Chapter 08
Climate

Contents

8 Climate

8.1 Introduction

This Chapter of the Environmental Impact Assessment Report (EIAR) has considered the potential climate impacts (both positive and negative) associated with the Construction and Operational Phases of the BusConnects Galway: Cross-City Link (University Road to Dublin Road) Scheme (hereafter referred to as the Proposed Scheme).

The aim of the Proposed Scheme when in operation is to provide enhanced walking, cycling and bus infrastructure in Galway city, which will enable and deliver efficient, safe, and integrated sustainable transport movement along the corridor. The objectives of the Proposed Scheme are described in Chapter 1 (Introduction) of this EIAR. The Proposed Scheme which is described in Chapter 4 (Proposed Scheme Description) of this EIAR has been designed to meet these objectives.

The Proposed Scheme will facilitate a resilient, accessible public transport and cycling network providing an attractive alternative to private car travel, encouraging more passenger travel by sustainable modes while providing a better quality of life for citizens. The improvements to sustainable modes provision as a result of the Proposed Scheme will facilitate a reduction in congestion, reduced greenhouse gas (GHG) emissions and associated air quality improvements along the Proposed Scheme, resulting in enhanced community wellbeing. The delivery of the Proposed Scheme will also aid in contributing to the national target of 500,000 additional trips by walking, cycling and public transport per day by 2030 as outlined as a target in the 2021 Climate Action Plan (CAP) (DCCAE 2021).

Potential climate impacts associated with the Construction Phase of the Proposed Scheme assessed, included temporary activities such as utility diversions, road resurfacing and road realignments. Construction access routes are also assessed for this phase of the works.

Potential climate impacts associated with the Operational Phase of the Proposed Scheme took into account predicted changes in traffic flows along the Proposed Scheme, reallocation of road space for sustainable modes and potential for displaced traffic flows. In addition, an assessment of the Proposed Scheme in relation to its vulnerability to climate change has been undertaken.

8.2 Climate Assessment Considerations

The Proposed Scheme aims to provide an attractive alternative to the private car and promote a modal shift to public transport, cycling and walking. It is, however, recognised that there will be an overall reduction in operational capacity for general traffic along the direct study area given the proposed changes to the road layout and the rebalancing of priority to walking, cycling and bus.

This reduction in operational capacity for general traffic along the Proposed Scheme is likely to create some level of trip redistribution onto the surrounding road network, in the absence of wider regional demand management measures (outside the scope of the Proposed Scheme).

It should be noted that the Do Minimum and Do Something scenarios are based on the assumption that travel behaviour will remain broadly consistent over the assessment period (2023-2038) and that car demand data used for this assessment, represents a reasonable worst-case scenario. However, it is anticipated that societal trends in the medium to long term may reduce car demand further due to the ongoing changes to travel behaviours and further shifts towards sustainable travel; flexibility in working arrangements brought on following COVID-19 restrictions; and delayed car ownership trends that are emerging.

The assessment also assumes that goods vehicles (HGVs and LGVs) continue to grow in line with forecasted economic activity with patterns of travel remaining the same. It should be noted, however, that the 2021 Climate Action Plan (CAP) (DCCAE 2021) includes reference to a freight strategy for the Country which will seek to further integrate smart technologies in logistics management and may include the regulation of delivery times as far as practicable to off-peak periods to limit traffic congestion in urban areas. The Plan outlines proposals to manage the increase in delivery and servicing requirements as the population grows, which may include the development of consolidation centres to limit the number of 'last-mile' trips made by larger goods vehicles with plans for higher use of smaller electric vans or cargo bikes for 'last-mile' deliveries in urban areas. As proposals for the above are at a pre-planning stage, it was not possible to account for them in the assessments and a worst-case assessment has been undertaken based on continued growth in goods traffic.

The design of the Proposed Scheme has evolved through comprehensive design iteration, with particular emphasis on minimising the potential for environmental impacts, where practicable, whilst ensuring the objectives of the Proposed Scheme are achieved. Significant design iterations were undertaken to mitigate against traffic re-distribution impacts and consequent increases in trip kilometres and in turn GHG emissions. In addition, feedback received from the comprehensive consultation programme undertaken throughout the option selection and design development process has been incorporated where appropriate.

8.3 Methodology

This section presents the study area, relevant guidance, legislation and appraisal method for the assessment of impacts to climate from the Proposed Scheme.

8.3.1 General

In the absence of appropriate guidance in Ireland, guidance from the United Kingdom Highway Agency (UKHA) Design Manual for Roads and Bridges (DMRB) - LA 114 Climate (hereafter referred to as LA 114 Climate) (UKHA 2021) has been consulted.

LA 114 Climate advises that the assessment of a Proposed Scheme should describe the likely significant effects on the environment resulting from both the:

- Impact of a project on climate (GHG emissions); and
- Vulnerability of a project to climate change (adaptation).

The assessment methodology has been derived with reference to the most appropriate guidance documents relating to climate which are set out in the following sections of this Chapter. An overview of the methodology undertaken for the climate impact assessment is outlined below:

- A detailed baseline review of GHG emissions has been undertaken to characterise the baseline environment. This has been undertaken through review of available published GHG emission data;
- A review of the most applicable guidelines for the assessment of GHG emissions has been reviewed in order to define the significance criteria for the construction and operational phases of the Proposed Scheme in both the Opening Year (2023) and the Design Year (2038);
- Predictive calculations and impact assessment relating to the construction phase of the Proposed Scheme have been undertaken;
- Predictive calculations have been performed to assess the potential climatic impacts associated with the operation of the Proposed Scheme;
- An assessment of the vulnerability of the Proposed Scheme to climate change has been undertaken; and
- Mitigation measures have been incorporated, where required to reduce, where necessary, the identified potential climatic impacts associated with the Proposed Scheme.

8.3.2 Study Area

The Proposed Scheme is located across Galway City centre, representing a west-east public transport corridor commencing at the junction of University Road/Newcastle Road, routing over Salmon Weir Bridge and onto St. Francis Street/Eglinton Street, continuing through Eyre Square and onto Forster Street and College Road, ultimately connecting with the existing outbound bus lane on the R338 Dublin Road to the east of the junction at Moneenageisha. Refer to Diagram 1.1 Chapter 1 (Introduction) of this EIAR for the extents of the Proposed Scheme. In terms of the climate study area, the assessment has taken into account the travel distances associated with the construction phase of the Proposed Scheme and, for the operational phase, changes to traffic flow due to Proposed Scheme across Galway city.

The likely significant climatic impacts for the construction and operational phases are discussed below.

During the construction phase, the focus is on the enabling infrastructure provision, which forms the Proposed Scheme including utility road widening works, road excavation works (where required), road reconfiguration and resurfacing works, and construction traffic.

During the operational phase, the focus is on GHG emissions associated with the Proposed Scheme including GHG emissions due to changes to mobility demands, changes to modal split and changes in traffic along diverted traffic routes within the study area. Potential impacts to climate relate to modal shifts towards more sustainable modes of transport, changes to traffic patterns, maintenance and changes to the number and type of traffic trips including public transport.

The assessment of the operational phase will also examine the vulnerability of the Proposed Scheme to climate change, including the risk of flooding and the potential increased frequency of storms and the measures that have been put in place to ensure the resilience of the Proposed Scheme to climate change.

8.3.3 Relevant Guidelines, Policy and Legislation

8.3.4 General

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 guideline was considered and consulted in the preparation of this assessment:

- Guidelines on the Information to be contained in Environmental Impact Assessment Reports (hereafter referred to as the EPA Guidelines) (EPA 2022).

The assessment has made reference to national guidelines, where available, in addition to international standards and guidelines relating to the assessment of GHG emissions and associated climatic impacts from road schemes. These are summarised below:

- National Adaptation Framework (hereafter referred to as the NAF) (DCCAE 2018);
- Climate Action Plan 2019 (hereafter referred to as the CAP 2019) (DCCAE 2019);
- Climate Action Plan 2021 (hereafter referred to as the CAP 2021) (DCCAE 2021);
- Department of Transport, Tourism and Sport (DTTAS) Transport – Climate Change Sectoral Adaptation Plan (DTTAS 2019);
- 2030 EU Climate Target Plan (European Commission 2021);
- Transport Infrastructure Ireland (TII) Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes (hereafter referred to as the TII Air Quality Guidelines) (TII 2011);

- LA 114 Climate (UKHA 2021);
- Institute of Environmental Management and Assessment (IEMA) Assessing Greenhouse Gas Emissions and Evaluating their Significance 2nd Edition (IEMA 2022);
- IEMA EIA Guide to: Climate Change Resilience and Adaptation (IEMA 2020);
- IEMA Greenhouse Gas Management Hierarchy (IEMA 2020) and
- Climate Action and Low Carbon Development (Amendment) Act 2021 (the 2021 Climate Act) (No. 32 of 2021).

8.3.5 International Policy

The Paris Agreement (UNFCCC 2015), which entered into force in 2016, is an important milestone in terms of international climate change agreements and includes an aim of limiting global temperature increases to no more than 2°C (degrees Celsius) above pre-industrial levels with efforts to limit this rise to 1.5°C. Nationally determined contributions (NDCs) are at the heart of the Paris Agreement and the achievement of these long-term goals. NDCs comprise the efforts and actions by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement requires each country to prepare the NDCs that it intends to achieve, updating and enhancing the NDCs every 5 years. Countries are required to implement mitigation measures, with the aim of achieving the objectives of such contributions. Each of the EU Member States submit their own NDCs, which contribute to the overall EU NDC.

The European Green Deal, published by the European Commission in December 2019, provides an action plan which aims for the EU to be climate neutral by 2050. The EU Green Deal highlights that further decarbonisation of the energy sector is critical to reach climate objectives in 2030 and 2050. The European Green Deal will increase the GHG emissions reduction 2030 target to at least 55% in comparison to 1990 levels. Targets for renewable energy and energy efficiency are also likely to be increased.

On 14 July 2021, the European Commission adopted a series of legislative proposals setting out how it intends to achieve climate neutrality in the EU by 2050, including the intermediate target of at least a 55% net reduction in greenhouse gas emissions by 2030. The package of proposals is known as the ‘Fit for 55’ package.

The package includes revisions to the legislation put forward as part of the Climate and Energy Framework 2021-2030, including the EU Emissions Trading System (ETS), Effort Sharing Regulation, transport and land use legislation, setting out in real terms the ways in which the Commission intends to reach EU climate targets under the European Green Deal.

The EU ETS was launched in 2005 as the world’s first international company-level ‘cap-and trade’ system for reducing emissions of greenhouse gases cost-effectively. The EU ETS regulates the GHG emissions of larger industrial emitters including electricity generation, cement manufacturing and heavy industry.

Under this new package of legislative proposals, the sectors of the economy covered by the current ETS must reduce emissions by 61% by 2030 compared to 2005 levels by increasing annual emissions reduction to 4.2% per annum. This is a substantial increase from the previous target which was a 43% reduction by 2030.

The non-ETS sector includes all domestic GHG emitters which do not fall under the ETS scheme and thus includes GHG emissions from transport, residential and commercial buildings and agriculture. Under this new package of proposals the Commission is now proposing to reduce emissions under the non-ETS sectors or the sectors which fall under the Effort Sharing Regulation by at least 40%, compared to 2005 levels. This is an increase of 11 percentage points compared to the existing target of a 29% emission reduction.

The European Climate Law aims to write into law the goal set out in the European Green Deal – for Europe's economy and society to become climate-neutral by 2050. On 17 September 2020, the Commission adopted a proposal to include a revised EU emissions reduction target of at least 55% by 2030 as part of the European Climate Law.

The 2021 EU Strategy on Adaptation to Climate Change sets out the pathway to prepare for the unavoidable impacts of climate change. The aim is that "*by 2050, when we aim to have reached climate neutrality, we will have reinforced adaptive capacity and minimised vulnerability to climate impacts…"* Adaptation refers to measures that can reduce the negative impact of climate change by, for example, ensuring a project is resilient to future increases in storm frequency and rainfall levels.

The EU has adopted integrated monitoring and reporting rules to ensure progress towards its 2030 climate and energy targets and its international commitments under the *2015 Paris Agreement*.

8.3.6 National Policy

In 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'*. This is referred to in the Climate Act as the '*national transition objective'*. The Climate Act allows for the submission of an adaptation framework for Ireland referred to as the 'National Adaptation Framework', which is required to be submitted to Government for approval every five years.

Ireland's first statutory National Adaptation Framework[1] (NAF) which was published in 2018, sets out the national strategy, for government and society, to reduce the vulnerability of the country to the negative effects of climate change.

[1] Department of the Environment, Climate and Communications (2021) National Adaptation Framework. Available from: https://www.gov.ie/en/publication/fbe331-national-adaptation-framework/

In May 2019, the Government of Ireland declared a climate and biodiversity emergency. Following on from this, the Government of Ireland's first national Climate Action Plan (CAP)[2] was published in 2019. It commits to achieving a net zero carbon energy systems objective for Ireland.

In October 2019, the Transport Climate Change Sectoral Adaption Plan[3] was published under the NCCAF. The Plan identifies the key vulnerabilities in the transport network and looks to promote greater resilience to safeguard its continued operation.

The new Programme for Government Our Shared Future[4], agreed in June 2020, accelerated the decarbonisation agenda, committing to a 7% average yearly reduction in overall greenhouse gases over the next decade, and to achieving net zero emissions by 2050.

The Government of Ireland's updated Climate Action Plan (CAP)[5] (2021) sets out a detailed sectoral roadmap to deliver a cumulative reduction in emissions, building on the commitments of the first Climate Action Plan (2019). The core measures for transport focus on accelerating the electrification of road transport, increasing the use of biofuels and a shift to low energy transport modes such as walking, cycling, active travel and public transport. There are measures focused on increasing the 'modal shift' to reduce the fossil fuelled distances taken by car by 10%. The CAP acknowledges that policies need to be better aligned to achieve more ambitious targets for modal shift, which will involve the building of supporting infrastructure.

The Climate Action and Low Carbon Development (Amendment) Act[6] was enacted into national law in July 2021. The Act commits Ireland, in law, to move to a climate resilient and climate neutral economy by 2050 in alignment with the European Green Deal, and includes the following elements:

- Establishes a 2050 emissions target;
- Introduces a system of successive 5-year, economy-wide carbon budgets. The first two carbon budgets covering the periods 2021-2025 and 2026-2030 were announced by the Climate Change Advisory Council in 2021 (with a provisional budget from 2031). Once adopted by the Oireachtas, the carbon budgets will be used to prepare sectoral emissions ceilings for relevant sectors of the economy - this will include emission ceilings for the transport sector;

[2] Department of the Environment, Climate and Communications, (2019). Climate Action Plan 2019. Available from: https://www.gov.ie/en/publication/ccb2e0-the-climate-action-plan-2019/
[3] Department of Transport (2019), Sectoral Adaptation Plan for Transport Infrastructure. Available from: https://www.gov.ie/en/publication/a2444e-sectoral-adaptation-plan-for-transport-infrastructure/
[4] Department of the Taoiseach (2020) Programme for Government: Our Share Future [online] Available at: https://www.gov.ie/en/publication/7e05d-programme-for-government-our-shared-future/
[5] Department of the Environment, Climate and Communications (2021) Climate Action Plan 2021 [online] Available at: https://www.gov.ie/en/publication/6223e-climate-action-plan-2021/
[6] Climate Action and Low Carbon Development (Amendment) Act 2021 [online] Available at: https://www.irishstatutebook.ie/eli/2021/act/32/section/15/enacted/en/html

- Strengthens the role of the Climate Change Advisory Council in proposing carbon budgets;
- Introduces a requirement to annually revise the Climate Action Plan and prepare a National Long Term Climate Action Strategy at least every decade;
- Introduces a requirement for all Local Authorities to prepare individual Climate Action Plans which will include both mitigation and adaptation measures.

The EU ETS is implemented in Ireland under the European Communities (Greenhouse Gas Emissions Trading) Regulations, SI 490 of 2012, and amendments and European Communities (Greenhouse Gas Emissions Trading) (Aviation) Regulations SI 261 of 2010 and amendments.

8.3.7 Local Policy

Galway City Council has prepared a Climate Change Adaptation Strategy for period 2019-2024 as a requirement under the National Adaptation Framework. The Climate Change Adaptation Strategy 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 and bring forward the implementation of climate resilient actions in a planned and proactive manner. The strategy ensures that climate adaptation considerations are mainstreamed into all plans and policies and integrated into all operations and functions of Galway City Council.

8.3.8 Data Collection and Collation

Baseline data has been collected through carrying out a desk study, availing of the most up-to-date available data, at the time of writing. This comprises research data and relevant publications from the following organisations which have been reviewed.

- Galway City Council;
- Department of the Environment, Climate and Communications;
- Met Eireann;
- Environmental Protection Agency (EPA); and
- Sustainable Energy Authority Ireland (SEAI).

Detailed traffic data used in the assessment of the construction and operational phases was supplied by the traffic consultants for the Proposed Scheme.

8.3.9 Appraisal Method for the Assessment of Impacts

This section sets out how the climate assessment has been undertaken and highlights where input from other environmental disciplines has been included within the assessment.

8.3.9.1 Overview

The climate assessment has been carried out in accordance with the Environmental Protection Agency (EPA) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (hereafter referred to as the EPA Guidelines) (EPA 2022). The EPA significance of impacts matrix has been used to determine the significance of impact (Table 8.1).

Table 8.1: EPA Significance Matrix

Significance		**Sensitivity**				
		Very Low	Low	Medium	High	Very High
Magnitude	Very Low	Imperceptible	Not significant	Slight	Slight	Slight
	Low	Not significant	Slight	Moderate	Moderate	Moderate
	Medium	Slight	Moderate	Moderate	Significant	Significant
	High	Slight	Moderate	Significant	Very significant	Profound
	Very High	Slight	Moderate	Significant	Profound	Profound

The LA 114 Climate Version 0.0.1 (UKHA 2021) outlines the recommended sources of input data and the appraisal methodology for the assessment of impacts for both the construction phase and operational phase as outlined in Table 8.2 (reproduced from Table 3.11.1 of LA 114 Climate). A detailed discussion of the input data and appraisal methodology for both the construction and operational phases is detailed in Section 8.3.9.2 to Section 8.3.9.5.

8.3.9.2 Construction Phase – Carbon

The assessment of carbon emissions was carried out to determine the likely greenhouse gas emissions (CO_2 eq) predicted due to the construction phase of the proposed development. The construction materials are manufactured using carbon intensive practices, which results in embodied carbon associated with the materials. The results of this assessment have been compared with the EPA's projected GHG emissions for Ireland's total projected emissions for 2024 (assumed worst case construction year). It is expected that construction will commence in Q4 2023, subject to approval, with a duration of approximately 18-20 months (75 working weeks). The assessment considers the material manufacture, the transport of construction materials to site, the construction processes and the construction compounds.

Section 3.13 of LA 114 Climate (UKHA 2021) recommends, that when calculating GHG emissions for a project life cycle, '*an industry recognized carbon calculation tool(s)*' should be used. The TII Carbon Assessment Tool (Version 2.1) (hereafter referred to as the TII Carbon Tool) (TII 2021) has been used to calculate the embodied carbon of materials in terms of carbon dioxide equivalency (CO_2 eq). The TII Carbon Tool uses emission factors from recognised sources including the Civil Engineering Standard Method of Measurement (CESSM) Carbon and Price Book database.

For a small number of materials not covered by the TII Carbon Tool, the UK Environment Agency's (UKEA) Carbon Calculator has been used to estimate carbon emissions due to construction activities in terms of carbon dioxide equivalency (CO_2eq). In addition, the UKEA Carbon Calculator has been used to estimate embodied carbon associated with the transportation of materials to and from site.

The carbon emissions are calculated by multiplying the emission factor by the quantity of the material that will be used over the construction phase. The varying, relevant transport distances have been included in the calculations for the transportation of materials to site.

The assessment includes the pre-construction (site clearance) stage, the assessment of the embodied carbon associated with all materials used in the construction of the road, the emissions during the construction phase and additionally emissions related to waste generated during the construction phase.

There is an increase in permeable area due to the Proposed Scheme, as outlined in Chapter 13 (Water) of this EIAR, therefore during the operational phase there will be a reduction in the area to be maintained when compared to the existing situation. On this basis, the Proposed Scheme will result in a reduction in the ongoing maintenance works compared to the Do Minimum situation, as such there will be a reduction in the carbon associated with operational maintenance compared to the Do Minimum situation. Therefore, the ongoing maintenance works have been excluded from further assessment.

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 Scheme will result in GHG emissions from various sources as outlined in Table 8.2. The construction phase embodied GHG emissions are considered at all construction stages including the following:

- Land clearance activities (including the removal of trees / vegetation);
- Manufacture of materials and transport to site;
- Construction works (including excavations, construction, water usage, personnel travel and project size); and
- Construction waste products (including transport off site).

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

Given the extent of the operational phase, decommissioning has been excluded from the climate assessment, in accordance with LA 114 Climate.

Table 8.2: Sources and Life Cycle Stages for a Project's GHG Emissions (reproduced from Table 3.11.1 of LA 114 Climate (UKHA 2021))

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)	Use of infrastructure by the end-use (road user).	Vehicles using highways infrastructure.	Traffic count / speed by vehicle type for highway links.
	Operation and maintenance (including repair, replacement and refurbishment).	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.
	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 Scheme.

The land use change associated with the construction phase of the Proposed Scheme has also been quantified using the approach outlined in Table 8.2. Trees are a natural carbon sink and absorb carbon dioxide (CO_2) from the atmosphere helping in the reduction of climate change.

A default value for the amount of CO_2 which a mature tree can absorb is approximately 22 kg CO_2eq/annum (EEA 2011). Trees have the ability to sequester carbon with the peak CO_2eq (carbon dioxide equivalent) uptake rate for tree stands in the order of 5t CO_2eq/hectare/year (tonnes of carbon dioxide equivalent per hectare per year) to 20t CO_2eq/hectare/year with CO_2eq uptake rates declining with maturity and health (UK Forestry Commission 2012). Thus, based on these emission rates, a hectare will typically contain between 225 – 900 trees depending on tree type and maturity. 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 Scheme, including the felling and planting of trees and vegetation, has been considered.

8.3.9.3 Operational Phase - Carbon

There will be carbon emissions associated with the operation of the Proposed Scheme due to the operational traffic.

The change in emissions due to operational phase traffic impacts of the Proposed Scheme have been assessed using the NTA Environmental Appraisal Module, which is based on the ENEVAL software. ENEVAL was developed by Systra Ltd in 2015 on behalf of the NTA. ENEVAL incorporates the official EU vehicle standard emission factor database, termed COPERT, and the emission data from the UK National Atmospheric Emissions Inventory (NAEI). Emissions from the zonal level ENEVAL tool can provide information on the carbon emissions for the different traffic scenarios on a regional basis. The ENEVAL software is recommended by the Codema in the publication Developing CO_2 Baselines – A Step-by-Step Guide for Your Local Authority (Codema 2017). The fleet assumptions for the opening year of 2023 and design year of 2038 provided by the traffic consultant are summarised in Table 8.3.

Table 8.3: Summary of Fleet Proportions

Vehicle Type		Opening Year 2023	Design Year 2038
Car	Petrol Car	38%	25%
	Diesel Car	55%	14%
	Electric Car	7%	61%
LGV	LGV	80%	34%
	Electric LGV	20%	66%
Bus	Electric LGV		100%
	Diesel Bus	100%	

Section 3.16 of LA 114 Climate (UKHA 2021) appraisal guidance recommends that ‘an appropriate validated traffic model shall be used to estimate operational

road user GHG emissions'. LA 114 Climate also outlines the approach for defining the scope of the assessment. LA 114 Climate states that road links meeting one or more of the following criteria can be defined as being 'affected' by a proposed development and should be included in the assessment:

- A change of more than 10% in annual average daily traffic (AADT);
- A change of more than 10% to the number of heavy-duty vehicles; and
- A change in daily average speed of more than 20km/hr (kilometres per hour).

Table 8.2 outlines the sources and activity classes for the operational phase of the Proposed Scheme including operational end-use (road user). The Construction Phase traffic movements are modelled using the same approach.

The results of this assessment have been compared with the EPA's projected transport sector GHG emissions for Ireland for 2023 and 2038.

8.3.9.4 Construction and Operational Phase Significance Criteria

LA 114 Climate (UKHA 2021) outlines a recommended approach for determining the significance of both the construction and operational phases of a road project. The approach is based on comparing the Do Something scenario and the net project GHG emissions (i.e. Do Something to Do Minimum) to the relevant carbon budgets, where available.

Currently, in Ireland the proposed carbon budgets have not been translated into sectoral emissions ceilings. The Climate Action and Low Carbon Development (Amendment) Act was enacted into national law in July 2021, as detailed in Section 8.3.6. These sectoral carbon budgets, including a budget for the transport sector, will be available for comparison with the net CO_2 project GHG emissions once adopted by the Oireachtas. When assessing significance, LA 114 Climate guidance recommends that the assessment of projects as significant should only occur '*where increases in GHG emissions will have a material impact on the ability of Government to meet its carbon reduction targets*'.

Given the current absence of specific sectoral carbon budgets in Ireland, for the purposes of this assessment any changes in net GHG emissions (either positive or negative) due to the Proposed Scheme will be compared to EPA's projected emissions for Ireland. The Institute of Environmental Management and Assessment (IEMA) Guidance Note on Assessing Greenhouse Gas Emissions and Evaluating their Significance (IEMA 2022) notes the importance of contextualising carbon emissions however an individual project's contribution to national emissions projections will always be small, thus the value may be limited. The IEMA 2022 guidance presents more nuanced levels of significance compared to the same 2017 guidance. The IEMA 2022 guidance stipulates that while all carbon emissions contribute to climate change, the significance ratings should not solely based on whether a project emits GHG emissions alone, but how the project makes a relative contribution towards achieving a science-based 1.5°C aligned transition towards net zero. The comparison to sectoral carbon budgets would allow for an assessment of the contribution towards sectoral targets rather

than a comparison to the projected baseline scenarios only. This would give a better indication of the project's alignment with decarbonisation targets. However, as mentioned, the sectoral carbon budgets are not available at the time of writing this assessment.

The IEMA guidance also states that when evaluating significance, '*some projects will replace existing development or baseline activity that has a higher GHG profile. The significance of a project's emissions should therefore be based on its net impact over time, which may be positive, negative or negligible*.' It goes on to state that '*where GHG emissions cannot be avoided, the goal of the EIA process should be to reduce the project's residual emissions at all stages'*.

The EPA Guidelines (EPA 2022) describe the quality of effects in terms of positive, neutral and negative where neutral is defined as effects that are imperceptible, within normal bounds of variation. Taking into account both the IEMA and EPA guidance approach, this chapter has assessed impacts as being either neutral or positively / negatively significant with neutral defined as a change in GHG emissions which is less than ±0.5% of the baseline emission level.

8.3.9.5 Vulnerability of the Proposed Scheme to Climate Change

LA 114 Climate (UKHA 2021) outlines an approach for undertaking a risk assessment where there is a potentially significant impact on the Proposed Scheme 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 impact. This assessment criteria is approved as an appropriate method in the IEMA EIA Guide to Climate Change Resilience and Adaptation (2020). The operational phase assessment, after identifying the hazards and benefits of the climate change impacts, assesses the likelihood and consequences using the framework outlined in Table 8.4 and Table 8.5. The guidance advises that for the construction phase, a qualitative description of disruption risk be reported.

Table 8.4: Likelihood Categories

Likelihood Category	Description (Probability and Frequency of Occurrence)
Very High	The event occurs multiple times during the lifetime of the project (60 years) e.g. approximately annually, typically 60 events.
High	The event occurs several times during the lifetime of the project (60 years) e.g. approximately once every five years, typically 12 events.
Medium	The event occurs limited times during the lifetime of the project (60 years) e.g. approximately once every 15 years, typically four events.
Low	The event occurs during the lifetime of the project (60 years) e.g. once in 60 years.
Very Low	The event occurs can occur during the lifetime of the project (60 years).

Table 8.5: Measure of Consequence

Consequence of Impact	Description
Very Large Adverse	Operation – national level (or greater) disruption to strategic route(s) lasting more than one week.
Large Adverse	Operation – national level (or greater) disruption to strategic route(s) lasting more than one day but less than one week or regional level disruption to strategic route(s) lasting more than one week.
Moderately Adverse	Operation – regional level disruption to strategic route(s) lasting more than one day but less than one week.
Minor Adverse	Operation – regional level disruption to strategic route(s) lasting less than one day.
Negligible	Operation –disruption to an isolated section of a strategic route lasting more less than one day.

The likelihood and consequence of each impact will then be combined in the form of a matrix to identify the significance of each impact as outlined in Table 8.6. The significance conclusions for each impact should be based on and incorporate confirmed design and mitigation measures. Where the assessment concludes that the impact is significant, LA 114 Climate states that '*the design and mitigation hierarchy should be reassessed to reduce the significance of impacts to an acceptable level (not significant)'*.

Table 8.6: Significance Matrix

		Measure of Likelihood				
		Very Low	**Low**	**Medium**	**High**	**Very High**
Measure of Consequence	**Very Large**	NS	S	S	S	S
	Large	NS	NS	S	S	S
	Moderate	NS	NS	S	S	S
	Minor	NS	NS	NS	NS	NS
	Negligible	NS	NS	NS	NS	NS

Note: NS = Not significant; S = Significant

8.4 Baseline Environment

8.4.1 Local Climate

The Galway City Council Climate Adaptation Strategy 2019-2024 states that the main risks around the City of Galway include the following:

- Sea level rise and inundation of low-lying communities
- Ocean warming and acidification
- Changes to natural ecosystems
- Increased temperatures increasing heat stress and diseases
- Increased incidence of heavy rainfall events, flooding and more sever cyclones.

The EPA (2019) Irish Climate Futures: Data for Decision Making report states that it is expected that weather extremes will become more likely and more frequent with future climate change.

The EPA (2021) The Status of Ireland's Climate 2020 includes a number of recent climate observations for Ireland. The report states that the annual average surface air temperature in Ireland has increased by approximately 0.9°C over the last 120 years, with a rise in temperatures being observed in all seasons. This compares with a global average temperature estimated to be 1.1°C above pre-industrial levels. The report indicates that the sea level around Ireland has risen by approximately 2–3 mm per year since the early 1990s. In addition, annual precipitation was 6% higher in the period 1989 to 2018, compared to the 30-year period 1961 to 1990.

The EPA's Climate Change Research Programme carries out relevant and up to date studies on climate change in Ireland (available at www.epa.ie). Analysis of the meteorological records shows that Ireland's climate is changing in line with global patterns.

According to the EPA (www.epa.ie) climate change is expected to lead to the following adverse effects:

- sea level rise;
- 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;
- changes in distribution of plant and animal species; and
- effects on fisheries sensitive to changes in temperature.

LA 114 Climate (UKHA 2021) outlines that the study area for assessing a project's vulnerability to climate change should be based on the construction footprint / project boundary (including compounds and temporary land take).

The region where the Proposed Scheme will be located has a temperate, oceanic climate, resulting in mild winters and cool summers. 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. Heavier historical rainfall events have also been recorded in recent years including heavy rainfall and flooding.

8.4.2 Climate Pollutants

Climate is defined as the average weather over a period of time, 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 2021).

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 number of decades. 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).

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 (GWPs) over a 100-year period, giving a measure of their relative heating effect in the atmosphere. The IPCC AR6 Synthesis Report: Climate Change 2021 sets out the global warming potential for a 100-year time period (GWP100) for CO_2 as the basic unit (GWP = 1) whereas CH_4 has a global warming potential equivalent to 29.8 units of CO_2 (for fossil sources) and N_2O has a GWP100 of 273. These values have been refined since the AR5 report.

8.4.3 Baseline Emissions

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 EU Effort Sharing 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.

In June 2021, the EPA released the report Ireland's Greenhouse Gas Emissions Projections 2020-2040, which includes total projected emissions and a breakdown of projected emissions per sector under the "With Existing Measures" and "With Additional Measures" scenarios.

Implementation of "Additional Measures" (including those in the 2019 Climate Action Plan) is projected to save 58 Mt $CO_{2\,eq}$ over the period 2021-2030 compared to the "With Existing Measures". This represents a reduction of 1.8% per annum in emissions over the period. The latest greenhouse gas emissions projections show total emissions decreasing from the latest Inventory (2019) levels by 3% by 2030 under the With Existing Measures scenario and by 20% under the With Additional Measures scenario.

Table 8.7 presents the EPA With Existing Measures and Additional Measures scenarios for 2023 (Opening Year, Construction Year) and 2038 (Design Year).

Table 8.7: Projected Emissions for the Transport Sector and Total Emissions (EPA, 2021)

Projections	Year	Transport Sector Only (Mt CO_2 eq.)	Road Transport Only (Mt CO2 eq.)	Total (Mt CO_2 eq.)
Projections (with existing measures)[7]	2023	12.74	12.15	62.41
	2038	10.24	9.59	62.49
Projections (with additional measures)[8]	2023	11.89	11.31	58.46
	2038	7.49	6.88	50.93

The transport sector accounts for approximately 20% of Ireland's total GHG emissions, which is the second largest contribution after the agricultural sector. In relation to transport GHG emissions, the dominant source is road transportation. In terms of modal split, private cars accounted for 73.7% of all road trips in 2019 whilst public transport accounted for 6.5% (DOT 2020). Compared to 2018, there was a 3% increase in the number of public transport passenger journeys in 2019 whilst the total kilometres driven by private cars reduced by 1.5% (DOT 2020). Private cars also remain the largest source of GHG emissions in the transport sector accounting for 50.4% of total transport emissions.

8.5 Potential Impacts

8.5.1 Characteristics of the Proposed Scheme

In the context of the Proposed Scheme, the potential air quality impact on the surrounding environment must be considered for two distinct stages:

- Construction Phase; and
- Operational Phase

8.5.2 Construction Phase

The construction phase of the Proposed Scheme will involve predominately utility diversions, road widening works, road excavation works (where required), road and junction reconfiguration and resurfacing works, public realm improvements including landscaping, pavement works including bus lanes, cycle tracks, bus terminals, and movement of machinery and materials within and to and from the Construction Compound along the Proposed Scheme.

During the construction phase, site clearance, landscaping, road and junction construction works all have the potential to generate GHG emissions on-site.

[7] With Existing Measures Scenario assume that no additional policies and measures beyond those already in place by the end of the latest national GHG inventory year at the time of the projections compilation. (EPA, 2021)

[8] With Additional Measures scenarios assume implementation of the WEM scenario in addition to, based on current progress, further implementation of planned government policies and measures adopted after the end of the latest inventory year. In the case of the latest projections (published in June 2021), this includes the implementation of Ireland's 2019 Climate Action Plan. (EPA, 2021)

Chapter 5 (Construction) of this EIAR provides a full description of the proposed construction phasing and works for the Proposed Scheme.

The total construction phase for the overall Proposed Scheme is estimated at approximately 18-20 months. However, individual activities will have shorter durations. The programme identifies the estimated duration of works at each sub-section. Works are envisaged to proceed concurrently on multiple work-fronts to minimise the overall construction duration.

In general, road works are transient in nature as the works will progress along the length of the route of the Proposed Scheme. This includes excavation and fill works, structures, and road completion works. Construction compounds will be set up typically at the commencement of the works and will remain in place until all construction in the area is completed.

8.5.2.1 Embodied Carbon Calculations

To quantify the construction phase embodied carbon, the assessment team utilised the TII Carbon Tool (2021), as outlined in Section 8.3.9.2. The TII Carbon Tool has the ability to quantify carbon in infrastructure projects using Ireland-specific emission factors and data suitable for the Irish context. In addition, the UK Environment Agency's (UKEA) Carbon Calculator has been used to estimate embodied carbon associated with transport distances and for a small number of materials not covered by the TII Carbon Tool.

The carbon footprint of the proposed development during the construction phase is estimated, based on an assessment of worst-case carbon equivalents, outlined in Table 8.8. The carbon assessment assumes no improvement in the carbon intensity of the production of cement and steel is achieved through time. The assessment assumes as a worst-case the recycling processes for materials being reused on site will occur off-site which is reflected in the transport distances. However, it is likely that some of these processes will occur on site to minimise transport distances.

Detailed project information including tonnage of materials was obtained from the engineering design team. The Proposed Scheme is expected to have a construction phase of 18-20 months approximately.

The predicted GHG emissions can be averaged over the full construction phase and the lifespan of the Proposed Scheme to give the predicted annual emissions to allow for a direct comparison with annual emissions and targets.

The construction phase emissions have been compared against the national GHG emissions in Ireland for 2024 (assumed the worst-case construction year), based on EPA projections outlined in Section 8.2.

End-of-life demolition is not assessed as it is assumed to be the same as without the Proposed Scheme and thus there are no emissions associated with this stage.

The predicted results are compared to the EPA's projected total CO_2 eq. emissions for Ireland in 2023 assuming additional measures, as a worst-case projection, in Table 8.9.

Table 8.8: Estimated embodied carbon associated with the construction phase

Element	Embodied Carbon Contribution tonnes CO_2eq	Estimated Quantity of material (tonnes)	Comment / Assumptions	Tonnes CO_2eq	Sources (TII / UKEA)
Pavements and Earthworks					
Aggregate (reuse on-site)	0.018	1,609	Assumed density 2t/m^3. Assumed recycling process off-site. Additional 101 tonnes for transport (assumed 70km).	40	TII
Aggregate (disposal)	0.001	13,525	Assumed density 2t/m^3. Assumed disposal to landfill as not suitable for reuse. Additional 12 tonnes for transport (assumed 70km).	115	TII
Aggregate (reuse off-site)	0.001	13,499	Assumed density 2t/m^3. Assumed to be reused off site. Additional 101 tonnes for transport (assumed 70km).	115	TII
Soil and stone (fill) (disposal)	0.018	1,394	Assumed density 2t/m^3. Assumed disposal to landfill as not suitable for reuse. Additional 3 tonnes for transport (assumed 70km).	28	TII
Aggregate (import)	0.0046	15,644	Assumed density 2t/m^3. Granular material average. Additional 67 tonnes for transport (assumed 40km)	139	TII
Asphalt (import)	0.0107	7,636	Assumed density 1.7t/m^3. Asphalt average. Additional 33 tonnes for transport (assumed 40km)	115	TII
Asphalt (reuse on-site)	0.001	1,648	Assumed density 1.7t/m^3. Assumed recycling process off-site. Additional 12 tonnes for transport (assumed 70km).	14	TII
Asphalt (reuse off-site)	0.001	11,998	Assumed density 1.7t/m^3. Assumed recycling process off-site. Additional 90 tonnes for transport (assumed 70km).	102	TII
Foamed bitumen (import)	0.0003	26	Assumed density 1.7t/m^3. Assumed as bituminous spray. Additional 0.1 tonnes for transport (assumed 40km).	0.11	TII
Concrete flags (import)	0.029	1,394	Assumed density 2.4t/m^3. Assumed average concrete flags. Additional 6 tonnes for transport (assumed 40km).	46	TII
Concrete materials (import)	0.0008	21,054	Assumed density 2.4t/m^3. Assumed 30% GGBS content.	107	TII

Element	Embodied Carbon Contribution tonnes CO_2eq	Estimated Quantity of material (tonnes)	Comment / Assumptions	Tonnes CO_2eq	Sources (TII / UKEA)
			Additional 90 tonnes for transport (assumed 40km).		
Concrete materials (reuse on-site)	0.001	2,430	Assumed density 2.4t/m^3. Assumed reuse on site with no additional transport.	2	TII
Concrete materials (reuse off-site)	0.001	7,774	Assumed density 2.4t/m^3. Assumed reuse on another site. Additional 58 tonnes for transport (assumed 70km).	66	TII
Concrete materials (disposed)	0.002	1,335	Assumed density 2.4t/m^3. Assumed disposal to landfill as not suitable for reuse. Additional 10 tonnes for transport (assumed 70km).	13	TII
Sand (reuse on-site)	0	38	Assumed density 2.24t/m^3. Assumed reuse on site with no additional transport.	0	TII
Sand (disposal)	0.001	239	Assumed density 2.24t/m^3. Assumed reuse off site. Additional 1.8 tonnes for transport (assumed 70km).	2	TII
Mortar (import)	0.16	1,418	Assumed density 2.2t/m^3. Assumed grout material. Additional 6 tonnes for transport (assumed 40km).	232	TII
Mortar (disposal)	0.002	1,034	Assumed density 2.2t/m^3. Assumed disposal to landfill as not suitable for reuse. Additional 8 tonnes for transport (assumed 70km).	10	TII
Geotextile (disposal)	0.009	0.05	Assumed density 1.38t/m^3. Assumed disposal to landfill as not suitable for reuse. Additional 0.004 tonnes for transport (assumed 70km).	0.005	TII
Gravel (reuse off-site)	0.001	7.4	Assumed density 2t/m^3. Assumed reuse off site. Additional 0.03 tonnes for transport (assumed 40km).	0.04	TII
Top-soil (reuse on-site)	452	0	Assumed density 2t/m^3. Assumed reuse on site with no additional transport.	0	TII
Stone paving (import)	0.08	2,239	Assumed density 2t/m^3. Common stonework. Additional 10 tonnes for transport (assumed 40km).	180	TII

Element	Embodied Carbon Contribution tonnes CO_2eq	Estimated Quantity of material (tonnes)	Comment / Assumptions	Tonnes CO_2eq	Sources (TII / UKEA)
Stone paving (disposal)	0.002	311	Assumed density 2t/m^3. Assumed disposal to landfill as not suitable for reuse. Additional 2.3 tonnes for transport (assumed 70km).	2.9	TII
Soil and stone (fill) (import)	0.001	372	Assumed density 2t/m^3. Assumed granular materials. Additional 1.6 tonnes for transport (assumed 40km).	3.3	TII
Soil and stone (cut) (reuse off-site)	0.001	1,391	Assumed density 2t/m^3. Assumed granular materials to be reused off site. Additional 10.4 tonnes for transport (assumed 70km).	12	TII
Above Ground Elements					
Masonry brick/blocks demolition (disposal)	0.001	600	Assumed reuse off site. Additional 2.5 tonnes for transport (assumed 40km).	3	TII
Mixed metals demolition (recycled off-site)	0.021	100	Assumed recycled off-site. Additional 0.8 tonnes for transport (assumed 70km).	3	TII
Plastic demolition (disposal)	0.009	10	Assumed disposal by incineration (waste to energy). Additional 0.2 tonnes for transport (assumed 180km).	0.41	TII
Timber demolition (disposal)	0.01	2	Assumed removal off site for composting. Additional 0.02 tonnes for transport (assumed 70km).	0.04	TII
Glass demolition (reuse/recycling off-site)	0.009	10	Assumed reuse/recycling off-site. Additional 0.08 tonnes for transport (assumed 70km).	0.3	TII
Masonry brick/block (import)	0.08	600	Common brickwork. Additional 2.5 tonnes for transport (assumed 40km).	48	TII
Mixed metals (import)	0.3	100	Assumed mixed metals -any type (average). Additional 0.8 tonnes for transport (assumed 70km).	32	TII
Plastic materials (import)	3.3	10	Assumed disposal to landfill as not suitable for reuse. Additional 0.08 tonnes for transport (assumed 70km).	33	UKEA
Timber (import)	0.31	2	Assumed removal off site for composting. Additional 0.007	0.6	UKEA

Element	Embodied Carbon Contribution tonnes CO_2eq	Estimated Quantity of material (tonnes)	Comment / Assumptions	Tonnes CO_2eq	Sources (TII / UKEA)
			tonnes for transport (assumed 70km).		
Glass (import)	1.35	10	Assumed disposed to landfill as not suitable for reuse. Additional 0.007 tonnes for transport (assumed 70km).	13.5	UKEA
Tree clearance	0.1	6	Assumed 59 trees removed off-site for composting. Additional 0.06 tonnes for transport (assumed 70km).	0.12	TII
Very Large size construction site, 3.5 tonnes CO_2eq per week, 87-week duration				304	TII
Total (tonnes of CO_2)					1,783

Table 8.9: Estimated carbon relative to projected carbon baselines

Estimated CO_2 eq during Construction Phase (Mtonnes)	Projected Total Irish CO_2 eq emissions in 2024 with additional measures (Mtonnes)	As a percentage of 2024 Total CO_2 eq emissions with additional measures
0.0018	56.9	0.003%

The Proposed Scheme is estimated to result in total construction phase GHG emissions of 1,783 tonnes embedded CO_2eq for materials, equivalent to an annualised total of 0.003% of Ireland's national GHG emissions in 2023.

On this basis, the potential impact to climate due to embodied carbon emissions during the construction phase, prior to mitigation, will be negligible and long-term. This finding aligns with the IEMA approach (IEMA 2022) which advises that the net impact over time should be considered and that the significance should depend on if the project will replace existing development with a higher GHG profile. As the Proposed Scheme will replace existing infrastructure with a more sustainable option, this advice is considered in the determination of the impact rating.

As improvements in sustainability and recycling measures are progressed throughout the construction industry it is expected that the embodied carbon calculated as part of this assessment can be taken as a worst case, as with time this figure will improve. In addition, the embodied carbon is calculated on the basis that all emissions occur over one year, a worst-case consideration.

8.5.2.2 Construction Traffic

In addition to direct impacts from the construction works including the construction compounds, as included in Table 8.8, there is also the potential for GHG impacts from additional construction vehicles using public roads. The transport distances have been included in the embodied carbon calculations for the

transportation and delivery of materials to and from site. Additional traffic generated due to construction works is considered negligible, as outlined in Chapter 6 (Traffic and Transport) of this EIAR.

Therefore, GHG emissions from additional construction traffic generated from the Proposed Scheme, other than the transportation of materials (accounted for in Table 8.8) is considered negligible.

8.5.2.3 Vulnerability to Climate Change

The appropriate flood risk measures and extreme weather events have been considered as part of the construction phase. However, 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 (2024). If appropriate, additional measures to ensure the resilience of the Proposed Scheme to impacts during extreme weather events will be implemented for the construction phase. Thus, in line with the methodology outlined in Table 8.4, Table 8.5 and Table 8.6, the likelihood of extreme weather and flooding in the year 2024 is assessed to be of medium likelihood and with a minor adverse effect leading to a not significant impact.

8.5.2.4 Land Use Change

The construction phase of the Proposed Scheme is predicted to result in the removal of 59 trees to facilitate construction works. However, these 59 trees will be replanted as well as additional planting of 127 trees as part of the reinstatement works. In addition, the Proposed Scheme will result in an increase in permeable area of approximately 1,770m^2. However, the impacts to carbon sequestration will not be effective until the operational phase. Therefore, there will be a negligible impact on carbon sequestration as a result of the construction phase of the Proposed Scheme.

8.5.3 Operational Phase

As outlined in Chapter 4 **(**Proposed Scheme Description) of this EIAR, the Proposed Scheme includes the reconfiguration of traffic movements to facilitate improved pedestrian, cyclist and bus accessibility and movement, infrastructural works at certain roads and junctions, and improvements to the public realm at a number of locations.

The Proposed Scheme will result in the redistribution of traffic which may result in an increase in vehicle kilometre travelled in some locations. However, this is expected to be offset by a shift away from private car use.

8.5.3.1 Operational Phase Carbon Emissions

The infrastructural works proposed as part of the Proposed Scheme will provide an attractive alternative to private car travel, encouraging more passenger travel by more sustainable modes. A greater share of the demand will be by sustainable modes (public transport, walking and cycling).

The potential changes in GHG emissions due to the direct operational phase traffic impacts of the Proposed Scheme have been assessed using the Environmental Appraisal Module, which is based on the ENEVAL software.

As shown in Table 8.10, a comparison between the Do Something and Do Minimum GHG emissions in 2023 within the study area predicts an increase 1.3ktonnes in CO_2eq. This is equivalent to a 0.39% increase in CO_2eq relative to the Opening Year Do Minimum estimates. This is equivalent to 0.01% of the projected transport sector emissions in 2023 under the With Additional Measures scenario, outlined in Section 8.4.3.

Table 8.10: Operational Phase GHG emissions – Opening Year (2023)

Scenario	Vehicle Class	CO_{2eq} (kt CO_{2eq})
DM	Car	214.2
DS		213.9
Change		0.3
% Change		0.18%
DM	Goods	97.4
DS		98.2
Change		0.8
% Change		0.82%
DM	Urban Bus	8.48
DS		8.53
Change		0.05
% Change		0.64%
DM	**Total**	319.7
DS		320.9
Change		1.3
% Change		**0.39%**

As shown in Table 8.11, a comparison between the estimated Do Something and Do Minimum GHG emissions in the Design Year (2038) indicates that there is potential for an overall increase of 6.7ktonnes in CO_2eq. This is equivalent to a 0.33% increase in CO_2eq relative to the Design Year Do Minimum estimates. This is equivalent to 0.09% of the projected transport sector emissions in 2038 under the With Additional Measures scenario, outlined in Section 8.4.3.

Table 8.11: Operational Phase GHG emissions – Design Year (2038)

	Vehicle Class	CO_{2eq} (kt CO_{2eq})
DM	Car	101.8
DS		102.2
Change		0.4
% Change		0.36%
DM	Goods	100.1

	Vehicle Class	CO_{2eq} (kt CO_{2eq})
DS		100.3
Change		0.2
% Change		0.3%
DM	Urban Bus	0
DS		0
Change		0
% Change		0%
DM	**Total**	201.9
DS		202.5
Change		0.6
% Change		**0.33%**

There will be a marginal increase in GHG emissions associated with the Proposed Scheme, which is attributable to the redistribution of traffic in both 2023 and 2038. Thus, the predicted impact to climate during the operational phase of the Proposed Scheme is predicted to be neutral and long-term as the change is less than 0.5%.

Furthermore, as outlined in Section 8.3.9.4, the IEMA guidance stipulates that significance ratings should not solely be based on GHG emissions alone, but how the project makes a relative contribution towards achieving a transition to net zero emissions. The infrastructural works proposed as part of the Proposed Scheme will support the delivery of government strategies outlined in the Climate Action Plan (CAP) and the Climate Action and Low Carbon Development (Amendment) Act, outlined in Section 8.3.4, by enabling sustainable mobility and delivering a sustainable transport system. Its aim is to provide enhanced walking, cycling and bus infrastructure on key access corridors in Galway City. This will subsequently enable and deliver integrated sustainable transport movement along these corridors. The proposed infrastructural works will provide connectivity and integration with other public transport services leading to more people availing of public transport.

By creating a resilient, accessible public transport network, the proposed infrastructural works will provide an attractive alternative to private car travel, encouraging more passenger travel by more sustainable modes. A greater share of the demand will be by sustainable modes (public transport, walking and cycling).

In terms of policy measures, CO_2 emissions for the average new car fleet will reduce from 130g/km (grams per kilometre) over the period 2015 to 2019 to 95g/km in 2021 (European Commission 2020). In addition, from 2025 the average emissions from new car fleet are required to reduce by 15% relative to 2021 levels and, by 2030, the average emissions from new car fleet are required to reduce by 37.5% relative to 2021 levels as outlined in Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011.

In relation to decarbonising the transport sector, the CAP has set a target that all new cars and vans sold in Ireland will be zero carbon emissions or zero emission capable by 2030. Targets are also included for public transport buses and trains.

8.5.3.2 Vulnerability to Climate Change

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 GHGs by implementing low-carbon energy options.

Adaptation during the operational phase of the Proposed Scheme aims to ensure potential climate change impacts will not significantly impact the operational phase.

A risk assessment has been conducted for potentially significant impacts on the Proposed Scheme 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 8.3.9.5.

Flood Risk

Flooding of the local transport infrastructure is a potential impact of climate change on the Proposed Scheme. A comprehensive flood risk assessment (FRA) has been carried out, full details of the FRA can be found in Appendix 13.1 Volume 4 of this EIAR.

The assessment found that one section of the Proposed Scheme will be partially located within Flood Zone A and B. As such, there are two locations at high risk of flooding (Flood Zone A) from tidal sources and further seven areas at moderate risk of flooding (Flood Zone B) from fluvial sources within the development area. A Stage 2 FRA is required as the Stage 1 assessment determined that the site, at least in part, is at risk of flooding from fluvial, tidal and groundwater sources.

The project scope does not include proposals to raise the road levels at any location or significantly increase the impermeable areas which will alter the hydrologic/hydraulic regime of the project area and hence the risk of flooding to the existing sites does not increase. Therefore, it was found that progression to Stage-3 Flood Risk Assessment is not required.

A Justification Test was applied for the whole development area. The Proposed Scheme has been determined to have satisfied all requirements of the justification test.

The mitigation proposed includes the upgrading or construction of the drainage network to ensure no worsening of flooding along the Proposed Scheme corridor, including an increase of 20% in rainfall to allow for climate change. In addition to increasing the green areas and providing additional gullies.

Thus, in line with the methodology outlined in Table 8.4, Table 8.5 and Table 8.6, the likelihood of flooding during operation is assessed to be of high likelihood and with a minor adverse effect leading to a not significant impact.

Increased Temperature and Extreme Weather

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) 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.

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

Thus, in line with the methodology outlined in Table 8.4, Table 8.5 and Table 8.6, the likelihood of increased temperatures impacting on the Proposed Scheme during the operational phase is assessed to be of high likelihood and with a negligible adverse effect, leading to a predicted impact of not significant.
In terms of extreme weather, the EPA Ensemble of Regional Climate Model Projections for Ireland (2015) there is a reduction in storms and wind intensity by mi-century predicted, thus the risk of extreme weather impacting on the Proposed Scheme will be not significant.

8.5.3.3 Land Use Change

The operational phase of Proposed Scheme will require some vegetation removal to facilitate the construction works however there will be additional planting and increased permeable areas compared to the existing situation, as outlined in Section 8.5.2.4. The additional tree planting has the potential to sequester up to 2.8 tonnes of CO_2 per annum (additional to the existing situation) during the operational phase. This is based on sequestration information outlined in Section 8.3.9.2. The additional permeable areas (assuming 0.1ha of grass and scrub areas, excluding additional trees) has the potential to sequester up to 2.6 tonnes of CO_2 per annum (additional to the existing situation) during the operational phase. This is based on the TII Carbon Tool sequestration factors. This amounts to additional sequestration potential of up to 5.4 tonnes of CO_2 per annum (additional to the existing situation) during the operational phase. Thus, there will be a slight, positive and long-term impact on carbon sequestration as a result of the operational phase of the Proposed Scheme.

8.6 Mitigation and Monitoring Measures

A schedule of mitigation measures has been formulated for the construction and operational phases of the Proposed Scheme.

8.6.1 Construction Phase

The construction traffic and the embodied energy of construction materials will be the dominant source of GHG emissions as a result of the construction phase of the Proposed Scheme. Construction vehicles, generators etc., may give rise to some CO_2 and N_2O emissions.

8.6.1.1 Construction Phase 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 Scheme.

These mitigation measures include:

- The replacement, where feasible, of concrete containing Portland cement with concrete containing ground granulated blast furnace slag (GGBS). This measure has the potential to result in an estimated saving of 5,352 tonnes of CO_{2eq} in the current design of the Proposed Scheme;
- The Proposed Scheme will minimise wastage of materials due to poor timing or over ordering on site thus helping to minimise the embodied carbon footprint of the Proposed Scheme;
- Where practicable, opportunities for materials reuse will be incorporated within the extent of the Proposed Scheme including the use of reclaimed asphalt and recycled aggregate. This measure has led to an estimated saving of 705 tonnes of CO_2eq; and
- Where practicable, materials will be sourced locally to reduce the embodied emissions associated with transport.

The combined measures, including the incorporation of GGBS, recycled and reused material where practicable has led to an estimated saving of 6,057 tonnes of CO_2eq.

The embodied carbon emissions associated with the construction phase of the Proposed Scheme will be short-term and temporary in nature with the implementation of the mitigation measures outlined above. The impact on GHG emissions, after mitigation, as outlined in Table 8.8, due to the embodied carbon associated with the construction phase of the Proposed Scheme is negligible and long-term. The impact rating post-mitigation is the same as pre-mitigation, as the mitigation measures proposed are inherent to the construction design. The mitigation measures will have the effect of reducing carbon emissions during the construction phase.

The construction traffic GHG emissions associated with the construction phase of the Proposed Scheme will be short-term and temporary in nature. The appointed contractor will develop a Construction Traffic Management Plan (CTMP) to manage traffic during the construction phase. An outline CTMP is included in the CEMP (Appendix 5.1 in Volume 4 of this EIAR). As outlined in Section 8.5.3.2, the GHG emissions associated with the additional construction traffic due to the Proposed Scheme will be negligible.

8.6.2 Operational Phase

8.6.2.1 Operational Phase Traffic Carbon Mitigation

The impact of the operational phase traffic of the Proposed Scheme is predicted to be neutral. Thus, the predicted impact to climate due to operational phase traffic as a result of the Proposed Scheme, after mitigation, will be neutral and long-term. However, as outlined above, the proposed infrastructural works will support the delivery of government strategies outlined in the Climate Action and Low Carbon Development (Amendment) Act by enabling sustainable mobility and delivering a sustainable transport system.

Its aim is to provide enhanced walking, cycling and bus infrastructure on key access corridors in Galway city. This will subsequently enable and deliver an integrated sustainable transport movement along these corridors.

By creating a resilient, accessible public transport network, the proposed infrastructural works will provide an attractive alternative to private car travel, encouraging more passenger travel by more sustainable modes while providing a better quality of life for citizens. Total trip demand is increasing into the future in line with population, employment and growth of jobs. The projected population growth within Galway City and its suburbs is expected to grow by 50-60% by 2040, or up to a total of 120,000 individuals. A greater share of the demand will be by sustainable modes (public transport, walking and cycling). It is expected that the infrastructural works will reduce car use and increase sustainable modes by 2038, as outlined in Chapter 6 (Traffic and Transport) of this EIAR. This will facilitate a reduction in congestion and associated air quality improvements along the corridors, resulting in enhanced community wellbeing. It will also enable the development of more efficient urban and intermodal transport solutions by removing traffic from Galway City.

8.7 Residual Impacts

8.7.1 Construction Phase

When the construction phase GHG mitigation measures detailed in Section 8.6 are implemented, GHG emissions from the Proposed Scheme are predicted to be neutral, long-term. This impact rating aligns with IEMA guidance on the basis that the Proposed Scheme replaces existing development that has a higher GHG profile and that the significance of a project's emissions should be based on its net impact over its lifetime, refer to Section 8.3 for further details. In addition, GHG emissions have been reduced where possible during the construction phase.

8.7.2 Operational Phase

The operational traffic GHG emissions associated with the operational phase of the Proposed Scheme is predicted to be neutral and long-term.

The proposed infrastructural works will also support the delivery of government strategies, outlined in Section 8.3.6, by enabling sustainable mobility and

delivering a sustainable transport system. Its aim is to provide enhanced walking, cycling and bus infrastructure on key access corridors in Galway City. This will subsequently enable and deliver an integrated sustainable transport movement along these corridors. The proposed infrastructural works will provide connectivity and integration with other public transport services leading to more people availing of public transport.

By creating a resilient, accessible public transport network, the proposed infrastructural works will provide an attractive alternative to private car travel, encouraging more passenger travel by more sustainable modes.

As a result, a greater share of the demand will be by sustainable modes (public transport, walking and cycling), which aligns with the scheme objectives set out in Chapter 1 (Introduction) of this EIAR.

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