Chapter 13
Climate

CONTENTS

13. CLIMATE

13.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) assesses the impact of the DART+ Coastal North project ("the Proposed Development"), on Climate during the Construction Phase and Operational Phase. This chapter describes and assesses the likely direct, indirect, secondary and cumulative significant effects of the Proposed Development on Climate. This chapter also provides a characterisation of the receiving environment within the Proposed Development and within a wider study area in the vicinity of the Proposed Development.

The assessment is based on a reasonable worst-case scenario with respect to potential climatic impacts arising from the Proposed Development as described in Chapter 4 and Chapter 5 of this EIAR. The description of the Proposed Development is based on the design prepared to inform the planning stage of the Proposed Development and to allow for a robust assessment as part of the Environmental Impact Assessment process.

This chapter has assessed the potential effects on Climate arising from the Proposed Development during the Construction and Operational Phases based on the draft Railway Order, Chapter 4 (Description of Proposed Development) and Chapter 5 (Construction Strategy).

13.2 Legislation, policy and guidance

13.2.1 Legislation

In 2015, the Climate Action and Low Carbon Development Act, 2015 (the Climate Act) was enacted by the Oireachtas. The purpose of the Climate Act was to enable Ireland 'to pursue, and achieve, the transition to a low carbon, climate resilient and environmentally sustainable economy by the end of the year 2050', referred to in the Act as the national transition objective.

Following on from Ireland declaring a climate and biodiversity emergency in May 2019 and the European Parliament approving a resolution declaring a climate and environment emergency in Europe in November 2019, the Climate Action and Low Carbon Development (Amendment) Act, 2021 (the 2021 Climate Act) was signed into law in July 2021. The Act was prepared for the purposes of giving statutory effect to the core objectives stated within the Climate Action Plan.

The purpose of the Act is to provide for the approval of plans '*for the purpose of pursuing the transition to a climate resilient, biodiversity rich and climate neutral economy by no later than the end of the year 2050'*.

The 2021 Climate Act provides for carbon budgets and a sectoral emissions ceiling to apply to different sectors of the economy.

The 2021 Climate Act defines the carbon budget as '*the total amount of greenhouse gas emissions that are permitted during the budget period*'.

13.2.2 Policy

In December 2023, the 2024 Climate Action Plan (CAP) was published (Department of Environment, Climate and Communications (DCCAE) 2023). This is the second CAP since the publication of the carbon budgets and sectoral emissions ceilings, and it aims to implement the required changes to achieve a 51% reduction in carbon emissions by 2030.

The 2024 CAP has identified six vital high impact sectors where the biggest savings can be made: renewable energy, energy efficiency of buildings, transport, sustainable farming, sustainable business and change of land-use.

Aims within the 2024 CAP that have the potential to affect transport emissions include reducing the dependency on private cars and a target to reduce the overall total distance driven across all car journeys by 20%. In addition, the 2024 CAP has an aim that 1 in 3 cars will be electric by 2030 and that there would be an annual increase in the percentage of biofuel in fossil fuels (E10:B12 by 2025 and E10:B20 by 2030). E10 is unleaded petrol blended with 10% ethanol, B20 is up to 20% biodiesel blended into diesel.

Within the 2024 CAP, key transport actions are considered using an 'Avoid-Shift-Improve' framework:

- Developing services, communities, and infrastructure in such a manner as to AVOID the need to travel as much as we do today
- Improving the relative attractiveness of sustainable travel modes such as public transport, cycling and walking, to SHIFT away from car use; this will facilitate increased use of lower-carbon modes and reduce the percentage of total journeys that are made by private car (modal share) from over 70% (today) to just over 50% in 2030; and
- Complement these measures by increasing the proportion of EVs in our car fleet to 30% by 2030, which will IMPROVE the efficiency of the national car fleet; electrification of the freight and public transport sector will also be key

The advancement of the DART+ programme is listed as an action in the 2024 CAP for 2024 (see: 2024 CAP, TR/24/12).

The first carbon budget programme proposed by the Climate Change Advisory Council was approved by Government and adopted by both Houses of the Oireachtas in April 2022. The carbon budgets comprise of three successive 5-year budgets. The total emissions allowed under each budget is set out in Table 13-1 as well as the average annual reduction for each 5-year period.

Table 13-1 2021-2035 Carbon Budgets

Period	Mt CO_2eq	Emission Reduction Target
2021-2025	295 Mt CO_{2eq}	Reduction in emissions of 4.8% per annum for the first budget period.
2026-2030	200 Mt CO_{2eq}	Reduction in emissions of 8.3% per annum for the second budget period.
2031-2035	151 Mt CO_{2eq}	Reduction in emissions of 3.5% per annum for the third provisional budget.

The 2024 CAP provides that the economy-wide carbon budgets will be supplemented by sectoral emissions ceilings, setting the maximum amount of GHG emissions that are permitted in a given sector of the economy during each five-year carbon budget. The Sectoral Emission Ceilings for each sector, published in July 2022, are shown in Table 13-2. It should be noted that 5.25 $MtCO_{2eq}$ of annual emissions reductions are currently unallocated on an economy-wide basis for the second carbon budget period (2026-2030). These will be allocated following a mid-term review and identification of additional abatement measures. The transport sector emitted approximately 12 $MtCO_{2eq}$ in 2018 and has a ceiling of 6 $MtCO_{2eq}$ in 2030 which is a 50% reduction over this period.

Table 13-2 Sectoral Emission Ceilings

Sector	Reduction Required	2018 Emissions ($MtCO_2eq$)	2030 Emission Ceiling ($MtCO_2eq$)
Electricity	75%	10.5	3
Transport	50%	12	6
Buildings (Commercial and Public)	45%	2	1
Buildings (Residential)	40%	7	4
Industry	35%	7	4
Agriculture	25%	23	17.25
Other (F-Gases, Waste & Petroleum refining)	50%	2	1

The Electricity & Gas Networks Sector Climate Change Adaptation Plan prepared under the National Adaptation Framework has been prepared by the Department of Communications, Climate Action and Environment (DCCAE 2019b) and considers future climate change impacts on energy infrastructure and aims to reduce vulnerability by building resilience in the energy sector. The plan proposes to avoid or minimise future adverse impacts within the sector and to exploit opportunities. Steps include diversification of energy sources, improved communication between relevant bodies/stakeholders, a requirement for energy network companies to continue to ensure climate change is taken into account in planning and design standards and engineering management practices and identification of vulnerable areas and measures to take with respect to climate impacts.

The Transport Climate Change Sectoral Adaptation Plan (DTTAS 2019) was also prepared under the National Adaptation Framework used the six-step approach outlined in the Sectoral Planning Guidelines for Climate Change Adaptation. The plan states that the adaptation measures should enable continued services and maintained infrastructure as well as safeguarding new assets from longer term impacts by ensuring that current design specifications will adequately address future infrastructure needs. Appendix II of the plan discusses how future climate change has the potential to impact the transportation and heavy rail network, the risks involved in these impacts (e.g. heat waves which increase risk of rail buckling and misalignment of tracks which would increase the need for network-wide speed restrictions), the risks associated with the impacts and consequences of such risks.

The local authorities within the region of the Proposed Development (Dublin City Council (DCC), Fingal County Council (FCC), Meath County Council (MCC) and Louth County Council (LCC)) each have individual climate change action plans.

The individual plans were prepared having regard to 'A Strategy Towards Climate Change Action Plans for the Dublin Local Authorities' (Codema 2017a). This combined plans stated aims include aiding the Councils in tackling climate change and setting a path to tackling the challenges related to the consequences of climate change. As the Proposed Development will pass through the DCC, FCC, MCC and LCC jurisdictions, a discussion on each of the respective climate action plans is provided.

The DCC 'Climate Change Action Plan' (DCC and Codema 2019) outlines a number of goals and plans to prepare for and adapt to climate change. There are five key action areas within the plan: energy and buildings, transport, flood resilience, nature-based solutions and resource management. Some of the transport-related measures promoted within the DCC Climate Action Plan involve the development of segregated cycle routes, the promotion of bike share schemes and promotion of the use of green infrastructure. Transportation integration is discussed within the DCC Climate Action Plan with DCC confirming that it will work with the National Transport Authority (NTA), TII, Dublin Bus, Iarnród Éireann, Bus Éireann, Road Safety Authority (RSA) and private operators to improve the connectivity of public transport systems. The Proposed Development will directly connect with DART, Luas and the proposed BusConnects. Other elements of the DART+ programme will connect with the proposed MetroLink. The DCC Climate Change Action Plan noted that transport accounted for 24.8% of GHG emissions in 2018 with 32% of transport in Dublin completed using a private car. DCC aims to achieve a doubling of all active travel and public transport trips and to halve private vehicle trips in Dublin by 2030. Action T50 is to implement policy to increase modal shift to public transport.

FCC has also produced a 'Climate Change Action Plan for 2019–2024' (FCC and Codema 2019) which outlines FCC's goals to mitigate GHG emissions and plans to prepare for and adapt to climate change. Appendix II of the FCC plan states that transport accounted for 44.6% of FCC's total GHG emissions in 2016. The FCC Climate Change Action Plan aims to reduce car dependency by encouraging modal shifts from car to more sustainable modes, including public transport and cycling. Similar to DCC, FCC states that it aims to work with the relevant transportation bodies to introduce measures to achieve better integration of transportation and land use planning, modal shifts and promote interchange between modes. A target of a 40% reduction in the Council's GHG emissions by 2030 has been set by Fingal County Council.

Part of the mechanism to achieve these goals will be through the improvement of public transport, with the DART+ Programme specifically mentioned as part of this integrated transport strategy (Action T24). The FCC Climate Change Action Plan highlights the risks that climate change poses to the transportation network with risks mainly associated with extreme weather events and sea level rise. The FCC Climate Change Action Plan notes that sea level rise, extreme weather events (and in particular cold snaps, heat waves and dry spells) and coastal, fluvial and pluvial flooding have the greatest future risk when both the likelihood and consequence are accounted for. Increases in fluvial and pluvial flooding will cause road damage, which can lead to disruption of transport services.

The Meath County Council (MCC) Climate Action Strategy (Meath County Council 2018) notes that its vision for climate change action presents a bold, exciting future for the county. The strategy aims to reduce CO_2 emissions of the county by at least 40% by 2030 while increasing the county's resilience by adapting to the impacts of climate change.

Another stated aim is to support the NTA in the delivery of a strategic multi-modal park-and-ride facility at M3 Parkway and support the improvement of existing rail transport infrastructure at the train station. The measures also state an objective to support the electrification of rail lines.

The Louth County Council (LCC) Climate Change Adaptation Strategy (Louth County Council 2019) takes on the role as the primary instrument at local level to:

- Ensure a proper comprehension of the key risks and vulnerabilities of climate change
- Bring forward the implementation of climate resilient actions in a planned and proactive manner; and
- Ensure that climate adaptation considerations are mainstreamed into all plans and policies and integrated into all operations and functions of Louth County Council

13.2.3 Guidance

The assessment has been undertaken with reference to the most appropriate guidance documents relating to climate which are set out in the following sections. In addition to specific climate guidance documents, the following guidelines were considered and consulted in the preparation of this chapter:

- Environmental Protection Agency (EPA) Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA 2022)

The following climate specific guidance was considered in the assessment:

- Climate Guidance for National Roads, Light Rail, and Rural Cycleways (Offline & Greenways) - Overarching Technical Document (TII, 2022a)
- Climate Assessment of Proposed National Roads - Standard (TII, 2022b); and
- LA 114 – Climate (UKHA 2021). Design Manual for Roads and Bridges Volume 11 Environmental Assessment, Section 3 Environmental Assessment Techniques, Part 14 LA 114 – Climate

13.3 Methodology

13.3.1 Study Area

During the Construction Phase, the focus is on the enabling infrastructure provision, which forms the Proposed Development including utility diversions, land take activities, excavation works, road reconfiguration, significant construction materials and construction traffic emissions.

During the Operational Phase, the study area focus is on GHG emissions associated with the Proposed Development including GHG emissions along impacted traffic routes within the study area. Potential impacts to climate relate to alterations to road traffic patterns, power for running substations and the Proposed Development, maintenance and changes to the number and type of road and rail traffic trips. The assessment of the Operational Phase also examines the vulnerability of the Proposed Development to climate change, including the risk of flooding and the potential increased frequency of storms.

13.3.2 Survey Methodology

The climate chapter is desktop based, with no surveys required.

13.3.3 Assessment Methodology

The TII Climate Assessment of Proposed National Roads - Standard (PE-ENV-01105) sets out the required approach to identify significant climate effects; in terms of both Greenhouse Gas (GHG) emissions and climate resilience, associated with all stages of developments. Although the Standard provides best practice methodology and processes for climate assessment for proposed national road developments, as well as light railway and rural cycleways projects, it is deemed appropriate for the assessment of the Proposed Development in the absence of other Irish guidance.

13.3.4 Construction Phase Appraisal Method for the Assessment of Impacts

TII Standard advises the use of the TII Carbon Tool to calculate emissions from construction.

Table 13-3 Data Types for Assessment of GHG Emissions

Lifecycle Stage	Type of data	Likely sources
Before Use / Construction	Information that defines and describes the size, magnitude, and physical nature of the proposed project. Project value for Construction Phase.	Project description
	Land use change – size of the area, existing and future by type of land use.	Biodiversity/Ecology consultant
	Construction material quantities.	Bill of Quantities
	Construction works techniques/technologies, volume of fuel/electricity consumed during advanced works and construction.	Contractor/Design Team
	Transportation distance and modes for construction workers and construction materials. Number of construction workers and their mode of transport to site.	Contractor/Design Team
	Waste generation during construction and quality of waste and disposal method, distance to the waste facility.	Contractor/Design Team
	Energy and water demand during construction.	Contractor/Design Team

The TII Carbon Tool (TII 2021) uses emission factors from recognized sources including the Civil Engineering Standard Method of Measurement (CESSM) Carbon and Price Book database (CESSM, 2013). The carbon emissions are calculated by multiplying the emission factor by the quantity of the material that will be used over the entire construction / maintenance phase. The assessment commences with the high-level design, through the pre-construction (site clearance) stage, followed by the assessment of the embodied carbon associated with all materials used in the construction of the Proposed Development, the emissions during the Construction Phase and additionally emissions related to waste generated during the Construction Phase. The tool also assesses on-going maintenance associated with a 35-year lifetime of the development. It is generally assumed that end-of-life demolition is not relevant and thus there are no emissions associated with this stage. The Construction Phase of the Proposed Development will result in GHG emissions from various sources, as outlined in Table 13-3. Embodied carbon refers to GHGs emitted during the manufacture, transport and use of building materials, together with end-of-life emissions.

As part of the Proposed Development, Construction Phase embodied GHG emissions are categorised under the following headings:

- Land clearance activities
- Manufacture of materials and transport to site
- Construction works (including excavations, construction, water usage, electrical power/fuel usage, personnel travel and project size); and
- Construction waste products (including transport off-site)

Detailed information for the Proposed Development, including volumes of materials were obtained from the design team.

The Proposed Development is expected to have a Construction Phase of approximately 36 months and an operational lifespan of 35 years. Standard maintenance, as indicated through the TII Carbon tool (TII 2021), required over the Operational Phase has also been considered as part of the embodied construction emissions including consideration of the maintenance cycles for embodied carbon for road pavements. Given the extent of the Operational Phase, 'LA 114 – Climate' (UKHA 2021) states that decommissioning should be excluded from the climate assessment. It should be noted that the quantification of materials at the preliminary design stage has been completed to assess the embodied construction carbon. The exact volumes of materials, location of waste disposal sites, sourcing of products and technical specification for materials will be finalised during the detailed design phase by the appointed contractor. Throughout the assessment, efforts have been made to provide the most likely scenario for the embodied carbon assessment.

13.3.4.1 Land Use Change

The land use change associated with the Construction Phase of the Proposed Development has been quantified using the approach outlined in Table 13-3. The DART+ Coastal North project is an infrastructural project which includes infrastructural interventions at locations along the operational line between Dublin City Centre and Drogheda, inclusive of the Howth Branch, as well as the extension of electrification from Malahide to Drogheda, which will enable an increased capacity and frequency of service in the future. The majority of the route has no land use change as a result of the Proposed Development, however there is land take required (permanent and temporary) such as for new substations, to provide for new turnback infrastructure, for utility diversions and for Construction Compounds which will result in change in land use. Trees are a natural carbon sink and absorb carbon dioxide (CO_2) from the atmosphere helping in the reduction of climate change; any felling of trees has the potential to result in a loss of this carbon sink thus increasing the levels of CO_2 in the atmosphere. In contrast, increased planting of trees on suitable lands will, over time, help to increase the carbon sink potential of the land and benefit climate. The change in land use associated with the Proposed Development, including felling and planting of trees and vegetation, has been calculated using the methodology outlined in the Intergovernmental Panel on Climate Change (IPCC) 'Guidelines on National Greenhouse Gas Inventories – Chapter 4: Forest Land' (IPCC 2006). Consideration is also given to the 2010 European Commission Guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive EU 2009/28/EC. Operational land use change is also appropriately assessed.

Table 13-4 Sources and Life Cycle Stages for a Project's GHG Emissions (reproduced from Table 3.11.1 of LA 114 – Climate (UKHA 2019))

Main Stage of a Project Life Cycle	Sub-stage of Life Cycle	Potential Sources of GHG Emissions (Not Exhaustive)	Examples of Activity Data
Construction stage	Product stage: including raw material supply, transport and manufacture.	Embodied GHG emissions associated with the required raw materials.	Material quantities.
	Construction process stage; including transport to/from works site and construction/installation processes.	Activities for organisations conducting construction work.	Fuel/electricity consumption. Construction activity type/duration. Transportation of materials from point of purchase to site, mode / distance. Area of land use change.
	Land use change.	GHG emissions mobilised from vegetation or soil loss during construction.	Type and area of land subject to change of usage.
Operation ('use-stage') (to extend 60 years in line with appraisal period)	Operation and maintenance (including repair, replacement and refurbishment). This also includes electrical power required for stations and traction.	Energy consumption for infrastructure operation and activities of organisations conducting routine maintenance.	Fuel/electricity consumption. For vehicles, lighting and plant. Raw material quantities and transport mode/distance. Waste and arisings quantities, transport mode/distance and disposal fate.
	Use of infrastructure by the end- use (road user).	Vehicles using highways infrastructure.	Traffic count/speed by vehicle type for highway links.
	Land use and forestry.	Ongoing land use GHG emissions/sequestration each year.	Type and area of land subject to change in usage. Net change in vegetation.
Opportunities for reduction	GHG emissions potential of recovery including reuse and recycling GHG emissions potential of benefits and loads of additional functions associated with the study system.	Avoided GHG emissions through substitution of virgin raw materials with those from recovered sources.	Waste and arisings material quantities and recycling/reuse fate.

Note: The first life cycle stage is 'construction', which includes GHG emissions from the construction process and the manufacture/transport of materials. The second life cycle stage is 'operation', which includes:

1) Operation and maintenance, repair, replacement, refurbishment and land use change (operational maintenance GHG emissions); and

2) Emissions from end-users (operational user GHG emissions).

The third life cycle stage comprises opportunities to minimise production/use of GHG emissions i.e. the potential for reduction of GHG emissions through reuse and recycling during the construction of the Proposed Development.

13.3.4.2 Traffic Related Emissions

The TII REM tool calculates greenhouse gas emissions from road transport integrating traffic volumes and speeds for light and heavy vehicles on the Irish national road network with Irish fleet composition information.

The TII REM has three main modular tools that are used together with traffic flows to generate emissions and local air quality predictions:

- Emissions Rate Database
- Fleet Mix Database; and
- Air Quality Algorithm

The Emissions Rate Database and the Fleet Mix Database are used with Traffic Data to generate vehicle emissions for individual roads (or sections of roads known as links), individual counties, or for total national emissions. The tool does this by multiplying together the classified vehicles in the Fleet Mix Database with the speed-based emission rates in the Emissions Rate Database and traffic flows. Traffic flows are inputted by the tool user through the Traffic Data File, whilst the Fleet Mix Database and Emissions Rate Database are embedded within the tool and linked to user control options. The last module is the air quality algorithm which takes the link-based emissions and calculates pollutant concentrations. This module incorporates calculations of background pollutant contributions and the conversion of NO_X to NO_2.

Table 13-4 outlines the sources and activity classes for the Operational Phase of the Proposed Development including operational end-use (road user) and operation and maintenance. The Construction Phase traffic movements are also included as part of embodied carbon assessment detailed in Section 13.5.1.2 as this assessment accounts for emissions that are outside of the study area for the traffic assessment. Hence there will be a degree of double counting.

13.3.5 Operational Phase Appraisal Method for the Assessment of Impacts

The Operational Phase impact of the Proposed Development has two significant sources that have the potential to lead to a change in GHG emissions. The most significant potential changes in GHG emissions are the operational emissions shift from diesel to electricity and the increase in frequency of rail movements. A change from fossil fuels to electricity, which can be provided from renewable sources, has significant potential for reducing emissions.

In addition to the running of the rail stock and stations, there will be electrical power requirements for the running of the proposed substations. There is also the potential for road traffic related emissions associated with the Operational Phase of the Proposed Development. Standard maintenance required over the Operational Phase has also been considered as part of the estimation of Construction Phase embodied emissions. The assessment of rail emissions assumes for the Do-minimum scenario that the previously approved battery-electric multiple units (BEMUs) has been already implemented.

The closure of one level crossing (level crossing reference number XB001 at Malahide estuary south of Donabate) is proposed. However, this crossing is a user worked level crossing and will have no impact on road traffic redistribution and therefore Operational Phase traffic inputs are not considered further.

13.3.5.1 Operational Phase Rail Emissions

Fossil fuel powered trains have the potential to have impacts on climate. The Proposed Development aims to reduce local and regional emissions of fossil fuels by the extension of the electrification of the rail line between Malahide and Drogheda.

The proposed Do Something (DS) scenario (i.e. the future scenario with the Proposed Development operational) will become heavily weighted towards electric multiple units (EMUs) with some diesel multiple units (DMUs) on the line due to shared use with intercity lines. Unlike the diesel units, the EMUs will have no localised tailpipe emissions. Table 12-12 in Section 12.3.6.4 of Chapter 12 Air Quality in Volume 2 of this EIAR provides information on the current fuel usage by the DMUs per km travelled. In addition, information has been provided on the electric power required to power an EMU (DART Unit 8537) for a km (1.43 kWh/km).

Emissions for diesel units are provided using the European Monitoring and Evaluation Programme (EMEP) and European Environment Agency (EEA) 2019 Air Pollutant Emission Inventory Guidebook for Railways (EMEP and EEA 2019). The guidebook is part of a series published which are designed to facilitate reporting of emission inventories by countries to the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution and the EU National Emission Ceilings Directive. Emissions of CO_2, CH_4 and N_2O are also included in the guidebook (see Table 13-5). Details on the three pollutants can be found in Section 13.4.2.

Emissions from diesel engines can be broken into three categories:

- Shunting locomotives
- Railcars; and
- Line-haul locomotives

Table 13-5 Rail Emission Factors of Climate Related Pollutants

Tier 2 Shunting Locomotives			
Pollutant	**Kg/Fuel Tonne Note 1**	**Kg Pollutant/Km Note 2**	**g Pollutant/Km**
CO_2	3190	1.79	1788
CH_4	0.176	0.00010	0.100
N_2O	0.024	0.00001	0.013
Tier 2 Rail Cars			
Pollutant	**Kg/Fuel Tonne Note 1**	**Kg Pollutant/Km Note 2**	**g Pollutant/Km**
CO_2	3140	1.76	1760
CH_4	0.179	0.00010	0.100
N_2O	0.024	0.00001	0.013
Tier 2 Line-Haul Locomotives			
Pollutant	**Kg/Fuel Tonne Note 1**	**Kg Pollutant/Km Note 2**	**g Pollutant/Km**
CO_2	3140	1.76	1760
CH_4	0.182	0.00010	0.102
N_2O	0.024	0.00001	0.013

Note 1: Emissions factors from Air Pollutant Emission Inventory Guidebook for Railways (EMEP and EEA 2019)

Note 2: Emission factors based on Air Pollutant Emission Inventory Guidebook for Railways (EMEP and EEA 2019) and Iarnród Éireann average Diesel usage.

The approach for the DMUs, referred to as Tier 2 in the Guidance (EMEP and EEA 2019), is based on apportioning the total fuel used by railways to that used by different locomotive technology types as the measure of activity. It assumes that the fuel can be apportioned for example using statistics on the number of locomotives, categorised by type, and their average usage, e.g. from locomotive maintenance records.

EMUs are powered by electricity generated at stationary power plants as well as other sources. As the rail stock move from DMUs to EMUs the associated emissions will be emitted at the powerplants generating electricity rather than through the DMU tailpipe. The emissions of pollutants generated due to the electricity power demand for the EMUs can be calculated using the carbon intensity of the fuel mix used in the generation of electricity nationally. In addition to the running of the railway corridor there will be energy required for running the proposed substations.

The carbon intensity is the amount of CO_2 that will be released per kilowatt hour (kWh) of energy of a given fuel. For most fossil fuels the emissions per unit is almost constant, but in the case of electricity it will depend on the fuel mix used to generate the electricity and on the efficiency of the technology employed. A figure for carbon (CO_2) for the generation of electricity is updated by Sustainable Energy Authority of Ireland (SEAI) annually. The provisional 2020 carbon intensity figure of 295.1 gCO_2/kWh has been published on the SEAI website (SEAI 2021).

This carbon intensity is applicable for 2020 however it is expected that the pollution intensity per kWh will reduce by the opening year. The 2024 Climate Action Plan (CAP) has set a national target of up to 80% of electricity demand by renewables by 2030 for the national electricity grid. Currently, approximately 40% of the national grid electricity comes from renewable sources. Increasing the proportion of renewables, which will not have any additional fossil fuel emissions associated with them, will reduce the emissions per kWh of electricity produced on the national grid. The remaining power on the national grid will be supplied by fossil fuels, the emissions of which are carefully controlled by the EPA under the Emissions Trading Scheme (ETS), which ensures that CO_2 emissions will be controlled.

An estimation of the 2030 carbon intensity has been made for the purposes of this assessment assuming a national target of 80% of electricity demand by renewables will be met. The figure of 102.047 gCO_2/kWh was calculated based on a normalization of the 2020 carbon intensity and increasing the percentage of renewables to 80%. This is an estimation of the potential future carbon intensity, the true value may be lower or higher depending on the carbon intensity of other fuels used to generate the remaining 20% and the changes in loss in transformation, transmission and distribution processes.

The Iarnród Éireann Climate Action Plan 2023 – 2030 (Iarnród Éireann 2023) states that existing and new DART fleet will benefit from increasing renewable energy content of the national grid, doubling to 80% by 2030 compared to c.40% currently, as well as the proposed Iarnród Éireann Corporate Power Purchasing Agreements (CPPAs). A CPPA is a financial contract with a renewable generator that will allow for a guaranteed source of renewable power for the operation of the Proposed Development in future. This will ensure that should the CAP target of 80% renewables not be achieved, the Proposed Development will still achieve the target within itself. For the purposes of the assessment, it has been assumed both the DN and DS have 80% renewables.

Table 13-6 Estimated Emission Factors of Regional Pollutant per kWh

Pollutant	Kg Pollutant/kWh
CO_2 (2030) at 80% Renewables	0.102

13.3.6 Impact Assessment Criteria

13.3.6.1 Construction and Operational Phase Significance Criteria

After the publication of the 2021 Climate Act in July 2021 and the 2021 CAP, carbon budgets and sectoral ceilings for the transport sector were adopted and detailed in the 2023 and 2024 CAPs which allows a comparison with the net CO_2 project GHG emissions.

As further context to this approach to significance, it is recognised that there are many activities and sectors which are contributing to net GHG emissions in Ireland. Large industrial and power GHG emissions are captured in the context of the EU-wide ETS which has set defined targets which are being met due to the structure of the Cap-and-Trade mechanism which allows the price of carbon to rise to ensure that GHG emissions are reduced with the least cost. Most other activities such as agriculture, transport, built environment, waste and smaller industry, however, are subject to the Effort Sharing Regulation (2023) which has set a specific target for Ireland of a 42% reduction in GHG emissions by 2030.

The TII Standard (TII 2022b) outlines a recommended approach for determining the significance of both the Construction and Operational Phases. The approach is based on considering the extent to which GHG emissions over the life of the project align with Ireland's GHG trajectory to net zero by 2050. This shall be done by considering the estimated emissions over the life of the project against Ireland's trajectory to net zero.

Table 13-7 outlines the significance criteria provided for the assessment of the assessment of GHG emissions.

Table 13-7 Climate Significance Matrix

Effects	Significance level	Description
Significant adverse	Major adverse	The project's GHG impacts are not mitigated; The project has not complied with do-minimum standards set through regulation, nor provide reductions required by local or national policies; and No meaningful absolute contribution to Ireland's trajectory towards net zero.
	Moderate adverse	The project's GHG impacts are partially mitigated; The project has partially complied with do-minimum standards set through regulation, and have not fully complied with local or national policies; and Falls short of full contribution to Ireland's trajectory towards net zero.
Not significant	Minor adverse	The project's GHG impacts are mitigated through 'good practice' measures; - The project has complied with existing and emerging policy requirements; and Fully in line to achieve Ireland's trajectory towards net zero.
	Negligible	The project's GHG impacts are mitigated beyond design standards; The project has gone well beyond existing and emerging policy requirements; and

Effects	Significance level	Description
		Well 'ahead of the curve' for Ireland's trajectory towards net zero.
Beneficial	Beneficial	The project's net GHG impacts are below zero and it causes a reduction in atmosphere GHG concentration; The project has gone well beyond existing and emerging policy requirements; and Well 'ahead of the curve' for Ireland's trajectory towards net zero, provides a positive climate impact.

13.3.7 Significance Criteria – Vulnerability of Proposed Development to Climate Change

In accordance with the TII Standard, a comprehensive list of risks based on the climate change hazards that have been deemed relevant to the project type and location should be generated. Risks should be associated with a specified climate variable and the project receptors for each risk should be stated. Risk statements should link a climate-related cause to a project related effect. For each risk, existing or planned controls should be noted. In this instance, existing or planned controls represent business-as-usual measures that are typically included in the design and operation of a TII project that work to mitigate the climate risk. A risk assessment to determine the significance of the risk of the Proposed Development's vulnerability to climate change is assessed in accordance with Table 13-8.

Table 13-8 Assessing Significance using the Risk Matrix

Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Rare	Not significant	Not significant	Not significant	Significant	Significant
Unlikely	Not significant	Not significant	Not significant	Significant	Significant
Moderate	Not significant	Not significant	Significant	Significant	Significant
Likely	Not significant	Significant	Significant	Significant	Significant
Almost certain	Significant	Significant	Significant	Significant	Significant

Legend

Low	Medium	High	Extreme

13.3.8 Consultation

Consultation is important to ensure that a sufficiently robust environmental baseline is established for the Proposed Development and its surroundings. Full details of the consultations are detailed in Chapter 3 (Alternatives) in Volume 2 of this EIAR.

Consultation helps to identify specific concerns and issues relating to climate early in the process. Public consultation was conducted as part of the early-stage design of the Proposed Development. The following organisations were also consulted:

- Dublin County Council
- Fingal County Council
- Louth County Council
- Meath County Council; and

- Environmental Protection Agency (EPA)

Dublin City Council requested that the amended Climate Change Act be referenced in the EIAR. No other specific climatic issues were raised as part of the consultation process by these organisations.

13.3.9 Difficulties Encountered / Limitations

No particular difficulties arose in the preparation of this chapter.

13.4 Receiving Environment

Climate is defined as the average weather over a period of time (usually 30 years), whilst climate change is a significant change to the average weather. Climate change is a natural phenomenon but in recent years human activities, through the release of GHGs, have impacted on the climate (IPCC 2014). The release of anthropogenic GHGs is altering the Earth's atmosphere resulting in a 'Greenhouse Effect'. This effect is causing an increase in the atmosphere's heat trapping abilities resulting in increased average global temperatures over the past 40 years. The release of CO_2 as a result of burning fossil fuels, has been one of the leading factors in the creation of this 'Greenhouse Effect'. The most significant GHGs are CO_2, methane (CH_4) and nitrous oxide (N_2O).

For the purposes of this assessment, the definition outlined in Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources for GHGs as amended by 2023/2413 has been used. In 'Annex V, C. Methodology Point 4' the relevant GHGs are defined as CO_2, N_2O and CH_4. CO_2 accounted for 60.8% of total GHG emissions in Ireland in 2020 while CH_4 and N_2O combined accounted for 37.7% (EPA 2021a).

GHGs have different efficiencies in retaining solar energy in the atmosphere and different lifetimes in the atmosphere. In order to compare different GHGs, emissions are calculated on the basis of their Global Warming Potential (GWP) over a 100-year period, giving a measure of their relative heating effect in the atmosphere. The IPCC Fifth Assessment Report (AR5) (IPCC 2014) sets out the global warming potential for a 100-year time period (GWP100) for CO_2 as the basic unit (GWP = 1) whereas methane gas (CH_4) has a global warming potential (GWP100) equivalent to 28 units of CO_2 and N_2O has a GWP100 of 265.

13.4.1 Vulnerability of the Proposed Development to Climate Change

Impacts to the Proposed Development as a result of climate change involve increases in global temperatures and increases in the number of rainfall days per year. Ireland has seen increases in the annual rainfall in the north and west of the country, with small increases or decreases in the south and east including in the region where the Proposed Development will be located (EPA 2017). The EPA has compiled a list of potential adverse impacts as a result of climate change including the following which may be of relevance to the Proposed Development:

- More intense storms and rainfall events
- Increased likelihood and magnitude of river and coastal flooding
- Water shortages in summer in the east
- Adverse impacts on water quality; and
- Changes in distribution of plant and animal species

The historical regional weather data for Dublin Airport which is considered representative of the current climate in the region of the Proposed Development is shown in Table 13-9 (Met Éireann 2020). The region where the Proposed Development will be located has a temperate, oceanic climate, resulting in mild winters and cool summers. The Met Éireann weather station at Dublin Airport, County Dublin, is the nearest weather and climate monitoring station to the Proposed Development that has meteorological data recorded for the 30-year period from 1981 to 2010. The meteorological station is located approximately 4km north-west of the Proposed Development at the closest point. Meteorological data recorded at Dublin Airport over the 30-year period from 1981 to 2010 indicates that the wettest months were August and October, and the driest month on average was February. July was the warmest month with a mean temperature of 15.6°C.

Table 13-9 30-Year Historical Weather Data for Dublin Airport 1981 to 2010 (Met Éireann 2020[1])

Measurement	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature (°C)													
Mean Daily Max	8.1	8.3	10.2	12.1	14.8	17.6	19.5	19.2	17.0	13.6	10.3	8.3	13.3
Mean Daily Min	2.4	2.3	3.4	4.6	6.9	9.6	11.7	11.5	9.8	7.3	4.5	2.8	6.4
Mean Temperature	5.3	5.3	6.8	8.3	10.9	13.6	15.6	15.3	13.4	10.5	7.4	5.6	9.8
Absolute Max.	16.5	16.2	17.2	20.5	23.5	25.7	27.6	28.7	24.6	21.0	18.0	16.2	28.7
Min. Maximum	-3.1	-0.1	2.4	4.5	6.6	10.4	11.7	11.9	11.2	5.3	-1.8	-4.7	-4.7
Max. Minimum	11.8	11.9	11.9	12.8	13.2	16.2	19.0	18.2	17.3	15.2	12.8	12.9	19.0
Absolute Min.	-9.5	-6.7	-7.9	-4.0	-1.6	2.1	4.6	2.4	1.2	-3.3	-8.4	-12.2	-12.2
Mean Num. of Days with Air Frost	6.4	6.5	3.8	2.4	0.3	0.0	0.0	0.0	0.0	0.5	3.0	6.4	29.4
Mean Num. of Days with Ground Frost	15.0	14.0	12.0	10.0	3.0	0.0	0.0	0.0	0.0	4.0	10.0	14.0	82.0
Mean 5cm Soil	3.8	3.8	5.4	8.2	12.2	15.2	16.7	15.8	13.1	9.4	6.2	4.5	9.5
Mean 10cm Soil	4.1	4.1	5.5	7.9	11.5	14.6	16.2	15.4	13.0	9.7	6.6	4.8	9.4
Mean 20cm Soil	4.6	4.7	6.1	8.4	11.7	14.8	16.5	16.0	13.7	10.5	7.3	5.3	10.0
Relative Humidity (%)													
Mean at 0900UTC	87.0	86.4	84.0	79.5	76.9	76.7	78.5	81.0	83.4	85.5	88.5	88.0	83.0
Mean at 1500UTC	80.6	75.7	71.0	68.3	68.0	68.3	69.0	69.3	71.5	75.1	80.3	83.1	73.3
Sunshine (hours)													
Mean Daily Duration	1.9	2.7	3.5	5.3	6.2	5.8	5.3	5.1	4.3	3.3	2.4	1.7	3.9
Greatest Daily Duration	8.1	9.8	11.9	13.3	15.4	15.9	15.6	14.2	12.4	10.2	8.8	7.3	15.9

[1] According to Met Eireann, data for 1991-2020 is in the process of being quality assured and collated. These tables will be available on www.met.ie in August 2023.

Measurement	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Num. of Days with No Sun	9.1	6.2	4.7	2.5	2.0	1.9	1.4	1.5	2.6	4.8	7.3	10.5	54.6
Rainfall (mm)													
Mean Monthly Total	62.6	48.8	52.7	54.1	59.5	66.7	56.2	73.3	59.5	79.0	72.9	72.7	758.0
Greatest Daily Total	27.1	28.1	35.8	30.4	42.1	73.9	39.2	72.2	40.6	53.2	62.8	42.4	73.9
Mean Num. of Days with >= 0.2mm	17	15	17	15	15	14	16	16	15	17	17	17	191
Mean Num. of Days with >= 1.0mm	12	10	11	10	11	10	10	11	10	11	11	12	129
Mean Num. of Days with >= 5.0mm	4	3	3	3	3	3	3	4	4	4	4	4	42
Wind (knots)													
Mean Monthly Speed	12.5	12.0	11.6	9.9	9.2	8.6	8.7	8.7	9.2	10.4	11.0	11.3	10.3
Max. Gust	80	73	66	59	58	53	54	56	59	69	66	76	80
Max. Mean 10-Minute Speed	53	49	45	39	39	38	36	37	36	51	43	55	55
Mean Num. of Days with Gales	2.3	1.5	1.1	0.1	0.1	0.1	0.1	0.1	0.2	0.5	0.8	1.3	8.2
Weather (Mean No. of Days with.)													
Snow or Sleet	4.6	4.2	2.8	1.2	0.2	0.0	0.0	0.0	0.0	0.0	0.8	2.9	16.6
Snow Lying at 0900UTC	1.6	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.9	3.4
Hail	1.2	1.5	2.0	1.9	1.3	0.1	0.2	0.1	0.1	0.3	0.3	0.7	9.7

The recent weather patterns and extreme weather events recorded by Met Éireann have been reviewed. A noticeable feature of the recent weather has been an increase in the frequency and severity of storms with notable events including Storm Darwin in February 2014, Storm Emma in March 2018, and Storm Ophelia in October 2018. The maximum wind gust for Dublin Airport for Storm Ophelia peaked at 104 km/hr with a 10-minute speed of 70 km/hr.

Heavier historical rainfall events have also been recorded in recent years including heavy rainfall and flooding in the summer of 2008, severe flooding in November 2009, and heavy rainfall in the Greater Dublin Area (GDA) on 24 October 2011. The rainfall recorded on 24 October 2011 totalled 66.8mm over a nine-hour period at Dublin Airport, which has an annual probability of 1 in 100 years.

Future climate predictions undertaken by Met Éireann have been published in 'Ireland's Climate: the road ahead' *(*Met Éireann 2013*)* based on four scenarios (RCP2.6, RCP4.5, RCP6.0 and RCP8.5) which are named with reference to a range of radiative forcing values for the year 2100 (i.e. 2.6, 4.5, 6.0 and 8.5 W/m^2 (watts per square metre)) respectively with focus on RCP4.5 (medium-low) and RCP8.5 (high) scenarios. In terms of mean temperatures, it is predicted that increases of between 1°C to 3°C will occur under RCP4.5 rising to 2°C to 4°C under RCP8.5. Warm extremes are expected to rise by 2°C to 3°C (RCP4.5) but by up to 5°C under RCP8.5.

'Report No.159 – Ensemble of regional climate model projections for Ireland' (EPA 2015) projected significant decreases in mean annual, spring and summer precipitation amounts with extended dry periods. The decreases are largest for summer, with reductions ranging from 0% to 13% and from 3% to 20% for the medium-to-low and high emission scenarios, respectively. Conversely increases of heavy precipitation of up to 20% are projected to occur during the winter and autumn months. The number of extended dry periods is projected to increase substantially by mid-century during autumn and summer.

In relation to storms, 'Report No.159 – Ensemble of regional climate model projections for Ireland' (EPA 2015) indicates that the overall number of North Atlantic cyclones is projected to decrease by 10% coinciding with a decrease in average mean sea-level pressure of 1.5 hectopascals (hPa) for all seasons by mid-century. Wind energy is also predicted to decrease for spring, summer and autumn with a projected increase in winter.

13.4.2 Existing GHG Emissions Baseline

The TII Standard states that a baseline climate scenario should identify, consistent with the study area for the project, GHG emissions without the project for both the current and future baseline (i.e. Do Minimum scenarios).

Given the circumstances of Ireland's declaration of a climate and biodiversity emergency in May 2019 and the November 2019 European Parliament approval of a resolution declaring a climate and environment emergency in Europe, in conjunction with Ireland's current failure to meet its EU binding targets under the GHG Regulation, changes in GHG emissions either beneficially or adversely are of more significance than previously viewed prior to these declarations. Thus, the baseline climatic environment should be considered a highly sensitive environment for the assessment of impacts.

Data published in 2023 (EPA 2023) estimates that Ireland exceeded its 2022 annual limit GHG emissions limit under Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013). These annual limits have been reduced further from 2023 onwards as Ireland's Effort Sharing commitment increased from a 30 per cent reduction on the 2005 level by 2030 to a 42 per cent reduction through the Commission Implementing Decision (EU) 2020/2126. New binding annual emission limits for 2023 to 2030 for the 42% reduction are not yet finalised and will be set by the EU later in 2023.

For 2022, 60.76 million tonnes of carbon dioxide equivalent (Mt CO_{2eq}) were emitted excluding emissions from Land Use, Land Use Change and Forestry (LULUCF).

Table 13-10 Total National GHG Emissions In 2022

Category	Kilotonnes (kt) CO2eq	% change 2021 - 2022
Waste	867	4.9%
Energy Industries	10,076	-1.8%
Residential	6,105	-12.7%
Manufacturing Combustion	4,288	-7.1%
Commercial Services	767	0.2%
Public Services	659	-1.9%
Transport	11,634	6%
Industrial Processes	2,289	-7.5%
F-gases	741	-0.5%
Agriculture	23,337	-2.1%
Total	60,764	-1.9%

In 2028 (opening year of the Proposed Development), the total projected GHG emissions for Ireland, with additional measures in place (including the implementation of the Climate Action Plan 2024), is 48,590kt (kilotonnes) CO_{2eq} with road transport emissions accounting for 7,750kt CO_{2eq} or 16% of total emissions (EPA 2023). The 2040 total projected GHG emissions for Ireland, with additional measures in place, are 34,731kt CO_{2eq}. Road transport emissions account for 3,749kt CO_{2eq} or 10.8% of the total (EPA 2023). No data is available post-2040 and thus a comparison with the Design Year is not possible.

13.5 Description of Potential Impacts

The Proposed Development comprises infrastructural interventions along the railway line between Dublin city centre and Drogheda, including the Howth Branch, over approximately 50 km, to enable a significant increase in train services and passenger capacity. It also includes the extension of electrification of the railway line between Malahide and Drogheda, over a distance of approximately 37 km. The project will link Iarnród Éireann, Dublin Bus, MetroLink, BusConnects and Luas services, assisting in creating a fully integrated public transport in the Greater Dublin Area.

When considering a development of this nature, the potential climate impact on the surroundings must be considered for each of two distinct stages:

- Construction Phase; and
- Operational Phase.

Two scenarios are assessed throughout the following sections:

- 'Do-Nothing' scenario (DN): which assumes that the Proposed Development is not in place in future years.
- 'Do-Something scenario (DS), which assumes that the Proposed Development is in operation in future years.

13.5.1 Potential Construction Impacts

13.5.1.1 Construction Road Traffic Impacts

As noted in Section 13.3.4.2 there is the potential for construction related road traffic impacts, these relate to additional vehicles on the road or the redistribution of other road users as a result of the Proposed Development. Construction Phase traffic impacts will fluctuate depending on the works progressing, however for the purposes of the construction assessment traffic volumes are assumed to occur for the full construction period and therefore are likely to overpredict emissions. In addition, these emissions are partly double counted in the Construction Phase assessment as transport of materials is included within the embodied carbon assessment in Section 13.5.1.2. The redistribution of private vehicles is not included in the embodied carbon assessment hence this assessment is also required.

Construction Phase mass CO_2 emissions for road links included in Chapter 12 (Air Quality) have been summed and provided in Table 13-11. The results show that the Construction Phase traffic emissions modelled using the REM tool assessment for the Proposed Development will increase CO_2 by 0.2 tonnes annually.

Table 13-11 Construction Phase Road Traffic Climate Impact Assessment

Scenario	Scenario	CO_2 (tonnes/annum)
Construction Phase Road Traffic	Do Nothing	0.395
	Do Something	0.597
Increment during construction per annum		0.202
Annualised Impact (%) (Compared to 2030 transport carbon budget)		0.0000034

No significant adverse impacts are likely to arise due to construction phase traffic movements.

13.5.1.2 Construction and Maintenance Embodied Carbon Impacts

To quantify the construction and maintenance phase embedded carbon, the assessment team utilised the TII Carbon toolkit (TII 2021). This toolkit has the ability to quantify carbon in infrastructure projects using Ireland-specific emission factors and data.

Detailed project information including site clearance areas, excavation quantities (along with the type and volume of waste generated, coupled with the nature of the waste treatment, e.g., reuse, recycling, recovery or disposal), and construction material quantities (e.g., tonnage of materials) was obtained from the Engineering Design Team. The Proposed Development is expected to have a Construction Phase of 36 months approximately and an operational lifespan of 35 years for the purposes of the maintenance embodied carbon. The predicted GHG emissions can be averaged over the full Construction Phase to give the predicted annual emissions to allow for direct comparison with annual emissions and targets.

The assessment commences with the high-level design, through the pre-construction (site preparation) stage, followed by the assessment of the embodied carbon associated with all materials used in the construction of the Proposed Development, the emissions during the Construction Phase and additionally emissions related to waste generated during the Construction Phase. The tool also assesses on-going maintenance associated with the 35-year lifetime of the Proposed Development. For public infrastructure projects such as roads or railways it is generally assumed that end-of-life demolition is not relevant and thus there are no emissions associated with this stage.

Construction emissions have been compared against the Ireland's non-Emissions Trading Scheme (non-ETS) 2030 target of 33,381kt CO_{2eq} (as set out in Commission Implementing Decision (EU) 2020/2126 of 16 December 2020 on setting out the annual emission allocations of the Member States for the period from 2021 to 2030 pursuant to Regulation (EU) 2018/842 of the European Parliament and of the Council). Maintenance phase emissions are calculated under construction emissions but included in the operational phase assessment.

The assessment has been broken down into a number of segments;

- Pre-Construction/Site clearance emissions associated with plant and machinery required to clear the site. The carbon tool has a range of assigned land use categories for estimating site clearance. Different land use types have higher or lower carbon intensity for site clearance, which is linked to the energy required to clear the site
- Embodied carbon is the carbon contained within a material or product. It is the sum of all carbon emissions that have been generated during the extraction, processing, and manufacturing of a particular product. Maintenance material impact is calculated automatically based upon defined replacement rates of materials during the project's lifetime. The impact of transporting materials from factory/source to site to facilitate construction is reported separately. A series of assumptions are made about the variables that impact transport emissions (material density, vehicle type, vehicle capacity and distance travelled). Where travel distances for material sourcing are currently unknown the following assumptions have been made
    - Locally – 50km;
    - Regionally – 100km; and
    - Nationally – 250km.
- Emissions arising from excavation activities based on the energy used in excavation activities. Energy expenditure varies depending on the type of ground to be excavated, e.g., rock excavation is much more energy intensive than topsoil excavation
- Construction activities cover carbon emissions generated during the construction of the Proposed Development based on the scale and duration of the project; and

- The generation of waste during the Construction Phase has potential for climate impact and the nature and scale of this impact depends on the type and volume of waste generated coupled with the nature of the waste treatment (reuse, recycling, recovery or disposal).

Based on the TII Carbon Tool (TII 2021), the breakdown of the activities between the different phases of the Proposed Development has been assessed. As shown in Table 13-12 and Table 13-13, the assessment indicates that the key phases of GHG generation are the embodied carbon of the construction materials and maintenance (use), which account for over 60% of all carbon emissions. Pre-construction and construction activities are expected to account for approximately 25% of all emissions, while Construction Waste processing and disposal is expected to account for the remaining 15%.

Table 13-12 Construction & Maintenance Stage Greenhouse Gas Emissions

Project Element	Before Use ($kgCO_2e$)	Fraction of Total (%)
Materials	7,635,371	56.6
Material Transport	2,014,133	14.9
Clearance and demolition	11,353	0.1
Excavations	722,349	5.4
Construction Worker Travel to Site	546,000	4.0
Construction Waste Disposal	507,829	3.8
Construction Waste Transport	1,536,221	11.4
Maintenance Material	525,697	3.9
Total	**13,498,952**	**100**

Table 13-13 Summary of Construction & Maintenance Stage Greenhouse Gas Emissions

Project Element	Total (kgCO2e)	Total (TonneCO2e)	% Of overall total	Total Annualised (TonneCO2e)	Annualised as % of 2030 Transport Target
Pre-Construction (Site Clearance)	11,353	11.4	0.08	3.8	0.0001
Embodied Carbon	10,175,201	10,175	75.4	3392	0.06
Construction Activities	1,268,349	1,268	9.4	423	0.007
Construction Waste	2,044,050	2,044	15.1	681	0.01
Total	**13,498,952**	**13,499**	**100**	**4,500**	**0.075**

13.5.2 Impact of Climate Change on the Proposed Development Construction Phase

The TII Climate Assessment of Proposed National Roads - Standard (PE-ENV-01105) outlines an approach for undertaking a risk assessment where there is a potentially significant impact on Proposed Development receptors due to climate change.

The risk assessment assesses the likelihood and consequence of the impact occurring to each receptor, leading to the evaluation of the significance of the effect. Appropriate flood risk measures and extreme weather events have been considered as part of the construction planning. The guidance advises that for the Construction Phase, a qualitative description of disruption risk be reported. The potential for changes to long-term seasonal averages as a result of climate change are not considered to be as significant by the construction year as models consider the mid-century for predictions (EPA 2020).

Flooding on construction sites, specifically within high flood risk areas has the potential to occur during the Construction Phase. Therefore, mitigation measures will be put in place during the Construction Phase. A Construction Environmental Management Plan (CEMP) will be prepared for the Proposed Development. An Environmental Operating Plan (EOP) will be prepared as part of the CEMP, see Appendix A5.1 in Volume 4 of this EIAR. An Incident Response Plan (see Appendix A5.1 – Appendix F in Volume 4 of the EIAR) will be prepared as part of the CEMP detailing the procedures to be undertaken in the event of flood risks. Monitoring of weather forecasts will be undertaken to ensure that necessary actions will be implemented in time at construction sites prior to prolonged / extreme weather events.

On the basis of the proposed incident response planning, the measure of consequences can be classed as negligible. Thus, in line with the methodology outlined in Table 13-3 and Table 13-4, the likelihood of Construction Phase climate change related extreme weather and flooding is assessed to be of low likelihood and with a negligible impact leading to a finding of a not significant effect.

13.5.2.1 Land Use Change

The Construction Phase of the Proposed Development is predicted to result in the temporary removal of grassland to facilitate the construction compounds, where appropriate and the permanent change of land use at the location of the new substations. However, overall, there will be a negligible impact on carbon sequestration as a result of the Construction Phase of the Proposed Development.

The landscaping plan includes the widespread planting of native Irish species of trees and shrubs and wildflower planting. It is predicted that replanting will be completed in association with the Construction Phase of the Proposed Development. This planting will have a change in land use due to the Proposed Development with the loss of a carbon sink.

13.5.3 Potential Operational Impacts

13.5.3.1 Maintenance Phase Embodied Carbon Impacts

The Proposed Development is expected to have an operational lifespan of 35 years. The predicted maintenance phase GHG emissions can be averaged over the full lifespan of the Proposed Development to give the predicted annual emissions to allow for direct comparison with annual emissions and targets. Only GHG emissions generated from the areas on the rail corridor that were

directly constructed as a result of the Proposed Development have taken place are considered in this assessment, as routine maintenance, and associated GHG emissions generated, would be carried out on the existing infrastructure, irrespective of the Proposed Development.

Maintenance phase emissions have been compared against Ireland's 2030 transport budget.

The TII Carbon Tool (TII 2021) assesses on-going maintenance associated with the 35-year lifetime of the Proposed Development. For major public infrastructure, it is generally assumed that end-of-life demolition is not relevant and thus there are no emissions associated with this stage.

The Proposed Development is estimated to result in total maintenance phase GHG emissions of 525 tonnes CO_{2eq} over the predicted 35-year lifespan as shown in Table 13-12. The annualised emissions due to the ongoing maintenance of the Proposed Development is predicted to reach, at most, 15 tonnes CO_{2eq} or 0.00025 % of Ireland's 2030 transport budget. These emissions have also been included in the totals provided for the construction stage.

The significance criteria for impacts (IEMA 2022) states that the impact significance must be taken from the project as a whole over its lifecycle rather than individual elements. Mitigation will be required in order to minimise the contribution of the embodied carbon from the maintenance of construction materials of the Proposed Development and therefore the overall significance rating.

13.5.3.2 Operational Rail Impacts

The Proposed Development's primary objective is to provide a higher frequency, higher capacity, electrified heavy rail service. The Do Minimum (DM) and Do Something (DS) regional emissions from the railway have been quantified using the assessment method detailed in Section 13.3.5.1.

Table 13-14 shows the change to rail numbers on rail sections which are currently in operation using data provided by Iarnród Éireann. The rail traffic figures can be used in conjunction with the length of the section and the emission factors detailed in Section 13.3.5.1 to calculate the mass pollutant emission. A sizable increase in the number of carriages and trains daily are proposed as part of the Proposed Development.

For the DM information has been provided on the number of carriages each locomotive has attached, this information has been utilised in calculating the total number of trains and carriages on a section of track. For the DS all EMUs are assumed to have 10 carriages with DMUs remaining with 8 carriages. In addition, both passenger and technical movements have been included for the DM and DS. As a result of the increased rail numbers and carriages on individual trains there is an overall increase of 46% in daily carriage numbers.

Table 13-14 Changes to Rail Numbers

Section of Track	DMU		Change Carriages Daily	EMU		Change Carriage Daily
Zone	DM Carriage Daily	DS Carriage Daily	(% increase from DM)	DM Carriage Daily	DS Carriage Dailly	(% increase from DM)
Connolly - Howth Junction (MP 0 1/4 -MP 4 3/4)	467	467	0 (0%)	2,186	2,200	14 (0.64%)
Howth Junction - Clongriffin (MP 4 3/4 -MP 5 3/4)	467	467	0 (0%)	1,426	2,200	774 (54%)
Clongriffin - Malahide Viaduct (MP 5 3/4 -MP 10 3/4)	467	467	0 (0%)	1,426	1,700	274 (19%)
Howth Branch	0	0	0 (0%)	1,056	1,490	434 (41%)
Malahide - South Gormanston (MP 10 3/4 -MP 24)	467	467	0 (0%)	530	1,200	670 (126%)
South Gormanston - Louth/Meath Border (MP 24 -MP 31 1/4)	467	467	0 (0%)	530	1,200	670 (126%)
Drogheda Station and Surrounds (MP 31 1/4 -MP 32 (ML)) (0 - 0 1/2 (Navan))	467	467	0 (0%)	530	1,200	670 (126%)
Total	**3,269**	**3,269**	**0 (0%)**	**7,684**	**11,190**	**3,506 (46%)**

The majority of these reductions of DMU carriages (Table 13-14) result from the shift from diesel units to electric rail units. The impact on emissions is significant enough that the increased frequency and capacity of the service does not result in an overall adverse impact. The emissions in the DS include emissions with respect to the generation of electricity to power the EMUs. As the national grid decarbonises in line with the 2024 CAP (up to 80% renewables by 2030) the improvements will become larger as fewer fossil fuels will be required to generate each kWh. Emissions calculations are based on this 80% target being reached by the national grid.

Mass pollutant emissions produced in both the DN and DS scenarios during the Operational Phase are shown in Table 13-15 and Table 13-16 respectively.

Table 13-17 shows the change in mass emissions between the DM and DS. Emissions have been compared against Ireland's transport budget for 2030.

Table 13-15 Do-Minimum Rail Emissions

Track Section	DM DMU Kg CO_2	DM EMU Kg CO_2
Connolly - Howth Junction (MP 0 1/4 -MP 4 3/4)	5,350	2,042
Howth Junction - Clongriffin (MP 4 3/4 -MP 5 3/4)	1,337	333
Clongriffin - Malahide Viaduct (MP 5 3/4 -MP 10 3/4)	6,687	1,665
Howth Branch	0	832
Malahide - South Gormanston (MP 10 3/4 -MP 24)	17,805	1,647
South Gormanston - Louth/Meath Border (MP 24 -MP 31 1/4)	9,697	897
Drogheda Station and Surrounds (MP 31 1/4 -MP 32 (ML)) (0 - 0 1/2 (Navan))	1,003	93
Sum Daily (kg Pollutant)	41,880	7,509
Sum Annually (kg Pollutant)	15,286,234	2,740,691
Sum Daily (kg Pollutant)	49,389	
Sum Annually (kg Pollutant)	18,026,925	
Sum Annually (Tonnes Pollutant)	18,026	
% of the 2030 Transport Budget	0.3%	

Table 13-16 Do-Something Rail Emissions

Track Section	DS DMU Kg CO_2	DS EMU Kg CO_2
Connolly - Howth Junction (MP 0 1/4 -MP 4 3/4)	5,350	2,055
Howth Junction - Clongriffin (MP 4 3/4 -MP 5 3/4)	1,337	514
Clongriffin - Malahide Viaduct (MP 5 3/4 -MP 10 3/4)	6,687	1,985
Howth Branch	0.00	1,174
Malahide - South Gormanston (MP 10 3/4 -MP 24)	1,7805	3,730
South Gormanston - Louth/Meath Border (MP 24 -MP 31 1/4)	9,697	2,031
Drogheda Station and Surrounds (MP 31 1/4 -MP 32 (ML)) (0 - 0 1/2 (Navan))	1,003	210
Sum Daily (kg Pollutant)	41,880	11,698
Sum Annually (kg Pollutant)	15,286,234	4,269,916
Sum Daily (kg Pollutant)	53,578	
Sum Annually (kg Pollutant)	19,556,150	
Sum Annually (Tonnes Pollutant)	19,247	
% of the 2030 Transport Target for 2030	0.3%	

The Proposed Development results in a slight increase in overall CO_2 emissions as shown in Table 13-17. However, as shown in Table 13-18, there is a predicted decrease in carbon emissions when considered on a per carriage km basis. These calculations assume 80% renewables have been met both in the DM and DS.

Table 13-17 Change in Rail Emissions

DS-DM- All Rail	Kg CO_2
Change Daily (kg Pollutant)	4,189
Change Annually (kg Pollutant)	1,259,225
Change as % of the 2030 Transport Carbon Budget	0.07%
Change in DMU carriage km	0
DS DMU carriage km as % of DM	100%
Change in EMU carriage km (daily)	28,710
DS EMU carriage km as % of DM	156%

Table 13-18 Rail Emissions per Carriage KM

kg CO_2 Carriage KM	
DM CO_2 per carriage km	0.66
DS CO_2 per carriage km	0.52
DS-DM CO_2 per carriage km	-0.142
% Reduction in CO_2 per Carriage km	-21.6%

As outlined in Section 13.3.5, the assessment of rail emissions assumes for the Do-minimum scenario that the previously approved battery-electric multiple units (BEMUs) has been already implemented.

13.5.3.3 Operational Road Traffic Impacts

As outlined in Section 13.3.5, the closure of one user worked level crossing (level crossing reference number XB001 at Malahide estuary south of Donabate) is proposed. However, this crossing is a user level crossing only and will have no impact on road traffic redistribution and therefore Operational Phase traffic inputs are not considered further.

13.5.3.4 Non-Rail Power Requirements

In addition to the above, there is the potential for carbon emissions from the substations proposed at the following locations:

1. Donabate (Zone C);
2. Rush & Lusk (Zone C);
3. South Skerries (Zone C);
4. North Skerries (Zone C);
5. Balbriggan (Zone C);
6. Gormanston (Zone D);
7. Bettystown (Zone D); and
8. Drogheda (Zone E).

These project elements require electricity to operate.

As the national grid decarbonises in line with the 2024 CAP (up to 80% renewables by 2030) the improvements will become larger as fewer fossil fuels will be required to generate each kWh. Emissions calculations are based on this 80% target being reached by the national grid. IÉ have agreed to the purchase of up to 80% of its operational demand from certified low or zero carbon electricity operations. This will ensure that should the CAP target of 80% renewables not be achieved the Proposed Development will still achieve this percentage. Therefore, an estimated 2030 carbon intensity figure of 102.04 gCO_2/kWh is used when calculating the non-rail power requirement emissions as discussed in Section 13.3.5.1.

A single 80 KVA diesel generator is proposed to be located at each of the new substations. These are considered minor emission points and are put in place as an emergency backup in the unlikely event that power is cut to the substation. The substations have looped connection with the ESB (redundant connection) and therefore already have a backup which will be used prior to the generator being operated. Due to the unlikely use of the generators, no significant carbon emissions are likely to arise.

13.5.4 Overall Level of Impact on GHG Emissions

In accordance with TII Standard (TII, 2022), the project's GHG emission trajectory and the extent to which it aligns with Ireland's net zero trajectory should be described. Although it is projected that GHG emissions are generated during the Construction Phase, these will be somewhat offset during the Operational Phase. The project's GHG emission trajectory aligns with Ireland's net zero trajectory as Operational Phase emissions are reduced compared to the DM scenario whilst carrying more passengers by sustainable modes.

13.5.5 Impact of Climate Change on the Proposed Development Operational Phase

Climate adaptation seeks to ensure adequate resilience of major projects to the adverse impacts of climate change, such as increased flooding or droughts. Mitigation, on the other hand, seeks to reduce the emissions of greenhouse gases by implementing low-carbon energy options. Adaptation during the design phase of the Proposed Development aims to ensure potential climate change impacts will not significantly impact the Operational Phase. In addition, with the change from DMU's to EMU's the flood level that would impact the operations of the railway is reduced by 200mm.

A risk assessment has been conducted for potentially significant impacts on the Proposed Development associated with climate change. The risk assessment assesses the likelihood and consequence of potential impacts occurring and then provides an evaluation of the significance of the impact using the framework set out in Section 13.3.7.

13.5.5.1 Flood Risk

Flooding of the local transport infrastructure is a potential impact of climate change on the Proposed Development. A comprehensive Site Specific Flood Risk Assessment (FRA) has been carried out; full details can be found in the supporting document FRA to the EIAR (see Volume 4 Appendix A10.1 (Flood Risk Assessment)). The FRA included climate change factors as per the OPW Mid-Range Future climate scenario as part of the assessment.

There are 18 no. watercourse crossings across the full area of the Proposed Development that may be at moderate risk of flooding in the absence of mitigation measures.

As some of these crossing locations are within Flood Zones A or B and the Proposed Development is classified as highly vulnerable as it includes essential transport infrastructure, a development management Justification Test is required. It is demonstrated in the FRA that all the Justification Test criteria are passed for the Proposed Development.

13.5.5.1.1 Surface Water Flooding

The existing rail corridor is drained via positive drainage, i.e., gullies and surface water carrier pipes. Track lowering has been avoided at locations prone to flooding. New gullies will be connected to the existing drainage network. Additional hardstanding area from the proposed junction upgrades will be negligible and should not increase capacity in such quantities to result in a flood risk. Although various locations within the development have been identified as potentially at risk from pluvial flooding, the implementation of SuDS throughout the scheme is seen as sufficient to mitigate this risk. The drainage design for the scheme has incorporated an appropriate allowance for climate change.

13.5.5.1.2 Fluvial/Coastal Flooding

The DART Line passes through Balbriggan and over the Bracken River and its associated flood extents. The track line itself is above the 1% AEP fluvial flood extent and is therefore classified as Flood Zone C. However, the surroundings of the track are within the 1% AEP fluvial floodplain and therefore interaction with lands outside of the site boundary including access to site in flood events may be affected.

The DART Line and temporary Construction Compound in this location are therefore at low risk.

The existing DART Line passes through Clongriffin and over the Mayne River and its associated flood extents. The track line itself is above the 1% AEP flood level, however the surroundings of the track are not. The proposed temporary Construction Compound and proposed arch bridge adjacent to UBB19 are designed considering the 1% AEP flood level with appropriate allowance of freeboard and climate change.

The DART Line passes through two watercourses north of the Rush and Lusk substation. Both watercourses have minor flood extents in the 1% AEP. The Bride Stream runs closer to Rush and Lusk substation and therefore is the examined watercourse.

The Rush & Lusk Substation and temporary Construction Compound in this location is not at risk.

The DART Line passes through a large flood extent through the River Pill as the watercourse becomes estuarine. The existing DART Line itself is within Flood Zone C. However, the surroundings of the track are within the 1% AEP fluvial floodplain and therefore interaction with lands outside of the site boundary including access to site in flood events may be affected.

The Donabate Substation is located on the northern boundary of this flood extent.

The Donabate Substation is proposed at 7m OD and is not at risk.

The Proposed Development will be designed to incorporate flood resilient construction measures and materials.

The Proposed Development including flood risk management elements will be subject to a maintenance plan. In the case of a flood event exceeding the design event, the flood emergency response plans will ensure safe egress to appropriate refuge locations.

13.5.5.1.3 Flood Risk Conclusions

The Site-Specific Flood Risk Assessment (FRA) has considered the local hydrological conditions pertaining to the DART+ Coastal North project and identified flood risk areas throughout the development lands. Where development is to be proposed within areas of flood risk, appropriate flood risk management measures have been adopted. The findings of the FRA indicate that flood risk to the scheme can be managed with negligible effect on flood risk elsewhere.

A number of key areas of the Proposed Development were found to have elevated levels of flood risk however management strategies are outlined in order to mitigate this risk. With the design mitigation measures in place the probability and frequency likelihood are considered in accordance with the criteria set out in Section 13.3.7 to have the potential to be low likelihood. The climate significance (Table 13-7) can be classed as minor adverse as an Operational Phase impact would cause regional level disruption to the strategic route lasting less than 1 day. The significance conclusion (Table 13-8) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with the TII Standard leading to a finding of a *not significant effect*.

13.5.5.2 Increased Temperature

Future climate predictions undertaken by the EPA have been published in 'Research 339: High-resolution Climate Projections for Ireland – A Multi-model Ensemble Approach (EPA 2020b). Mid-century mean annual temperatures are projected to increase by 1–1.2°C and 1.3–1.6°C for the RCP4.5 and RCP8.5 scenarios, respectively, with the largest increases in the east. Warming will be enhanced at the extremes (i.e. hot days and cold nights), with summer daytime and winter night-time temperatures projected to increase by 1–2.4°C.

These increased temperatures have the potential to cause the temperature of materials, such as tracks / OHLE / asphalt / bitumen, to increase. However, based on an increase in temperature of between 1 to 3 degrees Celsius under RCP4.5, it is considered that the impact of increased temperatures on materials will not be significant.

The probability and frequency likelihood are considered in accordance with the criteria set out in Section 13.3.7 to have the potential to be low likelihood. The climate significance (Table 13-7) can be classed as minor adverse as an Operational Phase impact would cause regional level disruption to a strategic route lasting less than 1 day. The significance conclusion (Table 13-8) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with the TII Standard leading to a finding of a *not significant effect*.

13.5.5.3 Ice or Snow

Future climate predictions undertaken by the EPA have been published in 'Research 339: High-resolution Climate Projections for Ireland – A Multi-model Ensemble Approach (EPA 2020b) which predicts that there will be a substantial decrease of approximately 50% in the number of frost and ice days for the RCP4.5 and RCP8.5 scenarios.

Snowfall is projected to decrease substantially by the middle of the century with “likely” reductions of 51% and 60% for the RCP4.5 and RCP8.5 scenarios, respectively.

Overhead line equipment has the potential to be impacted by ice or snow events. Unmitigated, this is likely to occur with a high consequence of impact. The overhead line equipment will be designed to take into account a range of minimum and maximum temperatures (-20°c to +40°c) and loads under current and future climate conditions. The contact and messenger overhead wires will be automatically tensioned which will adjust for additional loading from ice, snow or wind. Ice loading has been considered within the design and a 9.5 mm radial thickness of ice coating has been applied for protection. The mechanical tension in the contact and messenger wires will be maintained within the system design parameters. In addition, Iarnród Éireann has a Snow Plan in place which can be activated if snow or ice are forecast.

The probability and frequency likelihood are considered in accordance with the criteria set out in Section 13.3.7 to have the potential to be low likelihood. The climate significance (Table 13-7) can be classed as minor adverse as an Operational Phase impact would cause regional level disruption to a strategic route lasting less than 1 day. The significance conclusion (Table 13-8) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with TII Standard leading to a finding of a *not significant effect.*

13.5.5.4 Major Storm Damage

In Chapter 24 (Major Accidents and Disasters) in Volume 2 of this EIAR, an assessment of the risk potential of meteorological events such as gale force winds or storms was undertaken.

In terms of extreme weather, the EPA (EPA 2015b) is predicting a reduction in storms and wind intensity by mid-century and thus the risk of extreme weather impacting on the Proposed Development is not significant. However, more recent EPA research (EPA 2020b) show an overall reduction of ≈10% in the numbers of storms affecting Ireland and suggest an eastward extension of the more severe windstorms over Ireland and the UK from the middle of the century. However, the research notes that this should be taken with some caution as extreme storms are rare events. In addition the research indicated a reduction in windspeed by the mid-century. A summer reduction in 10-m wind speed range from 0.3% to 3.4% for the RCP4.5 scenario and from 2% to 5.4% for the RCP8.5 scenario is predicted.

The Electricity & Gas Networks Sector Climate Change Adaptation Plan prepared under the National Adaptation Framework has been prepared by the Department of Communications, Climate Action and Environment (DCCAE 2019b) which considers future climate change impacts on energy infrastructure and aims to reduce vulnerability by building resilience in the energy sector. In addition there is a Transport Climate Change Sectoral Adaptation Plan (DTTAS 2019) which was also prepared under the National Adaptation Framework. These adaptation plans will ensure that the future electrical supply will have added resilience. The electrical supply will be direct to the project by way of an underground cable which will be resistant to storm damage. The substations have looped connections with the ESB (redundant connection) and therefore already have a backup which will be used prior to the generator being required. In addition, there is a single 80 KVA diesel generator in the proposed substations as a backup in the event of storm damage.

The detailed design of the Proposed Development will be in accordance with all relevant codes and standards, including IS EN 1991-1-4:2005 Eurocode 1: Actions on structures – general actions - Wind actions. In addition, mitigation against lightning strikes will be accounted for by utilisation of methods contained in IEC 62305 'Protection Against Lightning, Part 2, Risk Management'.

Iarnród Éireann has a management protocol (CCE-TMS-311 Iarnród Éireann Weather Management Procedures) for preparedness and response to extreme weather events. This protocol includes assessing the operability of the network for services and co-operating and communicating with emergency services and national stakeholders, including participation in the National Emergency Coordination Group, to ensure passengers are accommodated insofar as is practical and safe. In addition, they have a management protocol to facilitate passenger services being brought back into operation as quickly and safely as possible after an extreme weather event.

The probability and frequency likelihood are considered in accordance with the criteria set out in Section 13.3.7 to have the potential to be significant. This is an unmitigated scenario, however due to the Proposed Development design these events can be mitigated to reduce the probability and frequency likelihood to low (approximately once in the Proposed Development's lifespan). Given the importance of the Proposed Development the climate significance (Table 13-7) can be classed as moderately adverse as an Operational Phase impact would cause disruption at regional level to strategic routes but it is unlikely that a storm would cause shutdown for longer than a week. The significance conclusion (Table 13-8) indicates that the impact is not significant and therefore the significance of impacts is at an acceptable level in accordance with TII Standard leading to a finding of a *not significant effect.*

13.5.5.5 Land Use Change

The Operational Phase of Proposed Development will not result in any significant change in land use in addition to the areas considered in the Construction Phase. Thus, there will be a negligible impact on carbon sequestration as a result of the Operational Phase of the Proposed Development.

13.6 Mitigation Measures

The Proposed Development sets out mitigation measures with respect to the Construction and Operational Phases in order to reduce its impact on climate related GHG emissions by implementing low-carbon energy options. The TII Standard (TII 2022b) states that the following should be applied as an overarching strategy for impact minimisation:

1. Avoid

Evaluation of the basic need for the proposed project scheme should be undertaken to explore alternative approaches to achieve outcomes set for the project.

2. Reduce

The proposed project should aim to build less, this evaluation should be undertaken to identify the potential for re-using and/or refurbishing existing assets to reduce the extent of new construction required.

3. Replace

Techniques that reduce resource consumption during the construction and Operational Phases should be identified. This will include applying low carbon and/or reduced resource consumption solutions (including technologies, materials and products).

4. Offset

Offset and sequester as a complementary strategy to the above by adopting off-site or on-site measures to offset and/or sequester GHG emissions to compensate for GHG emissions arising from the project.

Iarnród Éireann will actively purchase materials and services with lower embodied/embedded emissions. Where possible the aim is to design out and eliminate potential impacts completely. Where this is not possible impacts should be reduced/substituted to reduce impacts. Finally, if impacts cannot be eliminated by design or reduced/substituted then the IEMA GHG Management Hierarchy final mitigation measure that should be considered is compensation, this includes the use of carbon offsets.

The TII Standard (TII 2022b) states the project should be assessed against the extent to which GHG emissions over the life of the project aligns with Ireland's GHG trajectory to net zero by 2050. This shall be done by considering the estimated emissions over the life of the project against Ireland's trajectory to net zero. The Proposed Development's sustainability aims align with the project being net zero by 2050 and the mitigation measures below will be implemented in order to ensure that this aim is met.

13.6.1 Construction Phase

Construction traffic and the embodied energy of construction materials will be the dominant source of greenhouse gas emissions as a result of the Construction Phase of the Proposed Development. Construction vehicles, generators etc., may give rise to some CO_2 and N_2O emissions.

13.6.1.1 Construction Phase Embodied Carbon Mitigation

A series of mitigation measures have been incorporated into the construction design with the goal of reducing the embodied carbon associated with the Construction Phase of the Proposed Development. These mitigation measures include:

- Ground Granulated Blast-furnace Slag (GGBS) will be used in place of standard concrete resulting in savings of approximately 1,132 tonnes CO_2.
- Steel will be sourced from continental Europe where a high proportion of it is made from recycled materials. Discussions with a potential supplier confirmed that reinforcement for concrete is always produced using recycled material at no additional financial cost, structural steel is produced using recycled materials at no additional financial cost and steel for cladding can have the recycled content stipulated in contracts for a small cost (5-7% additional cost). Iarnród Éireann will pursue procurement of the highest recycled steel content that is available for the particular steel usage. This may vary depending on engineering constraints
- The Proposed Development will minimise wastage of materials due to poor timing or over ordering on site thus helping to minimise the embodied carbon footprint of the site
- Waste generated during the Construction Phase will be carefully managed according to the accepted waste hierarchy set out in the Waste Framework Directive (2008/98/EC), which gives precedence to prevention, minimisation, reuse and recycling over disposal with energy recovery and finally disposal to landfill. As reuse and recycling capacity is unknown for the construction year a conservative approach has been taken during the assessment. This assumes all waste that is not guaranteed to be reused onsite will be sent to landfill

13.6.1.2 Construction Phase Road Traffic Mitigation

Some site-specific mitigation measures will be implemented during the Construction Phase of the Proposed Development to ensure construction traffic emissions are reduced. A Construction Traffic Management Plan (CTMP) (See Appendix A5.1 – Appendix G in Volume 4 of this EIAR) and a Mobility Management Plan (MMP) will be implemented throughout the construction stage to avoid congestion and thus reduce GHG emissions. All plant and machinery will be maintained and serviced regularly.

Construction vehicles, generators etc., will give rise to some GHG emissions, however the Proposed Development impact on climate due to traffic (Section 13.5.1.1) will be minimised through mitigation measures. The following mitigation measures will be put in place to minimise emissions:

- Implement a policy which prevents idling of vehicles both on and off-site including HGV holding sites
- Construction Phase traffic should be monitored to ensure construction vehicles are using the designated haul routes
- All plant and machinery will be maintained and serviced regularly
- Efficient scheduling of deliveries to minimise number of road trips required

- Construction vehicles will conform to the current EU emissions standards and where reasonably practicable, their emissions should meet upcoming standards prior to the legal requirement date for the new standard. This will ensure emissions on haul routes are minimised

In addition, as part of the Proposed Development a Construction Traffic Management Plan (CTMP) will be put in place for the Construction Phase, see Appendix A6.3 in Volume 4 of this EIAR. The CTMP will be put in place for the Construction Phase following consultation with local authorities. Regional roads, primary roads and sections of the motorway will be used at every opportunity in order to reduce traffic impacts to local roads with reduced capacity which may result in traffic congestion and increased emissions. In addition, the CTMP proposes to minimise construction impacts on pedestrians, cyclists and on the operation of bus services which will ensure public transport remains a priority.

A Mobility Management Plan (MMP) will also be put in place for the Construction Phase. This plan will support and promote sustainable travel for construction staff travelling to and from the Proposed Development site. This will be achieved by setting out a strategy for eliminating barriers preventing travel by sustainable travel modes, improving travel choices and significantly reducing single occupancy car trips. Parking will not be available at construction sites for works. The MMP would be an active document that will require to be updated on a regular basis as construction activities take place and will present a series of measures designed to encourage travel to the constructions site(s) in a sustainable way.

13.6.2 Operational Phase

13.6.2.1 Maintenance Phase Embodied Carbon Mitigation

The maintenance phase GHG emissions will primarily consist of the maintenance of materials which were used in construction. No specific mitigation is set out however where possible, materials should be replaced in the most sustainable manner available. This may mean different materials used in replacement during the Operational Phase.

13.6.2.2 Operational Phase Rail Mitigation

The Operational Phase impact assessment assumed that the DN and DS scenarios achieve the CAP target of 80% renewables.

Iarnród Éireann has agreed to purchase up to 80% of its operational demand from certified low or zero carbon electricity for operations. A Corporate Power Purchase Agreement (CPPA) is a financial contract with a renewable generator that will allow for a guaranteed source of renewable power for the operation of the Proposed Development in future. This will ensure that should the CAP target of 80% renewables not be achieved the project will still achieve the target within itself. Should the national grid not achieve its target of 80% renewables by 2030 then the CPPA will further the beneficial impact of the Proposed Development.

Over 80% of Iarnród Éireann (Iarnród Éireann 2021) energy consumption is diesel fuel. In addition to changing the rail corridor to facilitate a change from DMUs to EMUs, further mitigation through improvements in fuel efficiency for the remaining DMUs will be implemented.

These include using timetable optimisation and driver training, fuel consumption telematics for older rolling stock, Auto-Shut down for a significant portion of the fleet, matching train sizes to customer demand and the elimination of Temporary Speed Restrictions (TSRs) arising from infrastructure renewals.

In addition a number of fuel efficiency programs are currently in progress / on-trial (Iarnród Éireann 2021). These include the trial replacement of ICR gearboxes, replacement of ICR diesel engines with hybrid drives, Envirox fuel additive to increase fuel efficiency and to keep diesel engine DP filters clean and replacement of diesel vans with electric road vehicles supported by charging points at depots and stations.

13.6.2.3 Operational Phase Demand

The Proposed Development also aims to reduce the energy demand with passive architectural strategies, reducing energy consumption with energy-efficient equipment and producing energy with renewable technologies. Energy is also related to CO_2 emissions and IÉ's future Carbon Neutrality goal. The use of building design to maximise natural lighting and solar gain, use of motion-controlled lighting systems and LEDs will reduce building energy requirements.

Potable water consumption will be minimised using low consumption fixtures and recycling and reuse of greywater. In addition, Iarnród Éireann will prioritise the use of environmentally friendly materials and the use of recycled and recyclable materials during the operation of the Proposed Development.

The Iarnród Éireann Sustainability strategy (Iarnród Éireann 2021 and 2022) notes the following key mitigation measures for reduction in their carbon footprint:

- Compliance with relevant ISO and national NSAI energy and environmental standards
- Contributing to transport sector decarbonisation including improving fleet and buildings fuel / energy performance, fleet hybridisation, phased network electrification and promoting and facilitating a shift to rail
- Recycling of 70% of all waste
- Near Zero Energy Building standard in all new buildings, and upgrades of 140 existing buildings to minimum BER B
- Reduction in overall carbon emissions by 51% between 2021 to 2030
- Improving operations, infrastructure and fleet climate change resilience including partnership approach to emergency responses and wide-ranging mitigation measures including coastal protection
- Reducing environmental impacts including LEAN management, waste and water management, green procurement in support of the circular economy and site decontamination
- Protecting habitats and promoting biodiversity in a partnership approach

The above actions and others within the Iarnród Éireann Sustainability strategy will be implemented as part of Iarnród Éireann's future mitigation and this includes the Proposed Development mitigation.

13.6.2.4 Operational Phase Road Traffic Mitigation

The Proposed Development will have no adverse impact on road traffic redistribution and therefore no mitigation measures are required.

13.7 Monitoring

No monitoring measures are proposed for the Operational Phase.

13.8 Residual Effects

13.8.1 Construction Phase

When the quantifiable Construction Phase GHG mitigation measures detailed in the mitigation section of this chapter are implemented, GHG emissions from the Proposed Development are predicted to be as detailed in Table 13-19. The embodied carbon includes for a reduction of 640 tonnes of CO_2 due to the use of GGBS.

Table 13-19 Summary of Predicted Construction Phase Residual Impacts

Project of Predicted Construction Phase Residual Impacts		CO_2 Tonnes Annualised
Construction Phase	Embodied Carbon	**3,019***
	Road Vehicle Emissions	**0.2**
Annual CO_2 Emissions		**3,019**

*Excludes maintenance.

13.8.2 Operational Phase

When the quantifiable Operation Phase GHG mitigation measures, such as use of 80% renewable electricity, detailed in the mitigation section of this chapter are implemented, GHG emissions from the Proposed Development are predicted to be as detailed in Table 13-20 for the Operational Phase. The Proposed Development is projected to result in a slight increase in annual GHG emissions of 1,259 tonnes per annum. However, as shown in Table 13-18**,** there is a predicted decrease in carbon emissions when considered on a per carriage km basis.

Table 13-20 Summary of Predicted Operational Residual Impacts

Project of Predicted Operational Phase Residual Impacts		CO_2 Tonnes Annualised
Operational Phase	Rail GHG Emissions	+1,259
	Maintenance	+15
Annual GHG Emissions		1,274

13.8.3 Summary of Predicted Residual Impacts

The significance criteria for impacts (IEMA 2022) states that the impact significance must be taken from the project as a whole over its lifecycle. Considering the IEMA significance criteria set out in Section 13.3.6.1 the Operational Phase of the Proposed Development can be considered to be negligible as a slight increase in carbon emissions is projected. However, the Proposed Development is predicted to result in a decrease in carbon emissions when considered on a per carriage km basis.

The impacts of embodied carbon from the Construction Phase results in a residual impact of 2,962 tonnes CO_2 annually or 0.049% of Ireland's 2030 transport budget.

The Proposed Development aims to assist in the transition to a low carbon and climate-resilient society. As a result of the Proposed Development there is an 80% reduction in CO_2 emissions on a per carriage km for the direct Operational Phase rail impacts of the Proposed Development as per Table 13-18. The assessment is based on 80% renewables for the DN and DS power. If the percentage of renewables is further increased as Ireland transitions to net carbon zero by 2050 then the impact of the Proposed Development will positively increase. In addition, future changes in DMU efficiency or technologies may result in lower emissions from the remaining DMU within the rail stock.

The Operational Phase of the DART+ project is consistent with, and supports, Project Ireland 2040, the National Development Plan 2017 to 2028, the National Planning Framework, the Sustainable Mobility Policy Action Plan 2022 – 2025 and the Climate Action Plan 2024. DART+ is a key deliverable measure in the Climate Action Plan 2024 to achieve targets for modal shift. The National Planning Framework and the National Development Plan list the DART+ Programme as a cornerstone project to assist in transition to a low carbon society. By creating a resilient, accessible public transport network, DART+ Coastal North project will provide an attractive alternative to private car travel, encouraging more passenger travel by more sustainable modes.

Dublin was selected in April 2022 as one of the EU Mission Cities (European Commission 2022), a program which has an aim to produce 100 climate-neutral and smart cities by 2030. The Cities Mission will receive €360 million of Horizon Europe funding covering the period 2022-23, to start the innovation paths towards climate neutrality by 2030. The research and innovation actions will address clean mobility, energy efficiency and green urban planning, and offer the possibility to build joint initiatives and ramp up collaborations in synergies with other EU programmes. Improvements in public transport such as those put forward in the Proposed Development will be essential in achieving this ambitious goal set by the European Commission.

Directive (EU) 2018/2001 of the European Parliament and if the Council on the promotion of the use of energy from renewable sources specifies a legally binding 14% renewable energy in transport target to be achieved by all Member States by 2030. Given its use of electricity, the Proposed Development has an ability to utilise renewable energy throughout its operation and assist in Ireland meeting this target.

In line with the TII significance criteria set out in Section 13.3.6.1 the overall residual impact of the Proposed Development is considered to be minor adverse in the short term due to the Construction Phase, however as Ireland further progresses towards net carbon zero and the percentage of renewables within electricity utilised for rail further increases the long-term impact of the Proposed Development is considered to have a beneficial effect on climate. It is also noted that the Proposed Development once operational will carry more passengers in the DS scenario compared to the DM scenario, this results in a greater saving in carbon emissions when considered on a per carriage basis.

Table 13-21 Summary of Predicted Construction and Operational Phase Residual Impacts

Project of Predicted Construction Phase Residual Impacts		CO_2 Tonnes Annualised
Construction Phase	Embodied Carbon	2,962
	Road Vehicle Emissions	0.2
Operational Phase	Rail Emissions	1,259
	Maintenance emissions	15
Annual CO_2 Emissions (short-term)		2,962
Annual CO_2 Emissions (long-term)		1,259
As % of Ireland 2030 CO_2 transport budget (long-term)		0.02%

13.9 Cumulative Effects

The cumulative assessment of relevant plans and projects is undertaken separately in Chapter 26 (Cumulative Effects) in Volume 2 of this EIAR.

13.10 References

Civil Engineering Standard Method of Measurement (CESSM) (2013). Civil Engineering Standard Method of Measurement Carbon and Price Book database.

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