factor Unit	Emissions (tCO_2e)
A1-A3	Track (twin running lines)	702	2.45	$kgCO_2e/kg$	1,720

LCA Stage	Item	Material Quantity (tonnes)	Emissions Factor (OneClick LCA, 2025)	Emissions Factor Unit	Emissions (tCO_2e)
	Sleepers	2,514	0.17	$kgCO_2e/kg$	435
	Track ballast	24,300	0.0044	$kgCO_2e/kg$	105
	Reinforced concrete apron - Concrete	84,000	0.13	$kgCO_2e/kg$	10,883
	Reinforced concrete apron – Reinforcement Steel bar	10,500	0.76	$kgCO_2e/kg$	7,980
	Copper signal cable	80	0.17	$kgCO_2e/kg$	208
	Concrete cable trough	120	0.12	$kgCO_2e/kg$	15
A1-A3	**Total**				**21,346**

Rail Building Elements

2.2.6 Published benchmark data has been used to calculate construction stage emissions arising from the rail terminal buildings in the absence of further detailed information in order to identify the potential impacts.

2.2.7 The Carbon Heroes Benchmarking Database, produced by LCA software OneClick LCA (OneClick LCA, 2023) is the source of benchmark data that has informed the assessment of construction effects. The Carbon Heroes Database is developed using data input into OneClick LCA, which is then anonymised and included into the benchmarks based on mechanical and manual screening that considers consistency, completeness and plausibility. Projects that display aberrant values or inconsistency have been excluded from the samples. The database includes lifecycle stages A1-A4, B4-B5 and C1-C4 and are given for UK warehouses and offices.

2.2.8 It should be noted that life-cycle analyses of different buildings may not be directly comparable (differing in scope, assumptions and energy mix for example). Furthermore, there is substantial variation in building design, material choice, year of development[4] and hence embodied carbon between benchmarks. As such, the most conservative of the available benchmarks have been used to ensure a robust assessment.

2.2.9 Upper limit (i.e. 70th percentile) Carbon Heroes database values for office buildings have been used to inform the calculations of embodied carbon associated with the Rail Building Elements, and total 799 $kgCO_2e/m^2$ for office use.

2.2.10 The RICS guide to calculation of embodied carbon (RICS, 2012) provides an estimation of the sources (in terms of lifecycle stages) of the GHG emissions involved in the construction and use of buildings. Figure 2.1 highlights that emissions associated with the OneClick Carbon Heroes Benchmarks (i.e. LCA stages A1-A4, B4-B5 and C1-C4) account for 16.9% of whole lifetime emissions. Emissions associated with distribution (A4) and construction (A5) each account for 1% of whole lifetime emissions. This is further summarised within Table 2.2.

Figure 2.1: Examples of building GHG emissions by life cycle stage

[4] The Carbon Heroes database provides benchmarks based on published data up to 2023.

Table 2.2: Rail building elements – embodied carbon factors

Life Cycle Stage	Contribution to lifetime emissions (%)	Scaling factor applied to OneClick Carbon Heroes Benchmark	Adjusted OneClick Carbon Heroes Benchmark - Offices ($kgCO_2e/m^2$)
A1-A4, B4-B5, C1-C4*	16.9%	n/a	799
A1 to A3	15.5%	91.7%	733
A4	1%	5.9%	47
A5	1%	5.9%	47

*i.e. LCA stages covered by the OneClick Carbon Heroes Benchmarks.

2.2.11 In order to reach construction stage emissions associated with LCA stages A1-A3, A4 and A5 only, a scaling factor was applied to the OneClick Carbon Heroes Benchmarks, informed by the contribution of each LCA stage to whole life cycle emissions (i.e. emissions associated with LCA stages A1-A3 comprise 91.7% of emissions associated with LCA stages A1-A4, B4-B5, C1-C4). See Table 2.2 for each scaling factor used and the adjusted OneClick Carbon Heroes Benchmarks.

2.2.12 Each relevant benchmark has been scaled by the maximum Gross Internal Area (GIA) for the rail terminal buildings (2,500 m^2); resultant emissions are summarised within Table 2.3.

Table 2.3: Rail building elements - A1 to A3 and A5 construction emissions

LCA Stage	Carbon Heroes Benchmark ($kgCO_2e/m^2$)	Total Embodied Carbon (tCO_2e) (worst case)
A1-A3	732.8	1,832
A5	47.3	118

Warehousing and Buildings

2.2.13 Emissions associated with the warehouses and buildings arise from the construction of the buildings, alongside associated infrastructure (i.e. parking and HGV turning/loading areas, provision of a new estate road, and drainage infrastructure). The methodologies used to calculate such construction stage emissions can be divided into that applied to the buildings, and that applied to the associated infrastructure. Each methodology is further detailed within the sections below.

Buildings

2.2.14 Published benchmark data has been used to calculate associated construction stage emissions associated with a business as usual approach, in the absence of detailed design information, in order to identify the potential impacts. As detailed in paragraph 1.3.5, the Central Hub construction emissions have been scoped out of further assessment.

2.2.15 The methodology used is consistent with that detailed from paragraph 2.2.7 to 2.2.11, and uses OneClick Carbon Heroes Benchmarks for warehousing/logistics, totalling 747 tCO_2e/m^2. The scaling factors and final adjusted emissions factors used are summarised within Table 2.4.

Table 2.4: Warehousing and buildings – embodied carbon factors.

Life Cycle Stage	Contribution to lifetime emissions (%)	Scaling factor applied to OneClick Carbon Heroes Benchmark	Adjusted OneClick Carbon Heroes Benchmark - Warehouses ($kgCO_2e/m^2$)
A1-A4, B4-B5, C1-C4*	16.9%	n/a	747
A1 to A3	15.5%	91.7%	685
A5	1%	5.9%	44

*i.e. LCA stages covered by the OneClick Carbon Heroes Benchmarks.

2.2.16 Each relevant benchmark has been scaled by the maximum GIA for the warehouse buildings (603,850 m^2); resultant emissions are summarised within Table 2.5 below.

Table 2.5: Warehousing and buildings - A1 to A3 and A5 construction emissions

LCA Stage	Carbon Heroes Benchmark ($kgCO_2e/m^2$)	Total Embodied Carbon (tCO_2e) (worst case)
A1-A3	685	413,708
A5	44	26,691

2.2.17 Embodied emissions associated with the PV proposed to be installed on the building roofs have been calculated by scaling the proposed roof area PV coverage (25,870 m^2, see Appendix 15.4: Energy Strategy), by an EPD for monocrystalline solar panels (148 $kgCO_2e/m^2$) (OneClick, 2025). Embodied emissions are calculated to be 3,829 tCO_2e.

2.2.18 The embodied emissions associated with the battery energy storage systems (BESS) proposed to be installed on the Main Site have been calculated on a per kWh battery-capacity basis and informed by life cycle assessment studies for BESS (Emilsson and Dahllöf, 2019; Dai *et al.*, 2019). Emissions associated with the manufacture of BESS (including the upstream supply of raw materials) is in the range of 61–106 $kgCO_2e/kWh$. To present a conservative assessment, the upper limit of this range has been used.

2.2.19 The lifetime of the battery packs is dependent on the average depth of discharge (DoD); while in reality this may vary depending on the state of the electricity market at any given moment, the current assumed average DoD for the BESS is 80%. Based on published literature values, a DoD of 80% would result in an expected lifetime of 5,000 cycles (IEA, 2020). Therefore, over the forecasted 60 year assessment period and assuming one full cycle per day, the battery packs would have to be replaced circa four times.

2.2.20 The maximum total capacity of BESS across the Proposed Development is 3 MW, assuming a discharge time of 7 hours, this results in a storage capacity of 21 MWh. When scaled by the associated emissions intensity and replacement rate, emissions arising from the BESS total 9,750 tCO_2e across the Proposed Development's lifetime. To be conservative, present-day values are used for the carbon intensity of battery pack production even for future replacements.

Associated Infrastructure

2.2.21 The infrastructure elements of the Main Site include:

- supporting infrastructure to the warehouse buildings (i.e. parking and HGV turning/loading areas);
- provision of internal roads serving the warehouse buildings;

- strategic drainage infrastructure and retaining walls.

2.2.22 To enable the Proposed Development, substantial earthworks will be required to be undertaken. Surplus soil will be used to create the mounding required as part of the landscaping strategy. The cut and fill exercise will be designed to enable a balance across the Proposed Development to avoid any off site removal or import of material. As such, there will be negligible emissions associated with the structural earthworks embodied carbon, given no material will be imported to site for this purpose. Emissions associated with the earthworks activities (i.e. plant use on site) and emissions from land use change are discussed in paragraphs 2.2.25 to 2.2.32 below.

2.2.23 The calculation of LCA stage A1-A3 emissions associated with the infrastructure elements have been informed by an indicative road and parking areas material profile provided by the project design team. The profile has been scaled by the development area, calculated from the illustrative masterplan (see Document No. 2.6) for each infrastructure element (504,099 m^2 for the HGV and car parking areas, and 64,684 m^2 for the internal roads and pavements), and subsequently scaled by relevant materials emissions factors (OneClick LCA, 2025). The resultant emissions are summarised within Table 2.6 below.

2.2.24 Approximate material quantities associated with the Main Site drainage infrastructure, retaining walls and EV charging infrastructure, provided by the project design team, have become available since the submission of the draft ES. The calculation of LCA stage A1-A3 emissions have been informed by material profile and quantities and applying relevant materials emissions factors (OneClick LCA, 2026). The resultant emissions are summarised within Table 2.6 below.

Table 2.6: Warehousing and buildings associated infrastructure – A1 to A3 construction emissions

LCA Stage	Infrastructure Component	Material Quantity	Material Quantity Unit	Emissions Factor (OneClick LCA, 2026)	Emissions Factor Unit	Emissions (tCO_2e)
HGV and car parking areas						
A1-A3	Type 1 Aggregate	120,984	tonnes	0.0075	$kgCO_2e/kg$	904
	Asphalt	435,542	tonnes	0.0542	$kgCO_2e/kg$	23,606
Internal roads and pavements						
A1-A3	Type 1 Aggregate	15,524	tonnes	0.0075	$kgCO_2e/kg$	116
	Asphalt	43,175	tonnes	0.0542	$kgCO_2e/kg$	2,340
Drainage						
A1-A3	Concrete pipe	8,357	m	70.3	$kgCO_2e/m$	587
	Concrete headwalls	43,713	kg	0.206	$kgCO_2e/kg$	9
	Concrete manhole	334	No.	138	$kgCO_2e/unit$	46
Retaining walls						
A1-A3	Concrete	44,786,545	kg	0.13	$kgCO_2e/kg$	5,822
	Steel rebar	4,171,852	kg	1.99	$kgCO_2e/kg$	8,302
EV charging infrastructure						
A1-A3	EV charge points	825	no.	97.5	$kgCO_2e/unit$	80
	Cabling for active charge points	1,300	m	7.75	$kgCO_2e/m$	10
	Cabling for passive charge points	5000	m	7.75	$kgCO_2e/m$	39

LCA Stage	Infrastructure Component	Material Quantity	Material Quantity Unit	Emissions Factor (OneClick LCA, 2026)	Emissions Factor Unit	Emissions (tCO_2e)
Total						**41,862**

Main Site Construction Activities

2.2.25 Construction site activities for the Main Site include:

- transport of materials and personnel to site; and
- plant use on site associated with earthworks and required to undertake construction of the Main Site buildings and infrastructure.

2.2.26 The emissions associated with the transport of materials and construction personnel to site (LCA stage A4) and the use of construction plant (LCA stage A5) have been calculated following the methodologies detailed below.

2.2.27 Indicative traffic movements were used to calculate LCA stage A4 emissions (comprising both material deliveries and personnel journeys to site) during the construction works associated with the Main Site.

2.2.28 Heavy Goods Vehicle (HGV) movements and personnel vehicle movements associated with the construction of the Main Site buildings and infrastructure were scaled by an assumed average distance of travel (120 km for HGVs, in line with RICS whole life carbon guidance (2024) for nationally manufactured products, 50 km for personnel and 13 km for the average car, as detailed in the findings of the National Travel Survey) and an emissions factor for average laden diesel HGVs (0.891 $kgCO_2e/km$), average diesel vans (0.256 $kgCO_2e/km$) and average diesel cars (0.173 $kgCO_2e/km$) (DESNZ, 2025).

2.2.29 In the absence of a detailed plant schedule for the construction works associated with the Main Site, emissions associated with LCA stage A5 for the rail terminal buildings, and Main Site warehousing have been calculated by scaling OneClick Carbon Heroes Benchmarks by appropriate scaling factors (see paragraphs 2.2.7 to 2.2.11). A5 emissions associated with Main Site infrastructure has been informed by OneClick LCA (2025) construction site scenarios.

2.2.30 LCA modules A4 and A5 emissions are summarised within Table 2.7.

Table 2.7: Main Site – A4 to A5 construction emissions

LCA Stage	Item	Emissions (tCO_2e)	
		Rail terminal	Warehousing
A4	Buildings	98	23,663
	Infrastructure		
A5	Buildings	118	26,691
	Infrastructure	1,023	3,076
A4-A5	**Total**	**1,239**	**53,429**
		54,669	

Land Use Change

2.2.31 The current land use for the Proposed Development predominantly consists of agricultural land used for mixed arable and grazing purposes and includes the Ashgrove farmstead ("Ashgrove Farm") which comprises a number of farm buildings and residences (to be retained for ancillary use). The site also includes sections of woodland which comprise

significant carbon stores that would be disturbed during the construction of the Proposed Development. Details and areas of such disturbance are provided within Chapter 6: Ecology and Arboriculture of the ES.

2.2.32 In order to calculate the loss of carbon stored within the woodland, the total area disturbed (circa 9 ha, comprising 1 ha of lowland deciduous woodland, and 8 ha other broadleaved and mixed woodland) has been scaled by appropriate emissions factors for carbon storage within woodland associated soils (114 tC/ha and 151 tC/ha, respectively (Natural England, 2021)) to identify emissions resulting from their removal, which total 2,392 tC. When scaled by an appropriate conversion factor this totals 8,771 tCO_2e. This total reflects the land use change across the Proposed Development including both Main Site and Highways Works.

Highways Works

2.2.33 Infrastructure elements proposed as part of the Highways Works include:

- Middleton Stoney Relief Road;
- Heyford Park Link Road;
- Ardley Bypass, a bypass to the east of the village of Ardley;
- Baynard Green;
- M40 Junction 10 (J10) Highways improvement;
- M40 Junction 9 (J9) Highways improvement;
- Camp Road/Chilgrove Drive junction upgrades; and
- active travel works, including provision of shared footpath/cycleway along Route 3 Cyclepath.

2.2.34 Construction stage emissions associated with the materials used in the construction of the above elements have been calculated based on an indicative bill of quantities provided by the project design team. Such material quantities were subsequently scaled by relevant materials emissions factors (OneClick LCA, 2025). The consideration of imported fill has also been included, with the relevant emissions factor (0.005 $kgCO_2e/kg$). The total material quantities and resultant emissions from the Highways Works component are summarised within Table 2.8 below.

Table 2.8: Highway Works – A1 to A3 construction emissions

LCA Stage	Infrastructure Component	Material Quantity	Material Quantity Unit	Emissions Factor (OneClick, 2025)	Emissions Factor Unit	Total Embodied Carbon (tCO_2e)
Middle Stoney Relief Road						
A1-A3	Asphalt Concrete	13,740,000	kg	0.0511	$kgCO_2e/kg$	**1,964**
	Concrete Kerb	7,300	m	10	$kgCO_2e/m$	
	Granular Fill	9,100	m^3	0.005	$kgCO_2e/kg$	
	Hexagonal Grid	26,000	m^2	1.7	$kgCO_2e/m^2$	
	High-density polyethylene pipe	3,100	m	15.34	kg CO_2e/m	
	Hot Rolled Asphalt	4,346,400	kg	0.0672	$kgCO_2e/kg$	
	Precast Concrete Manhole	24	Units	137	$kgCO_2e$/Unit	
	Type 1 Aggregate	5,270	m^3	0.0075	$kgCO_2e/kg$	
	Structures					
	Asphalt Concrete	34,560	kg	0.0511	$kgCO_2e/kg$	

LCA Stage	Infrastructure Component	Material Quantity	Material Quantity Unit	Emissions Factor (OneClick, 2025)	Emissions Factor Unit	Total Embodied Carbon (tCO_2e)
	Hot Rolled Asphalt	23,040	kg	0.0672	$kgCO_2e/kg$	
	Structural Steel	26,690	kg	1.74	$kgCO_2e/kg$	
	Precast Concrete	1,184	m^3	543.0	$kgCO_2e/m^3$	
Heyford Park Link Road						
A1-A3	Asphalt Concrete	13,891,200	kg	0.0511	$kgCO_2e/kg$	**1,525**
	Concrete Kerb	8,653	m	10	$kgCO_2e/m$	
	Granular Fill	10,700	m^3	0.005	$kgCO_2e/kg$	
	Hexagonal Grid	22,200	m^2	1.7	$kgCO_2e/m^2$	
	High-density polyethylene pipe	2,300	m	15.34	kg CO_2e/m	
	Hot Rolled Asphalt	6,439,200	kg	0.0672	$kgCO_2e/kg$	
	Precast Concrete Manhole	24	Units	137	$kgCO_2e/Unit$	
	Type 1 Aggregate	7,050	m^3	0.0075	$kgCO_2e/kg$	
	Structures					
	Structural Steel	1.6	kg	1.74	$kgCO_2e/kg$	
	Precast Concrete	25	m^3	543.0	$kgCO_2e/m^3$	
Ardley Bypass						
A1-A3	Asphalt Concrete	39,180,000	kg	0.0511	$kgCO_2e/kg$	**6,274**
	Concrete Kerb	11,150	m	10	$kgCO_2e/m$	
	Granular Fill	21,600	m^3	0.005	$kgCO_2e/kg$	
	Hexagonal Grid	61,700	m^2	1.7	$kgCO_2e/m^2$	
	High-density polyethylene pipe	5,450	m	15.34	kg CO_2e/m	
	Hot Rolled Asphalt	5,594,400	kg	0.0672	$kgCO_2e/kg$	
	Precast Concrete Manhole	40	Units	137	$kgCO_2e/Unit$	
	Type 1 Aggregate	5,388	m^3	0.0075	$kgCO_2e/kg$	
	Structures					
	Asphalt Concrete	521,280	kg	0.0511	$kgCO_2e/kg$	
	Hot Rolled Asphalt	347,520	kg	0.0672	$kgCO_2e/kg$	
	Structural Steel	251	kg	1.74	$kgCO_2e/kg$	
	Precast Concrete	5,638	m^3	543.0	$kgCO_2e/m^3$	
Baynard Green						
A1-A3	Asphalt Concrete	27,673,200	kg	0.0511	kgCO2e/kg	**2,288**
	Concrete Kerb	6,320	m	10	$kgCO_2e/m$	
	Granular Fill	17,400	m^3	0.005	$kgCO_2e/kg$	
	Hexagonal Grid	61,700	m^2	1.7	$kgCO_2e/m^2$	
	High-density polyethylene pipe	3,450	m	15.34	kg CO_2e/m	
	Hot Rolled Asphalt	5,448,000	kg	0.0672	$kgCO_2e/kg$	
	Precast Concrete Manhole	30	Units	137	$kgCO_2e/Unit$	
	Type 1 Aggregate	7,298	m3	0.0075	$kgCO_2e/kg$	
J10 M40						
A1-A3	Asphalt Concrete	26,514,000	kg	0.0511	kgCO2e/kg	**4,272**
	Concrete Kerb	7,350	m	10	$kgCO_2e/m$	
	Granular Fill	15,400	m^3	0.005	$kgCO_2e/kg$	

LCA Stage	Infrastructure Component	Material Quantity	Material Quantity Unit	Emissions Factor (OneClick, 2025)	Emissions Factor Unit	Total Embodied Carbon (tCO_2e)
	Hexagonal Grid	42,000	m^2	1.7	$kgCO_2e/m^2$	
	High-density polyethylene pipe	5,500	m	15.34	kg CO_2e/m	
	Hot Rolled Asphalt	5,112,000	kg	0.0672	$kgCO_2e/kg$	
	Precast Concrete Manhole	70	Units	137	$kgCO_2e/Unit$	
	Type 1 Aggregate	6,288	m3	0.0075	$kgCO_2e/kg$	
	Structures					
	Asphalt Concrete	400,320	kg	0.0511	kgCO2e/kg	
	Hot Rolled Asphalt	266,880	kg	0.0672	$kgCO_2e/kg$	
	Structural Steel	324	kg	1.74	$kgCO_2e/kg$	
	Precast Concrete	2,994	m^3	543.0	$kgCO_2e/m^3$	
J9 M40						
A1-A3	Asphalt Concrete	1,012,800	kg	0.0511	$kgCO_2e/kg$	**138**
	Concrete Kerb	700	m	10	$kgCO_2e/m$	
	Granular Fill	450	m3	0.005	$kgCO_2e/kg$	
	Hexagonal Grid	1,300	m2	1.7	$kgCO_2e/m^2$	
	High-density polyethylene pipe	1,050	m	15.34	kg CO_2e/m	
	Hot Rolled Asphalt	594,000	kg	0.0672	$kgCO_2e/kg$	
	Precast Concrete Manhole	10	Units	137	$kgCO_2e/Unit$	
	Type 1 Aggregate	1,240	m3	0.0075	$kgCO_2e/kg$	
Camp Road/Chilgrove Drive						
A1-A3	Asphalt Concrete	209,400	kg	0.0511	$kgCO_2e/kg$	**28**
	Concrete Kerb	315	m	10	$kgCO_2e/m$	
	Granular Fill	150	m3	0.005	$kgCO_2e/kg$	
	Hexagonal Grid	150	m2	1.7	$kgCO_2e/m^2$	
	High-density polyethylene pipe	150	m	15.34	kg CO_2e/m	
	Hot Rolled Asphalt	114,000	kg	0.0672	$kgCO_2e/kg$	
	Precast Concrete Manhole	5	Units	137	$kgCO_2e/Unit$	
	Type 1 Aggregate	103	m3	0.0075	$kgCO_2e/kg$	
Route 3 Cycleway						
A1-A3	Asphalt Concrete	632,520	kg	0.0511	$kgCO_2e/kg$	**71**
	Concrete Kerb	2,510	m	10	$kgCO_2e/m$	
	Hexagonal Grid	4,390	m^2	1.7	$kgCO_2e/m^2$	
	Type 1 Aggregate	565	m^3	0.0075	$kgCO_2e/kg$	
Additional Structures						
A1-A3	Asphalt Concrete	391,680	kg	0.0511	$kgCO_2e/kg$	2,345
	Hot Rolled Asphalt	261,120	m	10	$kgCO_2e/m$	
	Structural Steel	71	kg	1.74	$kgCO_2e/kg$	
	Precast Concrete	4,402	m^3	543.0	$kgCO_2e/m^3$	
A1-A3	**Total**					**18,905**

Construction Activities

2.2.35 The construction activities at the Highway Works includes:

- transport of materials and personnel to site; and
- plant use on site for earthworks and to undertake construction of the highways works infrastructure.

2.2.36 Emissions associated with construction traffic movements (A4) have been calculated using the methodology detailed in paragraph 2.2.27 above. Emissions associated with the plant use (A5) have been informed by OneClick LCA (2025) construction site scenarios.

2.2.37 Emissions associated with the highways works construction are shown in Table 2.9.

Table 2.9: Highway Works – A4 to A5 construction emissions

LCA Stage	Construction activity	Construction Emissions (tCO_2e)
A4	Transport of materials to site	25,083
A5	Construction plant use	1,255
A4-A5	**Total**	**26,338**

Land Use Change

2.2.38 Consistent with paragraphs 2.2.31 and 2.2.32, emissions associated with the removal of woodland during the construction of the Proposed Development is 2,392 tC, or 8,771 tCO_2e. This total reflects the land use change across the Proposed Development including both Main Site and Highways Works.

Summary and Magnitude of Impact

2.2.39 The estimated GHG emissions arising from the construction stage of the Proposed Development is presented in Table 2.10.

Table 2.10: Summary of Potential Impact construction stage GHG emissions

LCA Stage	Item	Emissions (tCO_2e)		
		Main Site		Highway Works
		Rail terminal	Warehousing	
A1-A3	Buildings	1,832	427,287	n/a
	Infrastructure	21,346	41,862	18,905
A4	Buildings	98	23,663	n/a
	Infrastructure			25,083
A5	Buildings	118	26,691	n/a
	Infrastructure	1,023	3,076	1,255
n/a	Land use change*		8,771	
A1-A5	**Total**	**24,418**	**531,350**	**45,243**
			601,011	

*Emissions arising from land use change from the Main Site have been attributed to the warehousing totals within this table.

2.3 Operational Stage Emissions

2.3.1 The operation stage emissions cover the LCA stages B2-B8. This includes operational energy emissions from the use of the Proposed Development, emissions from traffic (HGV movements, worker commuting and other road user emissions), and emissions from the maintenance and refurbishment of the Proposed Development.

Main Site

Rail Terminal

Emissions from Rail Freight Movements

2.3.2 Emissions arising from the operation of the rail freight (i.e. train movements) have been informed by the following assumptions detailed by project transport consultants (ADC, 2025):

- The Rail Freight Interchange will accommodate 12 intermodal trains per day through the site.
- Each train will accommodate 41 containers.
- The average payload of each container is 14.6 tonnes (assuming 50% capacity). To provide a conservative assessment of emissions, it has been assumed that each container will be at 100% capacity, i.e. 29 tonnes.

2.3.3 The total tonnage transported per train was calculated by scaling the total payload per container by the number of containers accommodated. This was then scaled by an approximate distance travelled for national freight (approximation informed by the container freight origin/destination locations and associated number of train movements, ADC 2025), and the relevant emissions factor for rail freight (0.02779 $kgCO_2e$/tonne/km) (DESNZ and Defra, 2025) to reach total emissions associated with each train movement of 7.8 tCO_2e. This was then scaled by the number of trains per day, and over the year, to reach 26,833 tCO_2e per annum, or 1,609,984 tCO_2e over the assessment lifetime.

Avoided HGV Emissions

2.3.4 The objective of the Proposed Development is, in part, to facilitate a modal shift from road to rail freight. As such, the operational carbon savings from this modal shift have been calculated, informed by assumptions detailed by project transport consultants (ADC, 2025).

2.3.5 Once the rail terminal facilities are fully operational, they could accommodate an average maximum through-put of around 984 containers a day. This is a mode shift from road freight to rail freight equivalent to 1,104 HGV movements per day.

2.3.6 The origin/destination location of containers and the number of trains to and from each location is not yet known. However, rail journeys would typically replace road freight for journeys of 100 miles or more. For the purpose of reaching an approximation of HGV mileage saved, an assumption has been made as to the potential origin and destination of the freight train services, and associated HGV mileage to travel to the same origin and destinations (ADC, 2025). Total annual HGV mileage avoided by the use of the rail terminal has been approximated to be 53,225,172 miles.

2.3.7 This was scaled by the relevant emissions factor for HGVs, conservatively assuming they are 50% laden (1.34523 $kgCO_2e$/tonne/km) (DESNZ and Defra, 2025), to reach total avoided emissions by the modal shift from road to rail of 71,600 tCO_2e per annum, or 4,296,006 tCO_2e over the assessment lifetime.

2.3.8 In the context of the additional emissions resulting from the rail freight movements (presented in paragraph 2.3.3), net avoided emissions total 44,767 tCO_2e per annum, or 2,686,022 tCO_2e over the assessment lifetime.

2.3.9 It should be noted that figures from the DESNZ and Defra (2025) GHG conversion factors have been used, and as such, the operational GHG emissions form a fixed current year estimate. Due to this, the per annum and assessment lifetime figures provided for avoided emissions arising from the modal shift from road to rail do not account for the steady decarbonisation of the transport sector that is expected in line with policy and legislation as the UK moves towards its net zero 2050 target. Any further decarbonisation associated with HGV movements will result in reduced avoided emissions associated with the rail freight.

Vehicle Emissions

2.3.10 The operational transport emissions associated with the rail terminal comprise external vehicle movements (i.e. those travelling to/from the rail terminal from wider regional or national locations), and internal vehicle movements (i.e. those travelling between the rail terminal from within the Main Site). The assessment of emissions arising from the rail terminal has focused on the external movements; any internal movements are accounted for within the assessment of emissions arising from the Main Site warehousing.

2.3.11 Development traffic flows for HGVs and light vehicles have been modelled to generate 24-hour two-way AADT movements associated with the rail terminal (summarised within Table 2.11, see Chapter 3: Transport for further detail). Light vehicle movements have been assumed to be predominantly car movements for commuting.

Table 2.11: Rail terminal external AADT movements (two-way)

	Light vehicles	HGVs	Total
Rail terminal external	90	718	808

2.3.12 The two-way light vehicle movements have been scaled by the average commuting distance in the South East (8.3 miles) (Department for Transport, 2024a), and relevant emissions factors for petrol, diesel, hybrid and electric vehicles (DESNZ and Defra, 2025), based on current UK fleet mix statistics (Department for Transport, 2025). The two-way HGV traffic movements were scaled by the average haulage distance (106 km (66.25 miles)) (Department for Transport, 2024b) and relevant emissions factor for average laden HGVs (1.43425 $kgCO_2e$/mile) (DESNZ and Defra, 2025). Resultant emissions have been calculated to total 24,970 tCO_2e in the first year of full operation.

2.3.13 It should be noted that the per annum figure provided for operational traffic emissions does not account for the steady decarbonisation of the transport sector that is in line with policy and legislation as the UK moves towards its net zero 2050 target. As such, it can be anticipated that associated emissions reduce throughout the Proposed Development's lifetime.

Energy Consumption

2.3.14 Energy intensities associated with the Main Site buildings were calculated within Appendix 15.4: Energy Statement (refer to for detailed methodology regarding the calculation of energy consumption). It should be noted that such energy intensities have been modelled on warehousing, including ancillary office accommodation, accounting for the embedded mitigation detailed from paragraph 2.3.14 to 2.3.16.

2.3.15 Overall, total energy demand was calculated to be 190 MWh per year (comprising 96 MWh per year of regulated energy[5], and 94 MWh per year of unregulated energy[6]). The total energy consumption (excluding PV generated energy) has been scaled by the current UK electricity emissions factor (0.177 $kgCO_2e/kWh$) (DESNZ and Defra, 2025) and associated upstream 'scope 3' transmission and distribution and well-to-tank losses (0.0684 $kgCO_2e/kWh$) (DESNZ and Defra, 2025). Resultant operational emissions from the rail terminal buildings total 47 tCO_2e per annum, or 2,795 tCO_2e over the assessment lifetime.

2.3.16 It should be noted that figures from the DESNZ and Defra (2025) GHG conversion factors have been used, and as such, the operational GHG emissions form a fixed current year estimate. Due to this, the per annum and assessment lifetime figures provided for operational energy use do not account for the steady decarbonisation of electricity that is expected in line with policy and legislation as the UK moves towards its net zero 2050 target. This therefore provides a conservative assumption for the magnitude of impact.

Maintenance, Repair and Replacement

2.3.17 In addition to the emissions arising from operational electricity and fuel consumption, operational emissions arise from maintenance, repair and replacement of the rail terminal buildings and infrastructure. The methodology to calculate such emissions is detailed below, with associated emissions summarised within Table 2.12.

2.3.18 Module B2 (maintenance) emissions have been calculated in line with the RICS (2023) guidance in the absence of further detailed information, which recommends an intensity of 10 $kgCO_2e/m^2$ of gross internal area, or 1% of all A1-A5 emissions depending on what methodology presents the worst case. The former has been used to approximate maintenance emissions arising from the rail terminal buildings (maximum 2,500 m^2), resulting in a total of 25 tCO_2e; the latter has been applied to the rail terminal infrastructure (A1-A5 emissions summarised within Table 2.10), resulting in a total of 224 tCO_2e.

2.3.19 Module B3 (repair) emissions have been calculated in line with RICS (2023) guidance which suggests repair impacts should be assumed as equivalent to 25% of B2 maintenance impacts for the relevant items.

2.3.20 Module B4 (replacement) emissions for the rail terminal buildings have been approximated, informed by the detailed information available for the assessment of residual effects of Main Site warehousing, where B4 emissions are equal to circa 16% of A1-A5 emissions. This ratio has been applied to the rail terminal buildings.

2.3.21 Module B4 (replacement) emissions associated with the rail terminal infrastructure have been calculated by applying material lifetimes from RICS (2023) and OneClick (2025) to the estimated material quantities for the rail terminal infrastructure listed within Table 2.1.

2.3.22 Total maintenance, repair and replacement emissions for the rail terminal buildings and infrastructure is summarised within Table 2.12. The annual values present an average emission, though individual years of operation may be more or less than this total (owing to the intermittent nature of maintenance programmes).

2.3.23 It should be noted that the per annum figure provided for maintenance, repair and replacement emissions does not account for the steady decarbonisation of the construction sector that is in line with policy and legislation as the UK moves towards its net zero 2050 target. As such, it can be anticipated that emissions associated with this activity reduce over the lifetime of the Proposed Development.

[5] Energy consumption from controlled fixed building services and fittings, such as space heating and cooling, lighting, hot water and ventilation.
[6] Energy consumption from other tenant installations and non-fixed appliances.

Table 2.12: Main Site rail terminal – B2 to B4 operational emissions

LCA Stage		Per annum (tCO_2e)	Lifetime (tCO_2e)
B2 (Maintenance)	Rail terminal buildings	<0	25
	Rail terminal infrastructure	4	224
B3 (Repair)	Rail terminal buildings	<0	6
	Rail terminal infrastructure	1	56
B4 (Replacement)	Rail terminal buildings	5	320
	Rail terminal infrastructure	3	210
B2-B4	**Sub-total (Rail terminal buildings)**	**6**	**351**
	Sub-total (Rail terminal infrastructure)	**8**	**490**
	Total	**14**	**841**

Warehousing and Buildings

Energy Use

2.3.24 Energy consumption associated with the Main Site warehousing was calculated in accordance with the methodology detailed from paragraph 2.3.14 to 2.3.16. The resultant final energy consumption intensities account for embedded mitigation measures detailed from paragraph 2.1.3, and were scaled by the maximum floor area for the Main Site warehousing.

2.3.25 With regards to the 'be lean' measures, energy modelling incorporated improvements beyond building regulation requirements, including fabric efficiency and glazing specifications, reduced air permeability and the specification of efficient heating services and control systems.

2.3.26 With regards to the 'be green' measures, solar PV will be installed to cover 25,870 m^2 of available roof area. Whilst the be green measures do not reduce primary energy demand, installation of PV reduces national grid imports, owing to increased self-generation of electricity. This is reflected in the emissions calculations, as PV-generated electricity has an emissions intensity of 0 $kgCO_2e/kWh$.

2.3.27 Overall, total energy demand was calculated to be 22,077 MWh per year (comprising 3,545 MWh per year of regulated energy expected to be met in its entirety by on-site solar PV generated electricity, and 18,532 MWh per year of unregulated energy). The total energy consumption (excluding PV generated energy) has been scaled by the current UK electricity emissions factor (0.177$kgCO_2e/kWh$) (DESNZ and Defra, 2025) and associated upstream 'scope 3' transmission and distribution and well-to-tank losses (0.0684$kgCO_2e/kWh$) (DESNZ and Defra, 2025). Resultant operational emissions from the warehousing total 4,548 tCO_2e in the per annum, or 272,867 tCO_2e over the assessment lifetime. This offers a 17% reduction in emissions when compared to a scenario without the inclusion of embedded mitigation.

2.3.28 It should be noted that figures from the DESNZ and Defra (2025) GHG conversion factors have been used, and as such, the operational GHG emissions form a fixed current year estimate. Due to this, the per annum and assessment lifetime figures provided for operational energy use do not account for the steady decarbonisation of electricity that is expected in line with policy and legislation as the UK moves towards its net zero 2050 target. This therefore provides a conservative assumption for the magnitude of impact.

Vehicle Movements

2.3.29 Consistent with paragraph 2.3.10, operational transport emissions associated with the Main Site warehousing comprise external vehicle movements (i.e. those travelling to/from the Main Site warehousing from wider regional or national locations), and internal vehicle movements (i.e. those travelling from the rail terminal from within the Main Site).

2.3.30 Development traffic flows for HGVs, and light vehicles have been modelled to generate 24-hour two-way AADT movements for the warehousing and buildings (summarised within Table 2.13, see Chapter 3: Transport for more information).

Table 2.13: Main Site warehousing external and internal AADT movements (two-way)

	Light vehicles	HGV	Total
Main Site warehousing external	15,640	4,203	19,843
Main Site warehousing internal*	0	386	386

* These movements are internal within the site between the rail terminal and the warehousing

2.3.31 Consistent with paragraph 2.3.12, the two-way light vehicle movements were scaled by the average commuting distance in the South East (8.3 miles) (Department for Transport, 2024a), and relevant emissions factors for petrol, diesel, hybrid and electric vehicles (DESNZ and Defra, 2025), based on current UK fleet mix statistics (Department for Transport, 2025). The two-way HGV traffic movements were scaled by the average HGV haulage distance (106 km (66.25 miles)) (Department for Transport, 2024b) and relevant emissions factor for average laden HGVs (1.43425 $kgCO_2e$/mile) (DESNZ and Defra, 2025).

2.3.32 Internal HGV haulage movements emissions between the Rail Freight Interchange and Main Site buildings have been calculated in line with the above methodology, however, has assumed a haulage distance of 1 mile based on the maximum likely distance between the warehousing and rail terminal, as informed by the illustrative masterplan draft ES Chapter 2: Description of Development and alternatives.

2.3.33 Resultant emissions have been calculated to total 157,837 tCO_2e in the first year of full operation. It is anticipated that it would take several years before the rail freight interchange would operate at full capacity. However, to ensure a robust approach, the maximum capacity of the Rail Freight Interchange has been assumed to occur within the operational periods set for the transport modelling assessment scenarios.

2.3.34 It should be noted that, similarly to paragraph 2.3.13 above, the per annum figure provided for operational traffic GHG emissions does not account for the steady decarbonisation of the transport sector that is in line with policy and legislation as the UK moves towards its net zero 2050 target. As such, it can be anticipated that associated emissions reduce throughout the Proposed Development's lifetime.

Maintenance, Repair and Replacement

2.3.35 In addition to the emissions arising from operational electricity and fuel consumption, operational emissions arise from maintenance, repair and replacement of the warehousing and buildings.

2.3.36 Emissions arising from the Main Site warehousing and associated infrastructure have been calculated using the methodology detailed from paragraph 2.3.18 to 2.3.21, and are summarised in Table 2.14. The annual values present an average emission, though individual years of operation may be more or less than this total (owing to the intermittent nature of maintenance programmes).

2.3.37 It should be noted that, similarly to paragraph 2.3.23 above, the per annum figure provided for maintenance, repair and replacement emissions does not account for the steady decarbonisation of the construction sector that is in line with policy and legislation as the UK moves towards its net zero 2050 target. As such, it can be anticipated that emissions associated with this activity reduce over the lifetime of the Proposed Development.

Table 2.14: Main Site warehousing, buildings and infrastructure – B2 to B4 operational emissions

LCA Stage		Per annum (tCO_2e)	Lifetime (tCO_2e)
B2 (Maintenance)	Main Site warehousing	101	6,039
	Main Site infrastructure	9	568
B3 (Repair)	Main Site warehousing	25	1,510
	Main Site infrastructure	2	142
B4 (Replacement)	Main Site warehousing	1,219	73,147
	Main Site infrastructure	594	35,637
B2-B4	**Sub-total (Main Site warehousing)**	**1,345**	**80,695**
	Sub-total (Main Site infrastructure)	**606**	**36,346**
	Total	**1,951**	**117,042**

Land Use Change

2.3.38 As outlined at paragraphs 2.2.31 and 2.2.32, areas of woodland will be disturbed as a result of the construction of the Proposed Development (see Chapter 6: Ecology and Arboriculture for further detail). Therefore, their removal will result in carbon sequestration that can no longer take place over the assessment lifetime of the Proposed Development.

2.3.39 The total area disturbed has been scaled by emissions factors for carbon sequestration in woodland and associated soils (14 tCO_2e/ha/year and 0.5 tCO_2e/ha/year, respectively) (Natural England, 2021) to quantify the loss of such carbon sequestration. Such loss totals 131 tCO_2e per annum, or 7,854 tCO_2e when scaled over the assessment lifetime of the Proposed Development.

2.3.40 There will be substantial landscape planting as part of the Proposed Development, including woodland, see illustrative masterplan (see Document No. 2.6). When managed sustainably, woodland acts as a "carbon sink", sequestering or removing CO_2 from the atmosphere over time. As such, the landscape planting will reduce total lifetime emissions associated with the Proposed Development. The ecology chapter (Chapter 6: Ecology and Arboriculture) includes areas of 54 ha for mixed broadleaf woodland planting and 6 ha for lowland and mixed deciduous woodland.

2.3.41 The emissions removals from woodland planting have been calculated using the Woodland Carbon Code (WCC) Carbon Calculator, an internationally recognised standard for calculating carbon credits from woodland restoration and planting projects (WCC, 2025). The total woodland area, alongside indicative species mixes and planting densities were input into the WCC modelling, which calculated emissions removals of a total of 11,870 tCO_2e over the assessment period. Average yearly removals during the operation stage of the Proposed Development are therefore calculated to be 198 tCO_2e.

Highway Works

Vehicle Emissions

2.3.42 The road user emissions associated with the Highway Works arise from modified traffic flows as a result of the proposed works. Such emissions have been investigated using the Defra

Emissions Factor Toolkit (Defra, 2025) and assessed to be negligible and immaterial (see paragraphs 1.3.6 and 1.3.7); such emissions are not assessed further.

Maintenance, Repair and Replacement

2.3.43 Emissions associated with maintenance, repair and replacement activities associated with the Highway Works have been calculated using the methodology detailed from paragraph 2.3.18 to 2.3.21. Such emissions are summarised within Table 2.15.

2.3.44 It should be noted that, similarly to paragraph 2.3.23 above, the per annum figure provided for maintenance, repair and replacement emissions does not account for the steady decarbonisation of the construction sector that is in line with policy and legislation as the UK moves towards its net zero 2050 target. As such, it can be anticipated that emissions associated with this activity reduce over the lifetime of the Proposed Development.

Table 2.15: Highway Works – B2 to B4 operational emissions

LCA Stage	Per annum (tCO_2e)	Lifetime (tCO_2e)
B2 (Maintenance)	8	452
B3 (Repair)	2	113
B4 (Replacement)	187	11,220
Total	**196**	**11,785**

Land Use Change

2.3.45 Emissions arising from the loss of carbon sequestration potential over the Proposed Development are detailed at paragraphs 2.3.38 to 2.3.41.

Summary and Magnitude of Impact

2.3.46 The estimated GHG emissions arising from the first year of operation of the Proposed Development, split by the Main Site (rail terminal, and warehousing and buildings) and the Highways works are presented in Table 2.16.

Table 2.16: Summary of Potential Impact operational stage GHG emissions

LCA Stage	Item	Emissions per year of operation (tCO_2e)		
		Main Site		Highway Works
		Rail terminal	Warehousing	
B2-B4	Maintenance	14	1,951	196
B6	Energy consumption	47	4,548	n/a
B8	Vehicle Movements	24,970	157,837	negligible
B8	Freight Movements	26,833	n/a	n/a
B8	Avoided Emissions	-71,600	n/a	n/a
n/a	Land use change*		131	
n/a	Carbon sequestration through landscape planting		-198	
B1-B8	**Total**	**-19,737**	**164,269**	**196**
		144,729		

[1]Emissions arising from land use change from the Main Site have been attributed to the warehousing totals within this table.

3 Residual Effect

3.1 Additional Mitigation

3.1.1 Full mitigation measures for the Proposed Development are provided in Chapter 15: Climate Change. A summary of those relevant for the GHG assessment are presented below.

Construction Stage

3.1.2 A Carbon Management Plan (Appendix 15.5) prepared for the Proposed Development details the measures to be implemented throughout the construction phase in order to further reduce emissions. Such measures include:

- Target an emissions intensity of 350 $kgCO_2/m^2$ for all buildings.
- Reduce material consumption (i.e. where feasible kerbs and pavements will be reduced and provided on one side of internal roads, in particular in areas where there is no frontage and within staff parking areas).
- Use low carbon and materials with recycled material content where feasible (e.g. recycled steel, steel produced from an electric arc furnace, concrete with recycled cement binders, recycled aggregates, warm mix asphalt, permeable paving, recycled plastic pipework, bitumen replacement).
- The use of renewable energy, including on-site renewables within the construction site compounds.
- The appointed Principal Contractor, informed by the Carbon Management Plan, will actively identify and pursue carbon reduction opportunities and mitigate carbon risks through all means as part of the integrated Proposed Development.

3.1.3 Through the implementation of the Carbon Management Plan it can be expected that emissions associated with the Proposed Development will be reduced. This reduction has been approximated with regards to the warehousing and buildings, however the implementation of the Carbon Management Plan has been considered qualitatively for all other elements given associated reductions are not able to be quantitatively approximated at this stage of design.

Operational Stage

3.1.4 The Carbon Management Plan (Appendix 15.5) prepared for the Proposed Development details the measures to be implemented throughout the operational phase in order to further reduce emissions. Such measures include the following:

- The Applicant will explore the inclusion of green clauses within tenant leases, where possible. Occupants will then be responsible for complying with such green lease clauses as set out within their lease agreements. Such clauses may include (subject to feasibility and tenant agreement) commitments by the tenant to ensure efficient use of energy within the buildings, and prioritising the use of renewable electricity; and commitments by the Applicant to enable utility consumption monitoring, and provide a forum to review and agree targets and strategies to improve environmental performance.
- A Framework Travel Plan along with a Public Transport Strategy is submitted as part of the DCO Application (ES Appendix 3.2). The Framework Travel Plan identifies the range of measures to be implemented or considered through future occupier Travel Plans to enhance the accessibility of the Main Site by public transport, cycling and walking. Site-wide measures proposed (to be secured via legal obligation) include a

significant investment in new or improved bus services to connect the site to nearby communities and destinations. Further details can be found in Chapter 3: Transport.

3.2 Construction Stage Emissions

3.2.1 The following paragraphs detail the construction stage emissions associated with the Proposed Development, following the implementation of additional mitigation measures summarised above.

Main Site

Rail Terminal and Associated Infrastructure

Rail Infrastructure Elements

3.2.2 Emissions associated with the rail terminal infrastructure are consistent with those presented in Section 2, as detailed material specifications accounting for the actions set out in the Carbon Management Plan (Appendix 15.5) are not available. Whilst the assessed emissions remain unchanged, it is expected that these would be reduced following principles set out in the Carbon Management Plan (Appendix 15.5), including selecting materials with a lower embodied carbon for the infrastructure.

3.2.3 The total A1-A3 emissions have been calculated to be 21,346 tCO_2e.

Rail Building Elements

3.2.4 Emissions associated with the rail terminal buildings are consistent with those presented in Section 2. It is expected there would be a reduction in such emissions following principles set out in the Carbon Management Plan (Appendix 15.5), including selecting materials with a lower embodied carbon for the buildings. However, at this stage of the Proposed Development, the specific materials are unknown and OneClick LCA 2023 benchmarks have been used to inform the embodied carbon associated with the Rail Freight Interchange Buildings.

3.2.5 The total A1-A3 (material cradle to gate) emissions have been calculated to be 1,832 tCO_2e.

Construction Activities

3.2.6 The additional mitigation measures set out in Section 3.1 above are anticipated to further reduce emissions arising from construction activity. However, as specific mitigation measures cannot be committed to at this stage (e.g. selection of electric site plant), it is not possible to quantitatively assess them. Therefore, post-mitigation A4-A5 emissions are calculated to be 1,239 tCO_2e, consistent with those presented in Section 2.

Warehouses and Buildings

Buildings

3.2.7 LCA modules A1-A3 construction emissions resultant from the Main Site warehouses and buildings have been calculated based on an estimated bill of quantities, incorporating good practice design measures common to the Applicant's developments, and which would be applied to the Proposed Development where feasible. This estimated bill of quantities has been informed by WLC assessments for recently completed developments by the Applicant.

3.2.8 The Applicant's previously completed example developments are considered to represent the Applicant's current standard design for buildings similar to those proposed for the Main

Site warehousing. As the specific design and associated bill of quantities (BoQ) for the warehousing at the Main Site has not yet been specified, it is considered that the resultant estimated BoQ will appropriately represent likely material use.

3.2.9 The WLC assessments for the sample developments include the foundations, ground floor structure, frame, floors, roofs, stairs and ramps, external walls, internal walls and partitions, windows and doors and internal finishes.

3.2.10 The quantity of materials presented in the Applicant's example WLC assessments for a comparable development was scaled accordingly with the Gross Internal Area of the Main Site warehousing, informed by Chapter 2: Description of Development and Alternatives. The resultant bill of quantities was subsequently scaled by relevant emission intensity factors. These factors were sourced from the OneClick LCA database (OneClick LCA, 2025). The estimated bill of quantities is shown in Table 3.1.

3.2.11 Embodied emissions associated with the PV have been calculated in line with the methodology in paragraph 2.2.17.

Table 3.1: Warehouses and buildings bill of quantities

Material	Quantity	Unit	Emissions Intensity Factor	Emissions Intensity Factor (Unit)
Carpet flooring	7,483.96	m^2	6.18	$kgCO_2e/m^2$
Concrete wall elements	9,774.52	m^2	336.36	$kgCO_2e/m^3$
Electrification components and systems	23,555	m	NA[1]	NA[1]
	8,160.90	Nos.		
Elevators and escalators	50	Nos.	969.29	$kgCO_2e$/unit
Energy production systems from renewable energy	65,939	m^2	195.5	$kgCO_2e/m^2$
Glass facades and glazing	25,126.66	m^2	72.99	$kgCO_2e/m^2$
Glass wool insulation	89,258.41	m^2	1.31	$kgCO_2e/kg$
Hot-dip galvanized/zinc coated steel	1,131	m	368.0	$kgCO_2e/m$
HVAC components and equipment	81,525.58	m	NA[2]	NA[2]
	46,381.73	m^2		
	201.92	Nos		
Lighting	1,592.01	Nos	NA[3]	NA[3]
Metal and industrial doors	11,824.90	m^2	98.47	$kgCO_2e/m^2$
Other precast concrete products	727.08	m	308.0	$kgCO_2e/m$
Paints, coatings and lacquers	23,913.39	kg	2190.0	$kgCO_2e/m^3$
	89,260.91	m^2	0.61	$kgCO_2e/m^2$
Plastic profiles and products	67,702.86	m^2	34.0	$kgCO_2e/m^2$
Raised flooring systems	28,444.05	m^2	6.38	$kgCO_2e/m^2$
Ready-mix concrete for external walls and floors	9,465.06	m^3	336.36	$kgCO_2e/m^3$
Ready-mix concrete for foundations and internal walls	111,583.11	m^3	326.79	$kgCO_2e/m^3$
Regular gypsum board	178,516.82	m^2	0.32	$kgCO_2e/kg$
Steel Reinforcement Bar	669,183.56	kg	2.89	$kgCO_2e/kg$
Sand, soil and gravel	604,267.45	m^2	0.0025	$kgCO_2e/kg$
Sandwich panels, metal	820,345.44	m^2	44.2	$kgCO_2e/m^2$

Material	Quantity	Unit	Emissions Intensity Factor	Emissions Intensity Factor (Unit)
Sanitary ware	1,479.25	Nos	NA[5]	NA[4]
Structural steel and steel profiles	885,584.90	kg	NA[6]	NA[5]
	18,113.81	tonnes		
Suspended ceiling systems	42,860.38	m^2	192.54	$kgCO_2e/m^2$
Wall and floor tiles	9,978.61	m^2	8.84	$kgCO_2e/m^2$
Wood and wood board doors	3,896.17	m^2	41.42	$kgCO_2e/m^2$
Solar PV	25,870	m^2	148	$kgCO_2e/m^2$
BESS[7]	21	MWh	106	$kgCO_2e/kWh$

1. A range of emissions intensities were used for electrification components. These ranged from 7.58 $kgCO_2e$/unit (LED downlight to 21.3 $kgCO_2e$/unit (Recessed modular LEDs)

2. A range of emissions intensities were used for HVAC components and equipment. These ranged from 16.36 $kgCO_2e$/m (ventilation ducting) to 7000.21 $kgCO_2e$/unit (Air handling unit)

3: A range of emissions intensities were used for lighting. These ranged from 29.88 $kgCO_2e$/unit (exterior lighting) to 206.84 $kgCO_2e$/unit (exterior lighting poles)

4: Sanitary ware includes sinks, shower enclosures toilet bowls and toilet flush tanks (ranging from 26 $kgCO_2e$/unit to 152.5 $kgCO_2e$/unit)

5: A range of emissions intensities were use for steel. These ranged from 1.12 $kgCO_2e$/kg (steel sheets) to 2.6 $kgCO_2e$/kg (structural steel)

6: A replacement rate is also applied across the Proposed Development's assessment lifetime.

3.2.12 Overall, Main Site warehousing A1-A3 emissions total 160,416 tCO_2e, resulting in a 62% reduction when compared to emissions presented within Section 2.

Associated Infrastructure

3.2.13 The additional mitigation measures summarised above are anticipated to reduce the magnitude of emissions arising from the Main Site warehousing infrastructure elements. However, at this early design stage, the exact emission reduction measures to be used have not been specified in detail. As such, A1-A3 emissions remain the same as those detailed in Section 2, totalling 41,862 tCO_2e.

Main Site Construction Activities

3.2.14 The additional mitigation measures summarised above are anticipated to reduce the magnitude of emissions arising from the construction site processes. However, at this early design stage, the exact emission reduction measures to be used have not been specified in detail. As such, A4-A5 emissions remain the same as those detailed in Section 2, totalling 53,429 tCO_2e.

Land Use Change

3.2.15 Emissions arising from land use change remain consistent with that detailed from paragraph 2.2.31 above.

Highways Works

3.2.16 The additional mitigation measures summarised above are anticipated to reduce the magnitude of emissions arising from the construction of the Highway Works (including structure). However, at this early design stage, the exact emission reduction measures to be used have not been specified in detail. As such, A1-A5 emissions remain the same as those detailed in Section 2, totalling 45,243 tCO_2e.

Land Use Change

3.2.17 As per paragraph 2.2.38 above, carbon emissions remain consistent with that detailed from paragraph 2.2.31 and 2.2.32 above.

Summary and Magnitude of Impact

3.2.18 The estimated post-mitigation GHG emissions arising from the construction stage of the Proposed Development are presented in Table 3.2. When compared with the emissions presented in Table 2.10, it can be seen that emission associated with the assessment of residual effects are reduced by 45%. These emissions totals will be updated following receipt of detailed information for the final ES (as detailed above).

Table 3.2: Summary of Residual Effect construction stage GHG emissions

LCA Stage	Item	Emissions (tCO_2e)		
		Main Site		Highway Works
		Rail terminal	Warehousing	
A1-A3	Buildings	1,832	160,416	n/a
	Infrastructure	21,346	41,862	18,905
A4	Buildings	98	23,663	n/a
	Infrastructure			25,083
A5	Buildings	118	26,691	n/a
	Infrastructure	1,023	3,076	1,255
n/a	Land use change*		8,771	
A1-A5	**Total**	**24,418**	**264,478**	**45,243**
			334,139	

*Emissions arising from land use change from the Main Site have been attributed to the warehousing totals within this table.

3.3 Operational Stage Emissions

3.3.1 The following paragraphs detail the construction stage emissions associated with the Proposed Development, following the implementation of additional mitigation measures summarised in Section 3.1 above.

Main Site

Rail Terminal

Avoided HGV Emissions

3.3.2 No additional mitigation is proposed regarding furthering the avoidance of HGV emissions through the use of the rail terminal, as such avoided emissions arising from avoided HGV movements are consistent with those presented in Section 2.

Emissions from Rail Freight

3.3.3 No additional mitigation is proposed regarding rail freight movements throughout the operation of the Proposed Development. As such resultant emissions are consistent with those presented in Section 2.

Vehicle Emissions

3.3.4 The implementation of the Travel Plan and Public Transport Strategy will enable the reduction of movements associated with light vehicles (i.e. commuting movements), enabling an associated reduction in emissions.

3.3.5 Development traffic flows for HGVs, and light vehicles have been modelled to generate 24-hour two-way Annual Average Daily Traffic (AADT) movements for the Main Site, split between the rail terminal, and warehousing and buildings (see Chapter 3: Transport for more information). Table 3.3 details the external traffic movements associated with the rail terminal, accounting for the additional mitigation. Internal movements within the main site have been considered in Table 2.13.

Table 3.3: Rail Freight Interchange external travel AADT movements (two-way)

	Lights	HGV	Total
Rail terminal external	67	718	784

3.3.6 Resultant emission were calculated following the methodology detailed at paragraph 2.3.12, and total 24,952 tCO_2e in the first year of full operation, offering a minor betterment when compared to the emissions set out in Section 2.

3.3.7 It is anticipated that emissions would be reduced further as the emissions factors used do not account for the steady decarbonisation of the transport sector that is in line with policy and legislation as the UK moves towards its net zero 2050 target. As such, it can be anticipated that associated emissions will be reduced throughout the Proposed Development lifetime.

Energy Consumption

3.3.8 Emissions arising from energy consumption at the rail terminal buildings are consistent with those detailed at Section 2, as there is no further quantifiable mitigation for energy consumption, which totals 47 tCO_2e per annum.

Maintenance, Repair and Replacement

3.3.9 Emissions arising from maintenance, repair and replacement are consistent with those presented in Section 2 and total 14 tCO_2e per annum.

Warehouses, Buildings and Associated Infrastructure

Energy Use

3.3.10 Emissions arising from energy consumption at the Main Site warehousing are consistent with those detailed at Section 2, as there is no further quantifiable mitigation for energy consumption, which totals 4,548 tCO_2e per annum.

Vehicle Movements

3.3.11 The implementation of the Travel Plan and Public Transport Strategy will enable the reduction of movements associated with light vehicles (i.e. commuting movements), enabling an associated reduction in emissions.

3.3.12 In line with paragraph 2.3.30 development traffic flows for HGVs, and light vehicles have been modelled to generate 24-hour two-way Annual Average Daily Traffic (AADT) movements for the warehousing and buildings (see Chapter 3: Transport for more

information) following the implementation of a Travel Plan. Table 3.4 details the external and internal traffic movements associated with the Main Site warehouses, accounting for the additional mitigation.

Table 3.4: Main Site warehouses external and internal AADT movements (two-way)

	Lights	HGV	Total
Main Site warehousing external	11,560	4,203	15,763
Main Site warehousing internal*	0	386	386

* These movements are internal within the site between the rail terminal and the warehousing

3.3.13 Resultant emission were calculated following the methodology detailed at paragraph 2.3.31 and 2.3.32, and total 154,741 tCO_2e in the first year of full operation, offering a 2% reduction when compared to the emissions set out in Section 2.

3.3.14 It should be noted that, similarly to paragraph 2.3.13 above, the 154,741 tCO_2e per annum figure provided for operational traffic GHG emissions does not account for the steady decarbonisation of the transport sector that is in line with policy and legislation as the UK moves towards its net zero 2050 target. As such, it can be anticipated that associated emissions reduce throughout the Proposed Development lifetime.

Maintenance, Repair and Replacement

3.3.15 Module B2 (maintenance) emissions arising from the Main Site buildings have been calculated in line with the methodology detailed in Section 2, with no change in the resulting emissions.

3.3.16 Module B3 (repair) emissions have been calculated using OneClick LCA (2025) software, informed by the detailed bill of quantities input associated with the construction of the Main Site warehousing. Module B4 (refurbishment) emissions have been calculated by applying material lifetimes from RICS (2023) and OneClick (2025), to the estimated material quantities for the Main Site buildings. LCA Stages B2-B4 emissions are reported in Table 3.5.

3.3.17 The Main Site infrastructure maintenance, repair and replacement emissions are unchanged following additional mitigation. Therefore, in line with the methodology detailed in Section 2 refurbishment emissions are as reported in Table 3.5.

Table 3.5: Main Site warehousing, buildings and infrastructure – B2 to B4 operational emissions

LCA Stage		Per annum (tCO_2e)	Lifetime (tCO_2e)
B2 (Maintenance)	Main Site warehousing	101	6,039
	Main Site infrastructure	9	568
B3 (Repair)	Main Site warehousing	15	910
	Main Site infrastructure	2	142
B4 (Replacement)	Main Site warehousing	521	31,240
	Main Site infrastructure	594	35,637
B2-B4	**Sub-total (Main Site warehousing)**	**636**	**38,188**
	Sub-total (Main Site infrastructure)	**606**	**36,346**
	Total	**1,242**	**74,535**

Land Use Change

3.3.18 Emissions arising from land use change remain consistent with that detailed from paragraphs 2.3.38 to 2.3.41.

Highway Works

Vehicle Emissions

3.3.19 As per paragraphs 2.3.42, operational transport emissions associated with the Highways Works have been investigated using the Defra Emissions Factor Toolkit (Defra, 2025) and assessed to be negligible and immaterial (see paragraphs 1.3.6 and 1.3.7); such emissions are not assessed further.

Maintenance, Repair and Replacement

3.3.20 Emissions arising from maintenance, repair and replacement are consistent with those presented in Section 2 and total 11,785 tCO_2e over the assessment lifetime of the Highways Works, and 196 tCO_2e per year of operation.

Land Use Change

3.3.21 Emissions arising from land use change remain consistent with that detailed at paragraph 2.3.45.

Summary and Magnitude of Impact

3.3.22 The estimated post-mitigation GHG emissions arising from the first year of operation of the Proposed Development are presented in Table 3.6.

Table 3.6: Summary of Residual Effect operational stage GHG Emissions

LCA Stage	Item	Emissions per year of operation (tCO_2e)		
		Main Site		Highway Works
		Rail terminal	Warehousing	
B1-B4	Maintenance	14	1,242	196
B6	Energy consumption	47	4,548	n/a
B8	Vehicle Movements	24,952	154,741	negligible
B8	Freight Movements	26,833	n/a	n/a
B8	Avoided Emissions	-71,600	n/a	n/a
n/a	Land use change*		131	
n/a	Carbon sequestration through proposed landscape planting		-198	
B1-B8	**Total**	**-19,754**	**160,465**	**196**
			140,907	

*Emissions arising from land use change from the Main Site have been attributed to the warehousing totals within this table.

3.4 Whole Lifetime Emissions

3.4.1 The net GHG emissions for the Proposed Development (accounting for additional mitigation) are presented in Table 3.7 below.

Table 3.7: Net whole life GHG emissions

LCA Stage	Item	Main Site		Highways Works	Proposed Development
		Rail terminal	Warehousing		
A1-A5	Construction emissions (tCO_2e)*	24,418	264,478	45,243	334,139
B1-B8	Lifetime operation emissions (tCO_2e)*	-1,185,237	9,627,874	11,785	8,454,422
	Total				**8,788,561**

*Emissions arising from land use change from the Main Site have been attributed to the warehousing totals within this table.

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