CHAPTER FIFTEEN CLIMATE

15.1 INTRODUCTION

This chapter assesses the likely climate impacts associated with the proposed development, and the likely impact of climate change risks on the proposed development. A full description of the development is available in Chapter 2.0. References to other chapters of this EIAR and supporting reports submitted as part of this planning application have been made throughout this chapter, as required in the relevant sections.

The proposed application site (Phase II) is part of a phased development proposal for a significant city centre, regeneration area or Masterplan Site (MS). This MS is divided into four different phases of delivery as detailed in Section 1.6.3 in Chapter 1.0 Introduction. The overall MS layout which illustrates the indicative layout of the subject site and adjoining lands in the ownership of the applicant is displayed in Chapter 1.0, Figure 1.4 and full details of the proposed development phases are provided in Chapter 2.0, Section 2.2.4.'In addition to an in-depth assessment of the Proposed Development, this assessment takes a holistic approach and examines the wider MS area, taking into account the proposed future phases of development based on the available information.

The assessment presented in the chapter with respect to climate takes a holistic approach and examines the wider masterplan area in so far as practicable and the likely impacts arising from the development proposal.

The climate assessment is divided into two distinct sections – a greenhouse gas assessment (GHGA) and a climate change risk assessment (CCRA).

- Greenhouse Gas Emissions Assessment (GHGA) – Quantifies the greenhouse gas (GHG) emissions from a project over its lifetime. The assessment compares these emissions to relevant carbon budgets, targets and policy to contextualise magnitude.
- Climate Change Risk Assessment (CCRA) – Identifies the impact of a changing climate on a project and receiving environment. The assessment considers a project's vulnerability to climate change and identifies adaptation measures to increase project resilience.

15.2 ASSESSMENT METHODOLOGY

15.2.1 Relevant Legislation & Guidance

15.2.1.1 Guidance

The principal guidance and best practice documents adhered to in carrying out the assessment of potential impacts on climate are summarised below. The assessment has adhered to national guidelines where appropriate, in addition to international standards and guidelines relating to the assessment of climate impacts:

- Transport Infrastructure Ireland (TII) PE-ENV-01104: Climate Guidance for National Roads, Light Rail and Rural Cycleways (Offline & Greenways) – Overarching Technical Document (TII, 2022a) (hereafter referred to as "the TII guidance");

- TII GE-ENV-01106: TII Carbon Assessment Tool for Road and Light Rail Projects and User Guidance Document (TII, 2024a);
- Institute of Sustainability and Environmental Professionals (ISEP) (formerly known as the Institute of Environmental Management & Assessment (IEMA)) Environmental Impact Assessment Guide to: Assessing GHG Emissions and Evaluating their Significance (hereafter referred to as the ISEP 2022 GHG Guidance) (ISEP, 2022);
- ISEP Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation (hereafter referred to as the ISEP 2020 EIA Guide) (ISEP, 2020a);
- ISEP GHG Management Hierarchy (hereafter referred to as the ISEP 2020 GHG Management Hierarchy) (ISEP, 2020b);
- ISEP Principles Series: Climate Change Mitigation & EIA (ISEP, 2010);
- Carbon Management in Infrastructure and Built Environment - PAS 2080 (BSI, 2023);
- Technical Guidance on the Climate Proofing of Infrastructure in the Period 2021-2027 (European Commission, 2021a) (hereafter referred to as “the EU technical guidance”); and
- Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment ((European Commission, 2013).

In addition to specific climate guidance documents, the following guidelines were adhered to in the preparation of this chapter:

- Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (hereafter referred to as the EPA Guidelines) (Environmental Protection Agency, 2022); and
- Environmental Impact Assessment of Projects – Guidance on the Preparation of the Environmental Impact Assessment Report (hereafter referred to as the EU Guidance) (European Commission, 2017).

15.2.1.2 Legislation

In 2015, the Climate Action and Low Carbon Development Act 2015 (No. 46 of 2015) (Government of Ireland, 2015) was enacted (the 2015 Act). The purpose of the 2015 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*” (section 3(1)). This is referred to in the 2015 Act as the “national transition objective”. The 2015 Act made provision for a national mitigation plan and a national adaptation framework. In addition, the 2015 Act provided for the establishment of the Climate Change Advisory Council, with the function to advise and make recommendations on the preparation of the national mitigation and adaptation plans and compliance with existing climate obligations.

The first Climate Action Plan (CAP) was published by the Irish Government in June 2019 (Government of Ireland, 2019). The CAP 2019 outlined the current status of key sectors including Electricity, Transport, Built Environment, Industry, and Agriculture, and outlined the various broadscale measures required for each sector to achieve ambitious decarbonisation targets. The CAP 2019 also detailed the required governance arrangements for implementation, including carbon-proofing of policies, establishment of carbon budgets, a strengthened Climate Change Advisory Council, and greater accountability to the Oireachtas. The Government published the second CAP in November 2021 (Government of Ireland, 2021a) with further updated CAPs in December 2022 (Government of Ireland, 2022) and December 2023 (DECC, 2023a). The fifth and most recent CAP, was published in April 2025 (Government of Ireland, 2025).

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 (Government of Ireland, 2021) (hereafter referred to as the 2021 Climate Act) was enacted on 23 July 2021, giving statutory effect to the core objectives stated within the CAP.

The 2021 Climate Act provides 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 also 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*".

In relation to carbon budgets, the 2015 Act (as amended) states "*A carbon budget, consistent with furthering the achievement of the national climate objective, shall be proposed by the Climate Change Advisory Council, finalised by the Minister and approved by the Government for the period of 5 years commencing on the 1 January 2021 and ending on 31 December 2025 and for each subsequent period of 5 years (in this Act referred to as a 'budget period')*". The carbon budget is to be produced for three sequential budget periods, as shown in Table 0.1. The carbon budget can be revised where new obligations are imposed under the law of the European Union or international agreements or where there are significant developments in scientific knowledge in relation to climate change. In relation to the sectoral emissions ceilings, the Minister for the Environment, Climate and Communications (the Minister for the Environment) shall prepare and submit to government the maximum amount of GHG emissions that are permitted in different sectors of the economy during a budget period, and different ceilings may apply to different sectors. The sectorial emission ceilings for 2030 were published in CAP24 (DECC, 2023a) and are shown in

Table 0.2.

Table 0.1 5-Year Carbon Budgets

Budget Period	Carbon Budget	Reduction Required
2021-2025	295 Mt CO_2e	Reduction in emissions of 4.8% per annum for the first budget period.
2026-2030	200 Mt CO_2e	Reduction in emissions of 8.3% per annum for the second budget period.
2031-2035	151 Mt CO_2e	Reduction in emissions of 3.5% per annum for the third provisional budget.

Table 0.2 Sectoral Emissions Ceilings 2030

Sector	Baseline ($MtCO_2e$)	Carbon Budgets ($MtCO_2e$)		2030 Emissions ($MtCO_2e$)	Indicative Emissions % Reduction in Final Year of 2025 – 2030 Period (Compared to 2018)
	2018	2021-2025	2026-2030		
Electricity	10	40	20	3	75
Transport	12	54	37	6	50
Built Environment – Residential	7	29	23	4	40
Built Environment – Commercial	2	7	5	1	45

Sector	Baseline ($MtCO_2e$)	Carbon Budgets ($MtCO_2e$)		2030 Emissions ($MtCO_2e$)	Indicative Emissions % Reduction in Final Year of 2025 – 2030 Period (Compared to 2018)
	2018	2021-2025	2026-2030		
Industry	7	30	24	4	35
Agriculture	23	106	96	17.25	25
Other (F-gases, waste, petroleum refining)	2	9	8	1	50
Land Use, Land-use Change and Forestry (LULUCF)	5	Reflecting the continued volatility for LULUCF baseline emissions to 2030 and beyond, CAP24 puts in place ambitious activity targets for the sector reflecting an EU-type approach.			
Total	68				
Unallocated Savings	-	-	26	-5.25	-
Legally Binding Carbon Budgets and 2030 Emission Reduction Targets	-	295	200	-	51

15.2.1.3 Policy

Greenhouse Gas Policy

In 2024, the Government published its Long-Term Strategy on Greenhouse Gas Emissions Reductions (DECC, 2024). This strategy provides a long-term plan on how Ireland will transition towards net zero by 2050, achieving the interim targets set out in the CAP.

In December 2023, CAP24 was published, establishing key actions to deliver a 51% reduction in GHG emissions by 2030 (compared to 2018 levels) and achieve climate neutrality by 2050 (DECC, 2023a). The updated and current CAP25, published in April 2025, builds on the progress of the previous four iterations of the CAP, with CAP23 first publishing carbon budgets and sectoral emission ceilings, and reaffirms Ireland's climate ambition, with a focus on delivery, implementation and measurable outcomes, particularly ahead of the second carbon budget period (2026–2030). 2025 is the last year in the first 5-year carbon budget period. During the initial 5-year budget period the average annual reduction required was 4.8%, this increases to 8.3% in the second budget period (2026-2030). CAP25 retains the high-impact sectors where the biggest savings can be achieved, while emphasising public sector leadership and green procurement. These sectors include renewable energy, energy efficiency of buildings, transport, sustainable farming, sustainable business and land-use change.

CAP25 also includes targeted actions to decarbonise industrial heat and support the transition to carbon-neutral manufacturing processes. Public sector leadership is strengthened through a new Buying Greener: Green Public Procurement Strategy and Action Plan 2024–2027 (Government of Ireland, 2024), the development of mandatory Climate Action Roadmaps, and enhanced emissions monitoring and reporting across government operations. To support innovation and ensure future economic resilience, IDA Ireland continues to attract and support businesses investing in climate technologies and low-carbon solutions.

CAP25 highlights a significant 17% reduction in electricity emissions in early 2024, with wind power supplying nearly 40% of Ireland's total electricity demand and over 100,000 rooftop microgenerators connected to the grid. Investments are ongoing in grid reinforcement, offshore wind development, and interconnectors with France and the UK to enhance renewable generation capacity. EirGrid, Enterprise Ireland and IDA Ireland have recently signed an MoU to collectively support offshore wind development in Ireland.

CAP25 also reinforces targets first outlined in CAP24 to reduce the embodied carbon of construction materials, with a 10% reduction by 2025 and 30% reduction by 2030 for materials produced and used in Ireland. Cement and high embodied carbon construction materials can be reduced through product substitution, reduced clinker content in cement and uptake of low-carbon construction methods, including those outlined in the Construction Industry Federation 2021 report Modern Methods of Construction (Construction Industry Federation, 2021). There also remains scope for the construction industry to use more timber in construction. In 2022, 24% of new construction in Ireland was built using timber frames to satisfy the demand for housing. Public bodies are now required under the Public Sector Mandate (Appendix 1 of CAP25) (Government of Ireland, 2025) to use best practice project design to reduce embodied carbon; procure concretes with clinker replacements (lower carbon); and require that large construction projects produce a whole life cycle GHG emissions assessment.

Furthermore, CAP25 advances sector-specific measures in green procurement, electrification of transport and heat, and just transition (with the introduction of a Just Transition Commission) to support vulnerable communities. Transport emissions increased by 0.3% in 2023. Electric vehicles and the use of biofuels are stated as the best means of transport emission reductions in the medium term.

The Limerick City and County Council Climate Action Plan 2024–2029 (LCCC, 2024) outlines the council's strategic approach to climate mitigation and adaptation, aiming to reduce greenhouse gas (GHG) emissions by 51% by 2030 (from a 2018 baseline) and to achieve climate neutrality by 2050. The plan is structured around a place-based approach, aligning with national and EU climate objectives, and is designed to support a just transition for communities across Limerick.

The plan is built on five key thematic areas:

- Buildings and Energy;
- Transport;
- Environment and Nature-Based Solutions;
- Flood Resilience and
- Circular Economy and Resource Management.

According to its Climate Action Plan, LCCC's Strategic Vision is – "*A Green City Region on the Waterfront By 2030, Limerick will become a green City region on the Shannon Estuary connected through people and places. This will be achieved through engagement, innovation, resilient urban development and self-sustaining rural communities*".

The LCCC's Energy Management Team will lead efforts to reduce emissions from its own operations. Initiatives such as BusConnects Limerick and expanded cycling infrastructure are central to reducing transport-related emissions.

The Environment section promotes nature-based solutions, green infrastructure, and biodiversity enhancement. Actions include tree planting, habitat restoration, and the integration of green spaces into urban planning.

Flood Resilience is addressed through measures such as Sustainable Drainage Systems (SuDS), improved stormwater management, and alignment with the Catchment Flood Risk Assessment and Management (CFRAM) programme. These actions aim to reduce the impact of pluvial and fluvial flooding, which are identified as key risks for Limerick.

The Circular Economy and Resource Management theme focuses on waste reduction, sustainable procurement, and community-led environmental initiatives. The Council aims to embed circular economy principles across its operations and support local businesses and communities in doing the same.

The plan also includes a Climate Change Risk Assessment, which identifies key hazards for Limerick, including increased frequency of heavy rainfall, flooding, heatwaves, and droughts.

A Decarbonisation Zone (DZ) has been designated in Limerick City, where targeted actions will be implemented to demonstrate low-carbon living and innovation. This zone will serve as a model for replication across the county.

Community engagement is a cornerstone of the plan, with the Community Climate Action Programme supporting local initiatives and building climate literacy. The Council also commits to working with regional partners, including the Atlantic Seaboard South Climate Action Region, to share knowledge and resources.

The plan is supported by a robust implementation and monitoring framework, including Key Performance Indicators (KPIs), annual reporting, and alignment with national funding streams. Strategic Environmental Assessment (SEA) and Appropriate Assessment (AA) processes were undertaken to ensure environmental compliance.

Climate Change Vulnerability Policy

The second National Adaptation Framework (NAF) (DECC, 2024) was published in June 2024, in line with the five-year requirement of the 2015 Act, as amended. The plan provides a whole of government and society approach to climate adaptation in Ireland to reduce Irelands' vulnerability to climate change risks including extreme weather events, flooding, drought, loss of biodiversity, sea level rise and increased temperatures. Similar to the *"Just Transition"* when considering carbon emissions, the NAF aims for *"Just Resilience"* stating that:

"A climate resilient Ireland will have a reduced reliance on fossil fuel, it will have widely accessible electrified public transport and will have transitioned towards sustainable agricultural practices such as agroforestry and organic farming."

In relation to the built environment, the NAF states *"buildings are highly exposed to climate change and can be severely impacted. Planning can have a significant contribution to increasing the resilience of the built environment".* Within the NAF it mentions that there is a risk of damage to buildings and

structures from severe weather events such as high winds and intense rainfall. New development should accommodate predicted future climate change impacts without requiring major redesign or redevelopment in the future, which may be costly and inefficient. This will require facilitating innovative building design, new materials and standards (to accommodate hotter summers while withstanding changes in precipitation patterns and more intense storms for example).

The National Climate Change Risk Assessment (NCCRA), published by the EPA (EPA, 2025c), was required to be developed under Action 457 from the 2021 CAP (Government of Ireland, 2021). Action 457 seeks to "*Further develop Ireland's national climate change risk assessment capacity to identify the priority physical risks of climate change to Ireland*". The NCCRA uses definitions of the risk determinants from the Intergovernmental Panel on Climate Change (IPCC) Risk Framework (IPCC 2023):

- **Hazard** – the potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.
- **Exposure** – the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.
- **Vulnerability** – the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity.
- **Risk** – the potential for adverse consequences for human or ecological systems.

When considering risk, the NCCRA assesses exposure and vulnerability for two future climate change scenarios or Representative Concentration Pathways (RCPs):

- RCP4.5 was selected as it represents a scenario aligned with the global temperature trajectory.
- RCP8.5 was selected as it represents a high-emissions scenario and achieves the highest level of modelled temperature increases by the end of the century. Consequently, this scenario will result in the highest level of physical risk for Ireland, and therefore the greatest requirement for adaptation.

These scenarios align with a conservative approach to the assessment of risks to Ireland and assume that global emission reduction targets are not met. This aligns with the Precautionary principle as stated in the NAF (DECC 2024). In addition to the future climate scenarios, the NCCRA assesses the risk from the future climate during the following timeframes:

- Present (~2030);
- Medium term (~2050); and
- Long term (~2100).

The LCCC (LCCC,2024), highlights the risks that climate change poses, with risks mainly associated with extreme weather events. The future risks of climate change hazards as identified and reproduced from the LCC Climate Action Plan 2024 – 2029 (LCCC,2024) are shown in Figure 0-1.

The risk matrix on the right shows the future change in risk with the hollow marker showing the current risk and the solid marker the future risk. The dotted line shows the change between the current and future risk.

The risk of existing hazards such as river, pluvial, and coastal flooding and coastal erosion is projected to increase in the future because of projected increases in the frequency of heavy precipitation events, rising sea levels and associated increases in inundation extent and depth. Heatwaves and droughts, although already experienced in Limerick City and County, are expected to occur more frequently due to climate change and with a greater impact on Limerick City and County in the future. These hazards can therefore be considered as resulting in emerging risks for the region. Although the frequency and impact of severe windstorms is thought to be unchanged in the future, these events will remain a risk for Limerick City and County. The level of impact associated with cold spells for Limerick City and County remains constant, however, due to the potential decrease in hazard frequency, the overall risk of these hazards is likely to reduce in the future, resulting in a lesser risk.

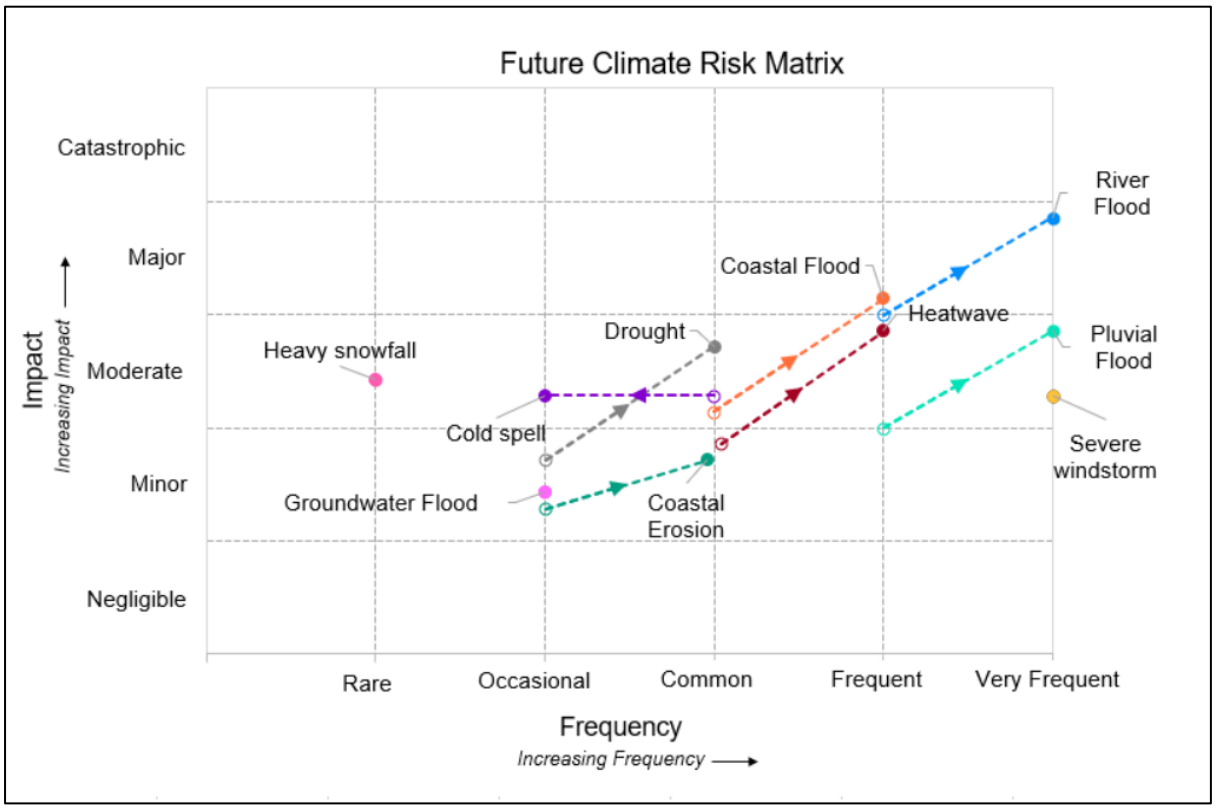


Figure 0-1 Assessment of Future Climate Hazards and in Limerick City and County (LCCC,2024)

15.2.2 Greenhouse Gas Assessment

As per the EU guidance document *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment* (European Commission, 2013) the climate baseline is first established with reference to EPA data on annual GHG emissions (see Section 15.3.1).

15.2.2.1 Construction Phase

The GHG assessment accounts for various components relating to the project during different life stages to determine the total impact of the development on climate. The reference study period (i.e. the assumed building life expectancy) for the purposes of the assessment is 60 years. Embodied carbon emissions are attributed to four main categories, taken from BS EN 15978 (British Standards Institution, 2011). The categories are:

- **Product Stages (Category A1 to A3)** The carbon emissions generated at this stage arise from extracting the raw materials from the ground, their transport to a point of manufacture and then the primary energy used (and the associated carbon impacts that arise) from transforming the raw materials into construction products.
- **Construction (Category A4 to A5)** These carbon impacts arise from transporting the construction products to site, and their subsequent processing and assembly into the building.
- **Use Stage (Category B1 to B7)** This covers a wide range of sources from the GHG emissions associated with the operation of the building (B1), maintenance (B2), repair (B3), refurbishment (B4) and replacement (B5) of materials, and operational energy use (B6) and water use (B7).
- **End of Life Stages (Category C1 to C4)** The eventual deconstruction and disposal of the existing building at the end of its life takes account of the on-site activities of the demolition contractors. No “credit” is taken for any future carbon benefit associated with the reuse or recycling of a material into new products.

PE-ENV-01104 (TII, 2022a) recommends the calculation of the construction stage embodied carbon using the TII Online Carbon Tool (TII, 2024a). Embodied carbon refers to the sum of the carbon needed to produce a good or service. It incorporates the energy needed in the mining or processing of raw materials, the manufacturing of products and the delivery of these products to site. The purpose of the embodied carbon assessment is to engage the design team in the consideration of embodied carbon at an early stage in the development and mitigate embodied carbon. This engagement aims to ensure carbon savings are made and to assist in aligning the project to Ireland’s CAP goal of Net Carbon Zero by 2050. TII also state that the use of other, alternative carbon tools is permissible for developments.

The TII Online Carbon Tool (TII, 2024) has been commissioned by TII to assess GHG emissions associated with road or rail projects in Ireland. The TII Carbon Tool (TII, 2024) uses emission factors from recognised sources including the Civil Engineering Standard Method of Measurement (CESSM) Carbon and Price Book database (CESSM, 2013), which can be applied to a variety of developments, not just road or rail. The tool aligns with PAS 2080.

For the building elements of the proposed development, the OneClick LCA 3D Designer tool was utilised. OneClick LCA is certified to EN 15978, EN 15978, ISO 21931 – 1 & ISO 21929, and data requirements of ISO 14040 & EN 15804, and is LEED, BREEAM and PAS 2080 aligned. It allows users to assess the carbon impact of buildings at various stages of design. The tool includes a detailed product and material list based on Irish materials as well as materials from the UK and Europe. The One Click LCA 3D Designer option allows for a high-level assessment of the embodied carbon impact of a development at early design stages when specific detailed design information is not known and based on professional judgement is considered suitable for the purpose of this assessment.

Inputs into the tool include gross floor areas for the building types (houses/duplexes/apartments), building frame type, number of above ground floors and building size and shape. The tool then makes necessary default assumptions based on these parameters and a typical build-up with the option to refine the default assumptions where project specific information is available. The tool allows for optioneering and optimization of the carbon impact, it highlights the key areas within the building with the highest carbon impact and provides options for lower carbon intensive materials.

The TII Carbon Tool was utilised to estimate the GHG emissions associated with the non-building elements of the proposed development including construction activities, land clearance activities and construction wastes.

Reasonable conservative estimates have been used in this assessment where necessary to provide an estimate of the GHGs associated with the proposed development.

15.2.2.2 Operational Phase

Traffic Emissions

Emissions from road traffic associated with the proposed development have the potential to emit carbon dioxide (CO_2) which will impact climate.

The TII guidance *Air Quality Assessment of Specified Infrastructure Projects – PE-ENV-01106* (TII, 2022b), 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 local air quality assessment, and also the climate assessment:

- Annual average daily traffic (AADT) changes by 1,000 or more;
- Heavy duty vehicle (HDV) AADT changes by 200 or more;
- Daily average speed change by 10 kph or more;
- Peak hour speed change by 20 kph or more;
- A change in road alignment by 5 m or greater.

While the guidance is specific to infrastructure projects the approach can be applied to any development that causes a change in traffic. Chapter 14 Air Quality and Chapter 18 Material Assets Traffic and Transport discuss the impact of operational traffic associated with the proposed development. The proposed development will not result in operational phase traffic increasing by more than 1000 AADT or 200 HDV AADT. Additionally, there is no proposed change to the road alignment or traffic speeds. As such, a detailed assessment of operational phase traffic emissions was scoped out as there is no potential for significant impacts to climate.

Operational Phase Energy Use

The EU Guidance (European Commission, 2013) also states that indirect GHG emissions resulting from the development must be considered, which include emissions associated with energy usage. An Energy Statement was prepared by Arup in relation to the proposed development. This document is submitted separately with this planning application. The report outlines a number of measures which have been incorporated into the overall design of the development, which will reduce the impact to climate during the operational phase.

15.2.2.3 Significance Criteria for GHGA

The Transport Infrastructure Ireland (TII) guidance document entitled *PE-ENV-01104 Climate Guidance for National Roads, Light Rail and Rural Cycleways (Offline & Greenways) – Overarching Technical Document* (TII, 2022a) outlines a recommended approach for determining the significance to climate of both the construction and operational phases of a development.

The significance of GHG effects set out in PE-ENV-01104 (TII, 2022a) is based on ISEP guidance (ISEP, 2022), which is consistent with the terminology contained within Figure 3.4 of the EPA Guidelines (EPA, 2022).

The 2022 ISEP Guidance (ISEP, 2022) sets out the following principles for significance:

- When evaluating significance, all new GHG emissions contribute to a negative environmental impact; however, 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 its lifetime, which may be positive, negative or negligible.
- Where GHG emissions cannot be avoided, the goal of the EIA process should be to reduce the project's residual emissions at all stages.
- Where GHG emissions remain significant, but cannot be further reduced, approaches to compensate the project's remaining emissions should be considered.

Determining the significance of effects is a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors (i.e. Ireland's National GHG targets or National Climate Objective). In relation to climate, there is no project specific assessment criteria, but the project will be assessed against the recommended TII significance determination. This takes account of any embedded or committed mitigation measures that form part of the design which should be considered. TII (TII 2022a) states that professional judgement must be taken into account when contextualising and assessing the significance of a project's GHG impact. In line with ISEP Guidance (ISEP, 2022), TII state that the crux of assessing significance is:
"*not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050".*

Significance is determined using the criteria outlined in Table 0.3 (derived from Table 6.7 of PE-ENV-01104 (TII 2022a) along with consideration of the following two factors:

- The extent to which the trajectory of GHG emissions from the project aligns with Ireland's GHG trajectory to net zero by 2050; and
- The level of mitigation taking place.

Table 0.3 Significance Criteria for GHGA

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 provided 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 has 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 • 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.

Ireland's carbon budgets can also be used to contextualise the magnitude of GHG emissions from the proposed development (TII, 2022a). The approach is based on comparing the net proposed development GHG emissions to the relevant carbon budgets (DECC, 2023a). With the publication of the Climate Action Act in 2021 and CAP24 and CAP25, sectoral carbon budgets have been published for comparison with the net GHG emissions from the proposed development over its lifespan. The aim of the carbon budgets is to ensure Ireland is on a trajectory to meet the National Climate Objective of Net Zero by 2050.

15.2.3 Climate Change Risk Assessment

The Climate Change Risk Assessment (CCRA) involves determining the vulnerability of the proposed development to climate change. This requires an analysis of the sensitivity and exposure of the development to climate hazards which together provide a measure of vulnerability.

PE-ENV-01104 (TII, 2022a) states that the CCRA is guided by the principles set out in the overarching best practice guidance documents:

- Technical Guidance on the Climate Proofing of Infrastructure in the Period 2021-2027 (European Commission, 2021a); and

- The ISEP, Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation (2nd Edition) (ISEP, 2020).

The baseline environment information provided in Section 0, future climate change modelling, and input from other experts working on the proposed development (i.e. hydrologists) should be used to assess the likelihood of a climate risk.

First, an initial screening CCRA based on the operational phase is carried out, according to the TII guidance PE-ENV-01104. This is carried out by determining the sensitivity of proposed development assets (i.e. receptors) and their exposure to climate change hazards.

The proposed development asset categories must be assigned a level of sensitivity to climate hazards. PE-ENV-01104 (TII, 2022a) provides the list of asset categories and climate hazards to be considered. The asset categories will vary for development type and need to be determined on a development by development basis.

- **Asset Categories** Pavements; drainage; structures; utilities; landscaping; signs; light posts; buildings; and fences.
- **Climate Hazards** Flooding (coastal, pluvial, fluvial); extreme heat; extreme cold; wildfire; drought; extreme wind; lightning and hail; landslides; fog.

The sensitivity is based on a High, Medium or Low rating with a score of 1 to 3 assigned as per the criteria below.

- **High Sensitivity** The climate hazard will or is likely to have a major impact on the asset category. This is a sensitivity score of 3.
- **Medium Sensitivity** It is possible or likely the climate hazard will have a moderate impact on the asset category. This is a sensitivity score of 2**.**
- **Low Sensitivity** It is possible the climate hazard will have a low or negligible impact on the asset category. This is a sensitivity score of 1.

Once the sensitivities have been identified the exposure analysis is undertaken. The exposure analysis involves determining the level of exposure of each climate hazard at the project location irrespective of the project type. For example, flooding could be a risk if the project location is next to a river in a floodplain. Exposure is assigned a level of High, Medium or Low as per the below criteria.

- **High Exposure** It is almost certain or likely this climate hazard will occur at the project location, i.e. might arise once to several times per year. This is an exposure score of 3.
- **Medium Exposure** It is possible this climate hazard will occur at the project location, i.e. might arise a number of times in a decade. This is an exposure score of 2.
- **Low Exposure** It is unlikely or rare this climate hazard will occur at the project location, i.e. might arise a number of times in a generation or in a lifetime. This is an exposure score of 1.

Once the sensitivity and exposure are categorised, a vulnerability analysis is conducted by multiplying the sensitivity and exposure to calculate the vulnerability.

15.2.3.1 Significance Criteria for CCRA

The CCRA involves an initial screening assessment to determine the vulnerability of the proposed development to various climate hazards. The vulnerability is determined by combining the sensitivity and the exposure of the proposed development to various climate hazards.

Vulnerability = Sensitivity x Exposure

The vulnerability assessment takes any proposed mitigation into account. Table 0.4 details the vulnerability matrix; vulnerabilities are scored on a high, medium and low scale.

TII guidance (TII, 2022a) and the EU technical guidance (European Commission, 2021a) note that if all vulnerabilities are ranked as low in a justified manner, no detailed climate risk assessment may be needed. Therefore, the impact from climate change on the proposed development can be considered to be not significant.

However, where residual medium or high vulnerabilities exist the assessment may need to be progressed to a detailed climate change risk assessment and further mitigation implemented to reduce risks. An assessment of construction phase CCRA impacts is only required according to the TII guidance (TII, 2022a) if a detailed CCRA is required.

The screening CCRA, detailed in Section 15.5.2, did not identify any residual medium or high risks to the proposed development as a result of climate change. Therefore, a detailed CCRA for the construction and operational phase were scoped out.

While a CCRA for the construction phase was not required, best practice mitigation against climate hazards is still recommended in Section 15.5.2.

Table 0.4 Vulnerability Matrix

		Exposure		
		High (3)	Medium (2)	Low (1)
Sensitivity	**High (3)**	9 - High	6 - High	3 - Medium
	Medium (2)	6 - High	4 - Medium	2 - Low
	Low (1)	3 - Medium	2 - Low	1 - Low

15.2.3 Difficulties Encountered During Preparation of This Chapter

There were no difficulties encountered when compiling this assessment.

15.3 EXISTING RECEIVING ENVIRONMENT

The receiving environment in terms of climate is the same for the proposed development and overall masterplan development. Therefore, the following sections detail the existing climate environment and do not differentiate between the overall cumulative masterplan development or the proposed development.

PE-ENV-01104 (TII, 2022a) 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.

Ireland declared a climate and biodiversity emergency in May 2019 and in November 2019 there was European Parliament approval of a resolution declaring a climate and environment emergency in Europe. This, in addition to Ireland's current failure to meet its EU binding targets under Regulation 2018/842 (European Union, 2018) results in changes in GHG emissions either beneficial or adverse being of more significance than previously considered prior to these declarations.

Climate impacts are assessed at a national level and in relation to national targets and sectoral emission ceilings. The study area for climate is the Republic of Ireland and the baseline is determined in relation to this study area.

15.3.1 Current GHG Baseline

Data published in July 2025 (EPA, 2025a), indicates that Ireland exceeded, without the use of flexibilities, its 2024 annual limit set under EU's Effort Sharing Decision (ESD) (EU 2018/842) by 1.03 $MtCO_2e$. However, the 2024 emissions represent the second consecutive year in which Ireland's emission were below (-4.2%) 1990 levels. ETS (Emissions Trading Scheme) emissions decreased (-7.4%) and ESR (Effort Sharing Regulation) emissions decreased (-0.5%). Ireland's target is an emission reduction of 626 kt of CO_2e by 2030 on an average baseline of 2016 to 2018.

The EPA estimate that 2024 total national GHG emissions, excluding LULUCF, have decreased by 2.0% on 2023 levels to 53.75 Mt CO_2e, with a 0.7 Mt CO_2e (-8.9%) reduction in electricity industries alone. This was driven by a 39.6% share of energy from renewables in 2024 and the complete phase-out of peat for electricity generation. Manufacturing combustion and industrial processes decreased by 4.6% to 6.0 Mt CO_2e in 2024 due to declines in fossil fuel usage. The sector with the highest emissions in 2024 was agriculture at 38% of the total, followed by transport at 21.7%. For 2024, total national emissions (including LULUCF) were 57.64 Mt CO_2e (EPA, 2025a) (Table 14.6).

The current estimates of National greenhouse gas emissions (including LULUCF) in 2024 are 12.0% below 2018, well off the National Climate ambition of a 51% reduction by 2030. The data indicate that from 2021- 2024 Ireland has used 82.5% of the 295 Mt CO_2e Carbon Budget for the five-year period 2021-2025. This leaves 17.5% of the budget available for 2025, requiring a substantial 10.3% annual emissions reduction for 2025 to stay within budget.

Table 0.5 Trends in Total National GHG Emissions 2021 – 2024

Sector *Note 1*	2021	2022	2023	2024	Total Budget (Mt CO_2e) (2021-2025)	% Budget 2021-2025 Used	Annual Change 2023 to 2024
Electricity	9.893	9.694	7.558	6.95	40	85.25%	-8.19%
Transport	11.089	11.760	11.791	11.65	54	85.74%	-1.27%
Buildings (Residential)	6.868	5.753	5.346	5.61	29	81.31%	4.86%
Buildings (Commercial and Public)	1.444	1.447	1.409	1.49	7	82.43%	7.19%
Industry	7.093	6.622	6.288	6.01	30	86.77%	-4.75%

Sector *Note 1*	2021	2022	2023	2024	Total Budget (Mt CO_2e) (2021-2025)	% Budget 2021-2025 Used	Annual Change 2023 to 2024
Agriculture	21.940	21.795	20.782	20.41	106	80.05%	-1.50%
Other *Note 2*	1.864	1.931	1.832	1.63	9	80.33%	-9.94%
LULUCF	4.628	3.983	5.614	3.89	–	–	0
Total including LULUCF	64.819	62.986	60.620	57.64	295	82.81%	-2.04%

Note 1 Reproduced from latest emissions data on the EPA July 2025 (EPA, 2025).
Note 2 Other includes Petroleum refining, F-Gases and Waste (emissions from solid waste disposal on land, solid waste treatment (composting and anaerobic digestion), wastewater treatment, waste incineration and open burning of waste).

15.3.2 Future GHG Baseline

The future baseline with respect to the GHGA can be considered in relation to the future climate targets which the assessment results will be compared against. In line with TII (TII, 2022a) and ISEP Guidance (ISEP, 2022) the future baseline is a trajectory towards net zero by 2050, "*whether it* [the project] *contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050*".

The future baseline will be determined by Ireland meeting its targets set out in the CAP25, and future CAPs, alongside binding 2030 EU targets. The European Union (EU) enacted *'Regulation (EU) 2018/842 on binding annual GHG 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'* (hereafter referred to as the Regulation) (European Union, 2018) to meet the commitments under the Paris Agreement. The Regulation aims to deliver, collectively by the EU in the most cost-effective manner possible, reductions in GHG emissions from the Emission Trading Scheme (ETS) and non-ETS sectors amounting to 43% and 30%, respectively, by 2030 compared to 2005. The Regulation was amended in April 2023 and Ireland must now limit its ETS and non-ETS greenhouse gas emissions by at least 42% by 2030. The ETS is an EU-wide scheme which regulates the GHG emissions of larger industrial emitters including electricity generation, cement manufacturing and heavy industry. The non-ETS sector includes all domestic GHG emitters which do not fall under the ETS scheme and includes GHG emissions from transport, residential and commercial buildings and agriculture.

In May 2025, the EPA released the report Ireland's Greenhouse Gas Emissions Projections 2024-2055 (EPA, 2025), which includes total projected emissions and a breakdown of projected emissions per sector under the 'With Existing Measures' and 'With Additional Measures' scenarios. The EPA projections indicate that currently implemented measures (With Existing Measures) will achieve a reduction of 10% on 2005 levels by 2030, significantly short of the 42% reduction target. If measures in the higher ambition (With Additional Measures) scenario are implemented, EPA projections show that Ireland can achieve a reduction of 22% by 2030, still short of the 42% reduction target.

15.3.3 Current CCRA Baseline

The region of the proposed development has a temperate, oceanic climate, resulting in mild winters and cool summers. The Met Éireann weather station at Shannon Airport is the nearest, representative, weather and climate monitoring station to the proposed development with historical regional meteorological data recorded for the 30-year period from 1991 to 2020. The data for the 30-year period from 1991 to 2020 indicates that the wettest months at Shannon Airport Metrological Station were January, October and December, and the driest month on average was May (Met Éireann, 2025a). July was the warmest month with a mean temperature of 16 Celsius. January was the coldest month with a mean temperature of 6.1 Celsius.

Met Éireann's 2023 Climate Statement (Met Éireann, 2024a) states 2023's average shaded air temperature in Ireland is provisionally 11.20°C, which is 1.65°C above the 1961-1990 long-term average. Before this, 2022 was the warmest year on record; however, 2023 was 0.38°C warmer (see Figure 0-2).

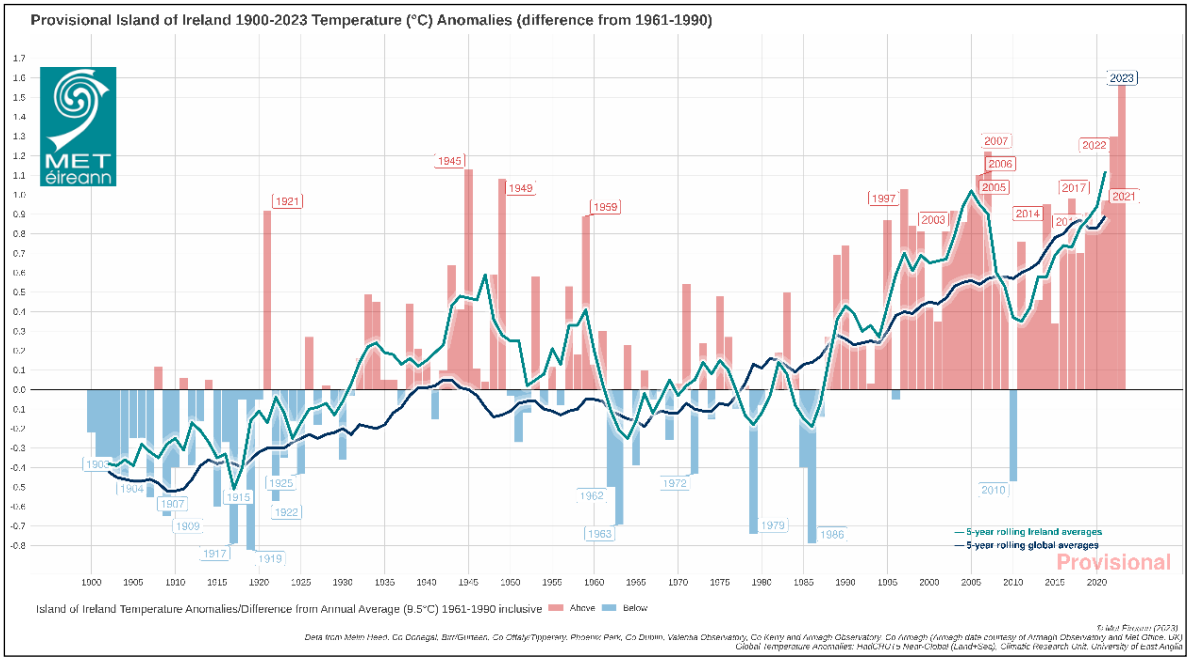


Figure 0-2 1900-2023 Temperature (°C) Temperature Anomalies (differences from 1961-1990)

2023 also had above average rainfall, this included the warmest June on record and the wettest March and July on record. Record high sea surface temperatures (SST) were recorded since April 2023 which included a severe marine heatwave to the west of Ireland during the June 2023. This marine heatwave contributed to the record rainfall in July.

Met Éireann's 2024 *Climate Statement* (Met Éireann 2025b) states 2024's average shaded air temperature in Ireland is provisionally 10.72°C, which is 1.17°C above the 1961-1990 long-term average or 0.55°C above the most recent 1991-2020 long-term average. This is the 4th warmest year on record with 2023 breaking previous records. Seven of the top ten warmest years have occurred since 2005. Record high sea surface temperatures (SST) were recorded in 2022, and in 2024 continued at or near record high levels. 2024 was overall drier than average, however there were many instances of heavy or intense rainfall which led to flooding events. This trend is predicted to continue with climate

change with an increase in both dry periods and heavy rainfall events. Considering the extraordinary data, Met Éireann states that the latest Irish climate change projections indicate further warming in the future, including warmer winters. The record temperatures mean the likelihood of extreme weather events occurring has increased. This will result in longer dry periods, heavy rainfall events, storm surges and coastal flooding due to sea level rise. Compound events, where coastal surges and extreme rainfall events occur simultaneously will also increase. Met Éireann has high confidence in maximum rainfall rates increasing but not in how the frequency or intensity of storms will change with climate change.

15.3.4 Future CCRA Baseline

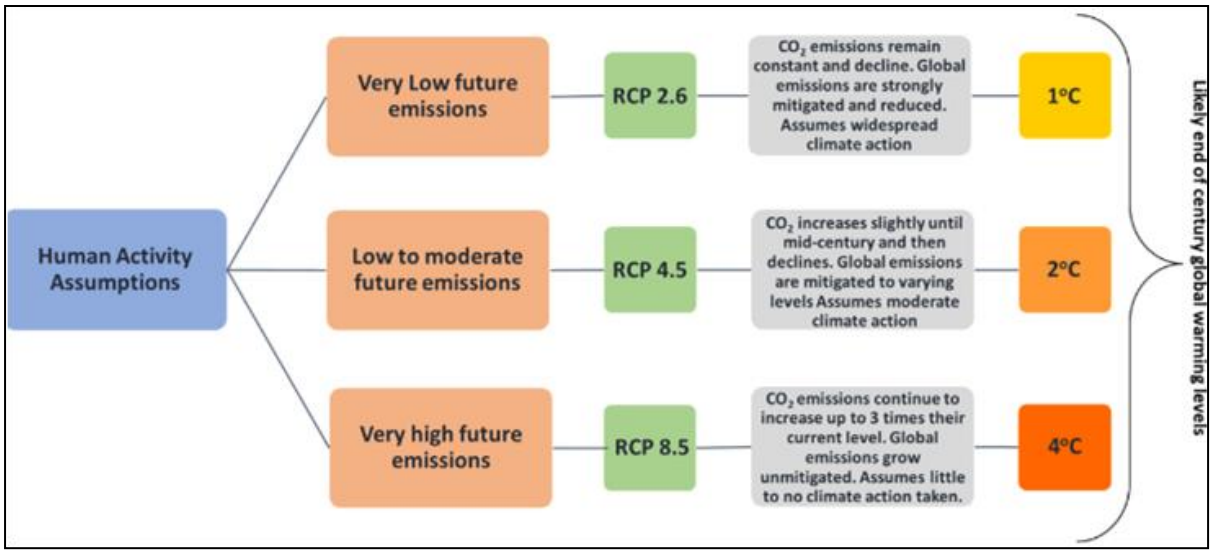
Impacts as a result of climate change will evolve with a changing future baseline. Changes have the potential to include increases in global temperatures and increases in the number of rainfall days per year. Therefore, it is expected that the baseline climate will evolve over time and consideration has been made with respect to this within the design of the proposed development.

Ireland has seen increases in 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, 2021b). The EPA have 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 (EPA, 2021b):

- 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.

TII's Guidance document PE-ENV-01104 (TII 2022a) states that for future climate change a moderate to high Representative Concentration Pathways (RCP) should be adopted. RPC4.5 is considered moderate, while RPC8.5 is considered high. Representative Concentration Pathways (RCPs) describe different 21st century pathways of GHG emissions depending on the level of climate mitigation action undertaken.

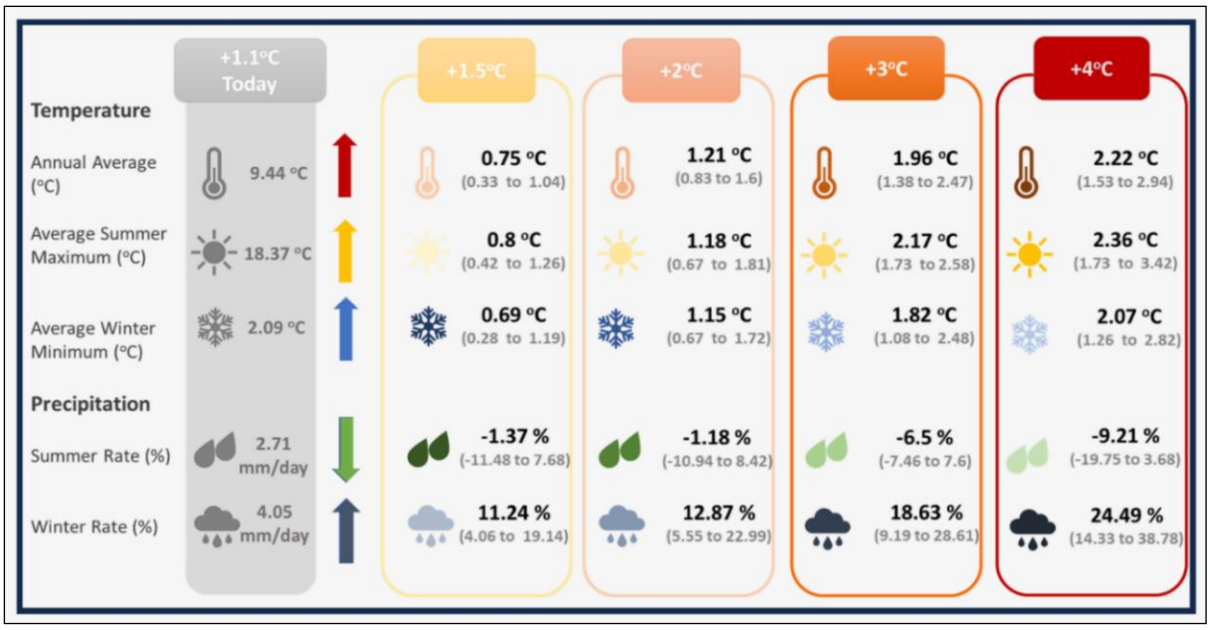
National Framework for Climate Services (NFCS) was founded in June 2022 to streamline the provision of climate services in Ireland and will be led by Met Éireann. The aim of the NFCS is to enable the co-production, delivery and use of accurate, actionable and accessible climate information and tools to support climate resilience planning and decision making. In addition to the NFCS, further work has been ongoing into climate projects in Ireland through research under the TRANSLATE project. TRANSLATE (Met Éireann, 2023b) has been led by climate researchers from University of Galway – Irish Centre for High End Computing (ICHEC), and University College Cork – SFI Research Centre for Energy, Climate and Marine (MaREI), supported by Met Éireann climatologists. TRANSLATE's outputs are produced using a selection of internationally reviewed and accepted models from both CORDEX and CMIP5. Representative Concentration Pathways (RCPs) provide a broad range of possible futures based on assumptions of human activity. The modelled scenarios include for "least" (RCP2.6), "more" (RCP4.5) or "most" (RCP8.5) climate change, see Figure 0-3.



Source: TRANSLATE project storymap (Met Éireann 2023)

Figure 0-3 Representative Concentration Pathways associated emission levels

TRANSLATE (Met Éireann, 2023b) provides the first standardised and bias-corrected national climate projections for Ireland to aid climate risk decision making across multiple sectors (for example, transport, energy, water), by providing information on how Ireland's climate could change as global temperatures increase to 1.5˚C, 2˚C, 2.5˚C, 3˚C or 4˚C. Projections broadly agree with previous projections for Ireland. Ireland's climate is dominated by the Atlantic Meridional Overturning Circulation (AMOC), a large system of ocean currents – including the Gulf Stream – characterised by a northward flow of warm water and a southward flow of cold water. Due to the AMOC, Ireland does not suffer from the extremes of temperature experienced by other countries at a similar latitude. Recent studies have projected that the AMOC could decline by 30 – 40 % by 2100, resulting in cooler North Atlantic Sea surface temperatures (SSTs) (Met Éireann, 2023b). Met Éireann projects that Ireland will nevertheless continue to warm, although the AMOC cooling influence may lead to reduced warming compared with continental Europe. AMOC weakening is also expected to lead to additional sea level rise around Ireland. With climate change Ireland's temperature and rainfall will undergo more and more significant changes e.g. on average summer temperature could increase by more than 2°C, summer rainfall could decrease by 9% while winter rainfall could increase by 24% (See Figure 0-4). Future projects also include a 10-fold increase in the frequency of summer nights (values > 15°C) by the end of the century, a decrease in the frequency of cold winter nights and an increase in the number of heatwaves. A heatwave in Ireland is defined as a period of 5 consecutive days where the daily maximum temperature is greater than 25°C.



Source: TRANSLATE project storymap (Met Éireann, 2023b)

Figure 0-4 Change of climate variables for Ireland for different global warming thresholds

The TRANSLATE research report (Met Éireann 2024d) finds that night-time temperatures will warm more than day-time temperatures, with temperature increases across all seasons but the highest in the summer (with an increase of 0.5°C to 3.5°C). Autumn is projected to have the highest increase in average minimum temperatures (with an increase of 1.1°C to 4.4°C). The variance is dependent on the scenario that is being reviewed. While these temperatures are projected across all of Ireland, they increase most in the east of the country compared to the west. With respect to rainfall, increases of 4% to 38% are projected, however this will not be spread across the year as during summer months there are projected decreases in rainfall beyond the 2°C warming scenario.

In January 2024, the EPA published *Ireland's Climate Change Assessment Synthesis Report* (EPA, 2024c) which contained four volumes:

- Volume 1: Climate Science: Ireland in a Changing World
- Volume 2: Achieving Climate Neutrality by 2050
- Volume 3: Being Prepared for Ireland's Future Climate
- Volume 4: Realising the Benefits of Transition and Transformation

This report reinforces the existing and future risks arising from climate change. Volume 1 (EPA, 2024c) states that under the 'early action' scenario, the temperature increase averaged across the island of Ireland relative to the recent past (1976 to 2005) would reach 0.91°C (0.44 to 1.10°C) by mid-century before falling back to 0.80°C (0.34 to 1.07°C) at the end of the century. Whereas under the 'late action' scenario, by the end of the century it is projected that the temperature increases could be 2.77°C (2.02 to 3.49°C). Heat extremes will become more frequent and more severe and cold extremes will become less frequent and less severe with further warming.

Precipitation was 7% higher over the period 1991 to 2020 than over the 1961 to 1990 period. The average future predicted increase in precipitation is <10% in annual mean accumulated. By 2100 projected additional rises in sea level range from 0.32 to 0.6m under early action to 0.63 to 1.01m under late action scenarios, with greater storm surges potentially effecting critical infrastructure along the

coastline. Projections of changes in storminess are highly uncertain and translate into large uncertainties in future frequency and intensity of extreme waves.

Volume 3 (EPA, 2024c) discusses how water supplies will face growing pressures resulting in increased water demand and how options need to be developed, including potential new sources. The report states the key role of critical infrastructure for delivering public services, economic development and a sustainable environment. This critical infrastructure is exposed to a range of climate extremes. Failures in critical infrastructure can cascade across other sectors and present a multi-sector risk due to climate change.

The report references the EPA's *Critical Infrastructure Vulnerability to Climate Change* report (EPA, 2021a) as the most substantial research project in Ireland to date on climate change and critical infrastructure which assesses the future performance of Ireland's critical infrastructure when climate is considered. The Critical Infrastructure Vulnerability to Climate Change report states with respect to water availability and quality, that flood risk and heatwaves have a medium vulnerability index and the underground supply network has a high vulnerability to snowstorms and cold spells. However, while the vulnerability is high, the exposure is likely to reduce due to future climate change resulting in less cold weather events. The risk assessment highlights the co-dependence of the water sector to the energy sector, and how vulnerability in the energy sector may have cascading impacts.

Volume 4 (EPA, 2024c) calls for system change, including a transformation of urban settings. It states that, meaningful urban transformation can create a better living environment while simultaneously reducing emissions.

The projections were echoed by the *Updated High-resolution Climate Projections for Ireland Research Report: 471* (EPA, 2024d) which was in broad agreement with previous research. The future autumn and winter months are projected to be up to 10% wetter, while summer is projected to be up to 8% drier.

15.4 CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

The proposed development will provide a mixed-use development including residential units, student accommodation, commercial spaces and a creche; public realm works; mobility hub and all associated site development works. A full description of the development is available in Chapter 2 (Description of the Proposed Development).

15.4.1 Construction Stage

During the construction stage the main source of climate impacts will be as a result of GHG emissions and embodied carbon associated with the proposed demolition activities, construction materials and construction activities for the proposed development.

15.4.2 Operational Stage

During the operational phase vehicle emissions from traffic accessing the site have the potential to release CO_2 and other GHGs which will impact climate. In addition, operational energy use will result in

GHG emissions. The vulnerability of the proposed development in relation to future climate change must also be considered during the operational phase.

15.5 LIKELIHOOD OF SIGNIFICANT EFFECTS

15.5.1 Greenhouse Gas Assessment

15.5.1.1 Construction Phase

The most significant proportion of GHG emissions tends to occur during the construction phase as a result of embodied carbon in construction materials and emissions from construction activities. Therefore, the assessment has been included in the construction phase assessment for the purposes of the EIAR. The assessment is broken down into the following stages as per Section 15.2.2.1:

- Product stage (A1 – A3);
- Transportation to site (A4);
- Site operations (demolition and construction activities) (A5); and
- Material replacement and refurbishment (B4 – B5).

The construction phase GHG emissions comprise stages A1 – A5, which include the demolition activities, construction materials, the transport of the materials to site, and the construction activities or site operations. Ongoing material refurbishment and replacement throughout the lifetime of the development is included within category B4 – B5; these are default values based on the typical maintenance requirements for the chosen material types over the assumed 60-year lifetime.

The carbon assessment highlights the areas where the highest embodied carbon emissions occur, specifically as a result of building materials based on a typical build-up for the building type (house; duplex; apartment, etc.).

The GHG emissions from the development as a total cannot be compared against one specific sector 2030 carbon budget. The emissions are broken down into different assessment categories and these must be compared separately to the relevant sectoral emissions budgets, which are detailed in

Table 0.2. The relevant sectoral emissions for the proposed development comparison include the Industry sector, Transport sector, and Waste sector. The predicted emissions for the proposed development are annualised over the assumed 60-year lifespan and then compared to the relevant sector 2030 carbon budgets. Annualising the full carbon emissions over the lifetime of the development allows for appropriate comparison with annual GHG targets.

The results of the GHGA are shown in Table 0.6. This includes both the outputs from the OneClick LCA tool and the TII Carbon Tool. Construction materials make up the majority of GHG emissions for the proposed development, accounting for approximately 64% of the total construction phase GHG emissions. Material replacement makes up the second highest contribution at 23% of the total. Material transport, construction activities and waste make up the remainder of the construction GHG emissions. Efforts to reduce the quantity of the materials used or swap them for lower carbon alternatives will impact on the carbon footprint of the units. The houses will be built from timber frames, and it is important to highlight that although the timber framework forms a significant part of the structural skeleton of the house units; it is not as carbon intensive as other materials. Both the Climate Change

Advisory Council (CCAC) and National Climate Action Plan advise for the use of timber framed buildings as a construction method. Timber frames have the additional benefit of having absorbed carbon from the atmosphere during their growth and providing a long-term carbon sink during their lifetime in the building.

It has been calculated that the total construction phase embodied carbon (including maintenance and replacement of materials over the development lifetime) will be 35,827 tonnes CO_2e (seeTable 0.6).

Table 0.6 GHG Assessment Results

Stage	GHG Assessment Category	Predicted GHG Emissions (tCO_2e)	Predicted GHG Emissions as % of Project Total	Relevant Sector for Carbon Budget Comparison
A1-A3	Materials	23,105	64%	Industry
A4	Material Transport	328	1%	Transport
A5	Site Clearance and Demolition	1.5	0.00004%	Industry
	Land Use Change and Vegetation Loss	29	0.08%	LULUCF
	Excavations	153	0.4%	Industry
	Construction site material waste	39	0.1%	Waste
	Construction site material waste transport	12	0.03%	Transport
	Construction site waste	3,035	8.5%	Waste
B4 - B5	Maintenance Material	8,308	23%	Industry
	Maintenance Material Transport	17	0.05%	Transport
	Maintenance Material Waste	799	2.2%	Waste
Total		**35,827**		

15.5.1.2 Construction Phase GHGA Summary

Figure 0-5 shows the GHG emissions for the proposed development per life-cycle stage based on the output from the OneClick LCA 3D Designer tool and the TII Carbon Tool combined.

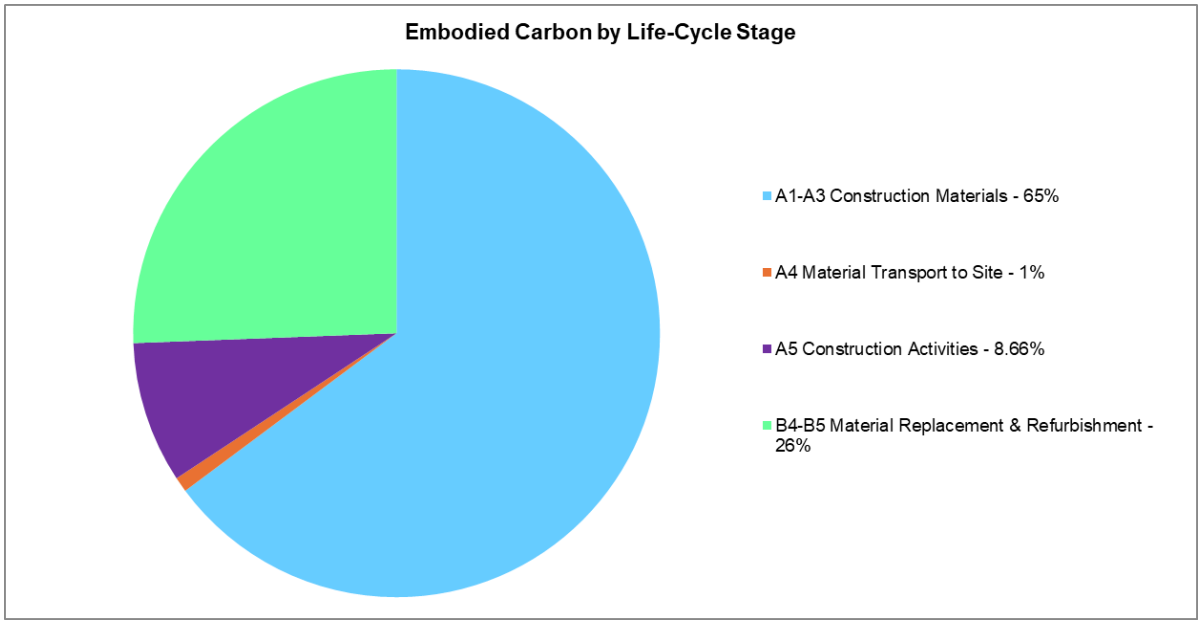


Figure 0-5 Embodied Carbon by Life-Cycle Stage

The total predicted GHG emissions (as shown in Table 0.6) can be averaged over the full lifespan of the proposed development to give the predicted annual emissions to allow for direct comparison with national annual emissions and targets.

In Table 0.7, GHG emissions have been compared against the carbon budget for the industry, transport, and waste sectors in 2030 (DECC, 2024), against Ireland's total GHG emissions in 2024, and against Ireland's EU 2030 target of a 42% reduction in non-ETS sector emissions based on 2005 levels (27.7 Mt CO_2e) (set out in Regulation EU 2018/842).

The estimated total GHG emissions, when annualised over the 60-year proposed development lifespan, are equivalent to 0.001% of Ireland's total GHG emissions in 2024 and 0.002% of Ireland's non-ETS 2030 emissions target. The estimated GHG emissions associated with transport-related activities are 0.0001% of the 2030 Transport budget, construction waste GHG emissions are 0.006% of the Waste budget, industry-related activities are 0.01% of the 2030 Industry budget.

Table 0.7 Estimated GHG Emissions Relative to Sectoral Budgets and GHG Baseline

Target/Sectoral Budget (tCO_2e)		Annualised Development GHG Emissions (tCO_2e)		% of Relevant Target/Budget
Ireland's 2024 Total GHG Emissions (existing baseline)	57,640,000	597	Total GHG Emissions	0.001%
Non-ETS 2030 Target	27,722,000	597	Total GHG Emissions	0.002%
2030 Sectoral Budget (Industry Sector)	4,000,000	526	Total Industry Emissions	0.01%
2030 Sectoral Budget (Transport Sector)	6,000,000	6	Total Transport Emissions	0.0001%
2030 Sectoral Budget (Waste Sector)	1,000,000	65	Total Waste Emissions	0.006%

15.5.1.3 Operational Phase

Operational Energy Usage

The proposed development has been designed to reduce the impact to climate where possible. A number of measures have been incorporated into the design to ensure the operational phase emissions are minimised. The primary measures with respect to reducing climate impacts and optimising energy usage are summarised in Section 15.7.2 and are based on information provided within the Energy Statement prepared as a part of this planning application.

Operational Traffic Emissions

There is the potential for increased traffic volumes to impact climate during the operational phase. The traffic associated with the proposed development will not increase substantially and is below the TII assessment criteria (see Section 0). A detailed assessment of traffic related CO_2 emissions was scoped out as a result and there is no potential for significant impacts to climate from traffic emissions relating to the proposed development.

15.5.1.4 GHGA Significance of Effects

The TII guidance states that the following two factors should be considered when determining significance:

- The extent to which the trajectory of GHG emissions from the project aligns with Ireland's GHG trajectory to net zero by 2050; and
- The level of mitigation taking place.

The level of mitigation described in Section 15.6 has been taken into account when determining the significance of the proposed development's GHG emissions. The proposed development has mitigated its GHG impacts to the greatest extent possible and is in line with national legislation and policy regarding climate change. According to the TII significance criteria described in Section 15.2.2.3 and Table 0.3, the significance of the GHG emissions during the construction and operational phase is minor adverse.

In accordance with the EPA Guidelines (EPA, 2022), the above significance "minor adverse" equates to a significance of effect of GHG emissions during the construction and operational phase which is ***direct, long-term, negative*** and ***slight***, which is overall ***not significant***.

15.5.2 Climate Change Risk Assessment

15.5.2.1 Construction Stage

A detailed CCRA of the construction phase has been scoped out on the basis that there are no residual medium or high-risk vulnerabilities to climate change hazards. However, consideration has been given to the proposed development's vulnerability to the following climate change hazards, with best practice mitigation measures proposed in Section 15.7.1:

- Flood Risk due to increased precipitation, and intense periods of rainfall. This includes fluvial and pluvial flooding;
- Increased temperatures potentially causing drought, wildfires and prolonged periods of hot weather;
- Reduced temperatures resulting in ice or snow; and
- Major Storm Damage including wind damage.

15.5.2.2 Operational Phase

The sensitivity and exposure of the development to various climate hazards must first be determined to then determine the vulnerability of the proposed development to climate change. Flooding (coastal, pluvial, fluvial), extreme heat, extreme cold, wildfire, drought, extreme wind, lightning, hail, landslides and fog are considered as climate hazards in the context of the proposed development.

The sensitivity of the proposed development to the climate hazards is assessed irrespective of the project location. Table 0.8 details the sensitivity of the proposed development on a scale of high (3), medium (2) and low (1). Once the sensitivity has been established the exposure of the proposed development to each of the climate hazards is determined, this is the likelihood of the climate hazard occurring at the project location and is also scored on a scale of high (3), medium (2) and low (1). The product of the sensitivity and exposure is then used to determine the overall vulnerability of the

proposed development to each of the climate hazards as per Table 0.4. The results of the vulnerability assessment are detailed in Table 0.8.

Table 0.8 Climate Change Vulnerability Assessment

Climate Hazard	Sensitivity	Exposure	Vulnerability
Flooding (Coastal, Pluvial, Fluvial)	1 (Low)	2 (Medium)	2 (Low)
Extreme Heat	1 (Low)	2 (Medium)	2 (Low)
Extreme Cold	1 (Low)	2 (Medium)	2 (Low)
Wildfire	1 (Low)	1 (Low)	1 (Low)
Drought	1 (Low)	1 (Low)	1 (Low)
Extreme Wind	1 (Low)	1 (Low)	1 (Low)
Lightning & Hail	1 (Low)	1 (Low)	1 (Low)
Landslides	1 (Low)	1 (Low)	1 (Low)
Fog	1 (Low)	1 (Low)	1 (Low)

The sensitivity and exposure of the area was determined with reference to a number of online tools and with input from the various discipline specialists on the project team, as described in Section 15.2.3. It was concluded that the proposed development does not have any significant vulnerabilities to the identified climate hazards as described in the below sections. All vulnerabilities are classified as low.

Flooding

A Flood Risk Assessment (FRA) was undertaken by ARUP and is submitted separately as part of this planning application. This document was reviewed to inform the climate change vulnerability assessment and assess the potential for flooding at the proposed development site.

The proposed development is located in areas at high, moderate, or low risk of flooding (Flood Zones A, B and C, respectively) (Section 3.5 of Flood Risk Assessment). The Shipyard Site and part of the Infiltration Galleries lie in Flood Zone A (high risk), parts of the Quarry Site lie in Flood Zone B (moderate risk) and the rest (majority) of the site lies in Flood Zone C (low risk). In summary the The Cleeves site is currently at risk of flooding from the following sources:

- Tidal flood risk: Shipyard Site and Quarry Site are at risk of flooding during the 1 in 200-year flood event, Flax Mill site could be at risk of flooding in the future, when climate change allowances for sea level rise are considered.
- Pluvial flood risk: The Quarry site, Salesian Site and Stonetown Terrace could potentially be at risk from overland flows from the upper catchment.
- Groundwater flood risk: There is low risk of groundwater flooding.
- Reservoir flood risk: An inlet flap valve has been identified with a potential to allow water ingress from the river to the Quarry Site.

However, as per Section 4 and Section 5 of the Flood Risk Assessment, the following measures relating to flood risk management, applied for the masterplan study, will ensure flood risk is manged to an acceptable level:

- Flood risk areas are avoided where possible;
- Highly vulnerable uses such as residential development are in areas at lower risk (Flood Zone C) or raised to a higher level. Residential uses are primarily proposed within the Salesian and

Stonetown Terrace sites. Where residential development is proposed in areas at risk of tidal flooding (O'Callaghan Strand, Quarry site), the development will be raised above flood levels and sleeping accommodation will be located on higher floors. Flood protection levels across the site have taken into consideration the High End Future Scenario (HEFS), which equates to an additional 30% future rainfall, and an allowance of 1m has been applied to the highly vulnerable elements of the development.

- Safe access and egress for emergency vehicles are provided to all buildings; and
- Finished floor levels are raised above the flood protection level with an allowance for climate change where possible. Raising of levels shall be considered in conjunction with compliance with the Building Regulations for access for all, economics of the development, aesthetics, and practical design.

It can be concluded that overall, with the incorporation of the above mitigation measures (detailed in full in the accompanying FRA), the proposed development has low vulnerability to flood risk.

Extreme Wind, Fog, Lightning & Hail

In relation to extreme winds, buildings as part of the proposed development shall be designed to the appropriate standards to account for the relevant wind loadings events for RCP4.5 and RCP8.5. If required as part of the building design, lightning protection shall be provided for. Hail and fog are not predicted to significantly affect the building due to its design.

It can be concluded that overall, the proposed development has low vulnerability to extreme wind, fog, lightning and hail.

Wildfires

In relation to wildfires, the *Think Hazard!* tool developed by the Global Facility for Disaster Reduction and Recovery (GFDRR, 2025), indicates that the wildfire hazard is classified as medium for the Limerick area. This means that there is between a 10% to 50% chance of experiencing weather that could support a hazardous wildfire that may poses some risk to life and property loss in any given year. Future climate modelling indicates that there could be an increase in the weather conditions which are favourable to fire conditions. These include increases in temperature and prolonged dry periods. However, due to the project location in a built-up, urban area the risk of wildfire is significantly lessened, and it can be concluded that the proposed development is of low vulnerability to wildfires.

Landslides

The Geological Society of Ireland (GSI) landslide susceptibility mapping database (GSI, 2025) was reviewed to inform the risk from landslides at the proposed development. There have not been any historical landslide events in the vicinity of the proposed development, and the area is of low susceptibility to future landslides. Therefore, the vulnerability of the proposed development to landslides is classed as low.

Extreme Temperatures (Heat & Cold) & Drought

Extreme temperatures, both extreme heat and extreme cold, have the potential to impact the building materials and some related infrastructure and potentially landscape planting. However, the building materials selected at the detailed design will take into consideration the likely future temperature ranges

Ireland will experience under RCP4.5 and RCP8.5 up to 2100. Therefore, extreme temperatures are not considered a significant risk.

Throughout detailed design phase, the architects will be using guidance documents to inform with design detail decisions including the EU Commission *Technical Guidance on Adapting Buildings to Climate Change* (European Commission (2021a), LETI emergency design guide (LETI, 2020), and the latest available IPCC report. In addition, should updated EuroCodes be published prior to completion of detailed design, which will include consideration for climate impacts, these design standards will be considered.

Summary
Overall, the proposed development has at most low vulnerabilities to the identified climate hazards. Therefore, no detailed risk assessment is required.

15.5.2.3 CCRA Significance of Effects

With design mitigation in place, there are no significant risks to the proposed development as a result of climate change. In accordance with the EPA Guidelines (EPA, 2022), the significance of effect of the impacts to the proposed development as a result of climate change are ***direct, long-term, negative*** and ***imperceptible***, which is overall ***not significant*** in EIA terms.

15.5.3 Do-Nothing Scenario

In the Do-Nothing scenario, the site will remain as per the baseline and will change in accordance with trends within the wider area (including influences from potential new developments in the surrounding area, changes in road traffic, etc). The Do-Nothing scenario is considered neutral in terms of the climate assessment.

As the site is zoned for development, in the absence of the proposed development it is likely that a development of a similar nature would be constructed in the future in line with national policy and the development plan objectives. Therefore, the construction and operational phase impacts outlined in this assessment are likely to occur in the future even in the absence of the implementation of the proposed development.

15.6 CUMULATIVE IMPACTS

With respect to the requirement for a cumulative assessment with additional developments (which includes permitted elements of the Masterplan) the ISEP (ISEP, 2022) and TII (TII, 2022a) guidance on which the assessment is based states that:

"*The identified receptor for the GHG Assessment is the global climate and impacts on the receptor from a project are not geographically constrained, the normal approach for cumulative assessment in EIA is not considered applicable. By presenting the GHG impact of a project in the context of its alignment to Ireland's trajectory of net zero and any sectoral carbon budgets, this assessment will demonstrate the potential for the project to affect Ireland's ability to meet its national carbon reduction target. This assessment approach is considered to be inherently cumulative*".

The traffic data used for the operational phase assessment included cumulative traffic from existing and permitted developments in the surrounding area as well as the proposed masterplan development. Therefore, this impact assessment is cumulative.

Future phases of the masterplan will be subject to their own assessments in terms of quantification of GHG emissions associated with construction materials and activities. Estimation of these emissions is outside the scope of this cumulative assessment. However, impacts associated with future phases are likely to similar to those identified for this phase of the Masterplan.

As per the above, the cumulative impact of the proposed development in relation to GHG emissions is considered ***direct, long-term, negative*** and ***slight***, which is overall ***not significant*** in EIA terms.

15.7 REMEDIAL & MITIGATION MEASURES

15.7.1 Construction Phase

Embodied carbon of materials and construction activities will be the primary source of climate impacts during the construction phase. In relation to mitigating construction phase GHG emissions, the Circular Economy Statement, Construction and Demolition Resource and Waste Management Plan (CDRWMP) and Chapter 18 Material Assets – Waste Management (submitted as part of the planning application) detail strategies for managing demolition and construction waste and minimising GHG emissions. These are summarised below.

During the construction phase the following best practice measures will be implemented on site to prevent significant GHG emissions and reduce impacts to climate:

- On-site or delivery vehicles will not leave engines idle, even for short periods.
- All plant and machinery will be well maintained and inspected regularly.
- Minimising waste of materials due to poor timing or over ordering on site will minimise the embodied carbon footprint of the site.
- The CDRWMP provides a detailed breakdown of the estimated resource and waste arising from the proposed deconstruction and demolition works, and a strategy for the management of these streams (which will minimise demolition and construction waste sent to landfill). Recycling of materials will be promoted to reduce the environmental footprint of the site.
- Sourcing materials locally will be prioritised. This will help to reduce transport related CO_2 emissions and helps support local suppliers, further promoting economic sustainability.
- Material choices and quantities will be reviewed during detailed design, to identify and implement any lower embodied carbon options, where feasible. For example, a 30% minimum clinker replacement in cement may be utilised in line with the requirements for public bodies (CAP25).
- The Salesians Individual town house units will be built of timber frame. Timber is not as carbon intensive as other materials and is a preferable structural material to traditional concrete blocks. Both the Climate Change Advisory Council (CCAC) and National Climate Action Plan advise for the use of timber framed buildings as a construction method. Timber frames have the

additional benefit of having absorbed carbon from the atmosphere during their growth and providing a long-term carbon sink during their lifetime in the building.

In terms of impact on the proposed development due to climate change, during construction the Contractor will be required to mitigate against the effects of extreme rainfall/flooding through site risk assessments and method statements. The Contractor will also be required to mitigate against the effects of extreme wind/storms, temperature extremes through site risk assessments and method statements. All materials used during construction will be accompanied by certified datasheets which will set out the limiting operating temperatures. Temperatures can affect the performance of some materials, and this will require consideration during construction. During construction, the Contractor will be required to mitigate against the effects of fog, lighting and hail through site risk assessments and method statements.

15.7.2 Operational Stage

A number of mitigation measures have been incorporated into the design of the development to reduce the impact on climate wherever possible. An Energy Statement was prepared by ARUP in relation to the proposed development.

The Energy Statement in relation to proposed development states that the development will be a Nearly Zero Energy Building (NZEB) in accordance with the requirements of Part L f the Second Schedule to the Building Regulations as inserted by the European Union (Energy Performance of Buildings) Regulations (S.I. No. 292 of 2019 and S.I. No. 393 of 2021), the European Union (District Heating) Regulations 2022 (S.I. No. 534 of 2022) and the Building Regulations (Part L Amendment) Regulations 2022 (S.I. No. 535 of 2022).

The development has been designed to reduce operational energy demand where possible. The development has also been designed to the Home Performance Index (HPI) Gold Standard, developed by the Irish Green Building Council. This certification is Ireland's national certification for new homes, specifically designed for residential development and aligns to Irish building regulations, EU CEN standards and international WELL certification for communities. HPI is also aligned with the EU Sustainable Finance Taxonomy and also with Level(s), the new EU sustainable buildings assessment and reporting framework, and is independently assessed, awarding certificates for the standard of a home's design, construction and environmental sustainability. HPI certification is based on over 30 verifiable indicators in five categories, with mandatory requirements are set in the most important areas, such as water efficiency, ventilation, thermal bridging, and enhanced airtightness.

The following outlines the primary elements included in the development for the residential dwellings based on the Energy Statement prepared by ARUP:

- The residential apartment units are expected to achieve A2 Building Energy Ratings (BERs), and the townhouses are projected to achieve A1 BERs, demonstrating strong operational energy efficiency in line with the NZEB and Part L requirements;
- Heat exchanger efficiency of 80%;
- Achieve air tightness standards of 1 $m^3/m^2/hr$;
- Ensure thermal bridging details are design to achieve thermal bridging factor of 0.04 W/m^2K;
- Install Air Source Heat Pumps to meet NZEB requirement;

- Install PV panels for apartments ensuring landlord areas meet renewable contribution requirements; and
- The energy strategy includes the deployment of renewable energy technologies, such as a photovoltaic (PV) panel array, alongside high-efficiency heat recovery and heat pumps for heating. These measures contribute to a low-carbon energy profile, enhancing overall sustainability.

The above measures will assist in optimising the energy consumed by the development and will also have the benefit of reducing the impact to climate during the operational phase of the development.

Some measures have been incorporated into the design of the development to mitigate the impacts of future climate change. The following is a summary of measures (detailed in full in Section 5 of the Flood Risk Assessment) which have been incorporated into the design to avoid potential flooding impacts due to increased rainfall events in future years:

- Flood risk areas are avoided where possible,
- Highly vulnerable uses such as residential development are in areas at lower risk (Flood Zone C) or raised to a higher level. Residential uses are primarily proposed within the Salesian and Stonetown Terrace sites. Where residential development is proposed in areas at risk of tidal flooding (O'Callaghan Strand, Quarry site), the development will be raised above flood levels and sleeping accommodation will be located on higher floors. Flood protection levels across the site have taken into consideration the High End Future Scenario (HEFS), which equates to an additional 30% future rainfall, and an allowance of 1m has been applied to the highly vulnerable elements of the development;
- Safe access and egress for emergency vehicles are provided to all buildings; and
- Finished floor levels are raised above the flood protection level with an allowance for climate change where possible. Raising of levels shall be considered in conjunction with compliance with the Building Regulations for access for all, economics of the development, aesthetics, and practical design.

These measures have been considered when assessing the vulnerability of the proposed development to climate change (see Section 15.5.2).

15.8 RESIDUAL IMPACTS

15.8.1 Proposed Development

The impact to climate as a result of a proposed development must be assessed as a whole for all phases. The proposed development will result in some impacts to climate through the release of GHGs. TII reference the ISEP guidance which states that the crux of assessing significance is "*not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050*". The proposed development has proposed some best practice mitigation measures and is committing to reducing climate impacts where feasible and will continue to investigate further measures during detailed design. According to the TII significance criteria described in Section 15.2.2.3 and Table 0.3, the significance of the GHG emissions during the construction and operational

phase is minor adverse. The proposed development aligns with the following GHG significance criteria as per Table 0.3:

- 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.

As per the assessment criteria in Table 0.3, the residual impact of the proposed development in relation to GHG emissions is considered ***direct, long-term, negative*** and ***slight***, which is overall ***not significant*** in EIA terms.

In relation to climate change vulnerability, it has been assessed that there are no significant risks to the proposed development as a result of climate change. The residual effect of climate change on the proposed development is considered ***direct, long-term, negative*** and ***imperceptible***, which is overall ***not significant*** in EIA terms.

15.8.2 Cumulative

With respect to the requirement for a cumulative assessment the ISEP (ISEP, 2022) and TII (TII, 2022a) guidance on which the assessment is based states that:
"*the identified receptor for the GHG Assessment is the global climate and impacts on the receptor from a project are not geographically constrained, the normal approach for cumulative assessment in EIA is not considered applicable. By presenting the GHG impact of a project in the context of its alignment to Ireland's trajectory of net zero and any sectoral carbon budgets, this assessment will demonstrate the potential for the project to affect Ireland's ability to meet its national carbon reduction target. This assessment approach is considered to be inherently cumulative*".

As per the above, the cumulative impact of the proposed development in relation to GHG emissions is considered ***direct, long-term, negative*** and ***slight***, which is overall ***not significant*** in EIA terms.

15.9 WORST CASE SCENARIO

Conservative assumptions have been made throughout the assessment. Specifically, as part of the GHG assessment, where specific materials were not available conservative equivalent material types were used instead. Additionally, in places, where exact material types were not known for the GHG assessment, the standard average material was assumed which can have a higher embodied carbon associated with it. Therefore, the assessment has been conservative in nature and a precautionary approach was taken for this assessment.

15.10 MONITORING

Monitoring and reporting of the embodied carbon in the construction phase will be conducted. The aim of monitoring will be to seek further ways to minimise climate impacts. Monitoring will include contractual obligations, in line with the most recent Climate Action Plan and sectoral targets, for the successful tenderer to ensure that the proposed development stays in line with updated aims. Commitments to monitor GHG emissions during the construction phase will also be secured through the Construction

Environmental Management Plan (CEMP). Monitoring will include embodied carbon of construction materials, water usage, power and fuel usage, and waste generation (including reuse and recycling rates). If, monitoring shows that the proposed development is not meeting its targets, further mitigation will be put in place.

Monitoring will also include reviewing potential for extreme weather events which may cause damage during construction. Contractors' Environmental Management System (EMS) will include measures to address risks during such events i.e. flooding.

15.11 REFERENCES

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